January 15, 1998

Bob Wooley, Director
Western Regional Office
340 9th St
Brandon MB

Bob Dubreuil, Director
Petroleum & Energy Branch
360-1395 Ellice Ave

OIL AND GAS OPERATIONS ON WMA'S

Routledge WMA

In June 1997, the Branch after consultation with Natural Resources approved reduced well spacing in Section 29-9-25 (WPM). The operator, Tundra Oil and Gas, had planned to drill 9 additional vertical wells in the section. Five of the wells were located on the WMA and four of the wells were adjacent to the east boundary of the WMA (see Fig. 1).

Tundra has reviewed its development plans and is now proposing to drill one vertical well and two horizontal wells all from the same surface location in the centre of the section (see Fig.1). The two horizontal wells will replace four vertical wells as shown on Fig. 1.

The proposed surface location for the three wells is located on the east boundary of the WMA between four existing wells. The proposed surface location is in hayland adjacent to an existing trail that runs N-S through the section. By locating the wells within the developed area of Section 29, Tundra will minimize the area needed for the wellsite, access road and flowline right-of-way.

Tundra would like to drill the wells as early as February 1998. The current approval includes the condition "no drilling activity is permitted during deer hunting season and in the winter to avoid disturbing/displacing deer from their wintering area". Under what conditions would Natural Resources allow Tundra to drill during the winter? If a white-tailed deer survey is required, what would the survey entail and how much would the survey cost?

If horizontal drilling is successful in the Routledge area, the impact of oil and gas development may be further reduced by reducing the number of wells required and allowing the wells to be located to minimize habitat fragmentation and disturbance.

Please provide the Branch with your comments on Tundra's revised drilling program by January 23, 1998.

Lauder Sandhills WMA

The Branch has leased a number of parcels in the Lauder Sandhills WMA. All Crown oil and gas leases contain the condition that surface access will be restricted in whole or in part and that an approved development plan is required.

In September 1997, Impact Exploration applied to the Branch for a geophysical licence to conduct seismic operations in the Lauder area including portions of the WMA. After discussions with Natural Resources, the company modified its seismic program, deleting over 20 km of seismic lines across the WMA. The company has asked what special considerations have to be addressed in a development plan for exploration in the Lauder Sandhills WMA, in accordance with the guidelines of our joint informational notice. The Branch has not received a response from Natural Resources on this inquiry. I suggest we have a meeting to discuss what oil and gas exploration and development in the Lauder area should involve and what conditions a company should address in a development plan. I will call you next week to discuss this matter.

ORIGINAL SIGNED BY LRD.

Bob Dubreuil

Tundra
oil and gas ltd.

1111 One Lombard Place, Winnipeg, Manitoba R3B 0X4 TEL: (204) 934-5850 FAX: (204) 934-5820

January 6, 1998

Manitoba Energy and Mines
Petroleum & Energy Branch
360 - 1395 Ellice Avenue
Winnipeg, MB R3G 3P2

Attention: **John Fox P. Eng.**
Chief Petroleum Engineer

Dear John:

Re: Routledge Area
TWP 9 RGE 25 WPM: SEC 29

Further to our telephone conversation, we have reviewed our development plans for the Routledge Area. After a good deal of thought, we believe that the best way to proceed with this project is by drilling a vertical well at 7C-29, followed by a horizontal well HZ15C-29 using the same surface location. Should we be successful, we would look at a second horizontal HZ3A-29, again from the same surface location.

There are a number of advantages associated with proceeding in this manner. Firstly, the proposed surface location would be accessed by an existing trail. The surface development would also be in the area currently being used as pasture. The most obvious advantage is that drilling from a single surface location would replace up to five proposed vertical locations. The attached plat shows the approximate size and location of the surface area that would be required.

We would ask that you review this proposal with Natural Resources. As usual, we are prepared to answer any questions or meet with Natural Resources if required. In order to meet the existing time constraints on development Tundra would like to commence this project as early as February, 1998.

Your assistance with this matter and in meeting our proposed timelines is appreciated. If you need anything further, please give me a call.

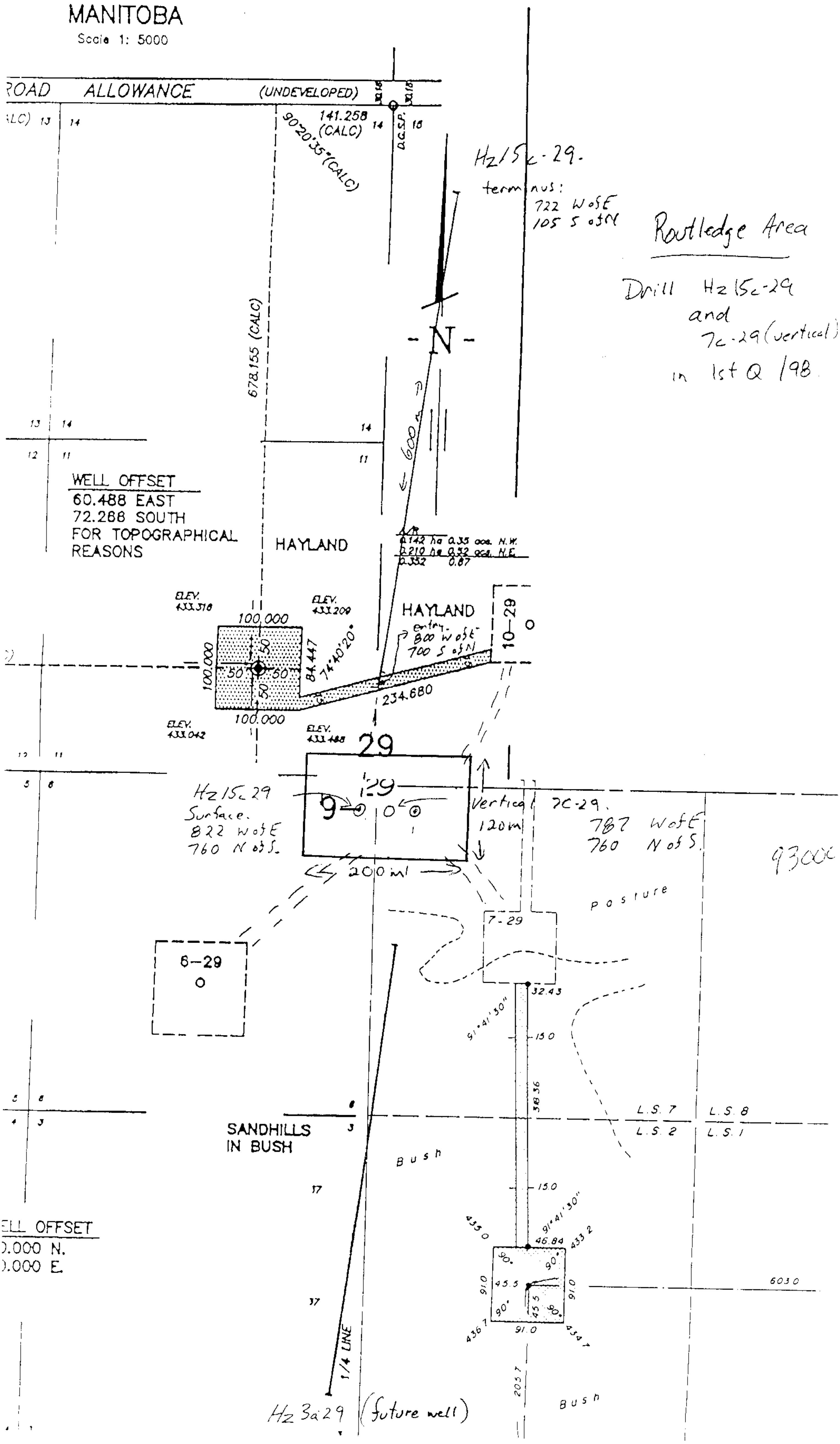
Sincerely,

TUNDRA OIL AND GAS LTD.

Brad Thiessen

Brad Thiessen
Land Manager

BT/ps



MANITOBA
Scale 1: 5000
ROAD ALLOWANCE (UNDEVELOPED)
141.258 (CALC)
90°20'35" (CALC)
678.155 (CALC)
Hz 15c-29.
terminus:
722 W of E
105 S of N
Routledge Area
Drill Hz 15c-29
and
7c-29 (vertical)
in 1st Q /98
N
600 m
WELL OFFSET
60.488 EAST
72.268 SOUTH
FOR TOPOGRAPHICAL
REASONS
HAYLAND
HAYLAND
0.142 ha 0.35 ac. N.W.
0.210 ha 0.52 ac. N.E.
0.352 0.87
entry.
800 W of E
700 S of N
10-29
100.000
84.447
74°40'20"
234.680
29
Hz 15c 29
Surface.
822 W of E
760 N of S.
Vertical 7C-29.
120m
787 W of E
760 N of S.
200 m
93000
pasture
7-29
6-29
SANDHILLS
IN BUSH
Bush
L.S. 7
L.S. 8
L.S. 2
L.S. 1
WELL OFFSET
0.000 N.
0.000 E.
1/4 LINE
Hz 3a 29 (future well)
Bush

Manitoba

Energy and Mines Petroleum

1395 Ellice Avenue Suite 360
Winnipeg MB R3G 3P2
CANADA

PH: (204) 945-6577
Fax: (204) 945-0586

June 6, 1997

Mr. George Czyzewski, P.Eng.
General Manager
Tundra Oil and Gas Ltd.
1111 One Lombard Place
Winnipeg MB R3B 0X4

Dear Mr. Czyzewski:

Re: Spacing Order No. 12 - Reduced 8 ha Spacing Routledge Area

The Petroleum and Energy Branch has completed it's review of the subject application. The Branch received comments from Chevron Canada Resources, the unit operator of Routledge Unit No. 1 and Natural Resources on the application. As a result of discussions with Chevron, the Department of Natural Resources and Tundra the application has been approved in part and subject to certain development conditions, in particular conditions related to activities on the Wildlife Management Area in the W/2 of Section 29-9-25 (WPM).

Attached is Spacing Order No. 12 approving 8 ha spacing in a portion of the area of application. The reduced spacing area has been modified to coincide with lands operated by Tundra and excludes partial 8 ha spacing units that extend into Routledge Unit No. 1. If Phase 1 of the project is commercially successful the Branch would be prepared to consider extending spacing to allow infill drilling adjacent to the unit boundary but would expect Tundra to initiate discussions with Chevron regarding support of and participation in the project.

The Department of Natural Resources expressed concerns that 8 ha spacing on the WMA will result in habitat fragmentation and disturbance, reducing the value of the site for wildlife. In order to minimize infill drilling activity on the WMA, the following locations are to be moved off the WMA:

FROM	TO
3D-29-9-25	2C-29-9-25 or 7B-29-9-25
11A-29-9-25	7C-29-9-25 or 10B-29-9-25
14A-29-9-25	10C-29-9-25 or 15B-29-9-25

Where possible the access roads, flowlines and other facilities associated with these wells are to be located outside the WMA.

Tundra's flora and fauna investigation, November 1996, also identified a number of development conditions to mitigate the impacts of infill drilling. These and other development conditions, listed below, will apply to wells drilled under Spacing Order No. 12:

1) no drilling is permitted during migratory bird nesting season, late-April to mid-July, unless a survey is conducted that confirms no nesting sites are present;

2) the area of disturbance is to be minimized by using existing access roads/trails and flowline rights of way, and reducing the actively used portion of the wellsite;

3) no drilling or construction activities are permitted during wet ground conditions, without the approval of the Department of Natural Resources;

4) where applicable, rehabilitation is to be done using prairie seed mixtures specified by the Department of Natural Resources;

5) no drilling activity is permitted during deer hunting season and in the winter to avoid disturbing/displacing deer from their wintering area; and

6) additional flora and fauna surveys may be required at infill locations on the WMA.

At least 6 months prior to commencing the drilling of Phase 3 infill wells located on the WMA, Tundra is to arrange a meeting with staff from Natural Resources and the Petroleum and Energy Branch to discuss the need for any additional flora and fauna surveys.

If you have any questions in respect of this approval please contact the undersigned at (204) 945-6574.

Yours truly,

John N. Fox, P.Eng.
Chief Petroleum Engineer

cc. Bob Wooley, Director, Western Region
Department of Natural Resources

MINISTERIAL ORDER

SPACING ORDER NO. 12

Pertaining to 8 ha Spacing Units for the Lodgepole Formation in the Virden Lodgepole C Pool - Section 29-9-25 (WPM)

1. The spacing unit for each well drilled, or to be drilled, for the purpose of obtaining oil from the Lodgepole Formation within the area outlined on Schedule A is a square 8 hectares in area, with corners located at the mid-points of the boundaries of each legal subdivision, as illustrated on Schedule A.

2. The target area of each spacing unit shall be an area having sides 65 metres from the sides of the spacing unit and parallel to them.

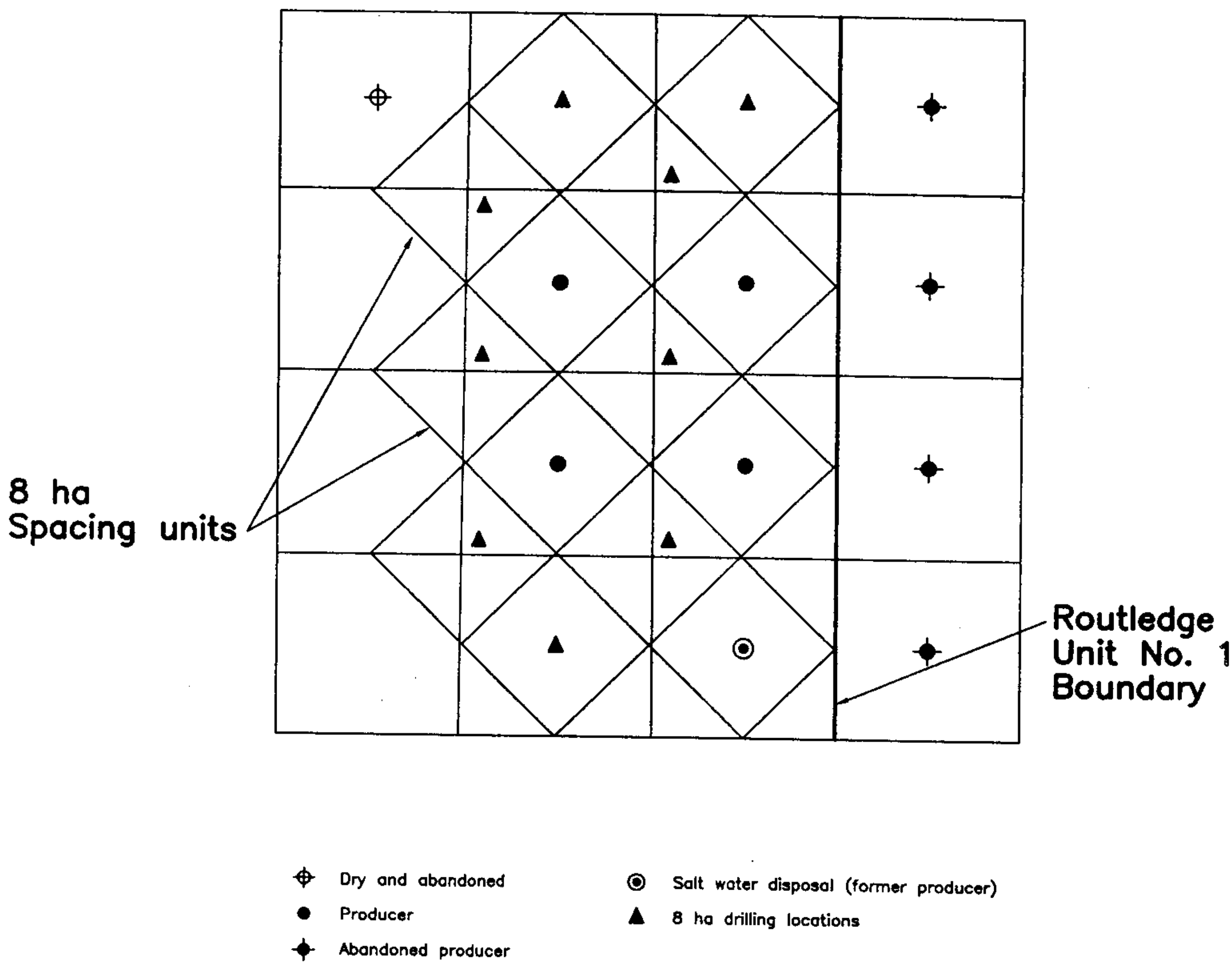
3. Where in the opinion of the Director of Petroleum, the location of an infill well on the Wildlife Management Area in the W/2 of Section 29-9-25 (WPM) might cause significant adverse impact on the environment or significantly impair use of the surrounding land, the Director may refuse to issue a well licence to drill the well.

4. The area outlined on Schedule A may be modified by the Director of Petroleum, from time to time, to meet changing conditions.

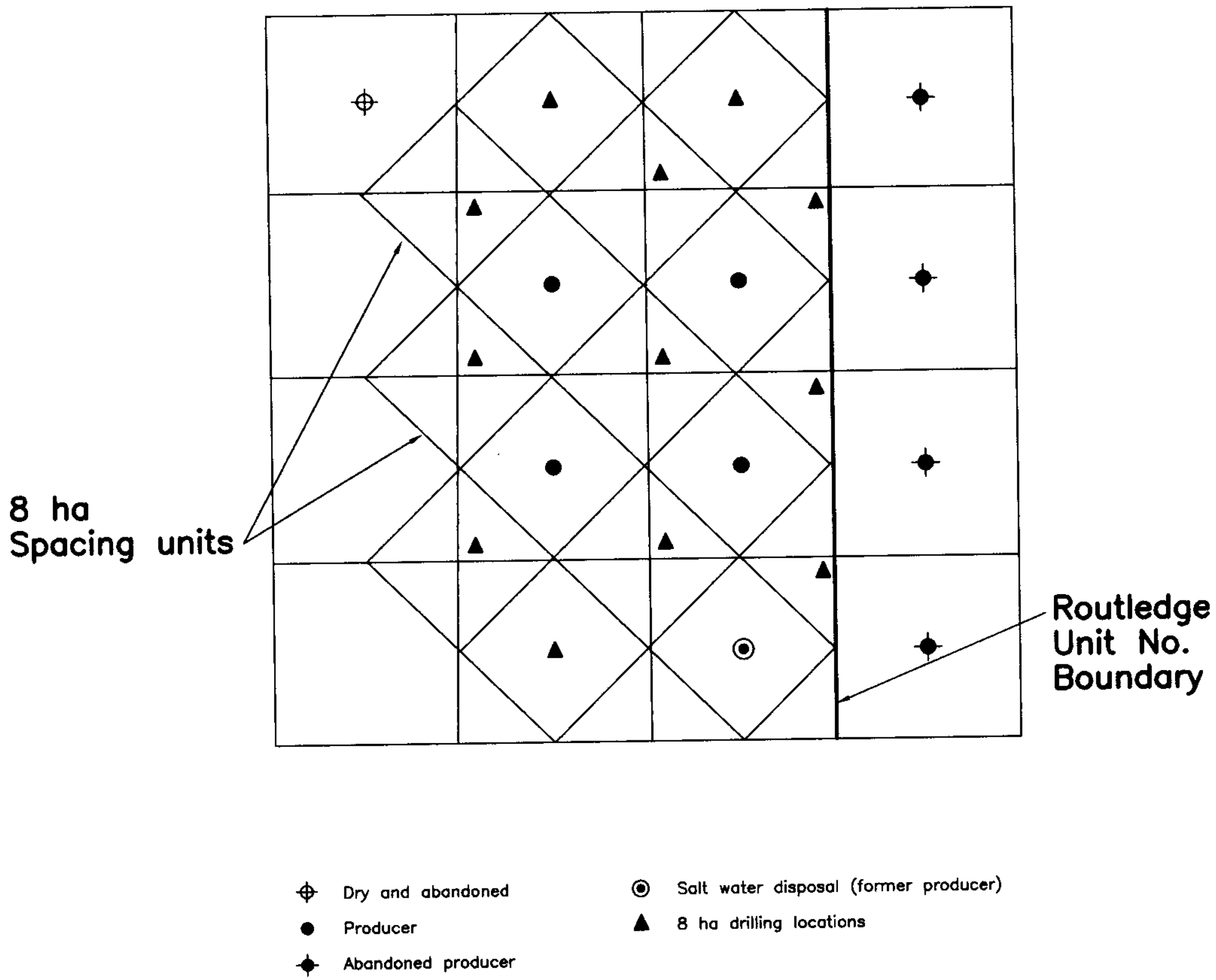
June 6, 1997
Date

Director of Petroleum for
Minister of Energy and Mines

SCHEDULE A
SPACING ORDER NO. 12
SECTION 29-9-25 (WPM)



SCHEDULE A
SPACING ORDER NO. 12
SECTION 29-9-25 (WPM)



Manitoba

Energy and Mines Petroleum

1395 Ellice Avenue Suite 360
Winnipeg MB R3G 3P2
CANADA

PH: (204) 945-6577
Fax: (204) 945-0586

June 6, 1997

Chevron Canada Resources
500-Fifth Avenue SW
Calgary AB T2P OL7

Attention: Sue Bradley

Re: Spacing Order No. 12 - Reduced 8 ha Spacing Routledge Area

The Petroleum and Energy Branch has completed its review of Tundra Oil and Gas Ltd.'s application for 8 ha spacing in the Routledge area. Attached for your information is a copy of Spacing Order No. 12 approving 8 ha spacing in a portion of Section 29-9-25. The spacing area has been modified in accordance with your letter of objection (27-Feb-97) to exclude partial 8 ha spacing units that extend into Routledge Unit No. 1 that would have required the pooling of unit and non-unit lands.

In its objection Chevron indicated this area may contain bypassed oil reserves and is a potential horizontal drilling candidate. The Branch shares both Tundra's and Chevron's views that additional reserves can be recovered along the boundary of the unit. If Tundra's infill drilling project is commercially successful, the Branch, at Tundra's request, will reconsider Tundra's application to extend 8 ha spacing into the Unit. At that time Chevron will be expected to outline its plans to optimize recovery from the unit area in Section 29 and/or provide technical/economic justification for not extending 8 ha spacing into the Unit. Prior to making reapplication Tundra has been advised to initiate discussions with Chevron regarding support of and participation in the project.

If you have any questions in respect of this matter please contact the undersigned at (204) 945-6574.

Yours truly,

John N. Fox, P.Eng.
Chief Petroleum Engineer

MINISTERIAL ORDER

SPACING ORDER NO. 12

Pertaining to 8 ha Spacing Units for the Lodgepole Formation in the Virden Lodgepole C Pool - Section 29-9-25 (WPM)

1. The spacing unit for each well drilled, or to be drilled, for the purpose of obtaining oil from the Lodgepole Formation within the area outlined on Schedule A is a square 8 hectares in area, with corners located at the mid-points of the boundaries of each legal subdivision, as illustrated on Schedule A.

2. The target area of each spacing unit shall be an area having sides 65 metres from the sides of the spacing unit and parallel to them.

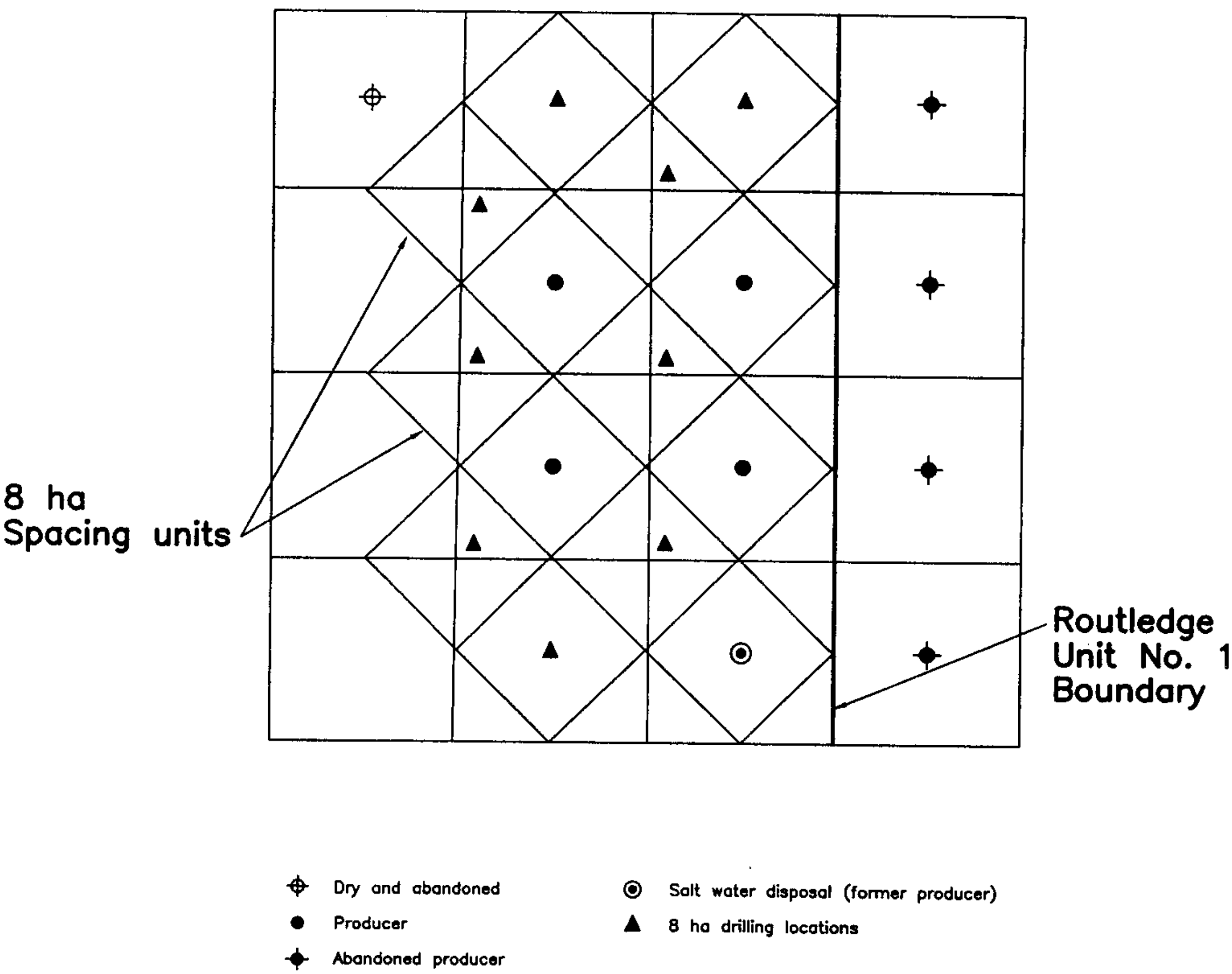
3. Where in the opinion of the Director of Petroleum, the location of an infill well on the Wildlife Management Area in the W/2 of Section 29-9-25 (WPM) might cause significant adverse impact on the environment or significantly impair use of the surrounding land, the Director may refuse to issue a well licence to drill the well.

4. The area outlined on Schedule A may be modified by the Director of Petroleum, from time to time, to meet changing conditions.

June 6, 1997
Date

Director of Petroleum for
Minister of Energy and Mines

SCHEDULE A
SPACING ORDER NO. 12
SECTION 29-9-25 (WPM)



Manitoba

Memorandum

Date June 6, 1997

To Bob Dubreuil
Director
Petroleum & Energy Branch

From John N. Fox
Chief Petroleum Engineer
Petroleum & Energy Branch

Telephone

Subject **Application for Reduced 8 ha Spacing - Routledge Area**

First | Fold

Notice of Tundra Oil and Gas Ltd.'s application for reduced 8 ha spacing in Section 29-9-25 (WPM) in the Routledge area was published in the Virden Empire Advance and Southwestern Gazette and sent to royalty and working interest owners in and within 0.5 km of the area of application and to Natural Resources, the surface owner in Section 29. Comments were received from Chevron Canada Resources, the operator of Routledge Unit No. 1, and Natural Resources.

Recommendation

It is recommended that Ministerial Spacing Order No. 12 be issued for a portion of the area of application that excludes the 8 ha spacing units that extend into Routledge Unit No. 1.

In response to Natural Resources concerns regarding 8 ha development on the W/2 of Section 29, which has been designated a WMA, additional development conditions are recommended:

(a) where possible, access roads, infill wells, flowlines are to be located outside the WMA; and

(b) additional flora and fauna surveys may be required at infill locations on the WMA.

These development conditions and other conditions to mitigate the environmental impact of infill drilling are included in the proposed letter of approval (attached). Natural Resources has had an opportunity to comment on the conditions. Also attached is a letter to Chevron indicating our approval excludes the 8 ha spacing units that extend into Routledge Unit No. 1. The letter also outlines our expectation that Chevron will optimize recovery from the unit area in Section 29.

Discussion

Chevron Canada Resources, unit operator of Routledge Unit No. 1, objected to the partial 8 ha spacing units bordering the Unit (see Fig. 1). In order for Tundra to develop these 8 ha spacing units, all tracts of unit and non-unit lands within the spacing unit would have to be pooled. The 3 infill wells proposed by Tundra that border the Unit are in Phase 2 of the company's project. Tundra would proceed with Phase 2 only if the initial infill wells were commercially successful. Tundra indicated it has no concerns if the partial 8 ha spacing units bordering the Unit are not approved at this time.

Tundra estimates the current recovery from the 4 abandoned unit wells in Section 29 is only 4.1% OOIP. Tundra estimates the infill wells in Phase 2 will recover an additional 26.7 $10^3 m^3$. Chevron in its objection indicated this area may have bypassed oil reserves and there is potential for a horizontal well. Attached is a letter to Chevron indicating at this time the Branch will not approve 8 ha spacing units that extend into Routledge Unit No. 1. If Tundra's infill drilling project is commercially successful, the Branch may reconsider Tundra's application to extend 8 ha spacing into the Unit. At that time Chevron will be expected to outline its plans to optimize recovery from the unit area in Section 29 and/or provide technical/economic justification for not extending 8 ha spacing into the Unit.

Natural Resources expressed concerns that 8 ha spacing on the WMA will result in habitat fragmentation and disturbance, reducing the value of this site for wildlife. In order to effectively mitigate impacts of the proposed development, Natural Resources requested the following additional surveys; flora inventory, spring breeding bird survey and winter white-tailed deer survey,. The Branch is of the opinion Tundra's flora and fauna investigation (Nov/96) adequately outlined development conditions to mitigate any adverse impacts from infill drilling. At a meeting between Natural Resources and the Branch on May 16th it was agreed, where possible, Phase 1 infill wells, access roads and flowlines would moved off the WMA and relocated to the E/2 of the section. It was also agreed that prior to any infill drilling on the WMA during Phase 3 of the project, the Branch, Natural Resources and Tundra would meet to discuss the need for any additional surveys.

Tundra's flora and fauna site investigation identified a number of development conditions, listed below, to mitigate any adverse impacts from infill drilling:

1) avoid drilling during migratory bird nesting season, late-April to mid-July, unless a survey is conducted that confirms no nesting sites are present;

2) minimize the area of disturbance;

3) avoid development activities during wet ground conditions;

4) rehabilitation should be done using specific prairie seed mixtures; and

5) no drilling activity during deer hunting season and in the winter to avoid disturbing/displacing deer from their wintering area.

These conditions will be included in the proposed letter of approval to Tundra (attached).

Ministerial Spacing Order No. 12 (attached) approves 8 ha spacing in a portion of the area of application. The order contains the standard provisions of a reduced spacing order and an additional condition that the Director may refuse to issue a well licence for a well on the WMA, if significant environmental or land use concerns exist. Concerns expressed by Chevron and Natural Resources have been resolved to the satisfaction of all parties at this time, therefore it is recommended that the Director sign the order on behalf of the Minister.

FAX

Date 27-may-97

Number of pages including cover sheet 5

TO: Bob Wooley
NATURAL RESOURCES

Phone

Fax Phone (204) 726-6301

CC:

FROM: John Fox, P.Eng.
Manitoba Energy & Mines
Petroleum & Energy Branch
360, 1395 Ellice Avenue
Winnipeg MB R3G 2P3

Phone 945-6574
Fax Phone 945-0586
e-mail jfox@em.gov.mb.ca

REMARKS: ☐ Urgent ☑ For your review ☐ Reply ASAP ☐ Please Comment

BOB, ATTACHED ARE THE PROPOSED DEVELOPMENT CONDITIONS FOR REDUCED SPACING IN SECTION 29-9-25 IN THE ROUTLEDGE AREA. PLEASE PROVIDE ME YOUR COMMENTS, AS SOON AS POSSIBLE.

THANKS. J

- message from B. Wooley
JUNE 5/97, indicating letter looks good, send out

ROUTLEDGE FIELD

INFILL DRILLING PROGRAM

20 ACRE SPACING

SECTION 29-9-25

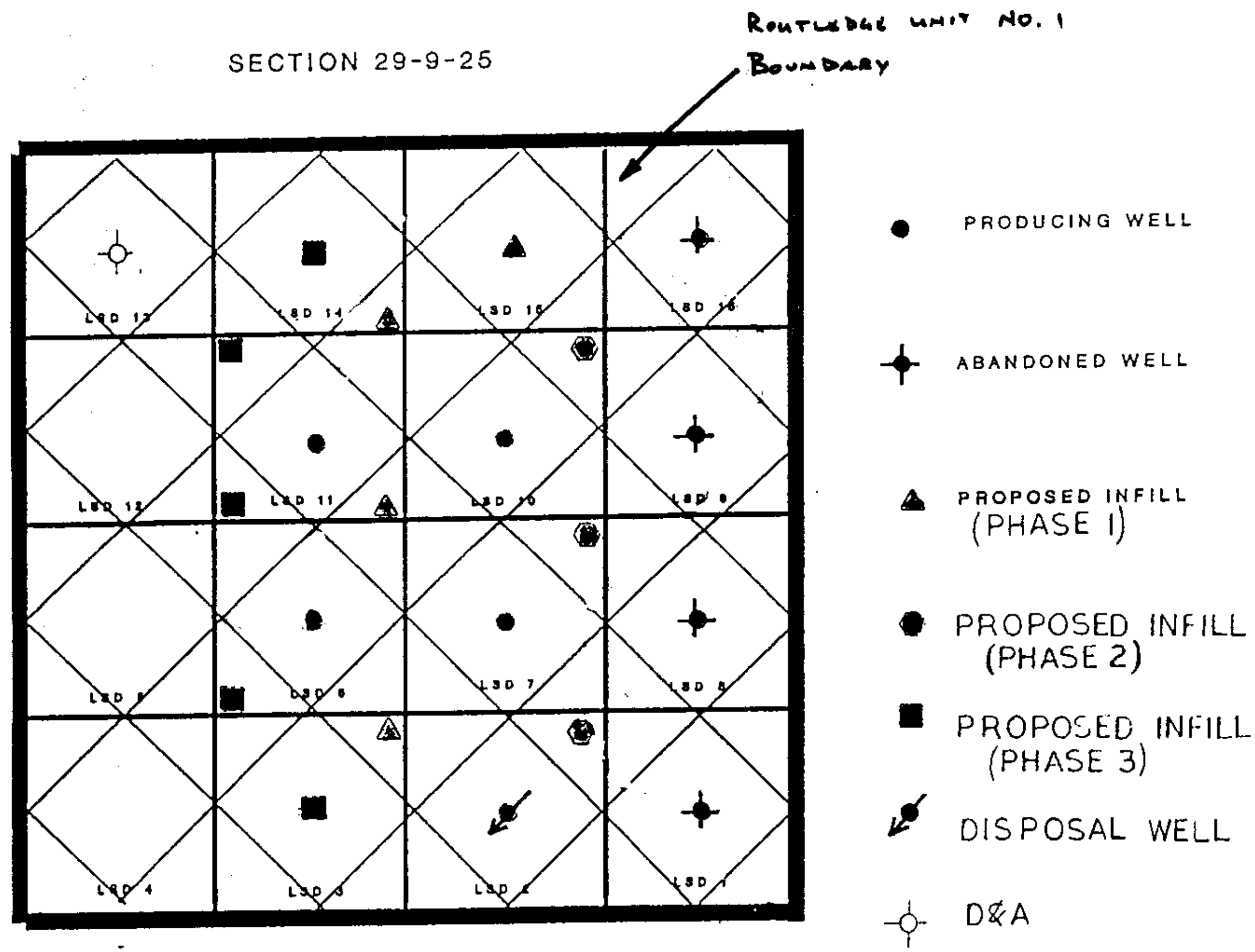


FIG. 1

MINISTERIAL ORDER

SPACING ORDER NO. 12

Pertaining to 8 ha Spacing Units for the Lodgepole Formation in the Virden Lodgepole C Pool - Section 29-9-25 (WPM)

1. The spacing unit for each well drilled, or to be drilled, for the purpose of obtaining oil from the Lodgepole Formation within the area outlined on Schedule A is a square 8 hectares in area, with corners located at the mid-points of the boundaries of each legal subdivision, as illustrated on Schedule A.

2. The target area of each spacing unit shall be an area having sides 65 metres from the sides of the spacing unit and parallel to them.

3. Where in the opinion of the Director of Petroleum, the location of an infill well on the Wildlife Management Area in the W/2 of Section 29-9-25 (WPM) might cause significant adverse impact on the environment or significantly impair use of the surrounding land, the Director may refuse to issue a well licence to drill the well.

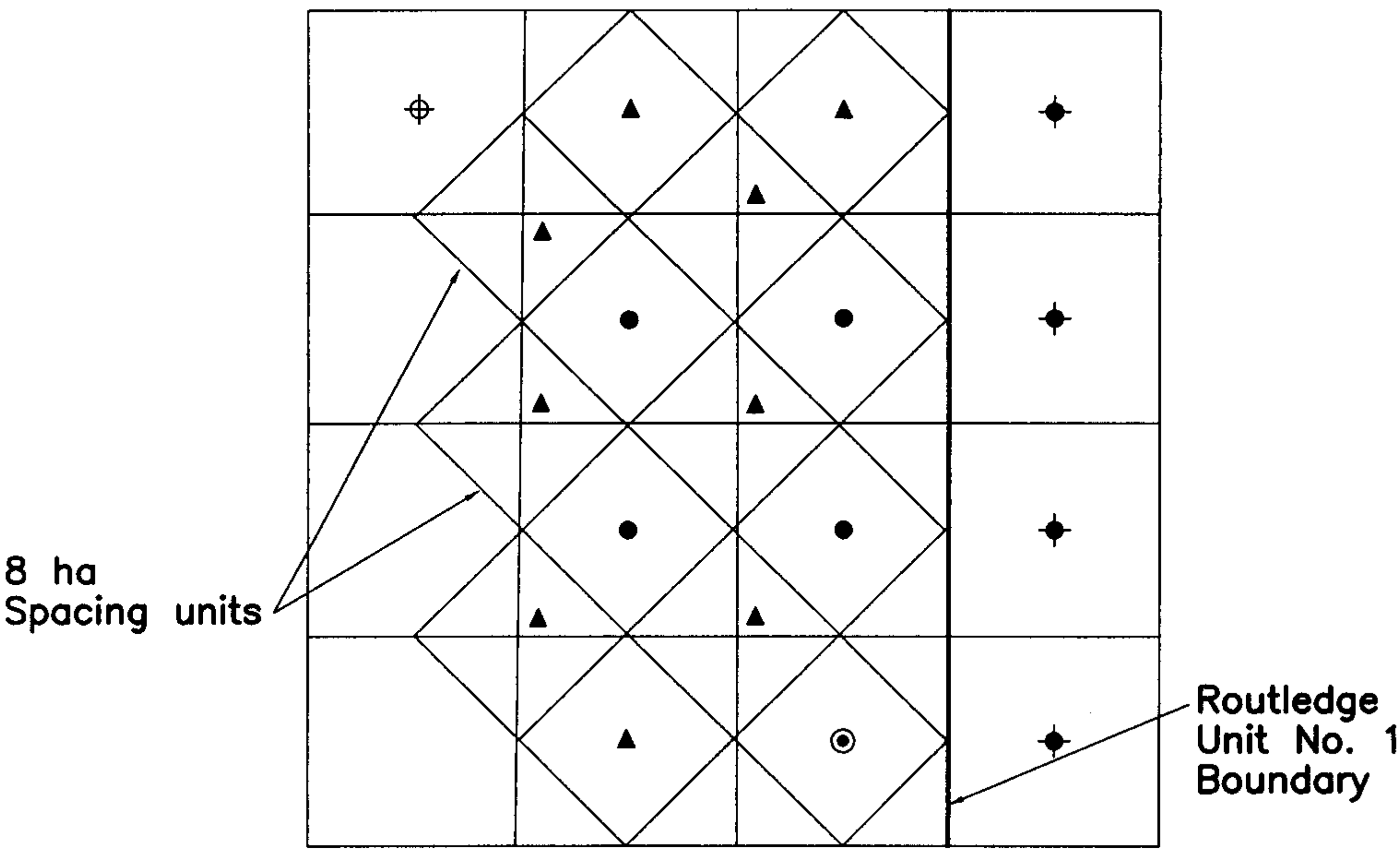
4. The area outlined on Schedule A may be modified by the Director of Petroleum, from time to time, to meet changing conditions.

June 6, 1997

Date

Director of Petroleum for
Minister of Energy and Mines

SCHEDULE A
SPACING ORDER NO. 12
SECTION 29-9-25 (WPM)



Dry and abandoned
Producer
Abandoned producer
Salt water disposal (former producer)
8 ha drilling locations

Manitoba

Energy and Mines Petroleum

1395 Ellice Avenue Suite 360
Winnipeg MB R3G 3P2
CANADA

PH: (204) 945-6577
Fax: (204) 945-0586

June 6, 1997

Mr. George Czyzewski, P.Eng.
General Manager
Tundra Oil and Gas Ltd.
1111 One Lombard Place
Winnipeg MB R3B 0X4

Dear Mr. Czyzewski:

Re: Spacing Order No. 12 - Reduced 8 ha Spacing Routledge Area

The Petroleum and Energy Branch has completed it's review of the subject application. The Branch received comments from Chevron Canada Resources, the unit operator of Routledge Unit No. 1 and Natural Resources on the application. As a result of discussions with Chevron, the Department of Natural Resources and Tundra the application has been approved in part and subject to certain development conditions, in particular conditions related to activities on the Wildlife Management Area in the W/2 of Section 29-9-25 (WPM).

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The Department of Natural Resources expressed concerns that 8 ha spacing on the WMA will result in habitat fragmentation and disturbance, reducing the value of the site for wildlife. In order to minimize infill drilling activity on the WMA, the following locations are to be moved off the WMA:

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3D-29-9-25	2C-29-9-25 or 7B-29-9-25
11A-29-9-25	7C-29-9-25 or 10B-29-9-25
14A-29-9-25	10C-29-9-25 or 15B-29-9-25

Where possible the access roads, flowlines and other facilities associated with these wells are to be located outside the WMA.

Tundra's flora and fauna investigation, November 1996, also identified a number of development conditions to mitigate the impacts of infill drilling. These and other development conditions, listed below, will apply to wells drilled under Spacing Order No. 12:

1) no drilling is permitted during migratory bird nesting season, late-April to mid-July, unless a survey is conducted that confirms no nesting sites are present;

2) the area of disturbance is to be minimized by using existing access roads/trails and flowline rights of way, and reducing the actively used portion of the wellsite;

3) no drilling or construction activities are permitted during wet ground conditions, without the approval of the Department of Natural Resources;

4) where applicable, rehabilitation is to be done using prairie seed mixtures specified by the Department of Natural Resources;

5) no drilling activity is permitted during deer hunting season and in the winter to avoid disturbing/displacing deer from their wintering area; and

6) additional flora and fauna surveys may be required at infill locations on the WMA.

At least 6 months prior to commencing the drilling of Phase 3 infill wells located on the WMA, Tundra is to arrange a meeting with staff from Natural Resources and the Petroleum and Energy Branch to discuss the need for any additional flora and fauna surveys.

If you have any questions in respect of this approval please contact the undersigned at (204) 945-6574.

Yours truly,

John N. Fox, P.Eng.
Chief Petroleum Engineer

cc. Bob Wooley, Director, Western Region
Department of Natural Resources

Manitoba

Energy and Mines

Petroleum

1395 Ellice Avenue Suite 360
Winnipeg MB R3G 3P2
CANADA

PH: (204) 945-6577
Fax: (204) 945-0586

June 6, 1997

Chevron Canada Resources
500-Fifth Avenue SW
Calgary AB T2P OL7

Attention: Sue Bradley

Re: Spacing Order No. 12 - Reduced 8 ha Spacing Routledge Area

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In its objection Chevron indicated this area may contain bypassed oil reserves and is a potential horizontal drilling candidate. The Branch shares both Tundra's and Chevron's views that additional reserves can be recovered along the boundary of the unit. If Tundra's infill drilling project is commercially successful, the Branch, at Tundra's request, will reconsider Tundra's application to extend 8 ha spacing into the Unit. At that time Chevron will be expected to outline its plans to optimize recovery from the unit area in Section 29 and/or provide technical/economic justification for not extending 8 ha spacing into the Unit. Prior to making reapplication Tundra has been advised to initiate discussions with Chevron regarding support of and participation in the project.

If you have any questions in respect of this matter please contact the undersigned at (204) 945-6574.

Yours truly,

John N. Fox, P.Eng.
Chief Petroleum Engineer

DNR MEETING - MAY 16/97

Bob Dubreuil	Energy & Mines
Kip TYLER	MNR
RICK CLINE	DNR - VIRDEN DIST. OFF
Tom MORAN	DNR - West. Region
LARRY BIDLAKE	" " " Brandon
BOB WOOLEY	DNR WEST REGION
BRUCE DUNNING	MB E+M
BLAIR BASTIAN	DNR - REGION
JOHN FOX	ENERGY & MINES

Manitoba

Memorandum

Date March 25, 1997

To Bob Dubreuil
Director
Petroleum and Energy Branch
Energy and Mines
360-1395 Ellice Avenue

From Bob Wooley
Regional Director
Western Region - Operations
Box 13, 340 - 9th Street
Brandon, Manitoba R7A 6C2

Telephone (204) 726-6299

Subject **TUNDRA OIL AND GAS LTD. - REDUCED SPACING APPLICATION**

First | Fold

I have reviewed your comments regarding the Western Region's response to the above-noted application. Regional staff continue to have concerns regarding the scope of development proposed for this relatively small area. The request for additional information on the site was aimed at providing detailed information on flora and fauna in order to effectively mitigate impacts of the proposed development.

As a wildlife management area, the site provides habitat for a variety of flora and fauna that collectively contribute to the biological diversity of this region. While the protection of rare and endangered species is of particular concern, we cannot lose sight of the importance of these natural areas to other species not presently listed on a rare, threatened or endangered species list. The habitat fragmentation and disturbance associated with development and operation of wells and flowlines on an eight-hectare spacing will seriously reduce the value of this site to wildlife and limit use by the general public.

If either directional drilling or an increase in well spacing to reduce the number of wells is not a practical method to reduce the impact of development on this site, then some other form of mitigation should be considered, including the purchase of alternate lands.

Bob Wooley

c.c. K. Tyler
T. Moran

Bob

I talked to Tom Masan about ~~a~~ meeting and I left a message with Bob Wooley, advising him to call you next week regarding a meeting
JL

MG 01-00930

Manitoba

FAXED

Memorandum

Date: March 5, 1997

To: Mr. Bob Wooley
Regional Director - Operations
Manitoba Natural Resources
340 Ninth Street, BRANDON

From: Bob Dubreuil, Director
Petroleum and Energy Branch
Energy and Mines
360-1395 Ellice Ave.
Winnipeg MB R3G 3P2

Telephone:

Subject: **TUNDRA OIL AND GAS LTD. - REDUCED SPACING APPLICATION**

I am in receipt of your memo dated February 24, 1997 respecting the subject application. In your memo, you suggest there is a need for additional surveys (flora, spring breeding birds and winter white tailed deer) prior to the project proceeding. I am concerned that, in view of the company's stated plans, these additional surveys are difficult to justify. I have include my specific comments in the following sections.

First | Fold

Rare and Endangered Plants

You indicate that additional flora inventories are required on the site.

The occurrence of the Western Spiderwort in the general vicinity of the project has been identified. The "Flora and Fauna Investigation" prepared by UMA Engineering Ltd for Tundra Oil and Gas indicates that the plant only occurs in sand dune areas, and that none of the proposed drilling sites "offers suitable habitat for the plant". An inspection of some of the dune areas along the north west margin of the section revealed several spiderwort plants "in the last stages of fall die off". While it is acknowledged that the timing of the survey was not optimal for detection of these plants, the company's mitigation strategy is to avoid the areas suitable for the plant. Because of this strategy, it is difficult to understand why additional flora surveys are required. I would suggest a more appropriate requirement would be for the company to take measures to ensure no disturbance to the duned areas occurred as a result of its activities.

Spring Breeding Bird Surveys

You indicate that spring breeding bird surveys are required on the site.

The UMA report noted a previous study by Natural Resources that found Section 29 did not represent high quality habitat for rare and protected grassland birds. Based on this study, UMA concluded that it is unlikely that any important grassland bird species would take up summer residence on the section. UMA goes on to suggest that "timing constraints may be necessary to avoid impacts on nesting migratory birds and interference with recreational land use during hunting season". In response to this comment, the company has indicated it will only drill wells on the site during a mid July to mid September time frame. I believe this is an effective mitigation against the possible disturbance of nesting birds, and it is not clear to me how the additional information from the requested survey will enhance the development plan. It is suggested that a more appropriate approach would be to impose restrictions on maintenance operations during critical nesting times.

While Tailed Deer

You indicate a white-tailed deer survey should be completed.

The UMA report notes that the only high quality deer habitat (Class 3 winter range) in Section 29 occurs in the extreme north-western part of the section. As the development plan indicates no wells are planned for this area, it is difficult to understand how an additional survey will have any meaningful impact on appropriate development in the area.

Directional Drilling

It would appear that the planned development is tailored, both in terms of timing and location of specific facilities, to minimize the impact of drilling and production operations on the area. The consultant's report concludes that "the drilling program ...... should not have an unacceptable impact on natural resources provided that industry standard drilling and extraction processes are used". In the absence of any unmitigatable circumstances a requirement to utilize more expensive and riskier directional drilling techniques would not appear to be reasonable at this time.

Summary

As I mentioned above I am concerned that a number of your requests involve additional surveys that due to mitigation proposed by the company, do not directly relate to the proposed development of the area. I suggest, a more appropriate approach would be to incorporate the proposed development restrictions in the final development plan.

Please contact me (945-6573) or John Fox (945-6574) at your earliest convenience with your comments and any questions. If required, we would be prepared to meet with you to resolve all the outstanding issues relating to the reduced spacing application.

L.R. Dubreuil

cc John Fox

j:\user\hlt\bob\natres\routledg.doc
LRD/pm

LETTER TO DNR

From your comments - see my E-mail

The Branch received Natural Resources comments on Tundra's application for reduced spacing in Section 29-9-25 (WPM). The thrust of Natural Resources concerns are directed towards requiring additional flora and fauna surveys and inventories. A review of the consultant's report suggests the impact on flora and fauna can be minimized by proper siting of the wells and restrictions on when the wells are drilled.

Rare and Endangered Plants

The consultant's report recognized that the timing of the survey was not ideal for identifying the presence of Western Spiderwort. However the consultant noted that none of the drilling sites offer suitable habitat for the spiderwort plant, which only occurs on sand dunes. The consultant concluded the project does not pose a threat to the two rare or protected vascular plant species in the section (Western Spiderwort and Purple Pin-Cushion Cactus). Is this conclusion in error and if not is there a need for additional flora inventories? What additional information on the potential for impact on rare plants is required?

Rare and Endangered Grassland Birds

The consultant's report noted that a previous study by Natural Resources found Section 29 did not represent high quality habitat for rare and protected grassland birds. The study also concluded that is it highly unlikely that any rare/protected grassland bird species will be affected by the project. Natural Resources has indicated a spring breeding bird survey is required to adequately identify and /or mitigate impacts on bird populations. The consultant is recommending that no drilling by permitted between late-March and mid-July to avoid disturbing nesting birds. If drilling is not conducted during nesting season is there a need for a spring breeding bird survey? How will general information on bird species composition be incorporated into the project development plan? Which type of habitat is amenable to sharp-tailed grouse breeding grounds and can an appropriate buffer zone be established around such areas?

White-Tailed Deer

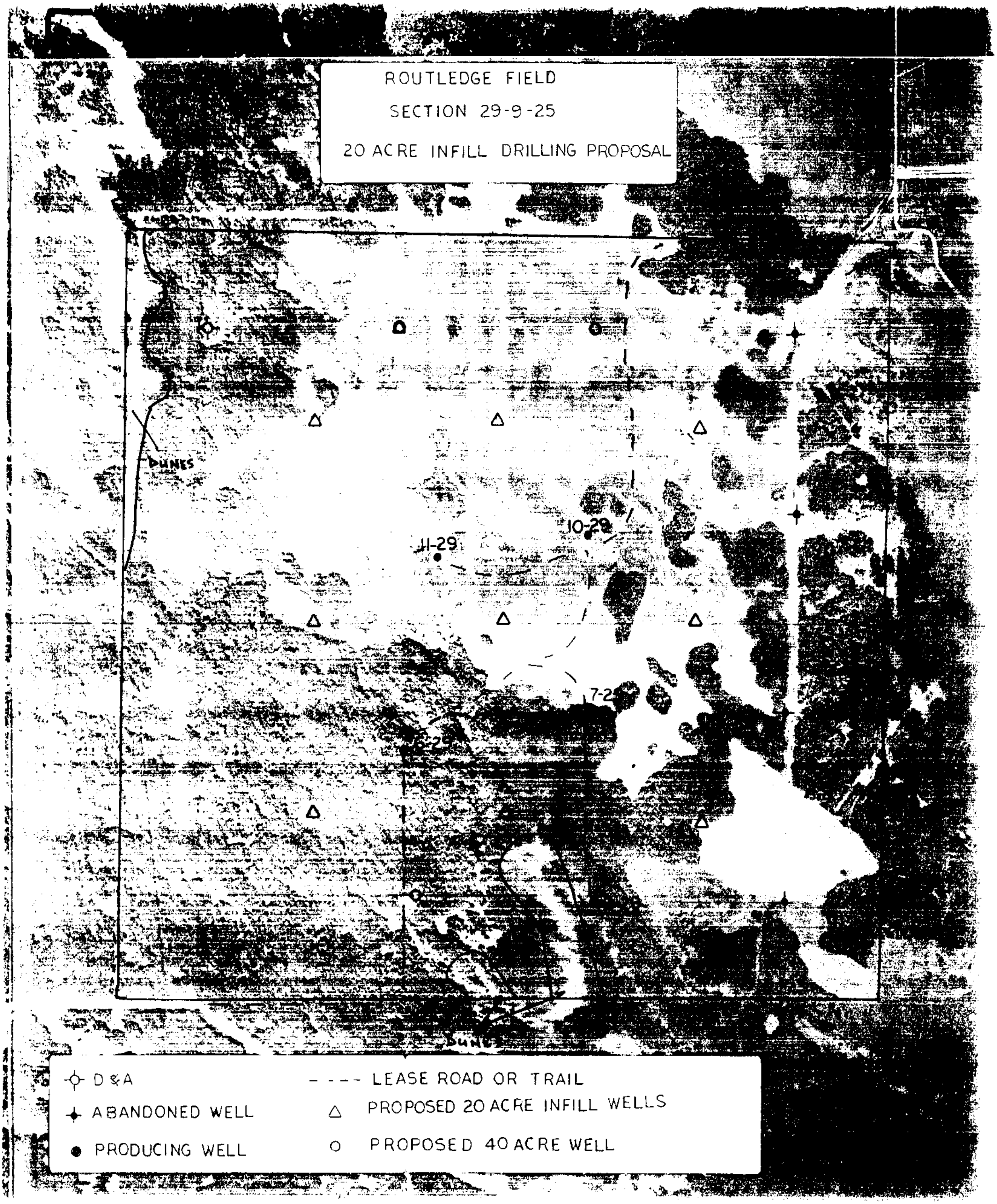
The consultant's report noted that the only high quality deer habitat (Class 3 winter range) in Section 29 occurs in the extreme NW corner of the section, where Tundra does not plan to drill. The surrounding Sections 30, 31 & 32 are also classified as Class 3 winter range. The consultant is recommending that no drilling occur in the winter to avoid displacing deer from their winter range. If drilling is not conducted during the winter is there a need for white-tailed deer survey?

It appears from my review of the flora and fauna investigation that the consultant has identified the potential impacts of the project on flora and fauna and rather than conduct additional surveys has recommended certain development conditions to mitigate the impact of the project. The Branch believes the consultant's report is a good foundation for Tundra's development plan for the reduced spacing project. Natural Resources suggests development restrictions should be considered for the E/2 of Section 29. The
Br ... ars from your
let ... /MA. It
sh ... 29 issued in
19

Section 29-9-25

No special conditions - 1, 2, 6, 7, 8, 9, 10, 16 + NW/4

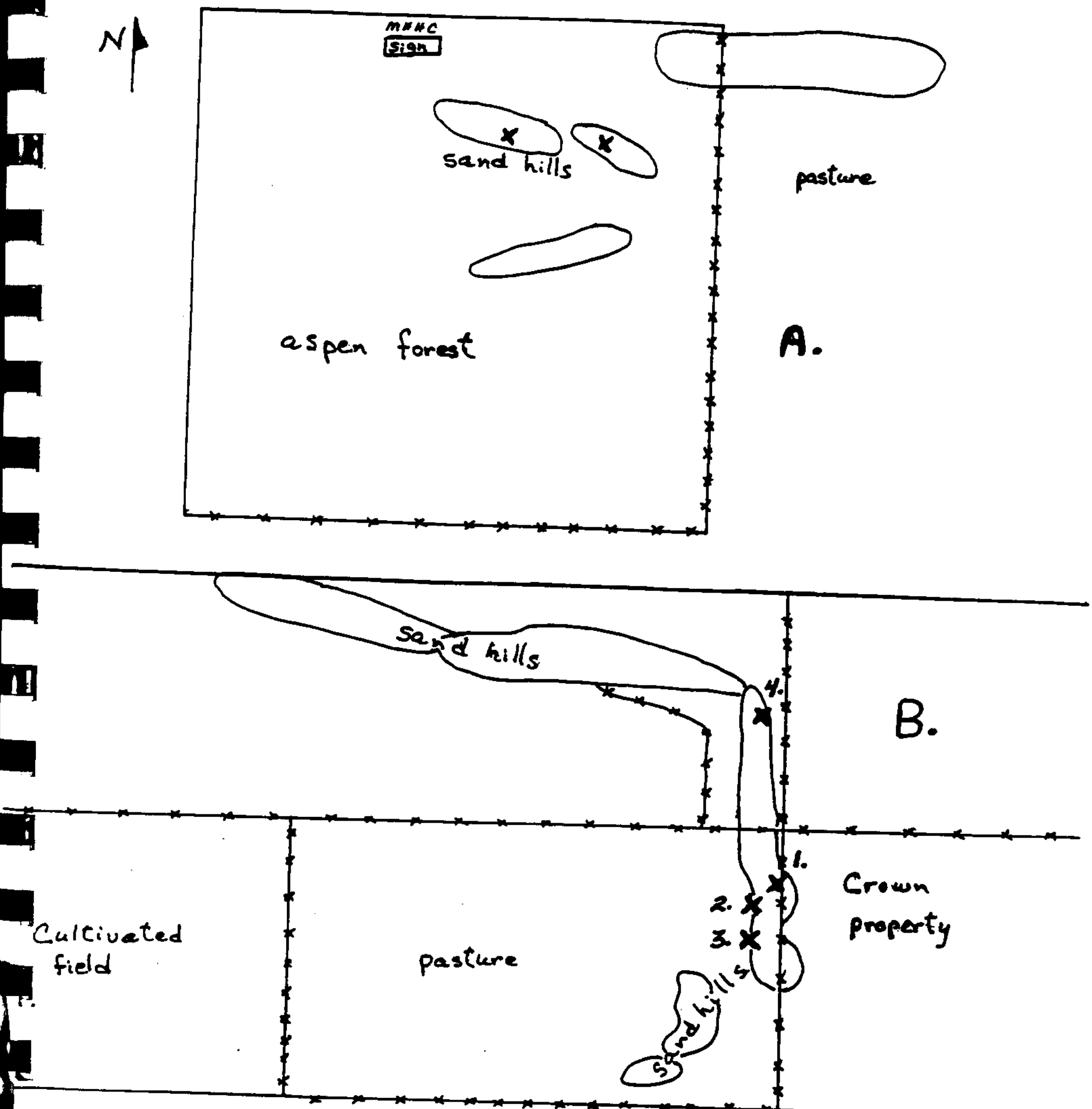
Special lease conditions, 3, 4, 5 + 15



ROUTLEDGE FIELD
SECTION 29-9-25
20 ACRE INFILL DRILLING PROPOSAL
DUNES
11-29
10-29
7-2
DUNES
D & A
ABANDONED WELL
PRODUCING WELL
LEASE ROAD OR TRAIL
PROPOSED 20 ACRE INFILL WELLS
PROPOSED 40 ACRE WELL

FIG. 5

Figure 4: Spiderwort sites.
A. Manitoba Habitat Heritage Corporation property
B. Hellman and Crown properties
(X) Leafy Spurge Beetle release sites.



Chapter Number	Act/Regulation Name	Base Regulation	Amendments	Gazette
W80	**The Water Rights Act**			
	Water Rights Regulation	126/87		Apr. 18/87
			19/90	Feb. 3/90
			107/90	June 2/90
W130	**The Wildlife Act**			
	Amphibians and Reptiles Regulation	215/89		Sept. 16/89
			121/90	June 16/90
	Bait Near the Hudson Bay Coastline Regulation	208/85		Oct. 5/85
			121/90	June 16/90
	Compensation for Hunter-Killed or Injured Livestock Regulation	26/88 R		Jan. 30/88
			145/90	June 30/90
	Compensation for Loss or Damage to Crops by Migratory Game Birds Regulation	28/88 R		Jan. 30/88
			73/89	Apr. 8/89
			145/90	June 30/90
	designation of nature centres	28/87		Feb. 7/87
	Designation of Trapping Areas Regulation	190/86		Sept. 6/86
			443/88	Nov. 12/88
			183/89	Aug. 12/89
			145/90	July 7/90
	Designation of Wild Animals Regulation	3/96		Jan. 27/96
	Designation of Wildlife Management Areas Regulation	57/90		Mar. 24/90
			106/90	June 2/90
			34/91	Feb. 23/91
			113/93	July 3/93
			32/95	Mar. 18/95
	Disposition of Black Bears Captured Alive Regulation	188/92		Oct. 10/92
	Fur Bearing Animal Seasons Regulation	245/90		Dec. 8/90
			237/91	Nov. 16/91
			72/92	Apr. 11/92
			168/92	Sept. 19/92
			231/94	Dec. 24/94
			114/95	Aug. 19/95
			194/96	Oct. 5/96
	Fur Dealers, Tanners and Taxidermists Regulation	33/88 R		Jan. 30/88
			121/90	June 16/90
			28/92	Mar. 7/92
	General Hunting Regulation	351/87		Oct. 17/87
			355/88	Sept. 24/88
			222/89	Sept. 23/89
			225/89	Sept. 23/89
			75/90	Apr. 21/90
			121/90	June 16/90
			194/90	Sept. 15/90
			196/90	Sept. 22/90
			114/91	June 8/91
			208/91	Sept. 28/91

14 Subsection 1(59)(a) of the Schedule is repealed and the following is substituted:

(a) Mimir Unit
In Township 5, Range 14 West and being the northwest quarter of Section 31; in Township 6, Range 14 West and being the southwest quarter of Section 6; in Township 6, Range 15 West and being the southeast quarter of Section 1.

14 L'alinéa 1(59)a) de l'annexe est remplacé par ce qui suit :

a) territoire de Mimir
Dans le township 5, rang 14 ouest : le quart nord-ouest de la section 31; dans le township 6, rang 14 ouest : le quart sud-ouest de la section 6; dans le township 6, rang 15 ouest : le quart sud-est de la section 1.

15 The Schedule is amended by adding the following after subsection 1(62)(k):

(l) Routledge Unit
In Township 9, Range 25 West and being the west half of Section 29.

15 L'annexe est modifiée par adjonction, après l'alinéa 1(62)k), de ce qui suit :

l) territoire de Routledge
Dans le township 9, rang 25 ouest : la moitié ouest de la section 29.

16 Subsection 1(69) of the Schedule is repealed and the following is substituted:

Whitemud Watershed
1(69)

(a) Lower Assiniboine Unit
In Township 9, Range 8 West and being that portion of the south half of the southeast quarter of Section 30 north of the Assiniboine River and that portion of the south half of the southwest quarter of Section 30 south of the Assiniboine River; in Township 9, Range 9 West and being that portion of the northeast quarter of Section 13 south of the Assiniboine River, the northwest quarter of Section 25, the northeast quarter of Section 29 excluding that portion taken for a road as shown on a Plan of survey registered in the Morden Land Titles Office (C. Div.) as No. 1242, the southeast quarter of Section 29 excluding that portion taken for a road as shown on a Plan of Survey registered in the Morden Land Titles Office (C. Div.) as No. 1242 and the north 968 feet perpendicular of the south 1258 feet perpendicular of the east 500 feet perpendicular, the southwest quarter of Section 29 and the east half of the northwest quarter of Section 35; in Township 9, Range 10 West and being that portion of the northeast quarter of Section 10 south of the Assiniboine River, that portion of the northwest quarter of Section 11

16 Le paragraphe 1(69) de l'annexe est remplacé par ce qui suit :

Ligne de partage des eaux de Whitemud
1(69)

a) territoire de la Basse-Assiniboine
Dans le township 9, rang 8 ouest : la partie de la moitié sud du quart sud-est de la section 30 située au nord de la rivière Assiniboine ainsi que la partie de la moitié sud du quart sud-ouest de la section 30 située au sud de la rivière Assiniboine; dans le township 9, rang 9 ouest : la partie du quart nord-est de la section 13 située au sud de la rivière Assiniboine, le quart nord-ouest de la section 25, le quart nord-est de la section 29, à l'exception de la partie prise pour route ainsi que l'indique le plan d'arpentage n° 1242 enregistré au Bureau des titres fonciers de Morden (Div. de C.), le quart sud-est de la section 29, à l'exception de la partie prise pour route ainsi que l'indique le plan d'arpentage n° 1242 enregistré au Bureau des titres fonciers de Morden (Div. de C.) et des 968 pieds les plus au nord, mesurés perpendiculairement, des 1 258 pieds les plus au sud, mesurés perpendiculairement, des 500 pieds les plus à l'est, mesurés perpendiculairement de la section 29 et le quart sud-ouest de la section 29 ainsi que la moitié est du quart nord-ouest de la section 35; dans le township 9, rang 10 ouest : la partie du quart nord-est de la section 10 située

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SCREEN 1          LAND UNIT DATA VIA SECTION TOWNSHIP RANGE    0913505  97/05/06
USER : MINES BRANCH USER 42                                              PAGE   1
                FOR S-T-R 29-009-25 -W  STATUS Y/(A) A
                                        SUBDIV(Y/N/A) A
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 3-184-0001054 NE          29                                 0000           161.000A
 3-184-0001056 SE          29                                 0000           160.600A
 3-184-0001057 NW          29                                 0000           161.000A
 3-184-0001059 SW          29                                 0000           161.000A

PF4 - 02  PF5 - 03  PF6 - 04  PF7 - 05  PF8   06               PF11- SEC 00
* END OF LAND REFERENCES *

SCREEN 3                  LAND UNIT DATA GENERAL INFORMATION     0913514  97/05/06
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                         FOR LAND UNIT 3-184-0001054
                         SIFTON
PART QTR      S-T-R     M GROUP  AREA     U PLAN               BLOCK  LOT    PROL LTO
NE          29 009 25   4 0000   161.000 A

NATURE ADMIN SURV MINERAL GRAVEL JUDGEMENT D !!   OWNERSHIP
       CLB    1       C       C                    P&M - SCHOOL LAND 1

           DOCUMENT  DOCUMENT      DOCUMENT
             NAME     NUMBER         DATE
            CLU      C             1989/01/01  CROWN LAND USE CODE (CLCC)
            CLU      7A            1989/01/01  CROWN LAND USE CODE (CLCC)

PF1   02              PF6 - 04  PF7 - 05  PF8 - 06  PF9 - 11  PF10- 21  PF11- 41
* END OF DOCUMENTS *
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                          FOR LAND UNIT 3-184-000004                    PAGE  1
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MC           29 009 25  W 0030   161.000 A

NATURE ADMIN SURV MINERAL GRAVEL JUDGEMENT D H   OWNERSHIP
       CLB    1      C       C                    P*M - SCHOOL LAND 1

SEQ                       LAND EXTENDED TEXT




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                          FOR LAND UNIT 3-184-0001054                   PAGE  1
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TRACT QTR      S-T-R    M GROUP  AREA     U PLAN             BLOCK  LOT   PRCL LTD
MC           29 009 25  W 0030   161.000 A

NATURE ADMIN SURV MINERAL GRAVEL JUDGEMENT D H   OWNERSHIP
       CLB    1      C       C                    P*M - SCHOOL LAND 1

 AIC  TYPE NUMBER  SEQ       AREA      U AGCY    START      EXPIRE    P D ACT  CS

 BASE RESV CHEVRLN 0002       0.000 A CLB  1969/10/00 9999/00/00 P    CLA
 BASE RESV 00925 W 0002       0.000 A CLB  1957/05/01 9999/00/00 P    CLA
 CALL RESV 00925 W 0003       0.000 A CLB  1966/09/01 9999/00/00 T    CLA
 CP   PERM 000321 0001       0.000 A CLB  1997/01/01 1997/12/31 T S CLA  F
 FORG LEAS 4026 *  0001     152.000 A ACL  1983/10/05 1990/12/31 T    CLA
 EACT AGRE MHY0596 0001       0.000   MHYD 1990/03/10 9999/12/31 T    CLA  V



PF4 - 02  PF5 - 03  PF6 - 04  PF7 - 05            PF9 - 11  PF10- 21  PF11- 41
* END OF ENCUMBRANCES *

SCREEN 3               LAND UNIT DATA GENERAL INFORMATION     0980425  97/05/06
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                      SIFTON
PART Q-S       S-T-R     M GROUP  AREA     U PLAN                 BLOCK  LOT   PROL LTO
SE           29 009 25  W 0000   160.000 A

NATURE ADMIN SURV MINERAL GRAVEL JUDGEMENT D H    OWNERSHIP
       CLB     1        C       C                   P&M - SCHOOL LAND 1

          DOCUMENT  DOCUMENT     DOCUMENT
            NAME     NUMBER        DATE
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           CLU      7J          1989/01/01  CROWN LAND USE CODE (CLUC)

PF4 - 02            PF6 - 04  PF7 - 05  PF8 - 06  PF9 - 11  PF10- 21  PF11- 41
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SE           29 009 25  W 0060   160.000 A

NATURE ADMIN SURV MINERAL GRAVEL JUDGEMENT D H    OWNERSHIP
       CLB     1        C       C                   P&M - SCHOOL LAND 1

GT3                     LAND EXTENDED TEXT

          PF5 - 03  PF6 - 04  PF7 - 05  PF8 - 06  PF9 - 11  PF10- 21  PF11- 41
* NO EXTENDED TEXT FOUND *

SCREEN 6                LAND UNIT DATA GENERAL INFORMATION    0915H46  97/05/06
USER : MINES BRANCH USER #2
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PRST QTR      S-T-R     M GROUP  AREA     U PLAN              BLOCK  LOT   PRCL LTO
SE           23 009 25  W 0609   160.000 A

NATURE ADMIN SURV MINERAL GRAVEL JUDGEMENT D H    OWNERSHIP
       CLB     1       C       C                        P*M - SCHOOL LAND 1

  ENC  TYPE NUMBER  SEC       AREA     U AGCY     START      EXPIRE    P D AUT  CS

  EASE RESV 00925 W 0604       0.000 A CLB  1958/06/06 9999/00/00 P    CLA
  GP   PERM 0003212 0001       0.030 A CLB  1997/01/01 1997/12/31 T S CLA  F
  GP   PERM 0004179 0001       0.060 A CLB  1997/01/01 1997/12/31 T S CLA  F
  RWAY PERM S7745   0001     473.000 A ACL  1993/01/01 9999/12/31 T    CLA

PF4 - 02  PF5 - 03  PF6 - 04  PF7 - 05             PF9 - 11  PF10- 21  PF11- 41
* END OF ENCUMBRANCES *

SCREEN 3                LAND UNIT DATA GENERAL INFORMATION     0981354  97/06/06
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                             FOR LAND UNIT 3-184-0001057                       PAGE   1
                             SIFTON
PARL QTR      S-T-R     M GROUP  AREA     U PLAN              BLOCK  LOT   PRCL LTO
NW           23 009 25  W 0000   161.000 A

NATURE ADMIN SURV MINERAL GRAVEL JUDGEMENT D H    OWNERSHIP
       CLB     1       C       C                        P*M - SCHOOL LAND 1

             DOCUMENT  DOCUMENT      DOCUMENT
               NAME      NUMBER        DATE
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             CLU       7J            1989/01/01  CROWN LAND USE CODE (CLUC)

PF4 - 02              PF6 - 04  PF7 - 05  PF8 - 06  PF9 - 11  PF10- 21  PF11- 41
* END OF DOCUMENTS *

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USER * MINES BRANCH USER #2
                             FOR LAND UNIT 3-184-0001057                       PAGE   1
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NW          29 009 25  W 0000   161.000 A

NAT AD ADMIN CURV MINERAL GRAVEL JUDGEMENT D H    OWNERSHIP
       CLB     1       C       C                  P&M   SCHOOL LAND 1

SEQ                          LAND EXTENDED TEXT










          PF5 - 03  PF6 - 04  PF7 - 05  PF8 - 06  PF9 - 11  PF10- 21  PF11- 41
* NO EXTENDED TEXT FOUND *

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                             FOR LAND UNIT 3-104-0001037                       PAGE   1
                             SIFTON
PART QTR       S-T-R     M GROUP   AREA     U PLAN                BLOCK  LOT    PRCL LTD
NW          29 009 25  W 0000   161.000 A

NATURE ADMIN CURV MINERAL GRAVEL JUDGEMENT D H    OWNERSHIP
        CLB     1       C       C                 P&M - SCHOOL LAND 1

  ENC  TYPE NUMBER  SEQ       AREA     U AGCY     START      EXPIRE    P D ACT  CS

  CP    CANC 0003210 0001       0.000  A CLB  1986/02/26 1986/12/31 T S CLA  H
  RWAY  PERM 57745   0001     473.000  A ACL  1993/01/01 9999/12/31 T   CLA
  GP    PERM 0005399 0001       0.000    CLB  1997/01/01 1997/12/31 T   CLA  F
  WMA   RESV WASS RL 0001       0.000  A WILD 1985/10/08 9999/12/31 P   XLA




PF4 - 02  PF5 - 03  PF6 - 04  PF7 - 05               PF9 - 11  PF10- 21  PF11- 41
* END OF ENCUMBRANCES *

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                             FOR LAND UNIT 3-104-0001033                       PAGE   1
                             SIFTON
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NATURE ADMIN SURV MINERAL GRAVEL JUDGEMENT D H   OWNERSHIP
       CLO     1       C       C                   P&M - SCHOOL LAND 1

          DOCUMENT  DOCUMENT     DOCUMENT
            NAME     NUMBER        DATE
           CLO        C          1980/01/01  CROWN LAND USE CODE (CLUC)
           CLO        7J         1980/01/01  CROWN LAND USE CODE (CLUC)

PF4 - 01              PF6 - 04  PF7 - 05  PF8 - 06  PF9 - 11  PF10- 21  PF11- 41
* END OF DOCUMENTS *

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                           SIFTON
PART QTR       S-T-R     M GROUP  AREA     U PLAN               BLOCK  LOT    PRCL LTO
SW           29 007 15  W 0000   161.000 A

NATURE ADMIN SURV MINERAL GRAVEL JUDGEMENT D H   OWNERSHIP
       CLO     1       C       C                   P&M - SCHOOL LAND 1

SEC                        LAND EXTENDED TEXT

           PF5 - 03  PF6 - 04  PF7 - 05  PF8 - 06  PF9 - 11  PF10- 21  PF11- 41
* NO EXTENDED TEXT FOUND *

SCREEN 6              LAND UNIT DATA GENERAL INFORMATION     0914419  97/05/06
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                           FOR LAND UNIT 9-184-0001059                    PAGE   1
                           SIFTON
PART QTR       S-T-R     M GROUP  AREA     U PLAN               BLOCK  LOT    PRCL LTO
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[illegible]
CLB 1 0 0 FGN - SCHOOL LAND 1

ENC	TYPE	NUMBER	SEQ	AREA		ACTV	START	EXPIRE	P	D	ACT	DS
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RWAY	PERM	57740	0001	[illegible]	A	[illegible]	1993/01/01	9999/12/31	[illegible]		CLA	
OP	CANC	0605400	0001	0.000		CLB	1996/01/01	1996/12/31	T		CLA	H
WMA	RESV	USS RL	0001	0.000	A	WLD	1980/10/00	9999/12/31	P		WLA	

PF2 - 02 PF5 - 03 PF6 - 04 PF7 - 05 PF9 - 11 PF10 - 21 PF11 - 41
* END OF ENCUMBRANCES *

Record of Special Conditions - L952-1383

DUE TO THE ENVIRONMENTALLY SENSITIVE NATURE OF THE LEASE AREA, THE FOLLOWING CONDITIONS HAVE BEEN INCLUDED:

1. That the Lessee shall, prior to the commencement of geophysical, drilling, production or other related operations within the lease area, obtain the approval of the Director of the Petroleum Branch of a plan of operations.

2. That all operations carried on within the lease area shall be in compliance with the plan of operations approved under Clause 1.

Record of Special Conditions - L951-1326

DUE TO THE ENVIRONMENTALLY SENSITIVE NATURE OF THE LEASE AREA, THE FOLLOWING CONDITIONS HAVE BEEN INCLUDED:

1. That the Lessee shall, prior to the commencement of geophysical, drilling, production or other related operations within the lease area, obtain the approval of the Director of the Petroleum Branch of a plan of operations.

2. That all operations carried on within the lease area shall be in compliance with the plan of operations approved under Clause 1.

Manitoba

Memorandum

Date June 21, 1995

To L.R. Dubreuil, Director
Petroleum Branch
Manitoba Energy & Mines
360 - 1395 Ellice Ave.

From G. Baker
Director
Policy Coordination Branch
Box 38, 1495 St. James Street
Winnipeg, MB R3H 0W9

Telephone

JUN 26 1995
PETROLEUM BRANCH

Subject PROPOSED SALE OF CROWN OIL AND NATURAL GAS LEASES
AUGUST 23, 1995

Manitoba Natural Resources has reviewed the latest listing of Oil & Natural Gas Leases that will be advertised for eventual sale, and provide the following comments.

First | Fold

Parcels identified as having a surface, mineral or other interest:

PARCEL	SURFACE DISPOSITION
A10	- A quarry lease is noted on the East half of the section.
A56 - LSD 15-29-9-25	- The surface is Crown and a Forage Lease (4026) exists. Agricultural Crown Lands should be contacted for their concerns.
	- Note: The site is currently hayland but has the potential as a mixed-grass prairie. Surface development could be planned in advance of any operational start up. Manitoba Natural Resources (and presumably Agricultural Crown Lands) staff will assist in the planning development, if contacted.
A58; A60 - A66	- These lands are withdrawn from prospecting because of the mineral disposition (potash).

The following parcels exhibit a concern relative to mineral ownership:
(Please contact Crown Lands Branch for actual documentation/clarification)

1) Parcel A5 ✓	- The SE has Crown minerals while the SW is patented.
2) Parcels A29, A32, A34, and A59	- Minerals are patented.

PS 1 25 894 01-00930

The following parcels have been identified as having wildlife concerns i.e. endangered bird species occurrences (nesting and foraging) on site. It is again recommended that the purchaser/developer contact the regional staff of Manitoba Natural Resources (1-204-726-6299) for information on how to minimize the impacts of development.

Parcel	Species
A3	Burrowing Owl (BO)
A6	Baird's Sparrow (BS)
A11	BO, BS, Ferruginous hawk (FH)
A12	BO, BS
A14	BS
A15	BS
A16	FH
A18	BO, BS
A19	Loggerhead Shrike (LS)
A30	BS
A31	LS
A33	BS
A38	BS
A42	BO, BS
A47	LS
A53	LS
A55	BS, LS

Not [illegible]

per G. Baker

Manitoba

Memorandum

Date February 24, 1995

To Kathryn Hepburn
I.D.G. Coordinator
Policy Coordination Branch
201 - 1495 St. James St.
Winnipeg MB R3H 0W9

From Bob Wooley
Regional Director
Western Region - Operations
Box 13, 340 - 9th Street
Brandon, MB R7A 6C2
Telephone (204) 726-6299

Subject **Proposed Sale of Crown Oil and Natural Gas Leases - May 3, 1995**

Western Region staff have reviewed the above list and have identified concerns regarding wildlife management areas, endangered plant and animal locations, surface water, fisheries issues, and habitat fragmentation.

1. Western Region staff have <u>no concerns</u> regarding oil/gas development on the following parcels:

   A7, A13-15 inclusive, A22-25 inclusive, A28-29, A33, A35-40 inclusive, A45-51 inclusive, A57, A59, A62, A65-66, A68, A71-72, A74, A77.

2. Parcel A9, SE 29 - 2- 27W. This is the Gainsborough Creek Unit of the Pierson W.M.A. This piece should be <u>withdrawn</u> from the sales list. It is a valuable wildlife land and its riparian habitat is rich with songbird species. Parcel A67 69 is habitat for western spiderwort, an endangered plant. The area must be surveyed to determine if the plant is present <u>before</u> development. See T. Moran's memo dated Feb. 22/95 for further details.

my proposal to N.R is to use the same addendum as used for the SE 1/4 Last year

OK. Note - refer to A69

3. On the basis of the following table, D.N.R. Western Region has identified the other parcels of concern and the natural resources issues related to development on these parcels.

In all cases, we will request that special development and /or operational restrictions will apply to the sites. Surface access will may have to be subject to approval of a development plan.

The following legend applies to the table below:

S.W.	- Surface water protection to protect fisheries required.
E.S. (BO, FH, LS, BS)	- Endangered species use of habitat; Burrowing Owl (BO), Ferruginous hawk (FH), Loggerhead Shrike (LS), and Baird's Sparrow (BS)
N.P.	- Native, mixed-grass prairie
W.T.D.	- White-tailed deer wintering habitat.

Sue
Determine if all parcels on the attached page are Crown surface
Include addendum for all parcels that are unless the only concern is surface water protection

bd

2

Crown Surface

S.T.G. - Sharp-tailed grouse breeding ground (lek)
W.S. - Western spiderwort habitat
W.M.A. - Wildlife Management Areas

Parcel #	Part	Sec.	Twp.	Rge	D.N.R. Issues
~~A1~~	S½	36	1	29	S.W.
~~A2~~	SE	29	1	27	S.W.
A3	SE	18	2	26	E.S. (B.O. & F.H.) nesting sites
A4	SW	18	2	26	N.P., S.W.
~~A5~~	LSD 4&5	19	2	26	S.W.
A6	N½	19	2	26	S.W., N.P., E.S. (F.H.) nesting site
~~A8~~	SW	16	2	27	S.W.
SE → A9	S½	29	2	27	W.M.A., N.P., S.W., W.T.D. - withdraw
~~A10~~	N½	29	2	27	S.W.
A11	W½	32	2	27	N.P.
A12	NE	36	2	27	N.P.
~~A16~~	NE	20	3	26	S.W.
A17	SW	20	3	26	S.W., E.S. (F.H.)
~~A18, 19, 20~~	SE & NW	22 & 28	3	26	S.W.
All → A21	All	29	3	26	S.W., E.S. (B.S.)
A26	N½	29	3	29	W.T.D. (wintering area)
W½ → A27	All	29	4	28	N.P., E.S. (B.S., F.H.)
A30	E½	10	4	29	S.W., N.P.
SW → A31	SW	11	4	29	S.W., N.P.
~~A32~~	S½ & NW	12	4	29	S.W.
~~A34~~	SE & N½	16	4	29	S.W.
~~A41~~	All	29	4	29	S.W.
~~A42~~	SE	32	4	29	S.W.

Parcel #	Part	Sec.	Twp.	Rge	D.N.R. Issues
A43	N½	18	5	27	E.S. (B.O., F.H., L.S.) nest site
	All	24	5	28	E.S. (B.O., F.H., L.S.)
A44	W½	2	5	28	S.W., E.S. (L.S., F.H.) nest site, S.T.G.
~~A52~~	All	12	5	29	S.W.
~~A53~~	All	4	5	29	S.W.
	W½	10	5	29	S.W.
~~A54~~	E½	6	5	29	S.W.
A56	All	16	5	29	S.W., N.P., E.S. (B.O.)
A58	NE	20	5	29	E.S. (L.S.)
A60	All	24	5	29	S.W., E.S. (L.S.)
A61	All	28	5	29	S.W., E.S. (B.S. & L.S.)
A63	S½	30	5	29	E.S. (L.S.)
~~A64~~	S½ & NE	32	5	29	S.W.
A67	W½	22	6	29	S.W., N.P.
all A69	LSD 3,4,& 5	29	9	25	E.S. (W.S.), W.T.D.
A70	LSD 13	6	9	27	E.S. (L.S.)
A73	LSD 16	30	9	29	W.T.D. (wintering area)
~~A75~~	E½	29	12	28	S.W.
~~A76~~	W½	29	12	28	S.W.

This oil/gas development sales list certainly highlights the natural resources sensitivity of a number of these areas. Oil companies should be encouraged to begin early discussion and consultation with my staff before development to ensure all issues are addressed.

Bob Wooley

DC/jd

c.c. L. Misanchuk, D. Chranowski, L. Bidlake, B. Howard, G. Suggett, T. Moran, K. Schykulski, K. DeSmet

TUNDRA'S PROPOSAL

- 12 wells of which 9 are 8 ha infill locations & 3 are actually 16 ha locations.

PHASE 1	3D-29	
	11A-29	
	14A-29	
	15-29	
PHASE 2	2D-29	
	7D-29	
	10D-29	
PHASE 3	3-29	
	6B-29	
	11B-29	
	11C-29	
	14-29	

INCREMENTAL RECOVERY

PHASE 1	30900 m^3
PHASE 2	26700 m^3
PHASE 3	13300 m^3

GROSS REVENUE @ \$160/m^3 - \$10.6 MM
CROWN REVENUE @ \$160/m^3 - \$1.4 MM

AVEP ROYALTY RATE - 12%
(BASED 2 [illegible])

Sec 29 - 9 - 25

L892-906	L892-906	L952-1383	L2014
L892-906	L892-906	L851-558	L2014
L951-1326	L841-425	L851-597	L2014
L951-1326	L951-1326	L851-597	L2014

LEASE NO.	LESSEE	SPECIAL CONDITIONS
L2014	CHEVRON	NONE
L841-425	TUNDRA	NONE
L851-558	TUNDRA	NONE
L851-597	TUNDRA	NONE
L892-906	TUNDRA	NONE
L951-1326	TUNDRA	Yes - Director of Petroleum to approve a plan of operations
L952-1383	TUNDRA	Yes - See L951-1326

HISTORY OF DEVELOPMENT AND LAND USE
SECTION 29-9-25

(1) INITIAL DRILLING ACTIVITY

WELL	FINISHED DRILLING	ABANDONED
1-29-9-25	NOV 21/65	OCT 4/74
8-29-9-25	DEC 2/60	OCT 4/74
9-29-9-25	NOV 6/60	OCT 11/74
13-29-9-25	DEC 30/53	ABD D
16-29-9-25	JUL 16/60	AUG 10/72

(2) SUBSEQUENT LEASING ACTIVITY

1984 - SW/4 of SEC 29
1985 - LSD'S 2,7,10 & 15 OF SEC 29
- NO SPECIAL DEVELOPMENT CONDITIONS

(3) DRILLING ACTIVITY

WELL	FINISHED DRILLING	STATUS
6-29-9-25	NOV 23/85	PRODUCING
7-29-9-25	FEB /86	PRODUCING
10-29-9 25	MAR 2/86	PRODUCING
2-29-9-25	MAR 1/89	WATER DISPOSAL

(4) LEASING ACTIVITY

1989 - NW/4 of SEC 29 BONUS $3400+ FEE $50 RENTAL $160 TOTAL PAYMENTS TO DATE - $5178, LEASE EXPIRES NOV 8/99
1995 - LSD'S 3,4,5 & 15 of SEC 29 SPECIAL CONDITIONS REQUIRING DIRECTOR TO APPROVE PLAN OF OPERATION REQUIRED

FLORA & FAUNA INVESTIGATION

- site investigation Sep [illegible] /96
- also discussion with MNR & Cdn Wildlife Service

- timing constraints
  late Apr - mid-July during migratory bird nesting season
  - hunting season

- western 1/2 of Sec 29 is to be designated a WMA in near future

- [illegible] agricultural - wild hay production NE/4
  - southern NE margin
  - [illegible] system of [illegible] [illegible] the [illegible]
  - [illegible] [illegible] hunting [illegible]
- sand dunes NW marginal & south central parts
  [illegible]
- microdune topography [illegible]/4, W/2 of SE/4 & NW of NW/4
- Aspen forest predominates S/2 of NW/4
- meadow & mixed grass prairie predominate N/2 [illegible]
occurs in [illegible]/4

- will drilling [illegible] in [illegible] area, 2 wells on wooded sites, with no drilling in dune area

- rare plant species ~~that~~ occurs in the area
Within Environment [illegible] Purple Pincushion Cactus

on [illegible]

- no significant plants found at proposed drilling sites, which only occurs in sand dunes
- development doesn't pose a threat to rare or protected plant species

  - some impacts on wildlife including loss or isolation of habitat, displacement of wildlife due to activity/noise, increase access for recreational users.

  - not major concerns

  - avoid work during migratory bird nesting season (late April to mid July) unless survey for the presence of nesting birds is conducted

  - some concerns re winter drilling on disturbance/displacement of deer

- reduce adverse impacts of development - minimizing area of disturbance & avoid working in wet conditions

- specific seed mixture for rehabs provided.

- suggestion that DNR may limited drilling activities during hunting season

REDUCED SPACING — ROUTLEDGE FIELD

(1) 1ST DISCUSSIONS WITH TUNDRA REGARDING 8 ha SPACING IN EARLY '95

(2) FEB 10/95 LETTER TO TUNDRA

- Sec 29 sandy soil, natural areas of habitat for Western Spiderwort

- development plan to minimize impact on:
  - existing land use
  - indigenous flora & fauna
  - aesthetic & scenic value of land
  - recreational uses

- anticipated development conditions.
  - where possible, locate wells on agricultural land
  - conduct survey for rare & endangered flora & fauna
  - no surface disturbance where rare & endangered species encountered
  - minimize surface disturbance & protect against erosion
  - restricted drilling windows
  - restoration & rehabilitation guidelines

(3) JUL 22/96 LETTER TO TUNDRA
- listing potential consultants for EA

(4) FLORA SURVEYS - WESTERN SPIDERWORT

- surveys conducted 1990, 92, 93
- location of plant in Routledge rediscovered = 1990
- restricted to sand dune areas.
-

(5) DRILLING ACTIVITY

WELL	FINISHED DRILLING	STATUS
11-29-9-25	AUG 24/94	PRODUCING
3-29-9-25	—	LICENCE CANCELLED

(6) WMA - Routledge Unit W/2 of Sec 29 established by regulation Jan /97

(7) OTHER LAND USES

NE/4 FORAGE LEASE - 152 ac OCT 5/83 to DEC 31/98

SE/4 RENEWABLE HAY PERMIT - 473 ac JAN 1/93

NW/4 RENEWABLE HAY PERMIT - 473 ac JAN 1/93
WMA RESV CLASS RL AREA - 0.0 OCT 8/85

SW/4 see NW/4

Chevron

Chevron

Chevron Canada Resources
500 - Fifth Avenue, S.W.
Calgary, Alberta T2P 0L7
Telephone (403) 234-5000
Fax (403) 234-5124

Eastern Business Unit

February 27, 1997

DEPARTMENT OF ENERGY AND MINES
FEB 28 1997
PETROLEUM BRANCH

By facsimile

Petroleum and Energy Branch
1395 Ellice Avenue, Suite 360
Winnipeg, Manitoba
R3G 3P2

Attention: Mr. John Fox, Chief Petroleum Engineer

RE: Application by Tundra Oil & Gas Ltd. to Reduce Spacing in Routledge, Manitoba
Section 29-9-25 WPM

Chevron Canada Resources is in receipt of a notice issued by the Petroleum and Energy Branch dated January 27, 1997 pertaining to the captioned application. It is our understanding that Tundra wishes to have spacing in Section 29-9-25 WPM reduced from 16 hectares to 8 hectares. It is our understanding from the notice that Tundra may wish to drill wells in partial 8 hectare spacing units bordering the Routledge Unit No. 1. You have indicated in the notice that certain portions of the Routledge Unit No. 1 would have to be included in a pooling agreement or order before drilling in these partial spacing units could take place.

As unit operator of the Routledge Unit No. 1, Chevron hereby gives notice to you that we object to allowing Tundra the reduced spacing for the three proposed wells offsetting our unit. These locations would be 2-29, 7-29 and 10-29.

We object on the basis that these proposed wells would drain reserves from our unit. Despite the fact that the Routledge Unit wells offsetting this application are currently abandoned, we have identified that this area may have bypassed oil reserves and as such is a potential location for a horizontal well for our unit.

Further questions may be directed to either Sue Bradley at (403) 234-5755 or Brian Grant at (403) 234-5812.

Yours truly,

Chevron Canada Resources

S. Bradley

Sue Bradley
Land/ JV, Eastern Business Unit

cc: Tundra Oil and Gas Ltd.
Attention: Mr. George Czyzewski, General Manager

Manitoba

Memorandum

Date: 24 February 1997

To: John Fox
Chief Petroleum Engineer
Petroleum & Energy Branch
Ste 360 - 1395 Ellice Ave.
Winnipeg, MB R3G 0G3

DEPARTMENT OF ENERGY AND MINES
FEB 28 1997
PETROLEUM BRANCH

From: Bob Wooley
Regional Director - Operations
Dept. Natural Resources
340 Ninth St.
Brandon, MB R7A 5A4

Telephone: 726-6299

Subject: **Reduced Spacing - Routledge Field**

First | Fold

Regional staff have reviewed the above noted application and have identified the following concerns with respect to Wildlife Management Area (WMA) lands on the west 1/2 of 29-9-25W:

- additional flora inventories are required on the site. Flora surveys completed by the consultant in September would have missed the most appropriate period (early to mid July) that the rare plant, Western Spiderwort, would be most easily identified. The spring and early summer period when plants are flowering would be better suited for flora inventories. Additional information on the potential for impact on rare plants should be provided.

- spring breeding bird surveys are required on the site to adequately identify and or mitigate impacts on bird populations. General information on species composition as well as locations of sharp-tailed grouse breeding grounds should be documented.

- a winter white-tailed deer survey should be completed to effectively assess the impact on deer using the area as winter habitat. Displacement of deer will not only result in potential loss of deer, it may further complicate an already serious depredation problem to stored feed supplies. In order to have any value this survey should be carried out as soon as possible.

There are fewer concerns regarding the east half of Section 29 however its proximity to WMA lands make it valuable to wildlife populations. A development plan would be appropriate for this site as development restrictions would apply.

Although Tundra Oil & Gas Ltd. indicate directional drilling is not the preferred method of recovering remaining oil reserves this method could effectively mitigate most concerns regarding development of Section 29 and in particular the WMA lands on the west half of the section. A more thorough investigation of the site is required to adequately assess the impact of development.

Bob Wooley

xc: I. Moran
L. Bidlake
C. Johnson
R. Cline

PS 125 894-01-00271

MEMO

To: John Fox
Chief Petroleum Engineer
Energy & Mines

From: Ed Sawatzky
Manager, Land Development
Corporate Planning & Business Development

Subject: Application for reduced Oil Well Spacing at Routledge Field (29-9-25W), RM of Sifton

Date: February 10, 1997

In reply to your memo to Ron Riopka, your request has been forwarded to Al Shier of our Brandon Community Economic Development Services Branch, by way of this memo. Al will advise whether our Department will want to be involved in the review of this application.

Thank you.

Ed Sawatzky

cc: Ron Riopka
Peter Mah
Al Shier

DEPARTMENT OF ENERGY AND MINES
FEB 12 1997
PETROLEUM BRANCH

Manitoba

Memorandum

Date: February 5, 1997

To: **John N. Fox**
Petroleum Engineer
Petroleum Branch
555-330 Graham Avenue

From: Floyd Phillips
Manager, Terrestrial Quality Mgmnt
Manitoba Environment
Bldg. 2, 139 Tuxedo Avenue
Winnipeg MB R3N 0H6

Telephone: (204) 945-7003

Subject **Tundra Oil and Gas Ltd. reduced spacing proposal - Section 29-9-25 WPM**

Thank you for providing me with the information re: the proposed reduced oil well spacing on the identified property, as well as the report on the flora and fauna investigation.

It is unfortunate that the flora and fauna survey could not have been conducted in June or early July so that a more accurate species list could have been compiled. For future developments, I would hope that more lead time could be provided to ensure that a thorough biological survey can be conducted at the proper time in the growing season. Nevertheless, I agree with the report that endangered plant species that may be present will probably not be impacted.

Given the input from MB Natural Resources, I probably do not need to be involved in the review. However, I would appreciate it if you could provide me with any further information or decisions that result from the review.

Floyd Phillips.

DEPARTMENT OF ENERGY AND MINES
FEB 7 1997
PETROLEUM BRANCH

Tundra
oil and gas ltd.

February 5, 1997

Petroleum and Energy Branch
1395 Ellice Avenue, Suite 360
Winnipeg, Manitoba
R3G 3P2

Attention: **Mr. J. Fox, P.Eng.**
Chief Petroleum Engineer

Dear John,

RE: Routledge Field
Reduced 8 Hectare Spacing Application

In reply to your letter dated 97.01.27 pertaining to the referenced subject matter, Tundra Oil and Gas Ltd. has the following feedback:

Question No.1: Location variation in oil/water contact in Scallion Member and impact on recovery.

The Scallion formation as outlined in the Discussion (Geology, Page 2) section of the application is a stratigraphic play with beds dipping in a northeast to southwest direction (refer to Figure No.4, Page 11). There appears to be local structural entrapment which would contribute to some variation in the oil/water contact in the area requested for reduced spacing. The variation in oil/water contact due to this reservoir phenomenon is about 1 to 2 metres between wells (refer to Appendix H), and would not significantly impact on recovery. Since the Scallion formation is highly stratified in the Routledge area, with natural fracturing, water coning due to this diagenetic feature may impact oil recovery more appreciably than local variations in the oil/water contact. The stratified nature of the reservoir with susceptibility to water coning is the primary reason for selecting reduced spacing to enhance oil recovery from this pool.

Question No.2: Discrepancy between Phi-h values in Figure No.3 and Table No.4.

There actually is no discrepancy between the phi-h values in Figure No.3 and Table No.4. Figure No.3 represents a phi-h map of the Scallion formation with local well phi-h values as noted. Table No.4 represents the average phi-h over the 16 heactare spacing area in each LSD. Porosity and

1111 - One Lombard Place, Winnipeg, Manitoba R3B 0X4 Telephone: (204) 934-5850 Fax: (204) 934-5820

Tundra
oil and gas ltd.

permeability cutoffs for the estimation of net oil pay in the Virden and Scallion Members were 9% and 1 md, respectively. Average net oil pay in the Virden and Scallion Members is estimated at 2 metres and 4 metres, respectively.

Question No.3: Method of estimating incremental oil recovery on 8 heactare spacing.

Tundra has estimated the incremental oil recovery attributable to infill drilling on 8 hectare spacing according to the following process. Table No.2 (page 20) indicates that the current and ultimate oil recovery on the existing producing lands is estimated at 10% and 17% of the oil-in-place, respectively. This falls short of the 25.9% of the oil-in-place ultimate recovery predicted in the Routledge Unit No.1 on 16 hectare spacing. The average ultimate oil recovery predicted for a pressure maintained oil reservoir (natural or mechanical) in Western Canada is projected to be 35% of the oil-in-place. Taking this into consideration, plus infill drilling on 8 hectare spacing, a maximum ceiling for ultimate recovery in the reduced spacing area was set at 35% of the oil-in-place. The Branch has implied in their question that an incremental oil recovery of 35% of the oil-in-place would be achieved with infill drilling. This is clearly not the case. The average infill well on 8 hectare spacing is projected to recover about 37,000 STB of oil which compares favourably to the ultimate recovery of 39,000 STB estimated for the existing wells (refer to Table No.7, page 25). Based on this approach, an ultimate recovery of 23% of the oil-in-place is forecasted with infill drilling in the total reduced spacing area (refer to Table No.7, page 25). This compares favourably with the aforementioned Chevron Unit ultimate oil recovery.

Question No.4: Pan Canadian is listed as the mineral owner of lands in the NE/4 of Section 19-9-25 (WPM) and the SE/4 of Section 31-9-25 (WPM). Who is lessee?

Tundra Oil and Gas Ltd. (TOGL) does not have the subject lands under lease. TOGL advises that the Branch contact the mineral owner directly to obtain this information.

Should you have any further questions pertaining to the subject application, please feel free to call me at 204-934-5853.

Tundra
oil and gas ltd.

Yours truly,

TUNDRA OIL AND GAS LTD.

G. Czyzewski

George Czyzewski, P.Eng.
General Manager

Manitoba

Energy and Mines Petroleum

1395 Ellice Avenue Suite 360
Winnipeg MB R3G 3P2
CANADA

PH: (204) 945-6577
Fax: (204) 945-0586

28-Jan-97

Mr. R. Riopka
Director, Corporate Planning and Business Development
Department of Rural Development
600, 800 Portage Avenue
Winnipeg MB R3G 0N4

Dear Mr. Riopka:

Re: Application for Reduced Oil Well Spacing under The Oil and Gas Act

The Petroleum and Energy Branch has received an application from Tundra Oil and Gas Ltd. for reduced 8 ha spacing in Section 29-9-25 (WPM) in the Routledge Field. A copy of the notice of application is attached for your reference. With previous applications for reduced spacing the Branch has consulted with the Departments of Rural Development, Agriculture and Environment. This consultation has proven useful and has ensured land use and environmental issues are addressed and appropriate development conditions are included in the Branch's approval. With respect to this particular application, the Department of Natural Resources is the owner of the surface and has been involved with the Branch and the applicant in extensive preparatory work. A copy of a flora and fauna survey carried out by the applicant at the request of Natural Resources is attached for your reference.

As a result of the involvement of Natural Resources, with their dual responsibility as owner of the surface and their role in integrated resource management, it is suggested that involvement of the other departments in review of this application would be a duplication of effort. Please let me know if you agree with this suggestion or if you would be like to be involved in the review process. I can be reached at (204) 945-6574 or e-mail at jfox@em.gov.mb.ca.

Yours truly,

John Fox, P.Eng.
Chief Petroleum Engineer

cc. Ken McGill, Manitoba Agriculture
Floyd Phillips, Manitoba Environment

January 27, 1997

Bob Wooley
Director, Western Region
Manitoba Natural Resources

John N. Fox
Chief Petroleum Engineer
Petroleum & Energy Branch

Application for Reduced 8 ha Spacing - Routledge Field

Tundra Oil and Gas Ltd. has applied for reduced 8 ha spacing in Section 29-9-25 (WPM) in the Routledge Field. Attached are copies of the application and results of the flora and fauna investigation carried out last fall. The application will be advertised in the local papers with a deadline for objections and interventions of February 28, 1997.

I propose the recommendations in the flora and fauna investigation form the basis of the development plan. Please advise me of any questions or concerns Natural Resources may have with the application. In accordance with our joint informational notice your comments would be appreciated by February 28, 1997. Any questions please don't hesitate to call me at (204) 945-6574.

John Fox

Manitoba

Energy and Mines

Petroleum

1395 Ellice Avenue Suite 360
Winnipeg MB R3G 3P2
CANADA

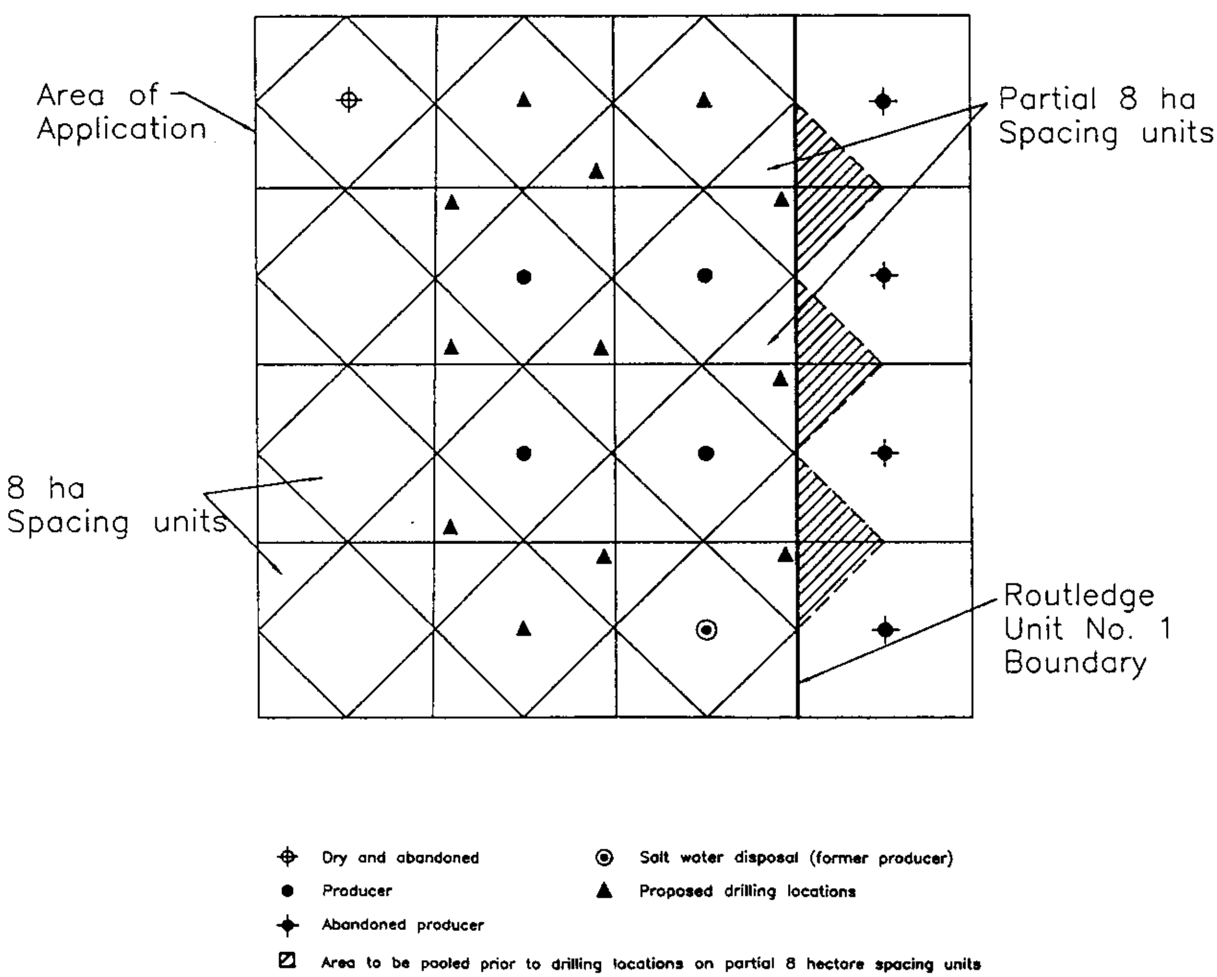
PH: (204) 945-6577
Fax: (204) 945-0586

NOTICE UNDER
THE OIL AND GAS ACT

Application for Reduced 8 Hectare Spacing in the Routledge Field

Tundra Oil and Gas Ltd. has made application under Section 102 of The Oil and Gas Act to reduce the size of spacing units from 16 hectares (40 acres) to 8 hectares (20 acres) in the portion of the Routledge Field shown below ("area of application"). If the application is approved, Tundra Oil and Gas Ltd. plans to drill as many as 12 wells in the area of application. Prior to drilling a well in a partial 8 ha spacing unit bordering Routledge Unit No. 1, all tracts of land in the area highlighted must be included in a pooling agreement or order.

SECTION 29-9-25 (WPM)



If you have any questions or require further information regarding the application, you may contact the company or the Petroleum and Energy Branch at:

George Czyzewski, P.Eng.
General Manager
Tundra Oil and Gas Ltd.
1111-One Lombard Place
Winnipeg MB R3B 0X4
Phone: (204) 934-5853

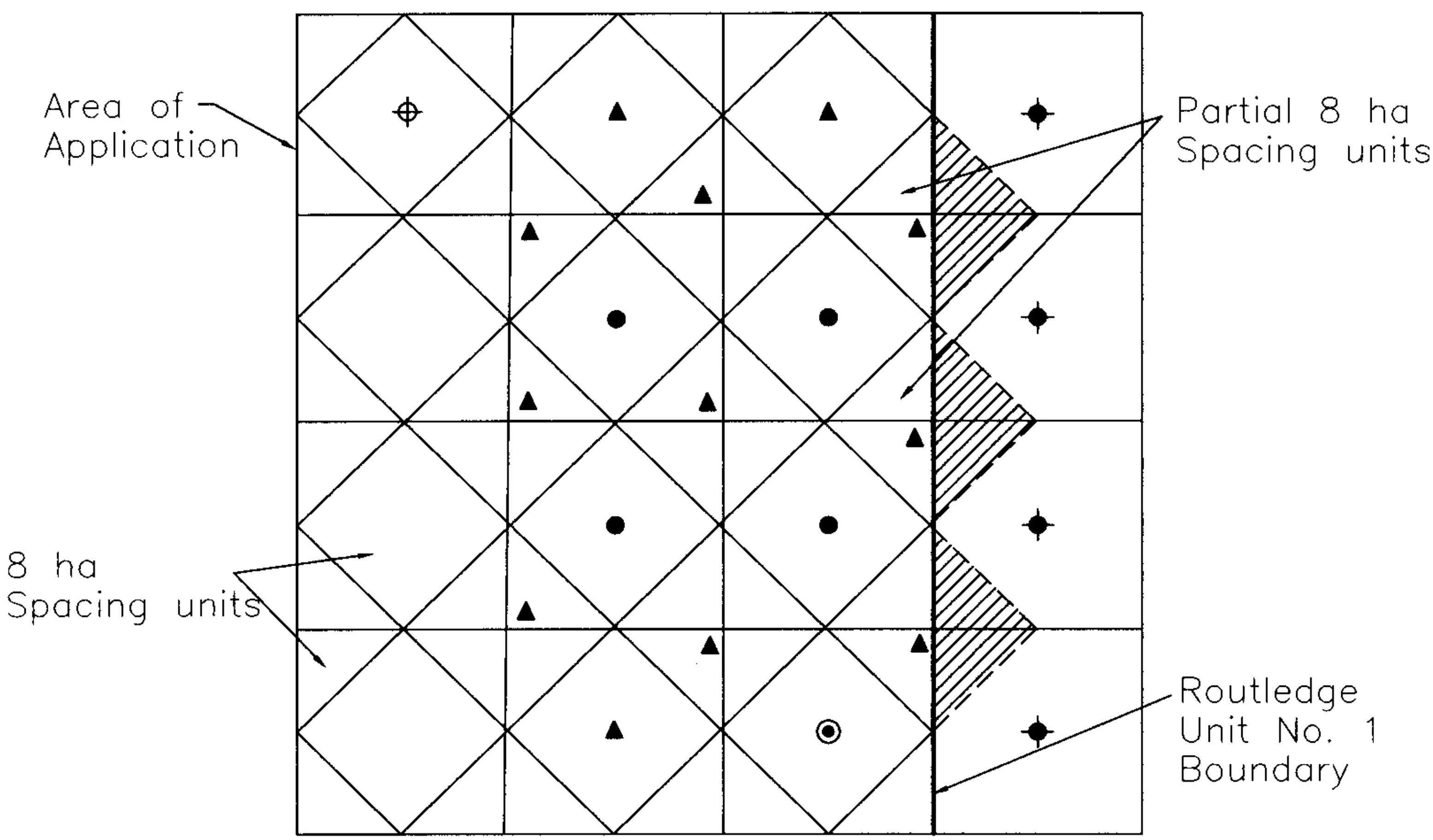
John Fox, P.Eng.
Chief Petroleum Engineer
Petroleum and Energy Branch
1395 Ellice Avenue, Suite 360
Winnipeg MB R3G 3P2
Phone: (204) 945-6574
Fax: (204) 945-0586
e-mail: jfox@em.gov.mb.ca

If no objections or interventions are received by the Petroleum and Energy Branch in writing by February 28, 1997, the application may be approved.

JAN 27, 1997
Date

L. R. Dubreuil
Director of Petroleum

SECTION 29-9-25 (WPM)



- ⌖ Dry and abandoned
- ● Producer
- ✦ Abandoned producer
- ◉ Salt water disposal (former producer)
- ▲ Proposed drilling locations
- ▨ Area to be pooled prior to drilling locations on partial 8 hectare spacing units

mornings from 9:00 to 10:00 a.m. at the Virden Odd Fellows Hall. The cost is $30.00 per month, or pay a drop-in fee of $4.00 per class. Come on out and start stepping!

Adult volleyball will be held Wednesday nights, February 5, 12, 19 and 26, at the Virden Junior High. The time is from 7:45 to 9:30 p.m., and there is a $2.00 drop-in fee.

Adult badminton will be held on Monday nights from February 3 to March 10 at the Virden Junior High gym. The time is 7:45 to 9:30 p.m., and the cost is $15.00.

Gymtastics will be held at the p.m., beginning on February 17 and continuing until April 14 in the Virden Junior High Band Room. The cost is $40.

A floor hockey program is being offered for those 18 and over at the Virden Junior High gym on Tuesday nights. This takes place from 7:45 to 9:30 p.m., and the cost is $2.00 each drop in.

Come on out and have some fun!

For more information, phone Prairie West Recreation at 748-2542.

"One of the greatest labor-saving inventions of today is tomorrow." — Vincent T. Foss

"Don't just talk about how good you are—come and show us."

Manitoba Energy and Mines

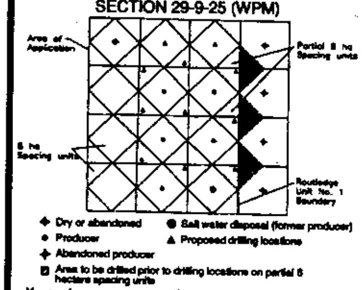
NOTICE

UNDER THE OIL AND GAS ACT

Application for Reduced 8 Hectare Spacing in the Routledge Field

Tundra Oil and Gas Ltd. has made application under Section 102 of The Oil and Gas Act to reduce the size of spacing units from 16 hectares (40 acres) to 8 hectares (20 acres) in the portion of the Routledge Field shown below ("area of application"). If the application is approved, Tundra Oil and Gas Ltd. plans to drill as many as 12 wells in the area of application. Prior to drilling a well in a partial 8 ha spacing unit bordering Routledge Unit No. 1, all tracts of land in the area highlighted must be included in a pooling agreement or order.

SECTION 29-9-25 (WPM)



- Dry or abandoned
- Salt water disposal (former producer)
- Producer
- Proposed drilling locations
- Abandoned producer
- Area to be drilled prior to drilling locations on partial 8 hectare spacing units

If you have any questions or require further information regarding the application, you may contact the company or the Petroleum and Energy Branch at:

George Czyzewski, P. Eng.
General Manager
Tundra Oil and Gas Ltd.
1111-One Lombard Place
Winnipeg, MB R3B 0X4
Phone (204) 934-5853

John Fox, P. Eng.
Chief Petroleum Engineer
Petroleum and Energy Branch
1395 Ellice Avenue, Suite 360
Winnipeg, MB R3G 3P2
Phone (204) 945-6574
Fax: (204) 945-0586
e-mail: jfox@em.gov.mb.ca

If no objections or interventions are received by the Petroleum and Energy Branch in writing by February 28, 1997, the application may be approved.

L.R. Dubreuil
Director of Petroleum

revision may be made in accordance with sections ... of the Assessment Act:

APPLICATION FOR REVISION

42 (1) A person in whose name property has been assessed, a mortgagee in possession of property under section 114(1) of The Real Property Act, an occupier of premises who is required under the terms of a lease to pay the taxes on the property, or the assessor may make application for revision of an assessment roll with respect to;

a) liability to taxation;
b) amount of an assessed value;
c) classification of property; or
d) a refusal by an assessor to amend the assessment roll under Subsection 13(2).

APPLICATION REQUIREMENTS:

43(1) An application for revision must

(a) be made in writing;
(b) set out the roll number and legal description of the assessable property for which a revision is sought;
(c) state the grounds on which the application is based; and
(d) be filed by
  (i) delivering it or causing it to be delivered to the office indicated in the public notice given under subsection 41(2), or
  (ii) serving it upon the secretary, at least 15 days before the scheduled sitting date of the board as indicated in the public notice.

The Board of Revision will sit on March 27th, 1997 at 10:00 a.m. in the council chamber of the Rural Municipality of Archie in the town of McAuley to hear applications.

The final date on which applications must be received by the Secretary of the Board is March 12th, 1997.

Dated this 5th day of February, 1997
Dawna Jamieson, Secretary, Board of Revision
Rural Municipality of Archie
Box 67, McAuley, MB R0M 1H0

Manitoba

Energy and Mines Petroleum

1395 Ellice Avenue Suite 360
Winnipeg MB R3G 3P2
CANADA

PH: (204) 945-6577
Fax: (204) 945-0586

27-Jan-97

Mr. George Czyzewski, P.Eng.
General Manager
Tundra Oil and Gas Ltd.
1111 One Lombard Place
Winnipeg MB R3B 0X4

Dear Mr. Czyzewski:

Re: Reduced 8 ha Spacing Application - Routledge Field

The Petroleum and Energy Branch has completed a preliminary review of the subject application. Attached is a copy of the notice of application to be published in the Virden Empire Advance and Southwestern Gazette and sent to royalty and working interest owners in and within 0.5 km of the area of application. Manitoba Natural Resources, as surface owner, will also be involved in the application review.

The reduced spacing area has been modified slightly to coincide with lands operated by Tundra. The lands in Routledge Unit No. 1, Lsd's 1, 8, 9 & 16 in Section 29 have been excluded. However, the Branch recognizes that infill drilling adjacent to the unit boundary may result in incremental recovery. Therefore the notice contains the proviso that infill drilling on the partial 8 ha spacing units bordering the unit may be allowed if non-unit and unit tracts are pooled by agreement or order. The Branch requests Tundra initiate discussions with Chevron Canada Resources, the operator of Routledge Unit No. 1, regarding their position on the application. Support from Chevron for reduced spacing could expedite disposition of the application.

The Branch has the following technical questions regarding the application:

(1) Comment on the variation between wells in the observed oil/water contact in the Scallion Member and the effect on recovery in the area of application.

(2) There appears to be a discrepancy between the phi-h values in Figure 3 and the phi-h values in Table 4. Tundra is to provide the following additional information with respect to OOIP estimates; net pay cut-offs (log & core) and average net pay, porosity and permeability for the Virden and Scallion Members in the area of application.

(3) Tundra's estimate for incremental recovery from 8 ha spacing appears to be based on a theoretical primary recovery of 35% OOIP. Compared to Chevron's estimate of ultimate recovery on 16 ha spacing in Routledge Unit No. 1 of 25.9%, Tundra estimate appears high. Please comment on Tundra's ultimate recovery estimate for 8 ha spacing.

(4) Are the lands in the NE/4 of Sec. 19-9-25 (WPM) and the SE/4 of Sec. 31-9-25 (WPM), where Pan Canadian is listed as the mineral owner, under lease? If so, who is lessee? This information should be provided to the Branch as quickly as possible.

If you have any questions in respect of this deficiency letter please contact the undersigned at (204) 945-6574.

Yours truly,

John N. Fox, P.Eng.
Chief Petroleum Engineer

Manitoba

Memorandum

Date January 20, 1997

To Michael Fine
Deputy Minister
Energy and Mines

From Bob Dubreuil
Director
Petroleum & Energy Branch

Telephone

Subject **Application for Reduced 8 ha Spacing - Virden Field**

First | Fold

Tundra Oil and Gas Ltd. has applied for reduced 8 ha spacing in Section 29-9-25 (WPM) in the Virden Field (see attached figure). The company currently operates 5 wells on Section 29 and proposes to drill as many as 12 additional wells if the application is approved.

The Crown is the surface owner in Section 29 and Natural Resources (DNR) is responsible for administration of the lands. Section 29 has been identified as habitat for the rare Western Spiderwort plant which grows on sand dunes. In Jan/97 the W/2 of the section was designated a WMA without direct consultation with our department. Of the 7 separate Crown oil and gas leases covering the section, only 2 contain the special condition:

"the lessee shall, prior to commencement of geophysical, drilling, production or other related operations in the lease area, obtain the approval of the director of Petroleum Branch of a plan of operations"

Tundra, in consultation with the Branch and DNR, carried out a flora and fauna site investigation in September 1996. The site survey identified a number of different types of habitat in Section 29:

- sand dunes along the NW border and south central portion of the section
- aspen forest in the S/2 and NW/4 of the section
- meadow and mixed grass prairie in the N/2 and SE/4 of the section

The NE/4 is in agricultural use for wild hay production with pasture along the NE margin of the section. Other land uses include recreational activities; hunting and snowmobiling.

The survey identified no rare plant species (Western Spiderwort or Purple Pin-Cushion Cactus) on the proposed infill drilling locations. The survey indicated there will be some impacts on wildlife including loss or isolation of habitat, displacement due to activity/noise and potential increased access for recreational uses. The survey identified a number of development conditions, listed below, to mitigate any adverse impacts from infill drilling:

1) avoid drilling during migratory bird nesting season (late-April to mid-July) unless a survey indicates the absence of nesting sites;

2) minimize the area of disturbance;

3) avoid development activities during wet ground conditions;

4) rehabilitation using specific prairie seed mixtures; and

5) consider limiting drilling activity during hunting season and in the winter (to avoid disturbing/displacing deer from their wintering area).

In its review of the application, DNR indicated additional inventories and surveys - flora inventory, spring breeding bird survey and winter white tailed deer survey are required to adequately assess the impact of development.

We believe that the proposed measures will successfully mitigate the adverse effects of the proposed development and that the additional surveys requested by DNR cannot be justified. Tundra has intimated it is not prepared to conduct any further surveys in the area.

John Fox and I are meeting with DNR in Brandon on May 16, and we hope to iron out our differences. However, if we are unable to come to some mutually acceptable solution, it might be necessary for you to raise the issue with David Tomasson. I will keep you advised.

The project has the potential to generate over $10 million in resource revenue including $1.4 million in Crown royalties over the next 10 years.

Bob Dubreuil

cc: John N. Fox

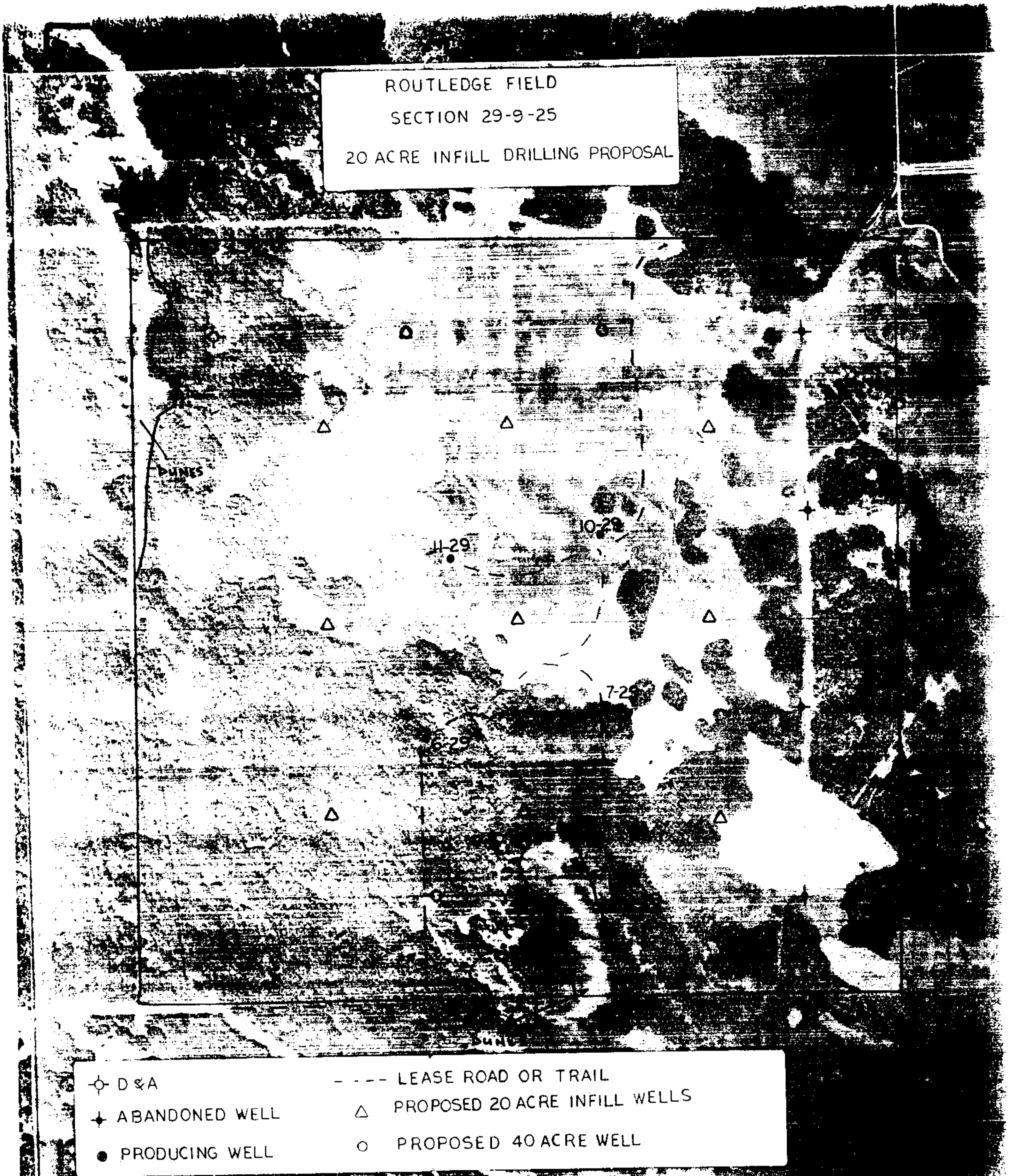

ROUTLEDGE FIELD
SECTION 29-9-25
20 ACRE INFILL DRILLING PROPOSAL
DUNES
11-29
10-29
7-29
6-29
D&A
ABANDONED WELL
PRODUCING WELL
LEASE ROAD OR TRAIL
PROPOSED 20 ACRE INFILL WELLS
PROPOSED 40 ACRE WELL

FIG. 5

January 20, 1997

Bob Dubreuil
Director
Petroleum & Energy Branch

John N. Fox
Chief Petroleum Engineer
Petroleum & Energy Branch

Application for Reduced 8 ha Spacing - Routledge Field

Tundra Oil and Gas Ltd. has applied for reduced 8 ha spacing in Section 29-9-25 (WPM) in the Routledge Field.

Recommendation

It is recommended that notice of the application be published in the Virden Empire Advance and the Southwestern Gazette and sent to royalty and working interest owners in and within 0.5 km of the area of application and to Natural Resources, the surface owner in Section 29. It is also suggested that with Natural Resources' involvement, Environment and Agriculture do not need to be involved in a review of the project.

Project Outline

Tundra has applied to reduce spacing in Section 29-9-25 (WPM) from 16 ha to 8 ha (see Fig. 1). Tundra operates 4 producers and a disposal well on Section 29. The company proposes in three phases to drill as many as 12 additional wells (see Fig. 1). Table 1 is a list of the proposed infill locations. It should be noted that three of the planned wells are actually 16 ha locations; 3-29, 14-29 & 15-29. In additional Tundra has indicated that the wells planned for Phase 3, with the exception of 3-29, may not be "commercially viable".

<u>Table 1</u>

Phase 1 - 3D-29, 11A-29, 14A-29, 15-29

Phase 2 - 2D-29, 7D-29, 10D-29

Phase 3 - 3-29, 6B-29, 11B-29, 11C-29, 14-29

The infill locations proposed in Phase 2, 2D-29, 7D-29 and 10D-29, are located on proposed 8 ha spacing units that extend in Routledge Unit No. 1. In order to drill these wells, Tundra would have to pool the lands or conversely the unit would have to be enlarged. Tundra has not discussed the application with Chevron Canada Resources, the unit operator of Routledge Unit No. 1. It is recommended that Tundra be requested to initiate discussions with Chevron to determine their position on the application.

Notice of the application will be published in the Virden Empire Advance and the Southwestern Gazette and sent to the royalty and working interest owners in and within 0.5 km of the area of application. A copy of the notice will be sent to Chevron, unit operator of Routledge Unit No. 1, as representative for all owners in the unit. A copy of the notice will also be sent to Manitoba Natural Resources (MNR) as the surface owner. MNR is aware of the project having consulted with Tundra regarding the flora and fauna survey for rare and endangered species the company carried out last year.

In the past reduced spacing applications have been reviewed by the Departments of Rural Development, Environment and Agriculture. In this case it is suggested that a review of the application by MNR, who as part of their review process will involve Agricultural Crown Lands (NE/4 of Sec. 29 is under a renewable hay permit), will be adequate to ensure all environmental and land use concerns are addressed.

A copy of the proposed notice is attached. It is recommended that the 8 ha spacing units that straddle the Routledge Unit No. 1 boundary be included in the area of application and the notice include the provision:

"Prior to drilling a well in a partial 8 ha spacing unit bordering Routledge Unit No. 1, all tracts of land in the area highlighted must be included in a pooling agreement or order."

This provision recognizes that the reduced spacing proposal by Tundra has merit and also eliminates the situation where one operator is applying for reduced spacing on another operator's lands.

Reservoir Characteristics and Production History

Wells in Section 29 produce from the Lower Virden and Scallion Members in the Virden Lodgepole C Pool (see Fig. 2). The Lower Virden reservoir consists of a series of oolitic limestone beds separated by tight stringers. The oolitic limestone beds range in thickness from 0.4 to 1.85 m in the wells examined. The underlying Scallion Member contains the majority of oil-in-place in the project area. The Scallion Member receives strong pressure support from a bottom water drive. A pressure survey at 6-29 in July/94 indicated the reservoir pressure has declined slightly from the original pressure of 6550 kPa (DST - Nov/84) to 6368 kPa. The estimated oil/water contact in the Scallion varies from -202.5 to -206.8 m subsea and appears to be lithologically controlled.

This type of stratified reservoir is not an ideal horizontal drilling candidate.

Tundra estimates OOIP in Section 29 of 555.7 10^3m^3. Tundra has divided the OOIP as shown in Table 2.

Table 2

	OOIP Total (10^3m^3)	OOIP per well (10^3m^3)	Recoverable Reserves (10^3m^3)	Recoverable Reserves per well (10^3m^3)	Rec. Factor (%)
Developed Lands					
- Non-Unit	285.5	57.1	49.7	9.9	14.4
- Unit	147.0	36.8	6.0	1.5	4.1
Undeveloped Lands	123.2	41.1	----------	--------	-------
Total Section 29*	555.7	46.3**	55.7	6.2	10.0

* excluding Lsd's 4-29, 5-29, 12-29 & 13-29

** OOIP per 16 ha

The Branch has examined logs and core analysis from three wells; 6-29, 7-29 & 10-29 and has estimated more net pay than Tundra. Tundra's Phi-h map (see Fig. 3) and tabular wellbore Phi-h estimates do not agree. Tundra will be requested to provide additional information on their OOIP estimate including net pay cut-offs and average net pay, porosity and permeability values for the Virden and Scallion Members.

Development in Section 29 took lace at two different times. The wells in Routledge Unit No. 1 were drilled between 1960-65 and produced until 1972. Cumulative production from these wells was 6016.5 m3 (see Table 2). In 1985 Saskoil extended the productive limits of the C Pool by drilling the 6-29 well. The 7-29 & 10-29 wells were drilled in 1986, 2-29 in 1989 and 11-29 in 1994. The four current producing wells (2-29 has been converted to disposal) produce a total of 8.8 m^3 OPD at a 84% water-cut. Cumulative production to 31-Oct-96 is 27,378 m3 or 9.6% OOIP. Production from these wells has been characterized by a steadily increasing water-cut and corresponding decline in oil production. The straight line observed on the log water-cut vs cumulative production plot (see Fig. 4) confirms bottom water influx from the Scallion Member. Tundra estimates ultimate recoverable reserves of 49,707 m3 or 17.4% OOIP (see Table 2).

Infill Drilling Recovery Predictions

Tundra estimates infill drilling, which includes (3) 16 ha locations at 3-29, 14-29 & 15-29, will recover an additional 126.6 10^3m^3, increasing recovery in Section 29 from 10% to 22.8% OOIP. The incremental recoverable reserves associated with each phase of the proposed project is shown on Table 3.

Table 3

	No. of Wells	Recoverable Reserves (10^3m^3)	Recoverable Reserves per well (10^3m^3)	Recovery Factor Sec. 29-9-25 Incremental (%)	Recovery Factor Sec. 29-9-25 Ultimate (%)
Developed Lands Unit & Non-Unit	9	55.7	6.2	-----	10.0
Phase 1	4	30.9	7.7	5.6	15.6
Phase 2	3	26.7	8.9	4.8	20.4
Phase 3	5	13.3	2.7	2.4	22.8
Total	21	126.6	6.0	12.8*	22.8

* Incremental recovery for 8 ha infill wells only - 9.7% OOIP

Tundra's incremental recovery estimate appears based on the assumption that on 8 ha spacing, wells in the pool are capable of recovering 35% of the OOIP. For Phases 1 & 2 Tundra has estimated an average recovery of 33% for the infill wells on 8 ha spacing. No technical evidence is provided to support of this theoretical primary recovery estimate. In Routledge Unit No. 1, the current recovery is

21.8% OOIP and Chevron estimates an ultimate recovery of 25.9% OOIP. Typical incremental recovery factors quoted for infill drilling in carbonate reservoirs are 2-9% OOIP. Tundra will be requested in the Branch's deficiency letter to provide technical support for their proposed 8 ha recovery factor of 33% OOIP.

Environmental and Land Use Concerns

Section 29-9-25 (WPM) has been identified as habitat for the endangered Western Spiderwort plant. Tundra, in consultation with the Branch and MNR carried out a flora and fauna site investigation in September 1996. The site survey identified a number of different types of habitat in Section 29 (see Fig. 5):

- sand dunes along the NW border and south central portion of the section
- aspen forest in the S/2 and NW/4 of the section
- meadow and mixed grass prairie in the N/2 and SE/4 of the section

The NE/4 is in agricultural use for wild hay production with pasture along the NE margin of the section. MNR indicated the W/2 of the section is to be designated a WMA. Other land uses include recreational activities; hunting and snowmobiling.

The survey identified no rare plant species (Western Spiderwort or Purple Pin-Cushion Cactus) on the proposed infill locations. Table 4 lists the habitat at each of the proposed infill locations.

Table 4

Infill Location	Habitat	Infill Location	Habitat
Phase 1		Phase 3	
3D-29	wooded forest	3-29	cleared forest
11A-29	well-drained meadow (hayed)	6B-29	wooded forest
14A-29	poorly drained meadow	11B-29	well-drained meadow margin
15-29	well-drained meadow (hayed)	11C-29	poorly drained meadow
		14-29	poorly drained meadow
Phase 2			
2D-29	well-drained meadow margin		
7D-29	well-drained meadow (hayed)		
10D-29	well-drained meadow (pasture)		

The survey indicated there will be some impacts on wildlife including loss or isolation of habitat, displacement due to activity/noise and potential increased access for recreational uses. These impacts however are not a major concern. The survey identified a number of development conditions, listed below, to mitigate any adverse impacts from infill drilling:

1) avoid drilling during migratory bird nesting season, late-April to mid-July, unless a survey is conducted for the presence of nesting sites;

2) minimizing the area of disturbance;

3) avoid development activities during wet ground conditions;

4) rehabilitation should be done using specific prairie seed mixtures; and

5) consider limiting drilling activity during hunting season and in the winter (to avoid disturbing/displacing deer from their wintering area).

NOTICE UNDER
THE OIL AND GAS ACT

Application for Reduced 8 Hectare Spacing in the Routledge Field

Tundra Oil and Gas Ltd. has made application under Section 102 of The Oil and Gas Act to reduce the size of spacing units from 16 hectares (40 acres) to 8 hectares (20 acres) in the portion of the Routledge Field shown below ("area of application"). If the application is approved, Tundra Oil and Gas Ltd. plans to drill as many as 12 wells in the area of application. Prior to drilling a well in a partial 8 ha spacing unit bordering Routledge Unit No. 1, all tracts of land in the area highlighted must be included in a pooling agreement or order.

If you have any questions or require further information regarding the application, you may contact the company or the Petroleum and Energy Branch at:

George Czyzewski, P.Eng.
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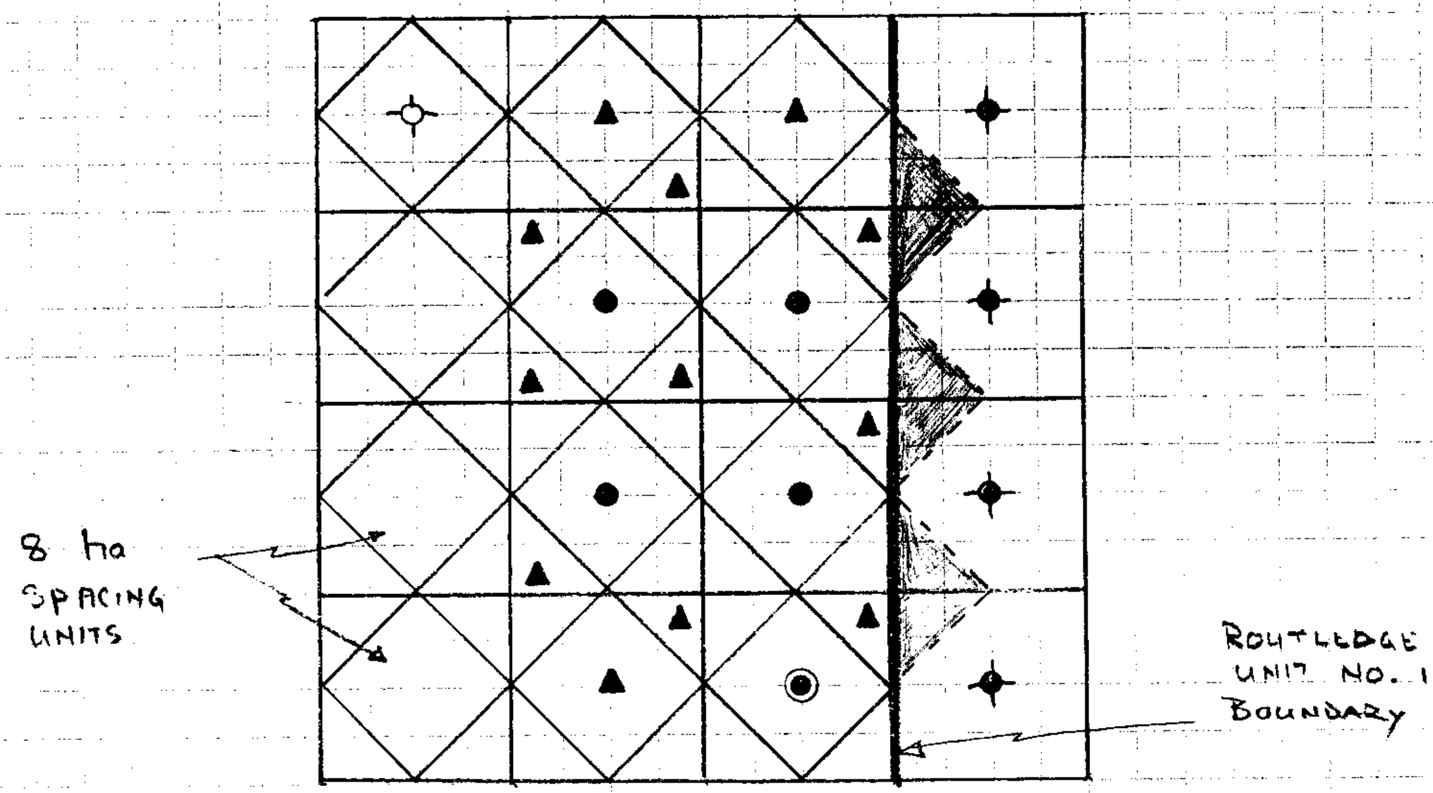
If no objections or interventions are received by the Petroleum and Energy Branch in writing by February 28, 1997, the application may be approved.

Date

L. R. Dubreuil
Director of Petroleum

SECTION 29-9-25 (WPM)



LEGEND

- PRODUCER
- ABANDONED PRODUCER
- ABANDONED DRY
- SALT WATER DISPOSAL
- PROPOSED DRILLING LOCATIONS
- AREA TO BE POOLED PRIOR TO DRILLING LOCATIONS ON PARTIAL 8 HECTARE SPACING UNITS

ROUTLEDGE FIELD

INFILL DRILLING PROGRAM

20 ACRE SPACING

SECTION 29-9-25

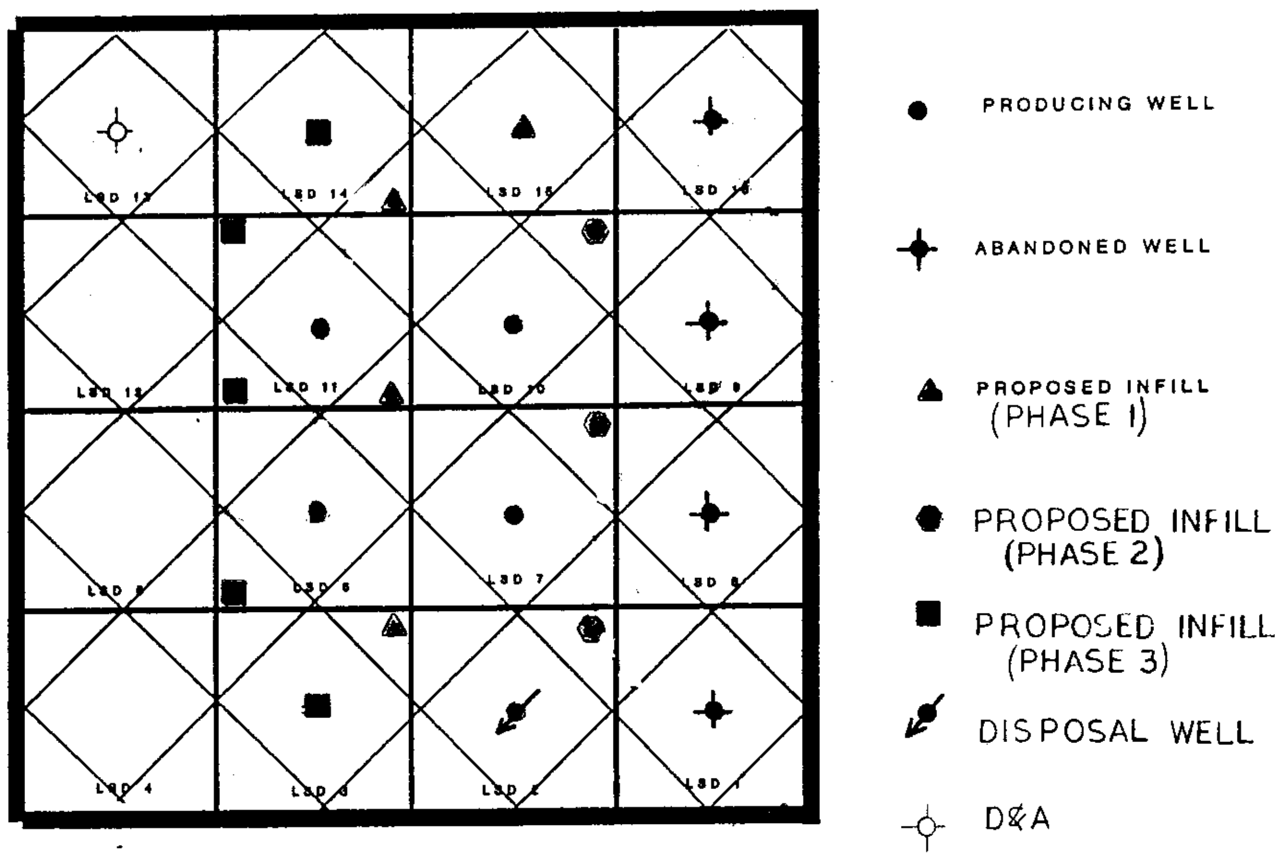
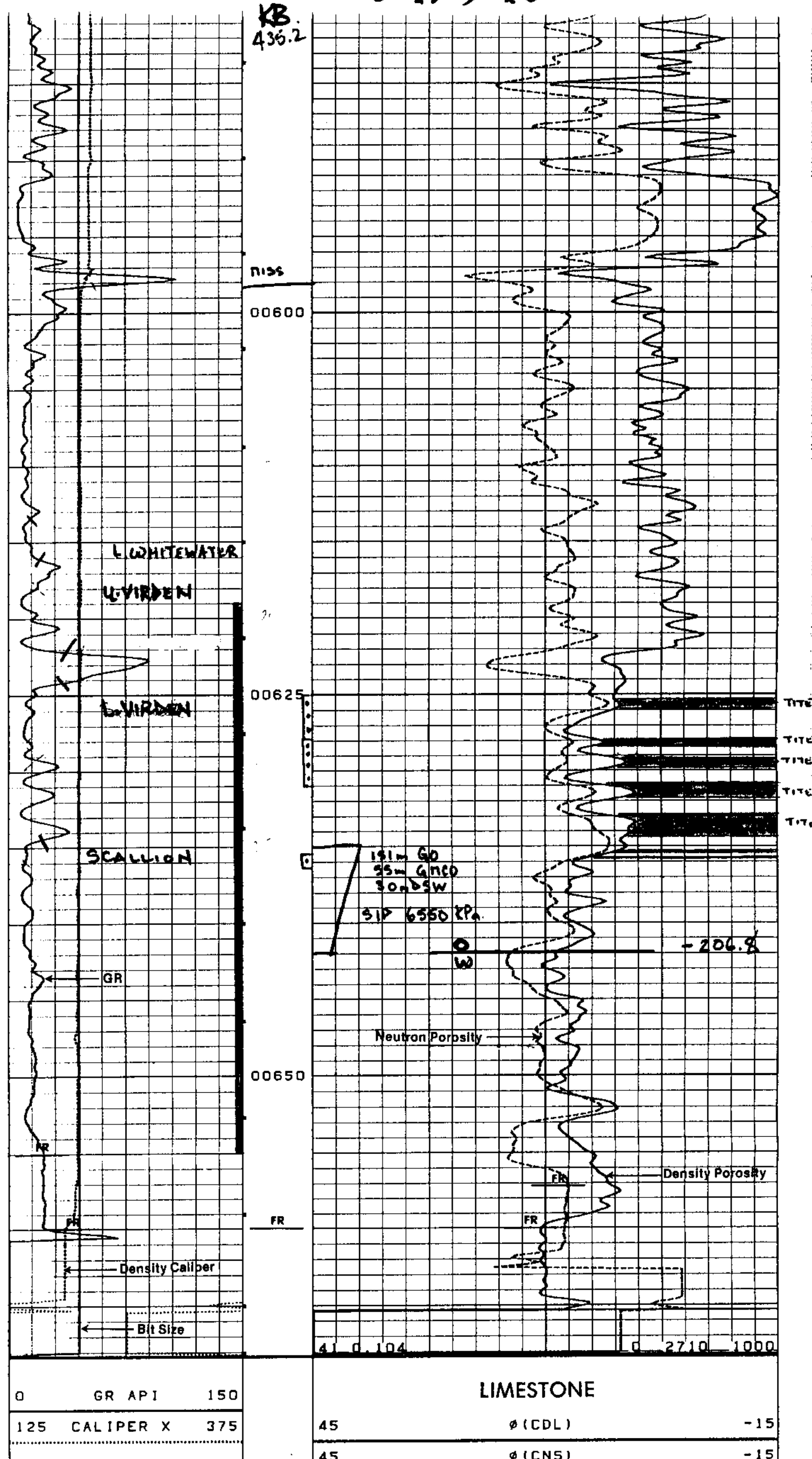


Fig. 1

6·29·9·25



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30m DSW
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Neutron Porosity
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FR
FR
FR
FR
Density Porosity
Density Caliper
Bit Size
41 0.104
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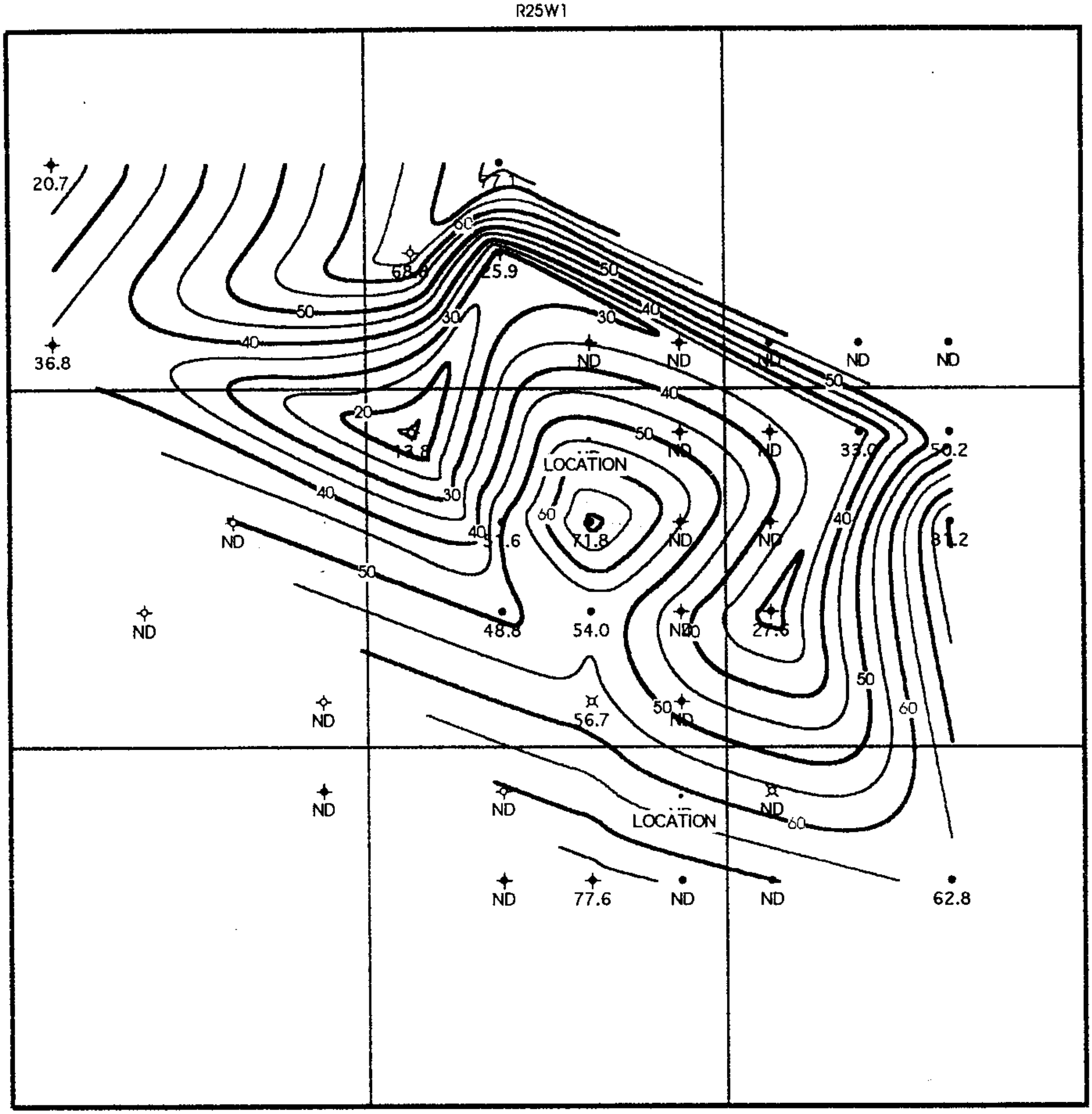
0 GR API 150
125 CALIPER X 375
LIMESTONE
45 ø(CDL) -15
45 ø(CNS) -15

FIG. 2

FIGURE NO. 3



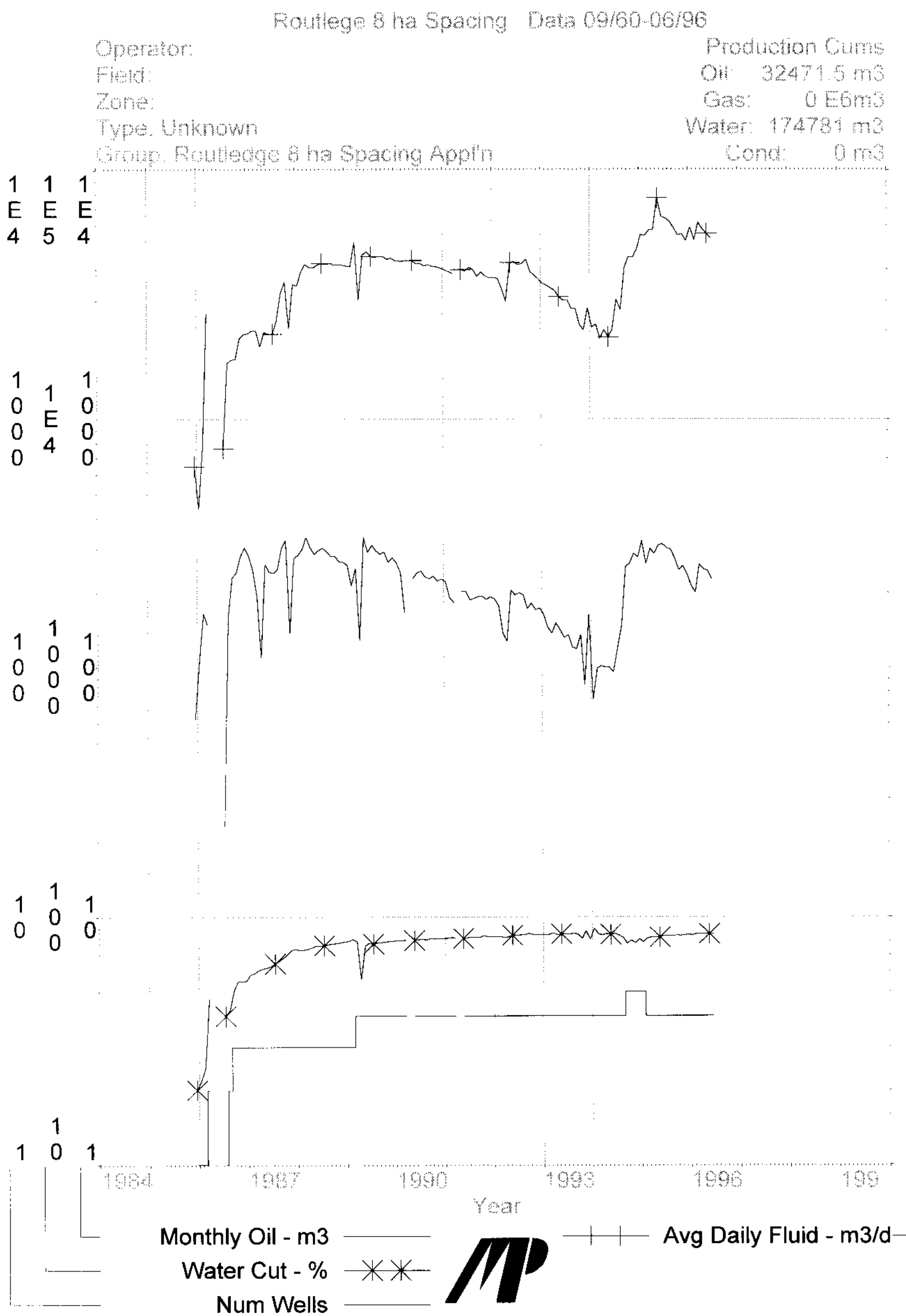
TUNDRA OIL AND GAS LTD.

WEST ROUTLEDGE

PHI-H at 5.0 Intervals

(1 km)

M.B. DUPONT	
Date:8/9/96	24000



Routlege 8 ha Spacing Data 09/60-06/96
Operator:
Field:
Zone:
Type: Unknown
Group: Routledge 8 ha Spacing Appl'n
Production Cums
Oil: 32471.5 m3
Gas: 0 E6m3
Water: 174781 m3
Cond: 0 m3
1984
1987
1990
1993
1996
199
Year
Monthly Oil - m3
Water Cut - %
Num Wells
Avg Daily Fluid - m3/d

FIG. 4

January 20, 1997

Bob Dubreuil
Director
Petroleum & Energy Branch

John N. Fox
Chief Petroleum Engineer
Petroleum & Energy Branch

Application for Reduced 8 ha Spacing - Routledge Field

Tundra Oil and Gas Ltd. has applied for reduced 8 ha spacing in Section 29-9-25 (WPM) in the Routledge Field.

Recommendation

It is recommended that notice of the application be published in the Virden Empire Advance and the Southwestern Gazette and sent to royalty and working interest owners in and within 0.5 km of the area of application and to Natural Resources, the surface owner in Section 29. It is also suggested that with Natural Resources' involvement, Environment and Agriculture do not need to be involved in a review of the project.

Project Outline

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Table 1

Phase 1 - 3D-29, 11A-29, 14A-29, 15-29

Phase 2 - 2D-29, 7D-29, 10D-29

Phase 3 - 3-29, 6B-29, 11B-29, 11C-29, 14-29

The infill locations proposed in Phase 2, 2D-29, 7D-29 and 10D-29, are located on proposed 8 ha spacing units that extend in Routledge Unit No. 1. In order to drill these wells, Tundra would have to pool the lands or conversely the unit would have to be enlarged. Tundra has not discussed the application with Chevron Canada Resources, the unit operator of Routledge Unit No. 1. It is recommended that Tundra be requested to initiate discussions with Chevron to determine their position on the application.

Notice of the application will be published in the Virden Empire Advance and the Southwestern Gazette and sent to the royalty and working interest owners in and within 0.5 km of the area of application. A copy of the notice will be sent to Chevron, unit operator of Routledge Unit No. 1, as representative for all owners in the unit. A copy of the notice will also be sent to Manitoba Natural Resources (MNR) as the surface owner. MNR is aware of the project having consulted with Tundra regarding the flora and fauna survey for rare and endangered species the company carried out last year.

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This provision recognizes that the reduced spacing proposal by Tundra has merit and also eliminates the situation where one operator is applying for reduced spacing on another operator's lands.

Reservoir Characteristics and Production History

Wells in Section 29 produce from the Lower Virden and Scallion Members in the Virden Lodgepole C Pool (see Fig. 2). The Lower Virden reservoir consists of a series of oolitic limestone beds separated by tight stringers. The oolitic limestone beds range in thickness from 0.4 to 1.85 m in the wells examined. The underlying Scallion Member contains the majority of oil-in-place in the project area. The Scallion Member receives strong pressure support from a bottom water drive. A pressure survey at 6-29 in July/94 indicated the reservoir pressure has declined slightly from the original pressure of 6550 kPa (DST - Nov/84) to 6368 kPa. The estimated oil/water contact in the Scallion varies from -202.5 to -206.8 m subsea and appears to be lithologically controlled.

This type of stratified reservoir is not an ideal horizontal drilling candidate.

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* excluding Lsd's 4-29, 5-29, 12-29 & 13-29

** OOIP per 16 ha

The Branch has examined logs and core analysis from three wells; 6-29, 7-29 & 10-29 and has estimated more net pay than Tundra. Tundra's Phi-h map (see Fig. 3) and tabular wellbore Phi-h estimates do not agree. Tundra will be requested to provide additional information on their OOIP estimate including net pay cut-offs and average net pay, porosity and permeability values for the Virden and Scallion Members.

Development in Section 29 took lace at two different times. The wells in Routledge Unit No. 1 were drilled between 1960-65 and produced until 1972. Cumulative production from these wells was 6016.5 m3 (see Table 2). In 1985 Saskoil extended the productive limits of the C Pool by drilling the 6-29 well. The 7-29 & 10-29 wells were drilled in 1986, 2-29 in 1989 and 11-29 in 1994. The four current producing wells (2-29 has been converted to disposal) produce a total of 8.8 m^3 OPD at a 84% water-cut. Cumulative production to 31-Oct-96 is 27,378 m3 or 9.6% OOIP. Production from these wells has been characterized by a steadily increasing water-cut and corresponding decline in oil production. The straight line observed on the log water-cut vs cumulative production plot (see Fig. 4) confirms bottom water influx from the Scallion Member. Tundra estimates ultimate recoverable reserves of 49,707 m3 or 17.4% OOIP (see Table 2).

Infill Drilling Recovery Predictions

Tundra estimates infill drilling, which includes (3) 16 ha locations at 3-29, 14-29 & 15-29, will recover an additional 126.6 10^3m^3, increasing recovery in Section 29 from 10% to 22.8% OOIP. The incremental recoverable reserves associated with each phase of the proposed project is shown on Table 3.

Table 3

	No. of Wells	Recoverable Reserves (10^3m^3)	Recoverable Reserves per well (10^3m^3)	Recovery Factor Sec. 29-9-25 Incremental (%)	Ultimate (%)
Developed Lands Unit & Non-Unit	9	55.7	6.2	-----	10.0
Phase 1	4	30.9	7.7	5.6	15.6
Phase 2	3	26.7	8.9	4.8	20.4
Phase 3	5	13.3	2.7	2.4	22.8
Total	21	126.6	6.0	12.8*	22.8

* Incremental recovery for 8 ha infill wells only - 9.7% OOIP

Tundra's incremental recovery estimate appears based on the assumption that on 8 ha spacing, wells in the pool are capable of recovering 35% of the OOIP. For Phases 1 & 2 Tundra has estimated an average recovery of 33% for the infill wells on 8 ha spacing. No technical evidence is provided to support of this theoretical primary recovery estimate. In Routledge Unit No. 1, the current recovery is

21.8% OOIP and Chevron estimates an ultimate recovery of 25.9% OOIP. Typical incremental recovery factors quoted for infill drilling in carbonate reservoirs are 2-9% OOIP. Tundra will be requested in the Branch's deficiency letter to provide technical support for their proposed 8 ha recovery factor of 33% OOIP.

Environmental and Land Use Concerns

Section 29-9-25 (WPM) has been identified as habitat for the endangered Western Spiderwort plant. Tundra, in consultation with the Branch and MNR carried out a flora and fauna site investigation in September 1996. The site survey identified a number of different types of habitat in Section 29 (see Fig. 5):

- sand dunes along the NW border and south central portion of the section
- aspen forest in the S/2 and NW/4 of the section
- meadow and mixed grass prairie in the N/2 and SE/4 of the section

The NE/4 is in agricultural use for wild hay production with pasture along the NE margin of the section. MNR indicated the W/2 of the section is to be designated a WMA. Other land uses include recreational activities; hunting and snowmobiling.

The survey identified no rare plant species (Western Spiderwort or Purple Pin-Cushion Cactus) on the proposed infill locations. Table 4 lists the habitat at each of the proposed infill locations.

Table 4

Infill Location	Habitat	Infill Location	Habitat
Phase 1		Phase 3	
3D-29	wooded forest	3-29	cleared forest
11A-29	well-drained meadow (hayed)	6B-29	wooded forest
14A-29	poorly drained meadow	11B-29	well-drained meadow margin
15-29	well-drained meadow (hayed)	11C-29	poorly drained meadow
		14-29	poorly drained meadow
Phase 2			
2D-29	well-drained meadow margin		
7D-29	well-drained meadow (hayed)		
10D-29	well-drained meadow (pasture)		

The survey indicated there will be some impacts on wildlife including loss or isolation of habitat, displacement due to activity/noise and potential increased access for recreational uses. These impacts however are not a major concern. The survey identified a number of development conditions, listed below, to mitigate any adverse impacts from infill drilling:

1) avoid drilling during migratory bird nesting season, late-April to mid-July, unless a survey is conducted for the presence of nesting sites;

2) minimizing the area of disturbance;

3) avoid development activities during wet ground conditions;

4) rehabilitation should be done using specific prairie seed mixtures; and

5) consider limiting drilling activity during hunting season and in the winter (to avoid disturbing/displacing deer from their wintering area).

NOTICE UNDER
THE OIL AND GAS ACT

Application for Reduced 8 Hectare Spacing in the Routledge Field

Tundra Oil and Gas Ltd. has made application under Section 102 of The Oil and Gas Act to reduce the size of spacing units from 16 hectares (40 acres) to 8 hectares (20 acres) in the portion of the Routledge Field shown below ("area of application"). If the application is approved, Tundra Oil and Gas Ltd. plans to drill as many as 12 wells in the area of application. Prior to drilling a well in a partial 8 ha spacing unit bordering Routledge Unit No. 1, all tracts of land in the area highlighted must be included in a pooling agreement or order.

SEE FOLLOWING PAGE
FOR FIGURE

If you have any questions or require further information regarding the application, you may contact the company or the Petroleum and Energy Branch at:

George Czyzewski, P.Eng.
General Manager
Tundra Oil and Gas Ltd.
1111-One Lombard Place
Winnipeg MB R3B 0X4
Phone: (204) 934-5853

John Fox, P.Eng.
Chief Petroleum Engineer
Petroleum and Energy Branch
1395 Ellice Avenue, Suite 360
Winnipeg MB R3G 3P2
Phone: (204) 945-6574
Fax: (204) 945-0586
e-mail: jfox@em.gov.mb.ca

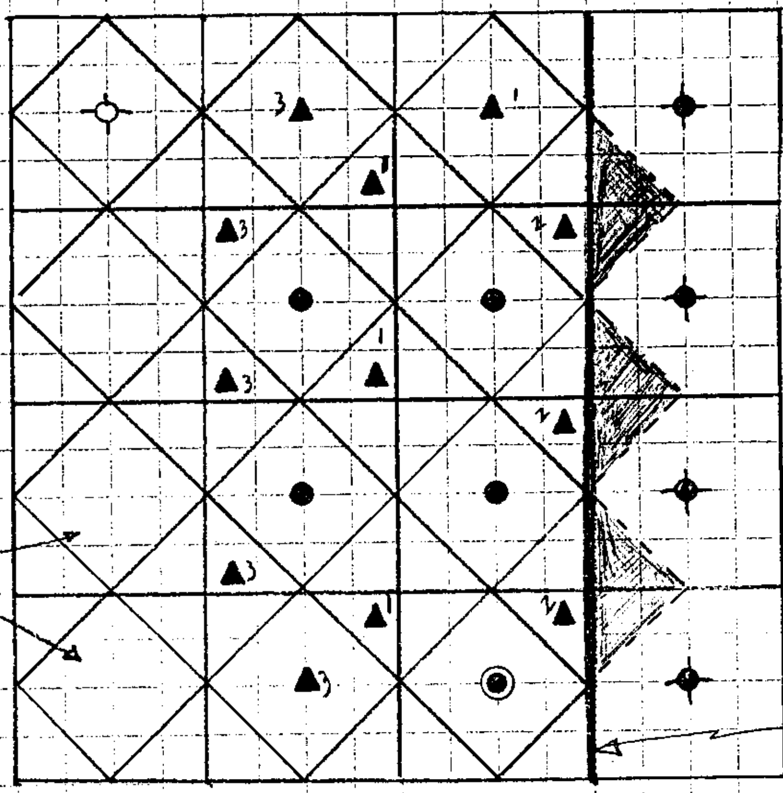
If no objections or interventions are received by the Petroleum and Energy Branch in writing by February 28, 1997, the application may be approved.

Date

L. R. Dubreuil
Director of Petroleum

FOR INCORPORATION
IN NOTICE

SECTION 29 · 9 · 25 (WPM)



8 ha
SPACING
UNITS

ROUTLEDGE
UNIT NO. 1
BOUNDARY

LEGEND

- PRODUCER
- ABANDONED PRODUCER
- ABANDONED DRY
- SALT WATER DISPOSAL

- PROPOSED DRILLING LOCATIONS

- AREA TO BE POOLED PRIOR TO DRILLING LOCATIONS ON PARTIAL 8 HECTARE SPACING UNITS

ROUTLEDGE FIELD

INFILL DRILLING PROGRAM

20 ACRE SPACING

SECTION 29-9-25

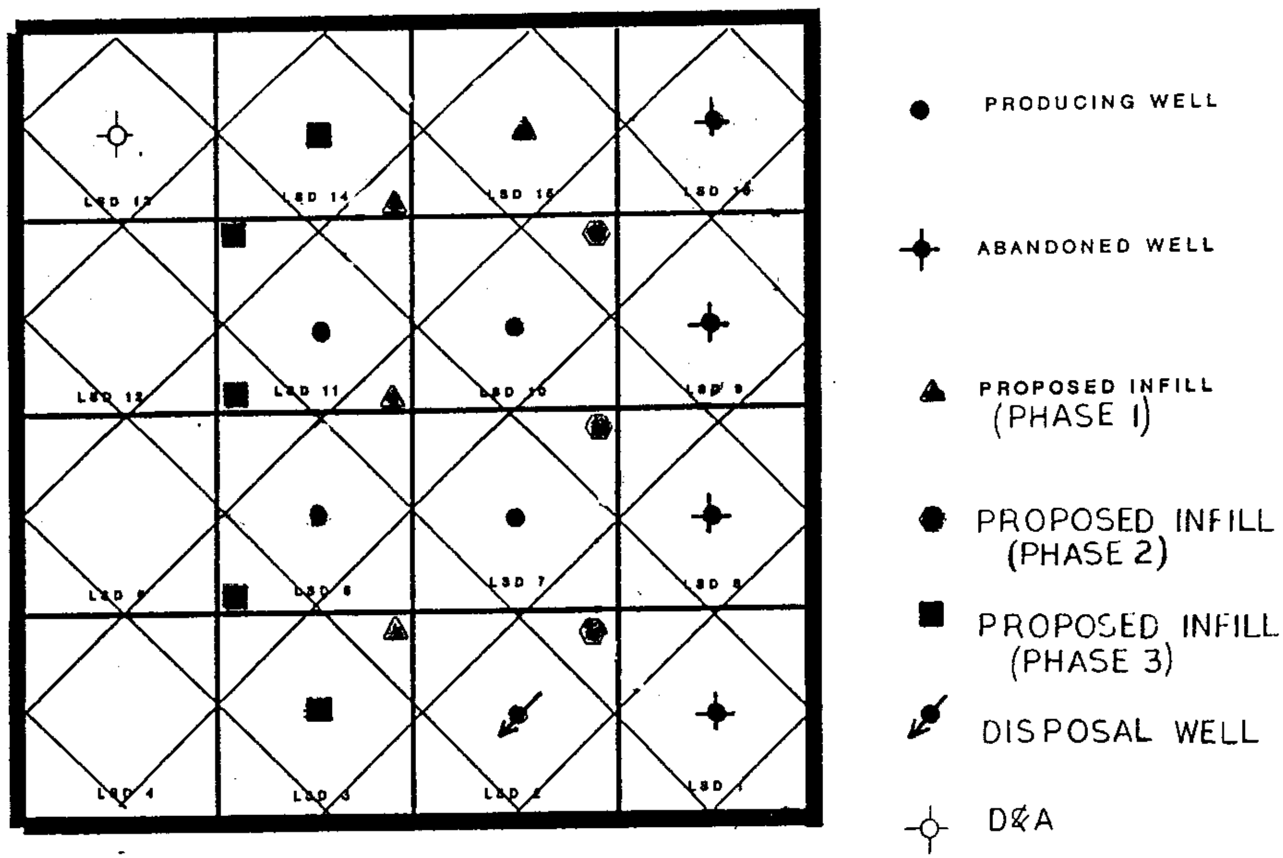


Fig. 1

6·29·9·25

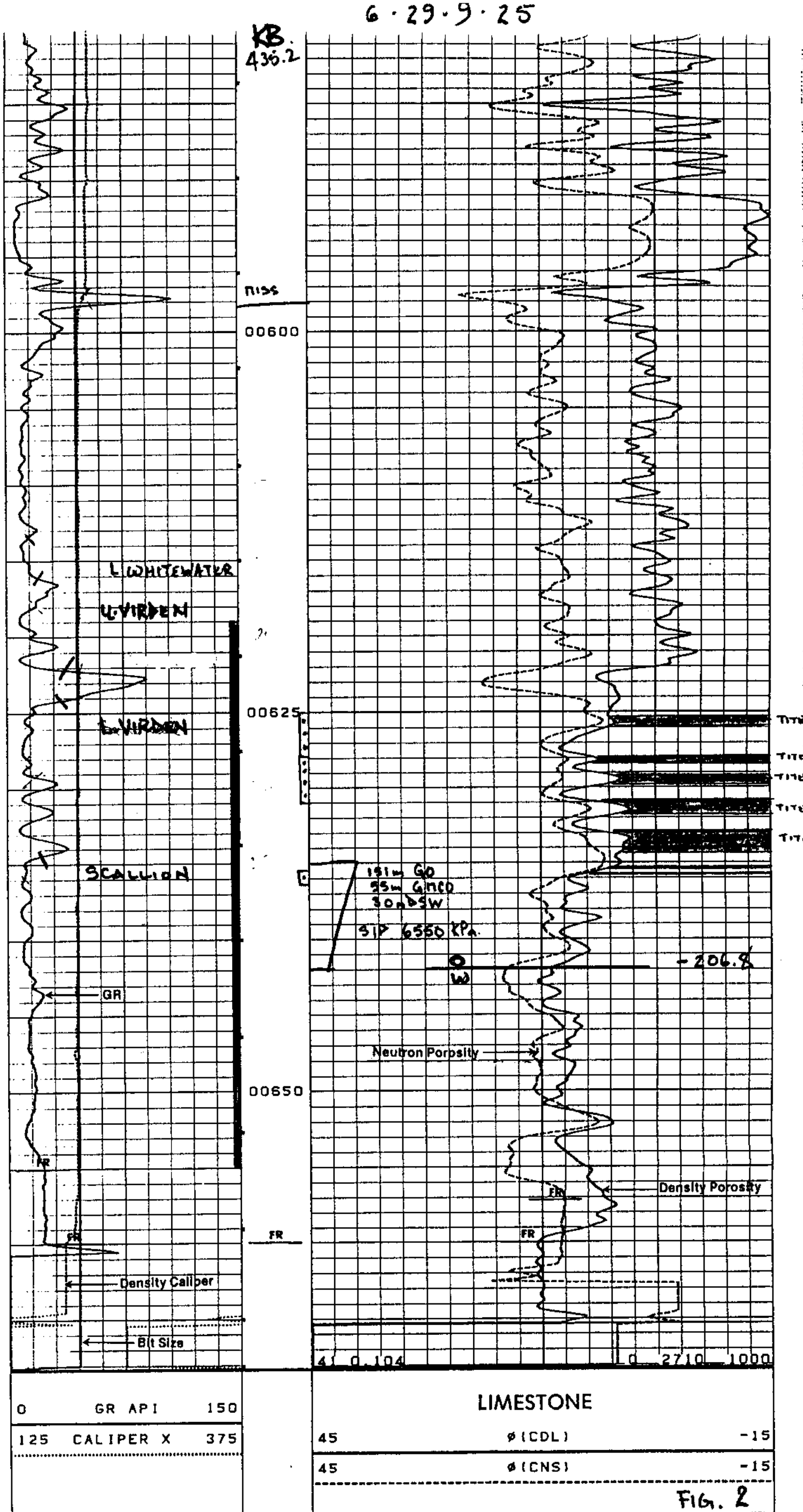
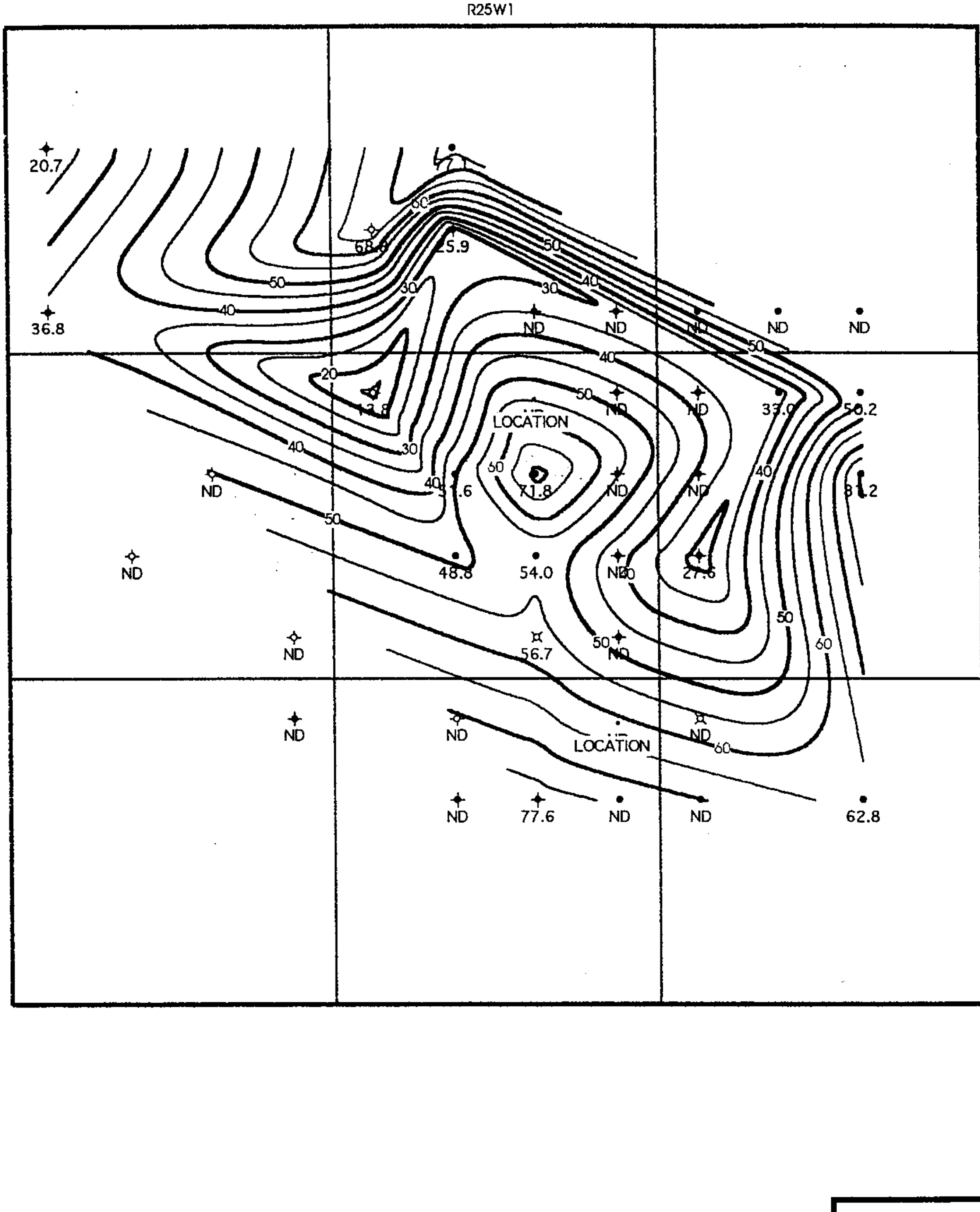

KB. 436.2
MSS
00600
L.WHITEWATER
U.VIRDEN
00625
L.VIRDEN
SCALLION
151m GO
55m GMCO
30mDSW
SIP 6550 KPa
O
W
-206.8
TITE
TITE
TITE
TITE
TITE
GR
Neutron Porosity
00650
FR
Density Porosity
FR
FR
FR
Density Caliper
Bit Size
41 0 104
0 2710 1000
0 GR API 150
125 CALIPER X 375
LIMESTONE
45 ø(CDL) -15
45 ø(CNS) -15

FIG. 2

FIGURE NO. 3



TUNDRA OIL AND GAS LTD.

WEST ROUTLEDGE

PHI-H at 5.0 Intervals

(1 km)

M.B. DUPONT	
Date:8/9/96	24000

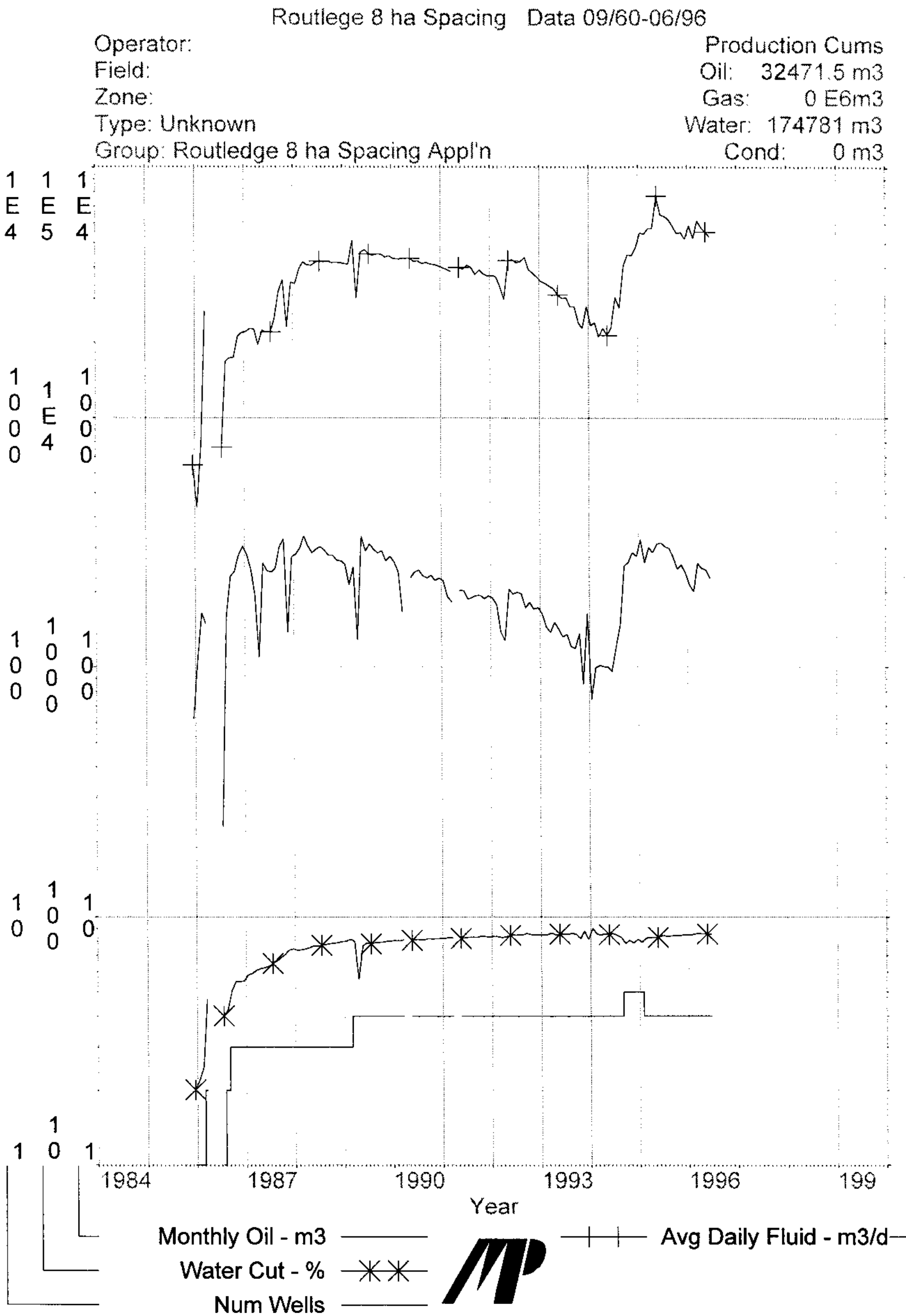

Routlege 8 ha Spacing Data 09/60-06/96
Operator:
Field:
Zone:
Type: Unknown
Group: Routledge 8 ha Spacing Appl'n
Production Cums
Oil: 32471.5 m3
Gas: 0 E6m3
Water: 174781 m3
Cond: 0 m3
1984
1987
1990
1993
1996
199
Year
Monthly Oil - m3
Water Cut - %
Num Wells
Avg Daily Fluid - m3/d

FIG. 4

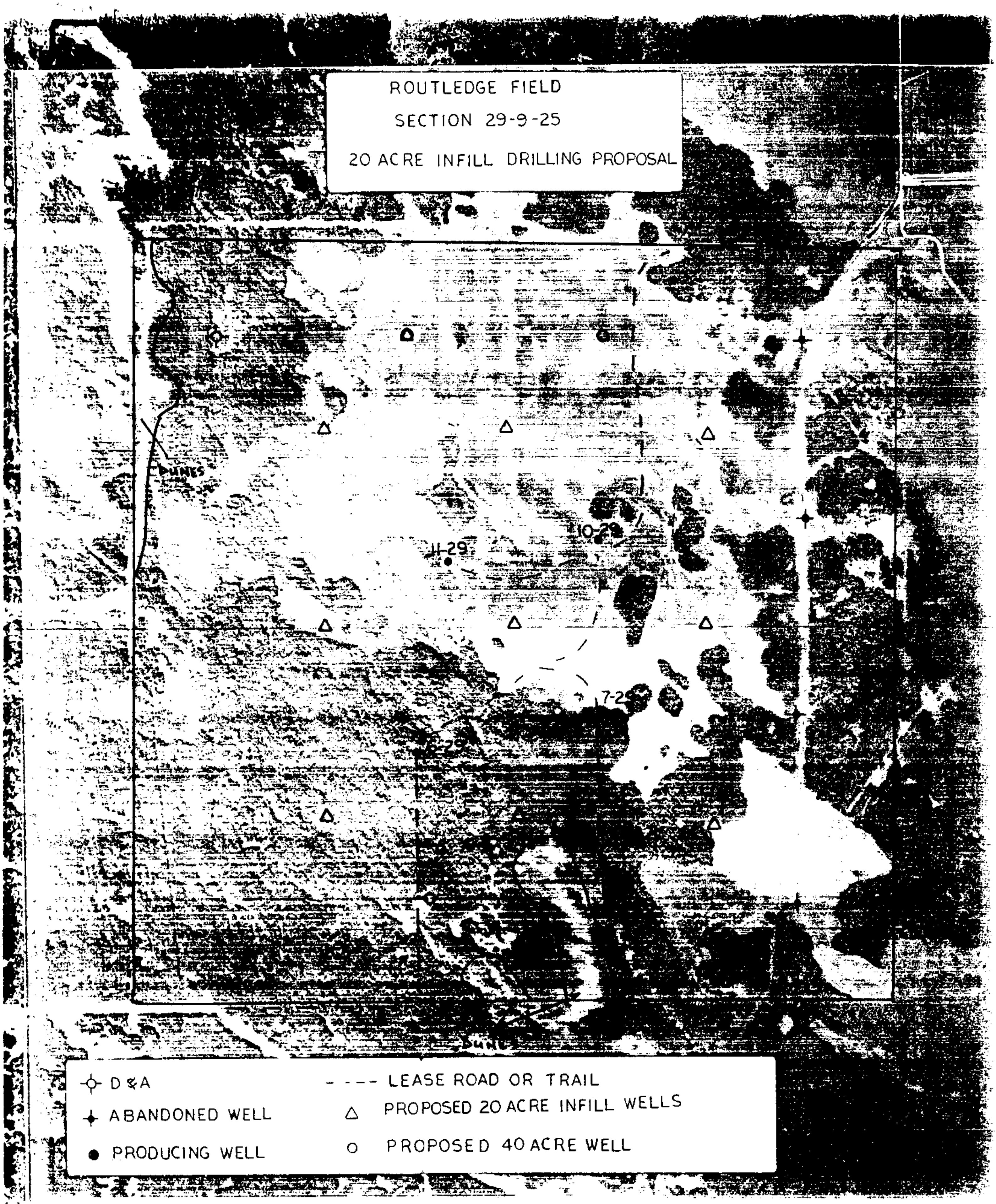
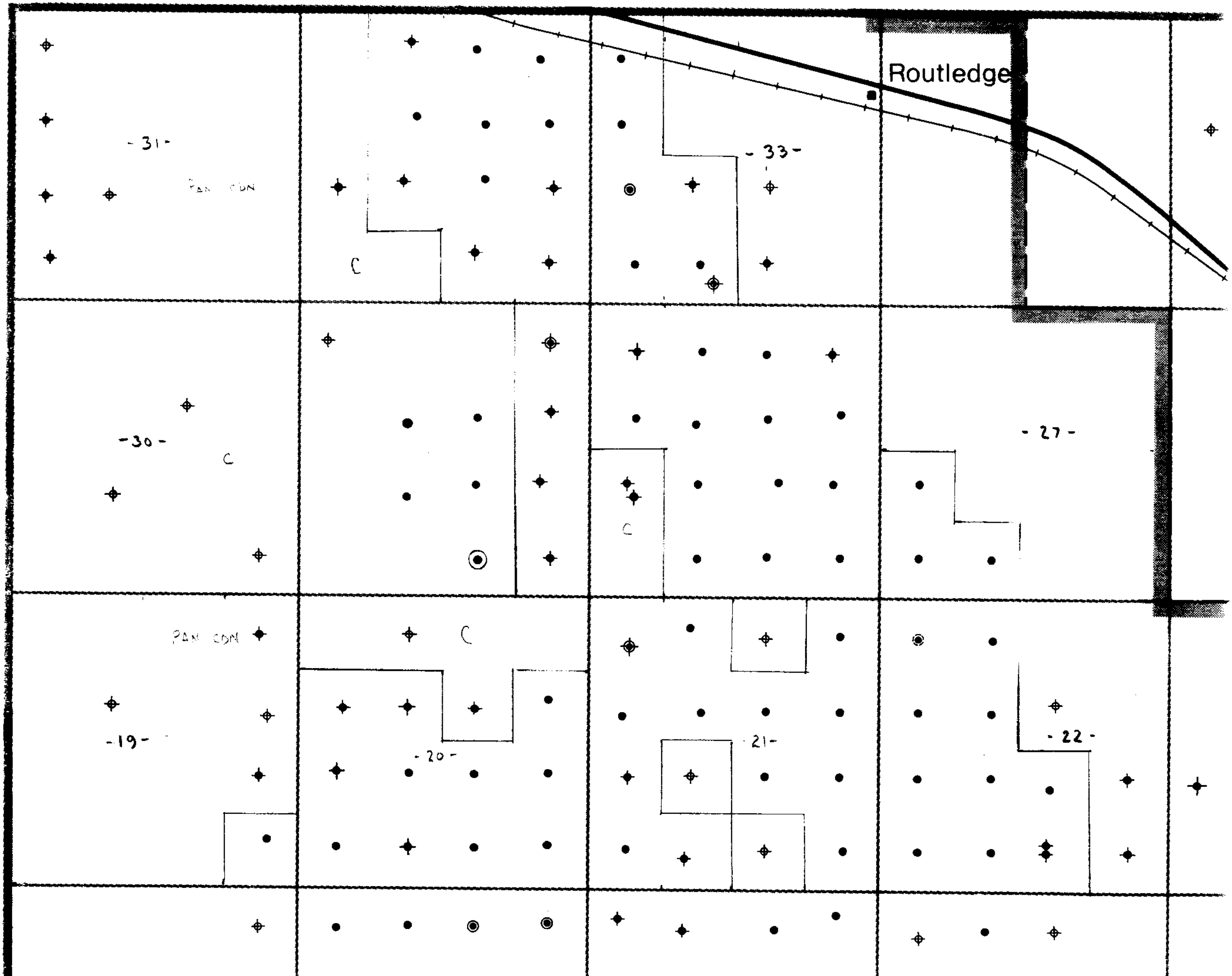

ROUTLEDGE FIELD
SECTION 29-9-25
20 ACRE INFILL DRILLING PROPOSAL
DUNES
11-29
10-29
7-29
D & A
ABANDONED WELL
PRODUCING WELL
LEASE ROAD OR TRAIL
PROPOSED 20 ACRE INFILL WELLS
PROPOSED 40 ACRE WELL

FIG. 5



Routledge
-31-
PAN CON
-33-
C
-30-
C
-27-
C
PAN CON
C
-19-
-20-
-21-
-22-

TABLE NO.7

ROUTLEDGE FIELD

INCREMENTAL RECOVERY WITH INFILL DRILLING

LSD	OOIP (STB)	Infill Well	Risk	OOIP in 8 ha Drainage Area (STB)	ROIP 8 Ha Spacing (STB)	LSD	ROIP 16 Ha Spacing (STB)	Existing Well Ult. Rec. (STB)	Infill Well Increm. Rec. (STB)	Total Rec. Factor (% OOIP)
LSD 1-29	230,570	11a-29-9-25	Low	177,371	53,211	LSD 1-29	80,700	8,740	0	4
LSD 2-29	376,598	3d-29-9-25	Low	171,216	51,365	LSD 2-29	131,809	14,190	51,719	18
LSD 3-29	287,012	14a-29-9-25	Low	150,141	45,042	LSD 3-29	100,454	0	94,417	33
LSD 6-29	349,698	15-29-9-25	Low	149,871	44,961	LSD 6-29	122,394	110,000	11,283	35
LSD 7-29	356,423	7d-29-9-25	Medium	153,488	58,326	LSD 7-29	124,748	64,900	58,326	35
LSD 8-29	218,561	10d-29-9-25	Medium	145,653	58,261	LSD 8-29	76,496	14,945	0	7
LSD 9-29	262,874	2d-29-9-25	Medium	147,769	51,719	LSD 9-29	92,006	11,800	0	4
LSD 10-29	390,048	3-29-9-25	High	143,506	43,052	LSD 10-29	136,517	72,650	58,261	34
LSD 11-29	322,798	14-29-9-25	High	188,539	20,739	LSD 11-29	112,979	51,300	62,090	35
LSD 14-29	188,539	6b-29-9-25	High	159,178	11,283	LSD 14-29	65,989	0	65,782	35
LSD 15-29	299,741	11b-29-9-25	High	168,124	5,044	LSD 15-29	104,909	0	44,961	15
LSD 16-29	212,557	11c-29-9-25	High	127,834	3,835	LSD 16-29	74,395	2,370	0	1
TOTAL	**3,495,419** ✓			**1,882,689**	**446,838**		**1,223,397**	**350,895**	**446,838**	**23**
								55760 m^3		
verage / Wel	**291,285**			**156,891**	**37,236**		**101,950**	**38,988**	**37,236**	

53/ 16 ha OOIP

TOTAL OOIP 1,882,689 + 1,223,397 = 3,106,086 stb
(493586 m^3)

ULT. REC 25.7 %

- AVERAGE INFILL RECOVERY
PHASE 1 (4 wells) - 7730 m^3/well (36%)
PHASE 2 (3 wells) - 8915 m^3/well (37.8%)
PHASE 3 (5 wells) - 2668 m^3/well (10.7%)

TOTAL INCREMENTAL ROIP = 71007 m^3 (ROIP 53725 m^3 excluding 40 ac wells 3,14 & 15-29)

ROUTLEDGE FIELD

INFILL DRILLING PROGRAM

20 ACRE SPACING

SECTION 29-9-25

PREDICTED ULTIMATE RECOVERABLE RESERVES (m^3)

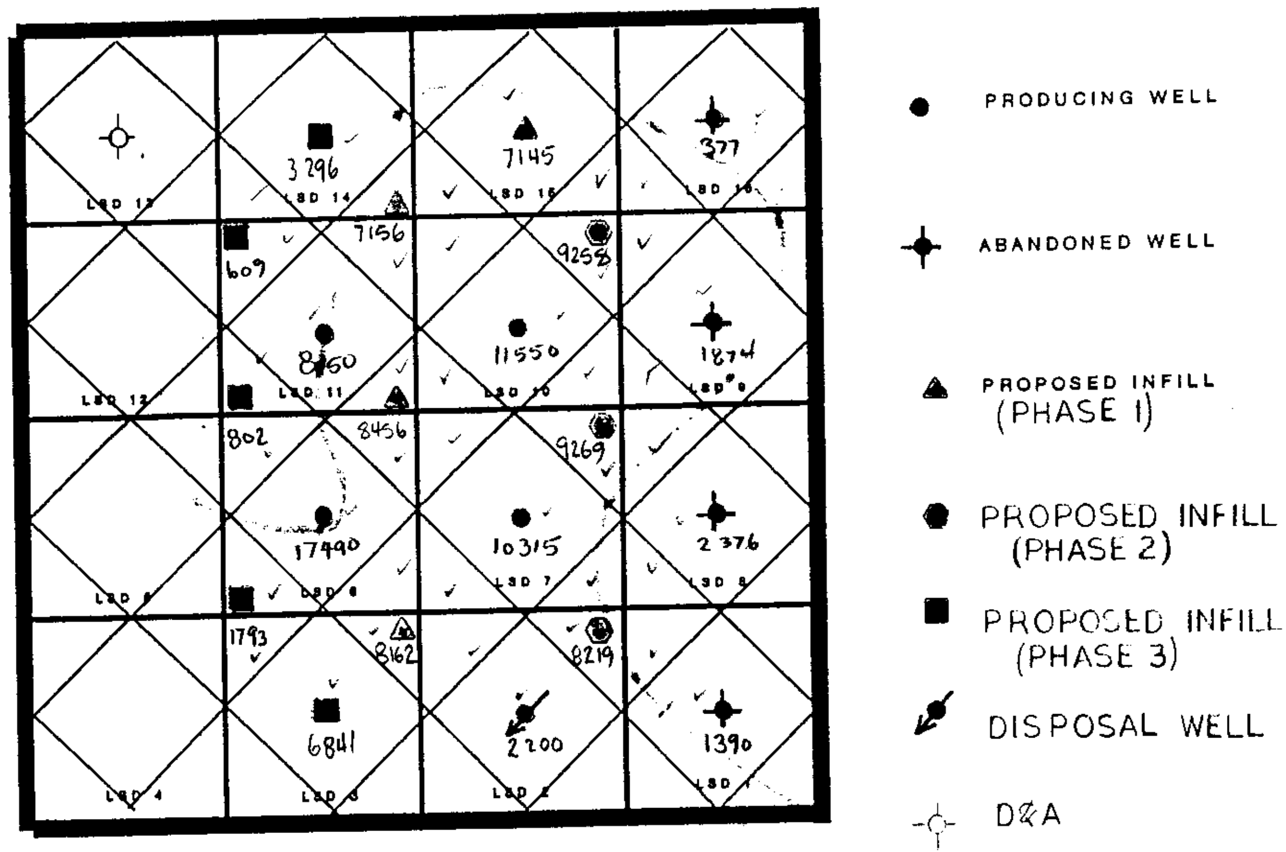


FIGURE No. 10

ROUTLEDGE FIELD

INFILL DRILLING PROGRAM

20 ACRE SPACING

SECTION 29-9-25

PREDICTED ULTIMATE RECOVERY (% OOIP)

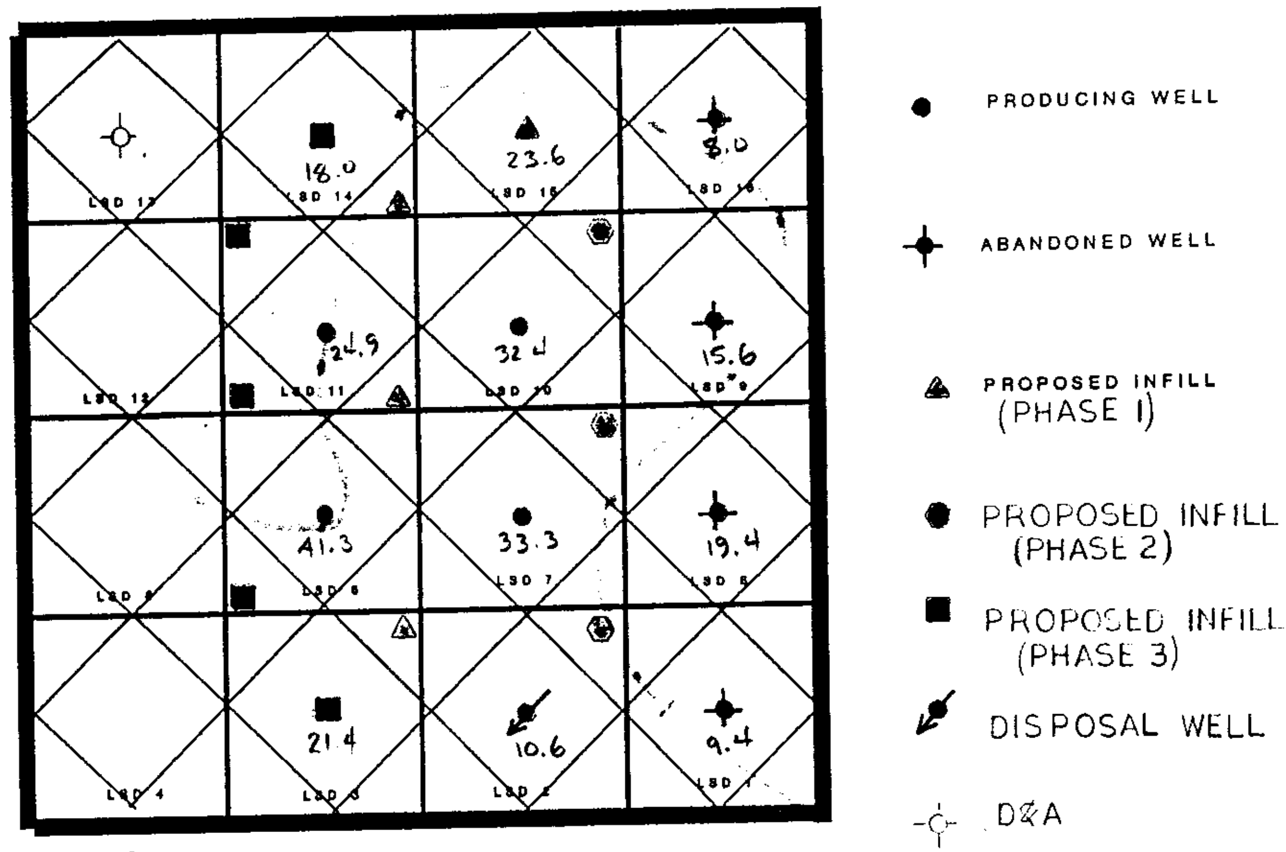


FIGURE N..1C

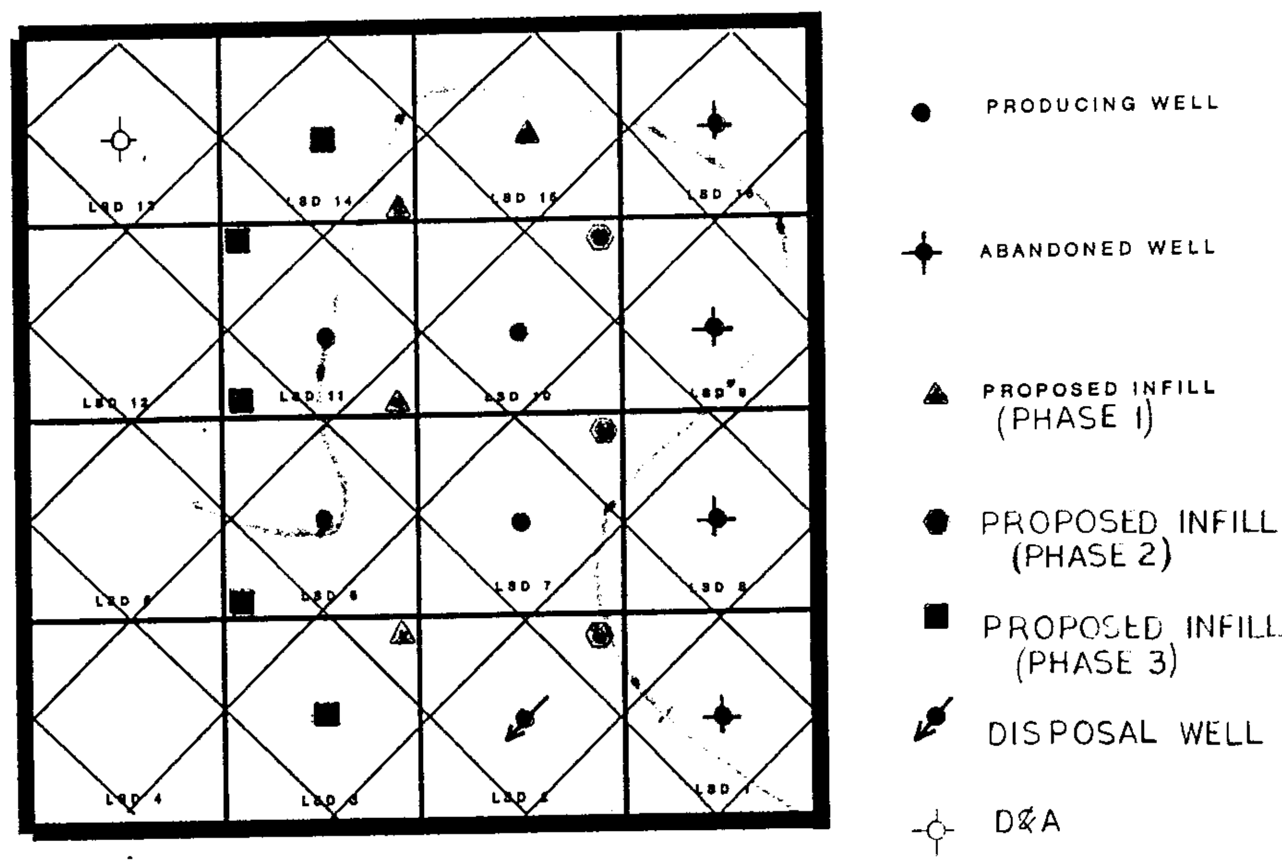
FIGURE No. 10

ROUTLEDGE FIELD

INFILL DRILLING PROGRAM

20 ACRE SPACING

SECTION 29-9-25



ROUTLEDGE LODGEPOLE C POOL

20 AC SPACING APPL'N

1/ AREA OF APPLICATION — REVIEW ⟨ 0.5 Km mineral owners lessees ⟩

SEC 29-9-25
EXCLUDING UNIT TRACTS

- surface owners in area of application
- publish in Emporia Advance

- 12 16 ha spacing units, (5) developed

MINERAL OWNERS - PANCANADIAN + UNIT OPERATOR (LEASED ?)

CROWN N/2-20, SW/4-21, 29, E/2-30, SW/4-32
PAN CANADIAN NE/4-19, NW/4-21, SE/4-31
ROUTLEDGE UNIT NO. 1 - CHEVRON (UNIT OPERATOR)

SURFACE OWNER - MNR

2 RESERVES & RECOVERY

- SCALLION MBR WTR INFLUX
- reservoir stratified, not amenable to HZ drilling — REVIEW CORE

- current rec non-unit lands - 7% OOIP
- ult. rec 16 ha spacing - 12% OOIP)

- REVIEW UNIT RECOVERY, WELLS 1-29, 8-29, 9-29, 16-29

- 20 ac spacing Δ rec 10% OOIP
- 8 INFILL WELLS RECOVER 65000 m^3 ⇒ 8100 m^3/well

$OOIP_{wells}$: 285,460 m^3 (wellbore reserves - 5 Tundra wells)

$OOIP_{\text{area of application lsd's } 2,3,6,7,10,11,14,15}$: 408720 m^3 $OOIP_{\text{sec } 29}$: 556,182 m^3

- Øh map has limited well data - do wells penetrate only the top of the Sealillie mbr.
  - Øh values on map & on table different
- is the Sealillie mbr the only productive mbr in Sec 29

- STRUCTURE MAP - top of Virden Coaloid ?
  is there a more appropriate structure map ie Øtop

3/ PRODUCTION

Tundra wells

- current prod Oct/96 9.8 m^3 OPD @ 87% wc
- cumul. prod 31 OCT 96 : 27276 m^3
- current recovery 10% OOIP ult. rec 17% OOIP 49705 m^3

- decline rate d_{exp} = 11.6% p.a. , economic limit 0.16 m^3OPD

DRAINAGE AREAS based 30% recovery

6-29 - 14.6 ha
7-29, 10-29 & 11-29 ≈ 8 ha
2-29 - 2 ha

4/ PRESSURE DATA

6-29 [illegible] - 640 kPa

- Routledge Unit No. 1 original pressure ?

5/ INFILL DRILLING Phase 1 - 3RD Qu/97

PHASE 1 - 15-29 (40 ac location)
14A-29
11A-29
3D-29

PHASE 2 - 10D-29
7D-29
1D-29

PHASE 3 - 14-29 (40 ac location)
11B-29 6B-29
11C-29 3-29 (40ac location)

- to drill Phase 2 infill wells would require pooling with unit lands or expansion of Routledge Unit No. 1

6/ EIA

- no endangered species will be affected by proposed development
- suggest no drilling during nesting season m d. May to m d. July unless nesting bird survey conducted

7/ WELLBORE PARAMETERS - ∃ existing producers

(Sw = 35% 15-29)

Sw = 30%   Boi = 1.06   (Sw - 50% @ 3-29 & 14-29 structurally lower ?)

OOIP/16 ha   57092 m³   AVER. REC. PER - 9941 m³

- best well 6-29 expected to recover 35.2% of current prod (31% wellbore OOIP)
  - average recovery excluding 2-29 (SWD) based 16 ha spacing -   CURRENT - 11.1% OOIP
    ULTIMATE - 21.1% OOIP

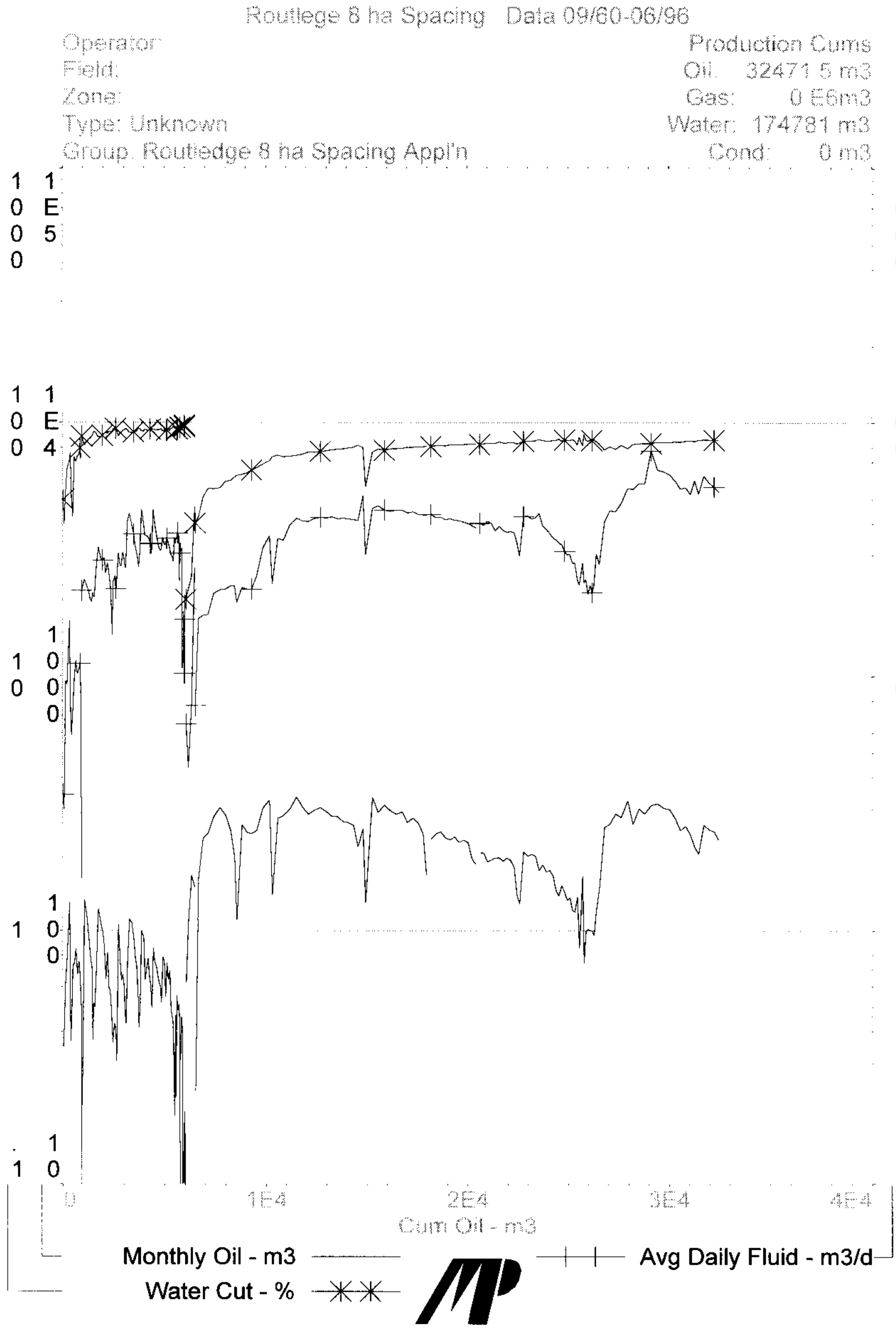
NOTE: WHEN TUNDRA indicates ult. recovery of 12%, it assumes 3-29, 14-29 & 15-29 - 16 ha drilling locations are not developed

- if ult. recovery estimate of 17% from existing wells is applied to 3-29, 14-29 & 15-29, these wells should recover 20.954 m³ or 6985 m³/well

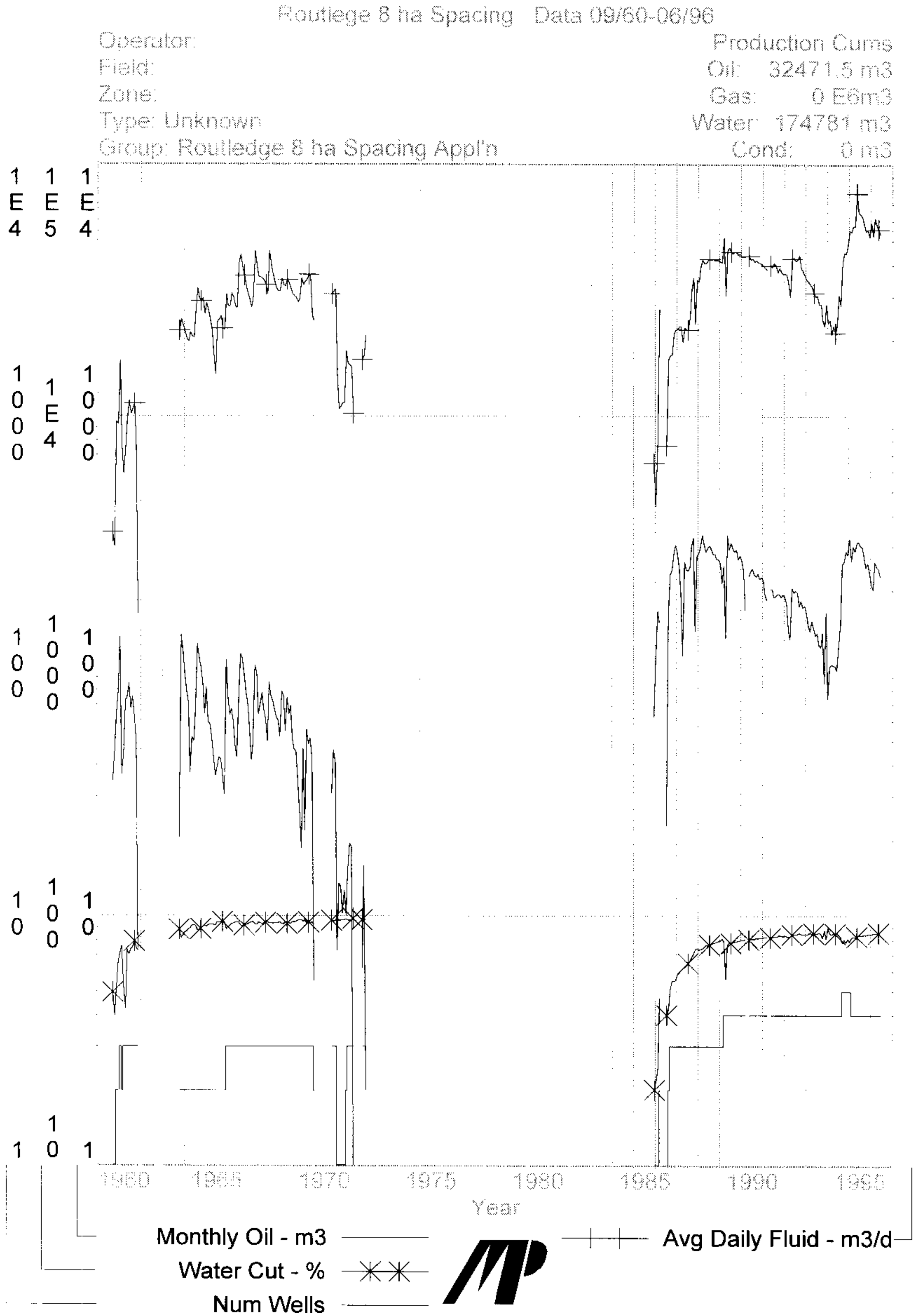
Table 1. Vegetation community types occurring at the proposed infill drilling sites. See Figure 1 for site locations and Table 2 for the species which characterize each community type.

Community Type	Drilling Sites
well-drained meadow margin	IIA, IIF 2D-29, 11B-29
well-drained meadow (hayed)	IA, IC, IIB 15-29, 11A-29, 7D-29
well-drained meadow (pasture)	IIC 10D-29
poorly drained meadow	IB, IIG, IIH 14A-29, 11C-29, 14-29
wooded forest	ID, IID 3D-29, 6B-29
cleared forest	IIE 3-29

WELL	ON PRODUCTION DATE		CURRENT DAILY OIL (m3/d)	PRODUCTION WC (%)	OCT/96
2-29	MAR/89	FINAL	0.6	54.7	CONVERTED TO SWD JAN/95
6-29	DEC/85		1.8	86.4	
7-29	SEP/86		1.3	83.1	
10-29	AUG/86		2.5	82.4	
11-29	SEP/94		3.3	84.0	



Routlege 8 ha Spacing Data 09/60-06/96
Operator:
Field:
Zone:
Type: Unknown
Group: Routledge 8 ha Spacing Appl'n
Production Cums
Oil: 32471.5 m3
Gas: 0 E6m3
Water: 174781 m3
Cond: 0 m3
1E5
1E4
1000
100
10
0
1E4
2E4
3E4
4E4
Cum Oil - m3
Monthly Oil - m3
Water Cut - %
Avg Daily Fluid - m3/d



Routlege 8 ha Spacing Data 09/60-06/96
Operator:
Field:
Zone:
Type: Unknown
Group: Routledge 8 ha Spacing Appl'n
Production Cums
Oil: 32471.5 m3
Gas: 0 E6m3
Water: 174781 m3
Cond: 0 m3
1960
1965
1970
1975
1980
1985
1990
1995
Year
Monthly Oil - m3
Water Cut - %
Num Wells
Avg Daily Fluid - m3/d

Manitoba

Energy and Mines

Petroleum

1395 Ellice Avenue Suite 360
Winnipeg MB R3G 3P2
CANADA

PH: (204) 945-6577
Fax: (204) 945-0586

August 21, 1996

Mr. George Czyzewski, P.Eng.
Senior Reservoir Engineer
Tundra Oil and Gas Ltd.
1111-One Lombard Place
Winnipeg, MB R3B 0X4

Dear George:

Re: Reduced Spacing in the Routledge Field

I have provided the Department of Natural Resources (DNR) with a copy of the information Tundra submitted regarding infill drilling in Section 29-9-25.

I have talked with Larry Bidlake, Regional Wildlife Manager with the DNR regarding requirements for a flora and fauna survey in the area proposed for infill drilling. He confirmed the area is potential habitat for the endangered western spiderwort plant. He suggested the consultant hired by Tundra contact Janet Moore, Prairie Specialist with the DNR at (204) 945-2395 for information on the western spiderwort plant, which can be found in a mixed grassland/woodland habitat, and guidelines for the survey. Two other contacts with the DNR who are willing to meet at the site are Tom Moran, Regional Wildlife Technician (204) 534-6838, and Rick Cline, Natural Resources Officer (204) 748-2043.

If you have any question please contact the undersigned at 945-6574.

Yours truly,

John N. Fox, P.Eng.
Chief Petroleum Engineer

cc. Larry Bidlake, DNR - Brandon

Manitoba

Energy and Mines

Petroleum

1395 Ellice Avenue Suite 360
Winnipeg MB R3G 3P2
CANADA

PH: (204) 945-6577
Fax: (204) 945-0586

July 22, 1996

Mr. George Czyzewski, P.Eng.
Senior Reservoir Engineer
Tundra Oil and Gas Ltd.
1111-One Lombard Place
Winnipeg, MB R3B 0X4

Dear George:

Re: Reduced Spacing in the Routledge Field

A review of the information Tundra filed with the Branch in Feb/95 indicates the proposed infill drilling area is a mix of agricultural land and natural areas with native tree and bush cover. A land sale review of Lsd's 3,4 & 5 in Section 29-9-25 by Natural Resources indicated the area is habitat for the endangered western spiderwort plant and wintering habitat for white-tailed deer. Our letter dated February 10, 1995 outlines the anticipated conditions for infill drilling in Section 29. Prior to drilling a survey for rare and endangered flora and fauna would be required. The following is a list of local consultants with environmental assessment experience:

Underwood McLellan & Associates - Ron Fromson 284-0580
Symbion Consultants - Wayne Wysocki 982-2940
Cochrane Environmental Consultants 453-3103
Acres International Ltd. 786-8751
Testres Consultants Inc. 942-2505

It would be advisable to have a meeting between Tundra, the Branch and Natural Resources to establish the survey requirements prior to commencing the site survey.

For your information I have also included siting criteria for infill drilling in Virden Roselea Unit No. 1, some of which would be applicable in Routledge and exerpts from Chevron's EIA for infill drilling in Daly Unit No. 3.

If you have any question please contact the undersigned at 945-6574.

Yours truly,

John N. Fox, P.Eng.
Chief Petroleum Engineer

Attachment 1

INFILL WELL SITING CRITERIA

VIRDEN ROSELEA UNIT NO. 1

1. WATER-COVERED AREAS

   Where there is potential for contaminants to enter water-covered areas, the wellsite should be

   (1) where possible, moved above the high water level, and

   (2) diked to prevent runoff of drilling or produced fluids.

2. NATURAL AREAS

   In natural areas with native tree or shrub cover, to avoid significant habitat loss and habitat fragmentation, site disturbance is to be minimized.

3. SPECIAL AREAS

   River valleys and other special areas, because of their unique microclimates, have greater potential for the occurrence of rare or endangered plant species. In special areas, a survey for rare and endangered plant species will be required and the site relocated if such species are found.

4. AREAS SUBJECT TO EROSION

   Where there is potential for erosion at a wellsite, the wellsite should be

   (1) revegetated,

   (2) diked to divert runoff water around the wellsite, and

   (3) where necessary to prevent erosion by diverted runoff water, flow control structures installed.

5. CULTIVATED LAND

   In order to minimize the loss of cultivated land and inconvenience to farming operations, the wellsite should be;

   (1) where possible, located along the edge of cultivated fields, and

   (2) where the wellsite cannot be located in accordance with (1), it should be located a minimum of 60 m from the edge of a field or such other distance as may be required to minimize inconvenience to farming operations.

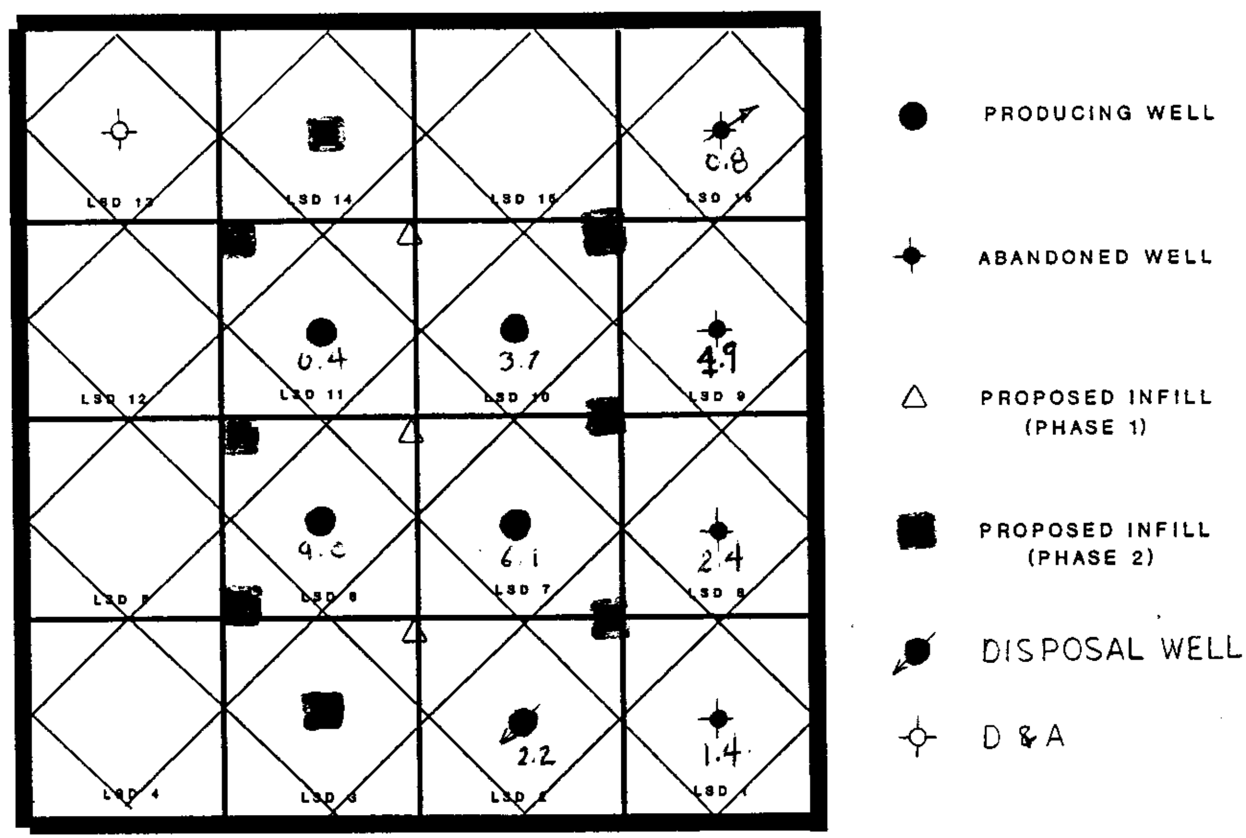
ROUTLEDGE FIELD

INFILL DRILLING PROGRAM

20 ACRE SPACING

SECTION 29-9-25

0.8 CUMULATIVE PRODUCTION $10^3 m^3$



Merak Projects Ltd. PFDB

Group : Tundra Virden 05 59C Pool
Well : Tundra 05 59C
: 000000013
Data : 8512-9412
Operator :
Type :
Field :
Zone :

2, 8, 6, 7, 10, 11 - 29 [illegible] - 25

2 - 29 CONVERTED TO SWD

11 29 DRILLED IN 1994

Nov/94

2-29 0.57 m^3/d

6-29 1.14

7-29 1.5

10-29 1.56

11-29 4.8 (ON PROD 94.0[illegible]

Oil Production HistoryTUNDRA DALY 05 59C POOL

Date	Oil m3	Water m3	Cum Oil m3	Cum Water m3	Num Well
TO DATE			0.0	0.0	
Jan 1985			0.0	0.0	
Feb 1985			0.0	0.0	
Mar 1985			0.0	0.0	
Apr 1985			0.0	0.0	
May 1985			0.0	0.0	
Jun 1985			0.0	0.0	
Jul 1985			0.0	0.0	
Aug 1985			0.0	0.0	
Sep 1985			0.0	0.0	
Oct 1985			0.0	0.0	
Nov 1985			0.0	0.0	
Dec 1985	62.1	15.6	62.1	15.6	1
	62.1	15.6			
Jan 1986	105.4	29.6	167.5	45.2	1
Feb 1986	165.2	54.3	332.7	99.5	1
Mar 1986	148.9	130.6	481.6	230.1	2
Apr 1986			481.6	230.1	
May 1986			481.6	230.1	
Jun 1986			481.6	230.1	
Jul 1986	22.9	15.3	504.5	243.4	1
Aug 1986	160.3	118.2	664.8	363.6	2
Sep 1986	230.7	238.1	895.5	601.7	3
Oct 1986	241.1	294.4	1136.6	896.1	3
Nov 1986	280.3	341.0	1416.9	1237.1	3
Dec 1986	304.0	376.3	1720.9	1613.4	3
	1658.8	1597.8			

Merak Projects Ltd. PFDB
Group : Tundra Virden 05 59C Pool
Well : Tundra 05 59C
: 000000013
Data : 8512-9412

Oil Production HistoryTUNDRA DALY 05 59C POOL

Date	Oil m3	Water m3	Cum Oil m3	Cum Water m3	Num Well
Jan 1987	283.6	400.9	2004.5	2014.3	3
Feb 1987	247.0	359.4	2251.5	2373.7	3
Mar 1987	194.1	303.8	2445.6	2677.5	3
Apr 1987	109.4	177.9	2555.0	2855.4	3
May 1987	260.9	433.4	2815.9	3288.8	3
Jun 1987	242.6	418.4	3058.5	3707.2	3
Jul 1987	240.2	443.3	3298.7	4150.5	3
Aug 1987	247.6	488.8	3546.3	4639.3	3
Sep 1987	302.8	655.9	3849.1	5295.2	3
Oct 1987	325.4	778.3	4174.5	6073.5	3
Nov 1987	137.7	379.3	4312.2	6452.8	3
Dec 1987	276.2	801.9	4588.4	7254.7	3
	2867.5	5641.3			
Jan 1988	282.8	780.1	4871.2	8034.8	3
Feb 1988	299.7	838.2	5170.9	8873.0	3
Mar 1988	334.5	964.0	5505.4	9837.0	3
Apr 1988	304.7	918.2	5810.1	10755.2	3
May 1988	286.5	930.7	6096.6	11685.9	3
Jun 1988	296.6	955.7	6393.2	12641.6	3
Jul 1988	303.7	1005.8	6696.9	13647.4	3
Aug 1988	293.3	1005.8	6990.2	14653.2	3
Sep 1988	280.5	991.0	7270.7	15644.2	3
Oct 1988	280.1	1010.5	7550.8	16654.7	3
Nov 1988	267.5	988.4	7818.3	17643.1	3
Dec 1988	265.5	1025.8	8083.8	18668.9	3
	3495.4	11414.2			
Jan 1989	258.8	1021.7	8342.6	19690.6	3
Feb 1989	213.5	934.6	8556.1	20625.2	3
Mar 1989	250.8	969.3	8806.9	21594.5	4
Apr 1989	128.9	163.7	8935.8	21758.2	4
May 1989	334.2	1083.8	9270.0	22842.0	4
Jun 1989	291.3	1061.4	9561.3	23903.4	4
Jul 1989	311.4	1088.0	9872.7	24991.4	4
Aug 1989	295.8	1086.8	10168.5	26078.2	4
Sep 1989	286.4	1068.9	10454.9	27147.1	4
Oct 1989	292.2	1105.8	10747.1	28252.9	4
Nov 1989	265.8	1052.1	11012.9	29305.0	4
Dec 1989	276.9	1099.2	11289.8	30404.2	4
	3206.0	11735.3			

Merak Projects Ltd. PFDB
Group : Tundra Virden 05 59C Pool
Well : Tundra 05 59C
: 000000013
Data : 8512-9412

Oil Production HistoryTUNDRA DALY 05 59C POOL

Date	Oil m3	Water m3	Cum Oil m3	Cum Water m3	Num Well
Jan 1990	264.3	1078.2	11554.1	31482.4	4
Feb 1990	239.8	969.5	11793.9	32451.9	4
Mar 1990	166.0	698.0	11959.9	33149.9	4
Apr 1990			11959.9	33149.9	
May 1990	228.4	944.0	12188.3	34093.9	4
Jun 1990	239.7	1025.5	12428.0	35119.4	4
Jul 1990	244.5	1057.6	12672.5	36177.0	4
Aug 1990	231.6	977.3	12904.1	37154.3	4
Sep 1990	227.6	1023.9	13131.7	38178.2	4
Oct 1990	233.2	1031.2	13364.9	39209.4	4
Nov 1990	222.6	1004.4	13587.5	40213.8	4
Dec 1990	226.9	1026.3	13814.4	41240.1	4
	2524.6	10835.9			
Jan 1991	221.6	1013.6	14036.0	42253.7	4
Feb 1991	191.8	903.3	14227.8	43157.0	4
Mar 1991	182.8	854.0	14410.6	44011.0	4
Apr 1991			14410.6	44011.0	
May 1991	202.4	915.9	14613.0	44926.9	4
Jun 1991	202.1	947.6	14815.1	45874.5	4
Jul 1991	187.2	913.7	15002.3	46788.2	4
Aug 1991	190.0	916.9	15192.3	47705.1	4
Sep 1991	193.3	928.3	15385.6	48633.4	4
Oct 1991	193.6	1015.2	15579.2	49648.6	4
Nov 1991	188.0	929.8	15767.2	50578.4	4
Dec 1991	193.0	950.4	15960.2	51528.8	4
	2145.8	10288.7			
Jan 1992	189.0	952.5	16149.2	52481.3	4
Feb 1992	177.6	886.8	16326.8	53368.1	4
Mar 1992	138.2	650.2	16465.0	54018.3	4
Apr 1992	127.6	629.8	16592.6	54648.1	4
May 1992	204.7	1103.0	16797.3	55751.1	4
Jun 1992	196.4	1069.0	16993.7	56820.1	4
Jul 1992	199.8	1091.5	17193.5	57911.6	4
Aug 1992	196.3	1089.5	17389.8	59001.1	4
Sep 1992	172.6	1043.9	17562.4	60045.0	4
Oct 1992	182.1	1028.6	17744.5	61073.6	4
Nov 1992	170.7	944.1	17915.2	62017.7	4
Dec 1992	173.3	958.3	18088.5	62976.0	4
	2128.3	11447.2			

Merak Projects Ltd. PFDB
Group : Tundra Virden 05 59C Pool
Well : Tundra 05 59C
: 000000013
Data : 8512-9412

Oil Production HistoryTUNDRA DALY 05 59C POOL

Date	Oil m3	Water m3	Cum Oil m3	Cum Water m3	Num Well
Jan 1993	164.1	921.5	18252.6	63897.5	4
Feb 1993	144.8	818.3	18397.4	64715.8	4
Mar 1993	137.5	860.5	18534.9	65576.3	4
Apr 1993	151.2	835.1	18686.1	66411.4	4
May 1993	141.7	820.6	18827.8	67232.0	4
Jun 1993	132.2	769.5	18960.0	68001.5	4
Jul 1993	135.4	769.0	19095.4	68770.5	4
Aug 1993	120.8	735.3	19216.2	69505.8	4
Sep 1993	118.7	662.3	19334.9	70168.1	4
Oct 1993	136.0	608.4	19470.9	70776.5	0
Nov 1993	85.3	600.7	19556.2	71377.2	0
Dec 1993	163.5	701.5	19719.7	72078.7	0
	1631.2	9102.7			
Jan 1994	74.0	652.6	19793.7	72731.3	4
Feb 1994	99.1	573.8	19892.8	73305.1	4
Mar 1994	101.3	551.8	19994.1	73856.9	4
Apr 1994	100.1	585.8	20094.2	74442.7	4
May 1994	99.8	563.0	20194.0	75005.7	4
Jun 1994	95.8	573.7	20289.8	75579.4	4
Jul 1994	119.9	645.1	20409.7	76224.5	4
Aug 1994	146.9	693.0	20556.6	76917.5	4
Sep 1994	254.7	905.0	20811.3	77822.5	5
Oct 1994	0.0	0.0	20811.3	77822.5	4
Nov 1994	0.0	0.0	20811.3	77822.5	4
Dec 1994	0.0	0.0	20811.3	77822.5	4
	1091.6	5743.8			
TOTAL	20811.3	77822.5			

$$Q_T = Q_i + \frac{365\,(q_i - q_t)}{D}$$

$Q_i = 20811$

$q_i = 10\ m^3/d$

$q_t = 0.4\ m^3/d * 4$ wells
$= 1.6\ m^3/d$

$D = 9.1\%$ (from plot)

$$Q_T = 20811 + \frac{365\,(10 - 1.6)}{.091}$$

$Q_T = 54503\ m^3$

Merak Projects Ltd. PFDE
Group : ROUTLEDGE REDUCED SPACING
Well : PRODUCTION WELL
: 000000014
Data : 6009-7206
Operator :
Type :
Field :
Zone :

Oil Production HistoryTUNDRA DALY 05 59C POOL

Date	Oil m3	Water m3	Cum Oil m3	Cum Water m3	Num Well
TO DATE			0.0	0.0	
Jan 1960			0.0	0.0	
Feb 1960			0.0	0.0	
Mar 1960			0.0	0.0	
Apr 1960			0.0	0.0	
May 1960			0.0	0.0	
Jun 1960			0.0	0.0	
Jul 1960			0.0	0.0	
Aug 1960			0.0	0.0	
Sep 1960	34.6	34.0	34.6	34.0	1
Oct 1960	44.7	29.6	79.3	63.6	1
Nov 1960	62.4	66.4	141.7	130.0	2
Dec 1960	78.5	148.5	220.2	278.5	2
	220.2	278.5			
Jan 1961	129.9	322.4	350.1	600.9	3
Feb 1961	36.6	115.8	386.7	716.7	2
Mar 1961	44.1	47.7	430.8	764.4	3
Apr 1961	72.5	53.3	503.3	817.7	3
May 1961	74.4	206.7	577.7	1024.4	3
Jun 1961	84.8	198.3	662.5	1222.7	3
Jul 1961	67.3	190.1	729.8	1412.8	3
Aug 1961	75.5	223.2	805.3	1636.0	3
Sep 1961	62.6	239.8	867.9	1875.8	3
Oct 1961	49.4	143.1	917.3	2018.9	3
Nov 1961	7.4	19.9	924.7	2038.8	3
Dec 1961			924.7	2038.8	
	704.5	1760.3			

	Cum Oil	Cum WTR
1-29	1390	7318.3
8-29	2375.5	18340.1
9-29	1874.2	42084.1
11-29	376.8	788.1

erak Projects Ltd. PFDB
roup : ROUTLEDGE REDUCED SPACING
ell : PRODUCTION WELL
: 000000014
ata : 6009-7206

il Production HistoryTUNDRA DALY 05 59C POOL

ate	Oil m3	Water m3	Cum Oil m3	Cum Water m3	Num Well
an 1962			924.7	2038.8	
eb 1962			924.7	2038.8	
lar 1962			924.7	2038.8	
pr 1962			924.7	2038.8	
lay 1962			924.7	2038.8	
Jun 1962			924.7	2038.8	
Jul 1962			924.7	2038.8	
Aug 1962			924.7	2038.8	
Sep 1962			924.7	2038.8	
Oct 1962			924.7	2038.8	
Nov 1962			924.7	2038.8	
Dec 1962			924.7	2038.8	
	0.0	0.0			
Jan 1963			924.7	2038.8	
Feb 1963			924.7	2038.8	
Mar 1963			924.7	2038.8	
Apr 1963			924.7	2038.8	
May 1963			924.7	2038.8	
Jun 1963			924.7	2038.8	
Jul 1963			924.7	2038.8	
Aug 1963			924.7	2038.8	
Sep 1963			924.7	2038.8	
Oct 1963	20.5	153.9	945.2	2192.7	2
Nov 1963	132.7	589.9	1077.9	2782.6	2
Dec 1963	114.0	591.2	1191.9	3373.8	2
	267.2	1335.0			
Jan 1964	94.5	577.5	1286.4	3951.3	2
Feb 1964	79.5	507.0	1365.9	4458.3	2
Mar 1964	71.2	538.3	1437.1	4996.6	2
Apr 1964	37.2	304.9	1474.3	5301.5	2
May 1964	51.8	548.8	1526.1	5850.3	2
Jun 1964	49.9	564.1	1576.0	6414.4	2
Jul 1964	66.3	677.7	1642.3	7092.1	2
Aug 1964	122.5	876.5	1764.8	7968.6	2
Sep 1964	107.3	768.8	1872.1	8737.4	2
Oct 1964	99.0	788.2	1971.1	9525.6	2
Nov 1964	85.9	792.4	2057.0	10318.0	2
Dec 1964	64.2	672.2	2121.2	10990.2	2
	929.3	7616.4			

erak Projects Ltd.   PFDB
roup : ROUTLEDGE REDUCED SPACING
ell : PRODUCTION WELL
: 000000014
ata : 6009-7206

il Production HistoryTUNDRA DALY 05 59C POOL

ate	Oil m3	Water m3	Cum Oil m3	Cum Water m3	Num Well
Jan 1965	82.0	785.3	2203.2	11775.5	2
Feb 1965	59.6	673.8	2262.8	12449.3	2
Mar 1965	58.2	684.1	2321.0	13133.4	2
Apr 1965	51.8	611.0	2372.8	13744.4	2
May 1965	43.0	503.4	2415.8	14247.8	2
Jun 1965	36.2	386.7	2452.0	14634.5	2
Jul 1965	39.1	656.6	2491.1	15291.1	2
Aug 1965	42.9	703.1	2534.0	15994.2	2
Sep 1965	42.1	704.6	2576.1	16698.8	2
Oct 1965	36.5	650.5	2612.6	17349.3	2
Nov 1965	30.6	550.6	2643.2	17899.9	2
Dec 1965	105.5	810.0	2748.7	18709.9	3
	627.5	7719.7			
Jan 1966	75.3	724.5	2824.0	19434.4	3
Feb 1966	63.5	635.8	2887.5	20070.2	3
Mar 1966	67.1	884.6	2954.6	20954.8	3
Apr 1966	60.1	825.2	3014.7	21780.0	3
May 1966	47.3	734.1	3062.0	22514.1	3
Jun 1966	42.9	758.6	3104.9	23272.7	3
Jul 1966	73.1	1140.8	3178.0	24413.5	3
Aug 1966	111.3	1191.0	3289.3	25604.5	3
Sep 1966	107.5	1072.3	3396.8	26676.8	3
Oct 1966	93.4	1029.6	3490.2	27706.4	3
Nov 1966	78.4	906.2	3568.6	28612.6	3
Dec 1966	71.8	878.5	3640.4	29491.1	3
	891.7	10781.2			
Jan 1967	57.0	842.9	3697.4	30334.0	3
Feb 1967	41.6	709.1	3739.0	31043.1	3
Mar 1967	48.7	869.9	3787.7	31913.0	3
Apr 1967	99.8	1262.9	3887.5	33175.9	3
May 1967	94.1	1131.4	3981.6	34307.3	3
Jun 1967	63.8	1010.7	4045.4	35318.0	3
Jul 1967	70.3	1037.0	4115.7	36355.0	3
Aug 1967	77.8	1016.4	4193.5	37371.4	3
Sep 1967	66.6	971.2	4260.1	38342.6	3
Oct 1967	61.0	970.4	4321.1	39313.0	3
Nov 1967	49.7	861.8	4370.8	40174.8	3
Dec 1967	85.6	1263.7	4456.4	41438.5	3
	816.0	11947.4			

erak Projects Ltd. PFDB
roup : ROUTLEDGE REDUCED SPACING
ell : PRODUCTION WELL
: 000000014
ata : 6009-7206

il Production HistoryTUNDRA DALY 05 59C POOL

ate	Oil m3	Water m3	Cum Oil m3	Cum Water m3	Num Well
an 1968	75.5	1160.9	4531.9	42599.4	3
eb 1968	71.8	983.4	4603.7	43582.8	3
lar 1968	66.9	988.1	4670.6	44570.9	3
pr 1968	62.1	899.9	4732.7	45470.8	3
lay 1968	60.3	906.4	4793.0	46377.2	3
Jun 1968	52.0	869.3	4845.0	47246.5	3
Jul 1968	78.8	1012.5	4923.8	48259.0	3
Aug 1968	75.6	949.3	4999.4	49208.3	3
Sep 1968	54.8	929.5	5054.2	50137.8	3
Oct 1968	74.4	1006.2	5128.6	51144.0	3
Nov 1968	63.9	944.4	5192.5	52088.4	3
Dec 1968	69.1	923.6	5261.6	53012.0	3
	805.2	11573.5			
Jan 1969	50.8	890.5	5312.4	53902.5	3
Feb 1969	45.7	789.1	5358.1	54691.6	3
Mar 1969	45.7	865.2	5403.8	55556.8	3
Apr 1969	34.6	812.7	5438.4	56369.5	3
May 1969	26.5	704.5	5464.9	57074.0	3
Jun 1969	18.6	498.4	5483.5	57572.4	3
Jul 1969	46.3	827.2	5529.8	58399.6	3
Aug 1969	21.9	534.5	5551.7	58934.1	3
Sep 1969	55.3	851.3	5607.0	59785.4	3
Oct 1969	48.4	781.0	5655.4	60566.4	3
Nov 1969	51.1	747.5	5706.5	61313.9	3
Dec 1969	42.5	728.8	5749.0	62042.7	3
	487.4	9030.7			
Jan 1970	5.5	65.7	5754.5	62108.4	2
Feb 1970			5754.5	62108.4	
Mar 1970			5754.5	62108.4	
Apr 1970			5754.5	62108.4	
May 1970			5754.5	62108.4	
Jun 1970			5754.5	62108.4	
Jul 1970			5754.5	62108.4	
Aug 1970			5754.5	62108.4	
Sep 1970			5754.5	62108.4	
Oct 1970			5754.5	62108.4	
Nov 1970	30.9	711.2	5785.4	62819.6	3
Dec 1970	45.7	923.2	5831.1	63742.8	3
	82.1	1700.1			

Merak Projects Ltd. PFDB
Group : ROUTLEDGE REDUCED SPACING
Well : PRODUCTION WELL
: 000000014
Data : 6009-7206

Oil Production HistoryTUNDRA DALY 05 59C POOL

Date	Oil m3	Water m3	Cum Oil m3	Cum Water m3	Num Well
Jan 1971	40.7	904.6	5871.8	64647.4	3
Feb 1971	7.3	405.7	5879.1	65053.1	1
Mar 1971	13.5	317.8	5892.6	65370.9	1
Apr 1971	13.0	314.3	5905.6	65685.2	1
May 1971	10.2	260.0	5915.8	65945.2	1
Jun 1971	12.6	325.1	5928.4	66270.3	1
Jul 1971	10.1	342.2	5938.5	66612.5	2
Aug 1971	15.3	384.5	5953.8	66997.0	3
Sep 1971	19.4	458.7	5973.2	67455.7	3
Oct 1971	18.9	463.8	5992.1	67919.5	3
Nov 1971	0.5	20.0	5992.6	67939.5	3
Dec 1971			5992.6	67939.5	
	161.5	4196.7			
Jan 1972			5992.6	67939.5	
Feb 1972			5992.6	67939.5	
Mar 1972			5992.6	67939.5	
Apr 1972	6.3	161.5	5998.9	68101.0	3
May 1972	15.8	370.2	6014.7	68471.2	3
Jun 1972	2.1	60.9	6016.8	68532.1	3
	24.2	592.6			
TOTAL	6016.8	68532.1			

Tundra oil and gas ltd.

January 3, 1997

Manitoba Energy and Mines
Petroleum Branch
1395 Ellice Avenue, Suite 360
Winnipeg, Manitoba
R3G 0G3

Attention: **Mr. J. Fox, P.Eng.**
Chief Petroleum Engineer

Dear John,

RE: Routledge Field - Lodgepole C Pool - Section 29-9-25 W1M
Reduced Spacing Application (8 hectare)

Please find attached 2 copies of the referenced application for your review and approval. Two copies of the Routledge Environmental Impact Assessment study are also attached.

Should you have any questions during the review process, please contact me at (204) 934-5853.

Yours truly,

TUNDRA OIL AND GAS LTD.

George Czyzewski, P.Eng.
General Manager

1111 - One Lombard Place, Winnipeg, Manitoba R3B 0X4 Telephone: (204) 934-5850 Fax: (204) 934-5820

TUNDRA OIL AND GAS LTD.

ROUTLEDGE

REDUCED SPACING APPLICATION

JANUARY, 1997

Tundra oil and gas ltd.

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Tundra
oil and gas ltd.

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APPENDICES

Tundra oil and gas ltd.

January 3, 1997

Manitoba Energy and Mines
Petroleum Branch
1395 Ellice Avenue, Suite 360
Winnipeg, Manitoba
R3G OG3

Attention: **Mr. J. Fox, P.Eng.**
Chief Petroleum Engineer

Dear John,

RE: Routledge Field - Lodgepole C Pool - Section 29-9-25 W1M
Reduced Spacing Application

INTRODUCTION

Tundra Oil and Gas Ltd., as Operator of the referenced pool, pursuant to Section 20(3) of the Manitoba Petroleum Drilling and Production Regulations, hereby requests approval for reduced drilling spacing units of 20 acres (8.1 hectares) in the Routledge Field - Lodgepole C Pool in Section 29-9-25 W1M. The current approved well spacing is for 40 acres (16.19 hectares).

The reduced drilling spacing program offers the possibility of improving oil recovery from the Lodgepole C Pool, while at the same time is respecting existing land owner and environmental considerations.

CONCLUSIONS

1. Oil recovery from the Routledge Lodgepole C Pool (Scallion formation) is impacted by water influx either through natural fractures and/or water coning.

2. Infill drilling, as an enhanced recovery program, offers an opportunity to improve oil recovery from the Lodgepole C Pool.

3. Since the oil reservoir consists of thin layers and is stratified, horizontal drilling would not be the best method to exploit the remaining recoverable reserves.

4. Current ultimate recovery in the non-unit lands is estimated at 7% of the original oil-in-place (OOIP). Ultimate oil recovery with the existing spacing from the non-unit lands is estimated at 12% of the OOIP. Infill

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drilling on 20 acre spacing will increase ultimate oil recovery from this pool by an additional 10% of the OOIP. Total ultimate recovery with the existing and proposed infill wells is estimated at 22% of the OOIP.

5. Incremental oil reserves of up to 65,000 m3 (405 M STB) are estimated by drilling up to 8 infill wells. Initially 4 infill wells will be drilled to test the commercial viability of the program.

6. An environmental impact assessment study completed in 1996 jointly by UMA Engineering Ltd. and Agassiz North Associates Limited concluded that the proposed infill drilling program will not adversely impact the indigeneous flora and fauna in Section 29-9-25 W1M.

DISCUSSION

The following sections outline the supporting documentation pertaining to Tundra's application for reduced drilling spacing units in Section 29-9-25 W1M of the Routledge Field.

1. Land

Figure No.1 outlines Tundra's Routledge Field lands. Figure No.2 outlines the reduced spacing application area in Section 29-9-25 W1M. Appendix J outlines the mineral and surface owners in Section 29-9-25 and within a 16 hectare perimeter of the proposed reduced spacing area. Table No.1 outlines Tundra's existing wells in the proposed reduced spacing area.

2. Geology

The productive zone in the Routledge Field is the Scallion member of the Lodgepole formation (Mississippian strata). The Scallion formation is characterized by complex reservoir facies changes from fine-grained limestones to coarse fossil fragmental limestones, red and grey calcareous shales, and local black shale. The hydrocarbon trapping mechanism within the field appears to be basically stratigraphic in nature. Structural entrapment may be important locally, but the lack of regional structural closure indicates that the trap is caused primarily by stratigraphically controlled variations in porosity and permeability. On a regional basis, entrapment occurs where the permeable reservoir beds have been truncated at the Mississippian erosion surface. The degree of dolomitization

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and/or leaching of the reservoir beds below the Mississippian erosional surface determines the degree of oil storage. Oil storage in the up-dip portion of the reservoir is controlled primarily by the degree of dolomitization. As dolomitization increases, there is a corresponding decrease in the permeability of the reservoir beds near the subcrop edge.

The following geological data of the Lodgepole C Pool is included in the reduced spacing application:

* Figure No.3: Pore Volume Map Scallion Formation
* Figure No.4: Structure Map of Scallion Formation
* Appendix F : Core Reports
* Appendix H : Open-Hole Logs

3. Reserves

Volumetric oil-in-place estimates have been prepared for both developed and undeveloped lands. Total oil-in-place of 1.8 MM STB (285,460 m3) is estimated in the developed producing lands (refer to Table No.2). Total oil-in-place in the producing and undeveloped lands (excluding Routledge Unit No.1 lands) is estimated at 2.6 MM STB (408,720 m3). Table No.3 outlines the individual well oil-in-place estimates for the producing and undeveloped lands (excluding Routledge Unit No.1). Total oil-in-place of 3.5 MM STB is estimated in Section 29 with the inclusion of Routledge Unit No.1 lands (refer to Table No.4).

4. Production History

Production commenced from the Tundra operated portion of the Routledge Field in December, 1985 from well 6-29-9-25 W1M. There are currently 4 producing wells in the Lodgepole C Pool lands operated by Tundra. The total field oil production during October, 1996 was 8.8 m3/day at a watercut of 84%. Cumulative field oil production at 96.10.31 was 27,276 m3. Figure No.5 outlines the total historical production of the Tundra operated wells in Section 29-9-25. Appendices A and B outline the total field and individual well production histories, respectively. Appendix C outlines the individual well production plots.

5. Recovery Profiles

Current oil recovery to 96.10.31 on the producing lands (Section 29-9-25) is estimated at 10% of the OOIP (original oil-in-place). Ultimate oil recovery from the producing

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lands on 40 acre spacing is estimated at 17% of OOIP or 49,705 m3 (63 M STB/well). Table No.2 outlines the individual well recovery profiles on the proved developed producing lands.

Oil recovery profiles were also investigated on both the producing and undeveloped lands in Section 29-9-25 W1M (excludes Routledge Unit No.1 lands). Using this approach current oil recovery to 96.10.31 is estimated at 7 % of the OOIP. Ultimate oil recovery from the producing and undeveloped lands in Section 29 is estimated at 12% of the OOIP. Table No.3 outlines the field recovery profiles for the producing and undeveloped lands scenario.

Finally, if the total area is considered in Section 29 (includes Routledge Unit No.1 lands), current recovery is estimated at 6% of the OOIP. Ultimate oil recovery in this case is estimated at 10% of the OOIP (refer to Table No.4).

Ultimate oil recovery was estimated by two methods. The traditional plot of oil rate vs cumulative oil production was used as an initial estimate. This approach was further refined by using a plot of oil-cut vs cumulative oil production. Figures No.6 and No.7 illustrate the oil rate vs cum. oil and oil-cut vs cum. oil methods, respectively. Appendices D and E outline the individual well ultimate recovery predictions using oil rate vs cum. oil and oil-cut vs cum. oil, respectively.

An estimate was also made of the current and ultimate drainage areas with the existing wells on 16 hectare spacing. This information was used to optimize the selection of the infill locations. Figures No. 8 and No.9 outline the current and ultimate drainage areas, respectively. Tables No.5 and No.6 outline the methodology that was used to estimate the current and ultimate drainage areas, respectively.

6. Pressure Surveys

A pressure buildup test was completed at the pool discovery well 6-29-9-25 in July, 1994 to assess current reservoir pressure conditions. The 6-29 well built up to original reservoir pressure of 6,400 kPag after 1 week of shut-in time. This indicates that the Scallion reservoir has good acquifer pressure support. On this basis, the Scallion reservoir will be able to handle a higher well density in Section 29 without further pressure support to facilitate incremental oil recovery with infill drilling. Appendix G outlines the pressure survey data and analysis for the 6-29-9-25 well.

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7. Development Program

The infill well development program has been divided into three phases (refer to Figure No.10). Phase 1 is designed to test the commercial feasibility of infill drilling the Scallion formation on 8 hectare spacing. A total of 4 infill locations will be tested in Phase 1. Pending a successful outcome from Phase 1, three additional infill wells have been proposed for Phase 2. A final round of drilling has been proposed, which will constitute Phase 3. Phase 3 has potentially up to 5 infill locations, however, only 1 location (3-29) has sufficient reserves to pursue drilling at this time. Although there up to 12 infill locations identified on 8 hectare spacing, only 8 infill wells have been assessed as commercially viable at this time. Table No.7 outlines the incremental oil recovery predicted for each of the 8 hectare infill locations.

8. Environmental Impact Assessment Study

Tundra Oil and Gas Ltd. was requested by both the Manitoba Petroleum Branch and the Department of Natural Resources to complete an environmental impact assessment of the proposed infill program on the indigeneous flora and fauna in Section 29-9-25 W1M. Specifically, the impact assessment study was focused on the Western Spiderwort plant, which is a rare prairie grass. Some focus was also placed on identifying any critical wildlife habitat in the area of proposed infill drilling. UMA Engineering Ltd., in association with Agassiz North Associates Limited were selected as the environmental consultants to complete the study.

The environmental consultants concluded after their site survey that no protected plant or wildlife species will be affected by the proposed infill drilling program. The only drilling constraint that was identified pertained to nesting migratory birds. The period from late May to mid-July would require pre-drilling nesting bird surveys prior to commencement of drilling. Otherwise, the period from mid-July to April was not impeded by any environmental constraints. The standard reclamation practices after well site abandonment will apply after economic operations cease from a specfic well location. A copy of the Section 29-9-25 W1M Flora and Fauna Study is attached for further review.

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SUMMARY

The Section 29-9-25 W1M reduced spacing application offers an attractive opportunity to significantly improve oil recovery by infill drilling on 8 hectare spacing. The infill drilling program is sensitive to the prevailing environmental conditions, and will not adversely impact the indigeneous flora and fauna. Tundra envisions commencing drilling the initial 4 infill locations during the 3rd quarter of 1997. In order to facilitate a timely approval of the current application, Tundra is prepared to further assist your staff and office in any further information requirements. Should you or your staff have questions during the review and approval process, please call the undersigned at (204) 934-5853.

Respectfully Submitted,

TUNDRA OIL AND GAS LTD.

George Czyzewski, P.Eng.
General Manager

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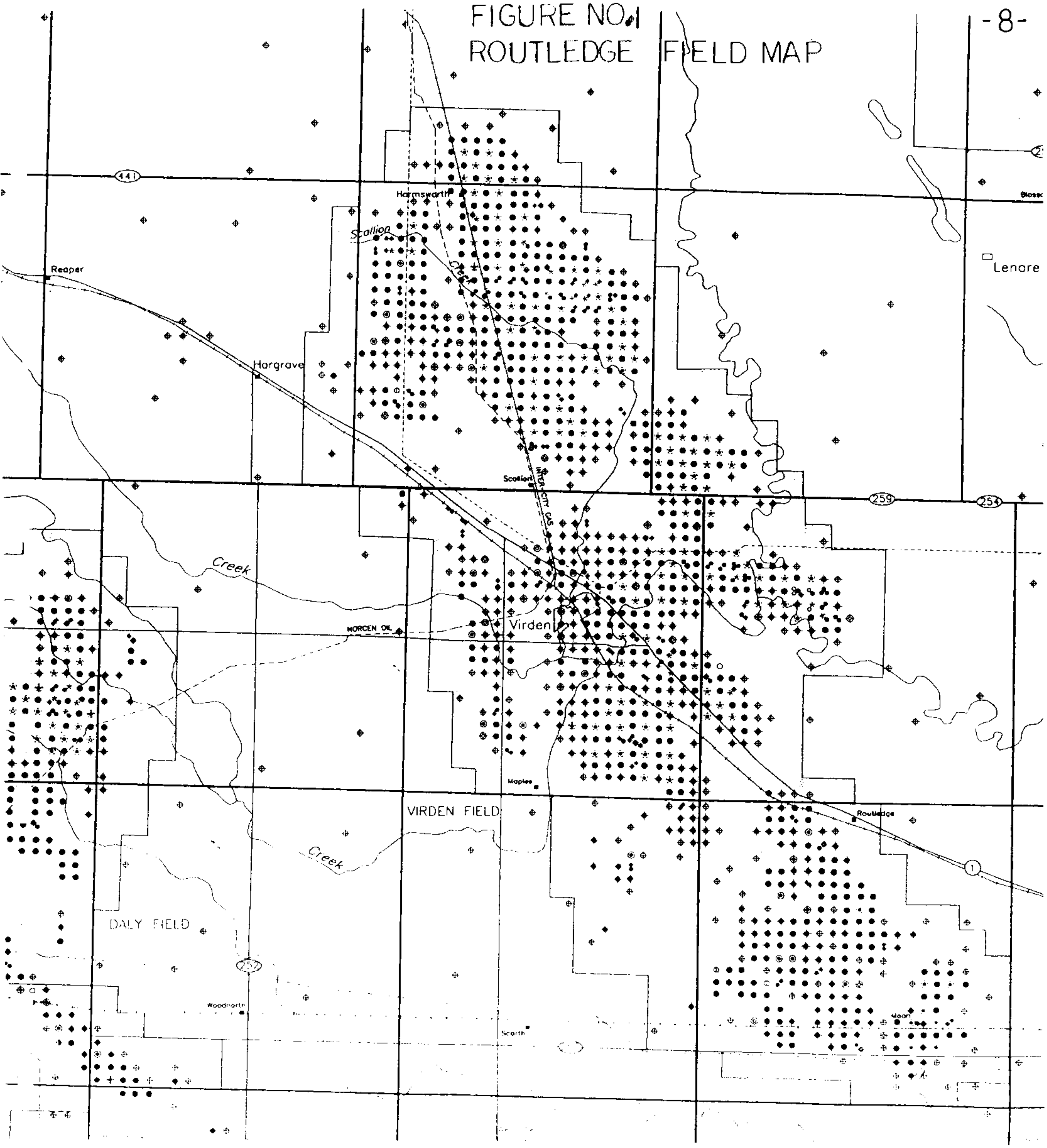
LIST OF FIGURES

FIGURE NO. 1
ROUTLEDGE FIELD MAP



SECTION 29-9-25

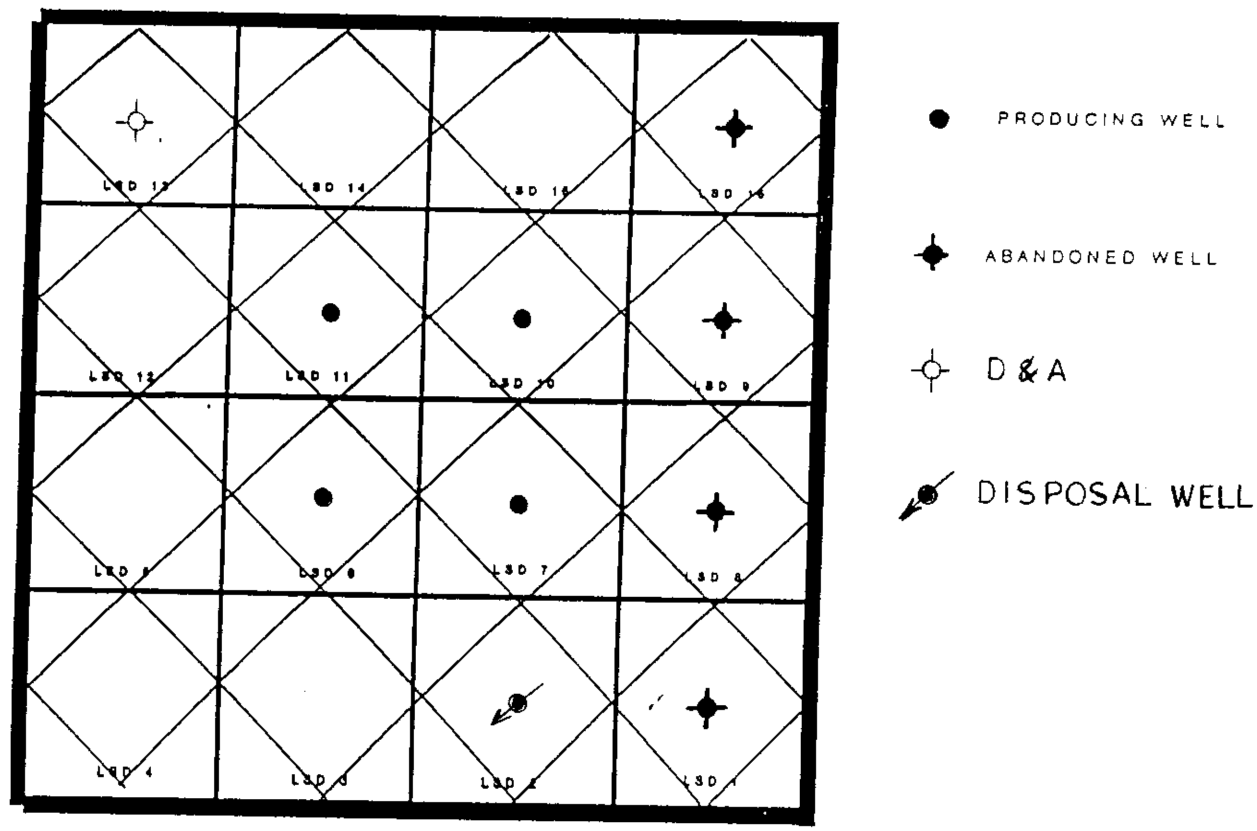
FIGURE NO. 2

ROUTLEDGE FIELD

INFILL DRILLING PROGRAM

20 ACRE SPACING AREA

SECTION 29-9-25



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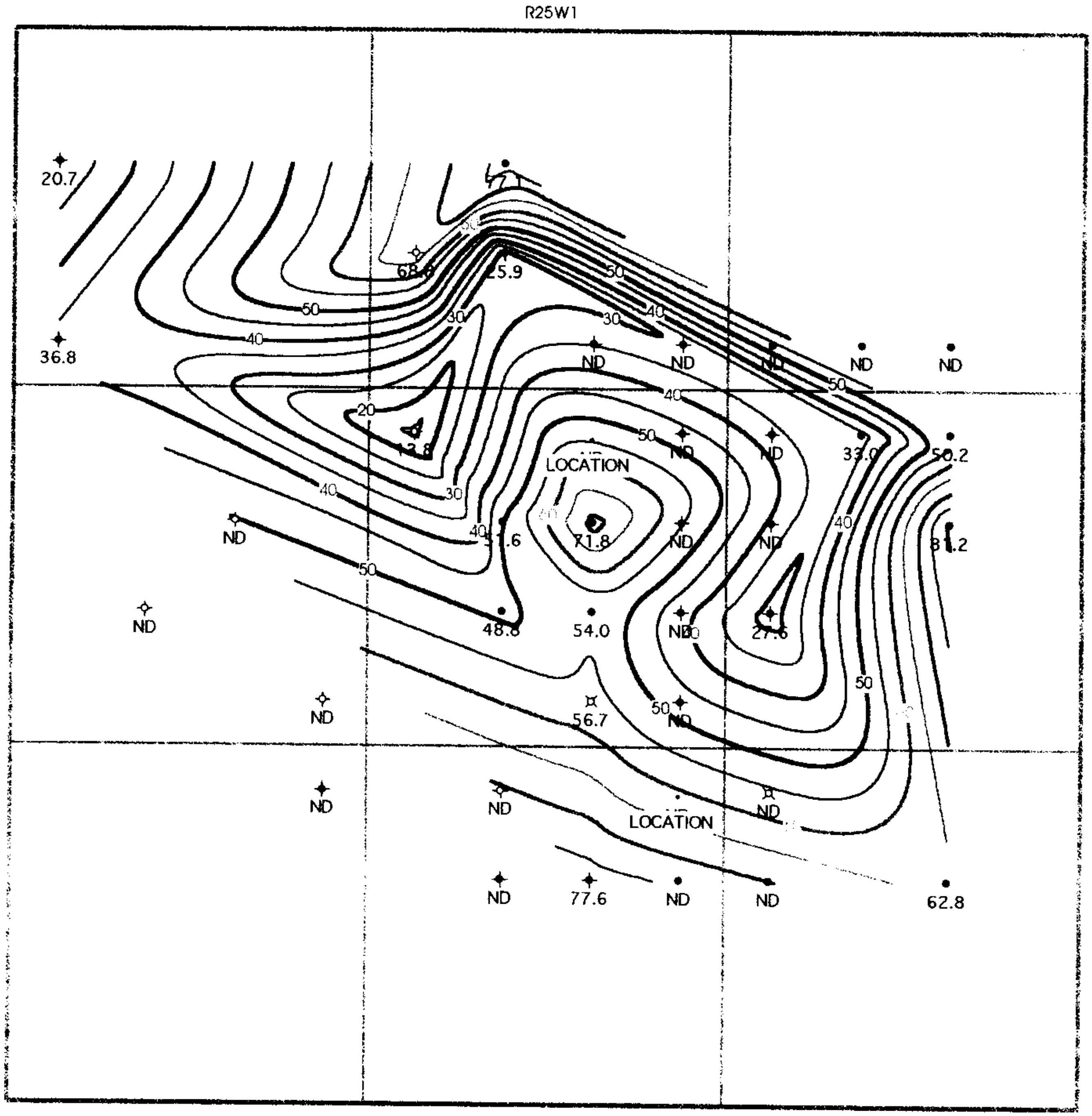


TUNDRA OIL AND GAS LTD.	
WEST ROUTLEDGE PHI-H at 5.0 Intervals (1 km)	
M.B. DUPONT	
Date:8/9/96	24000

FIGURE NO.4 Rg25W1M

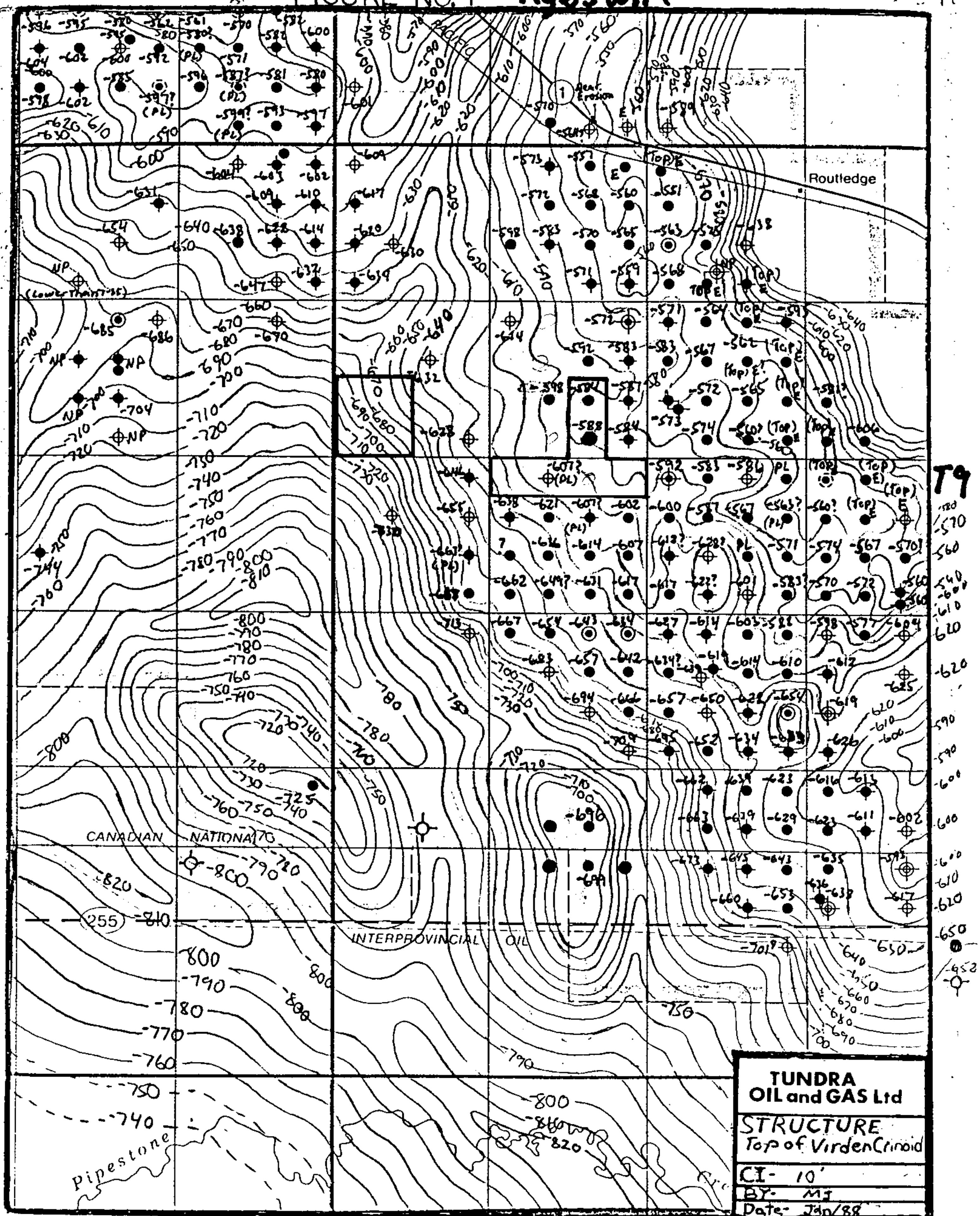
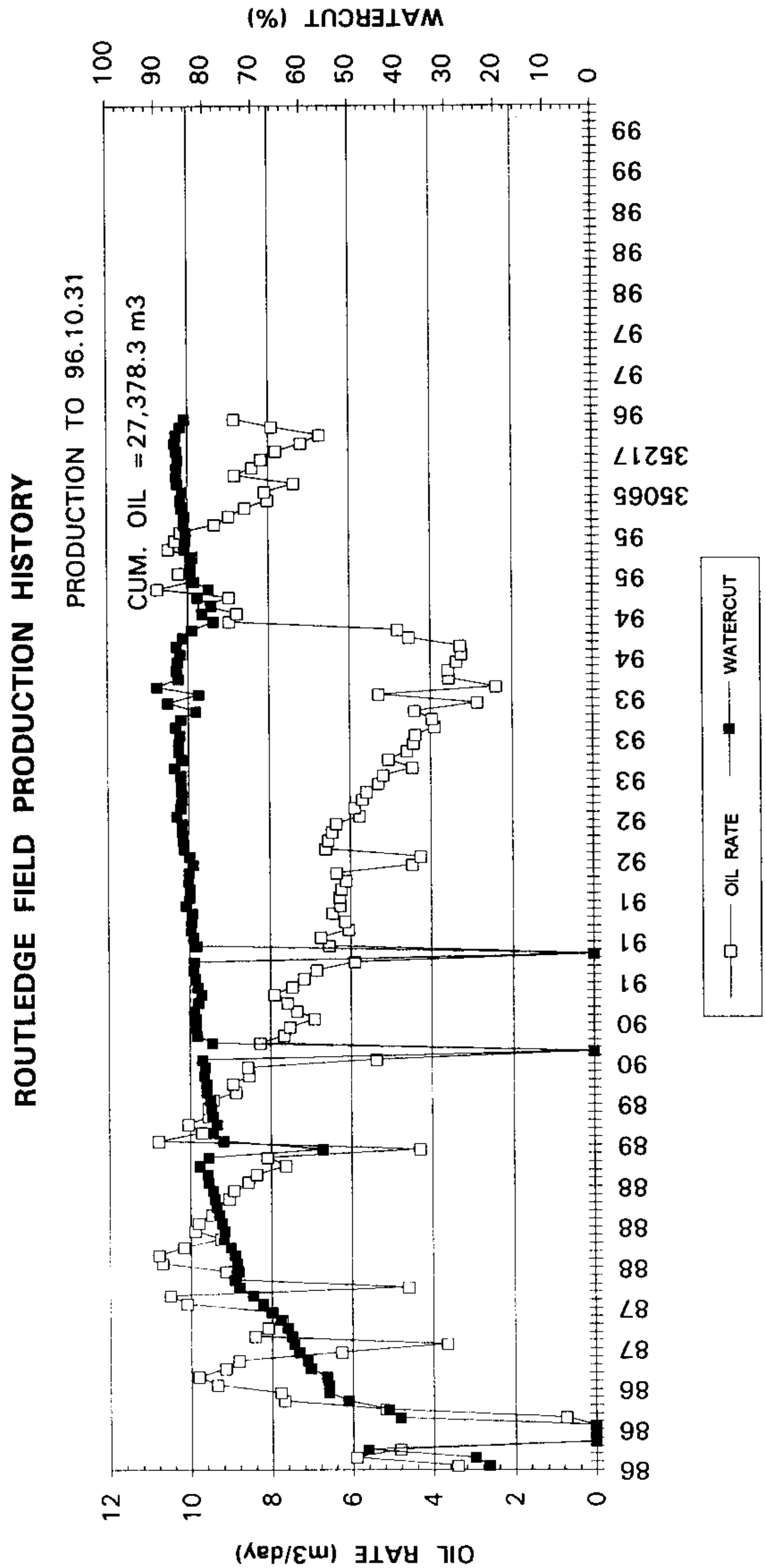
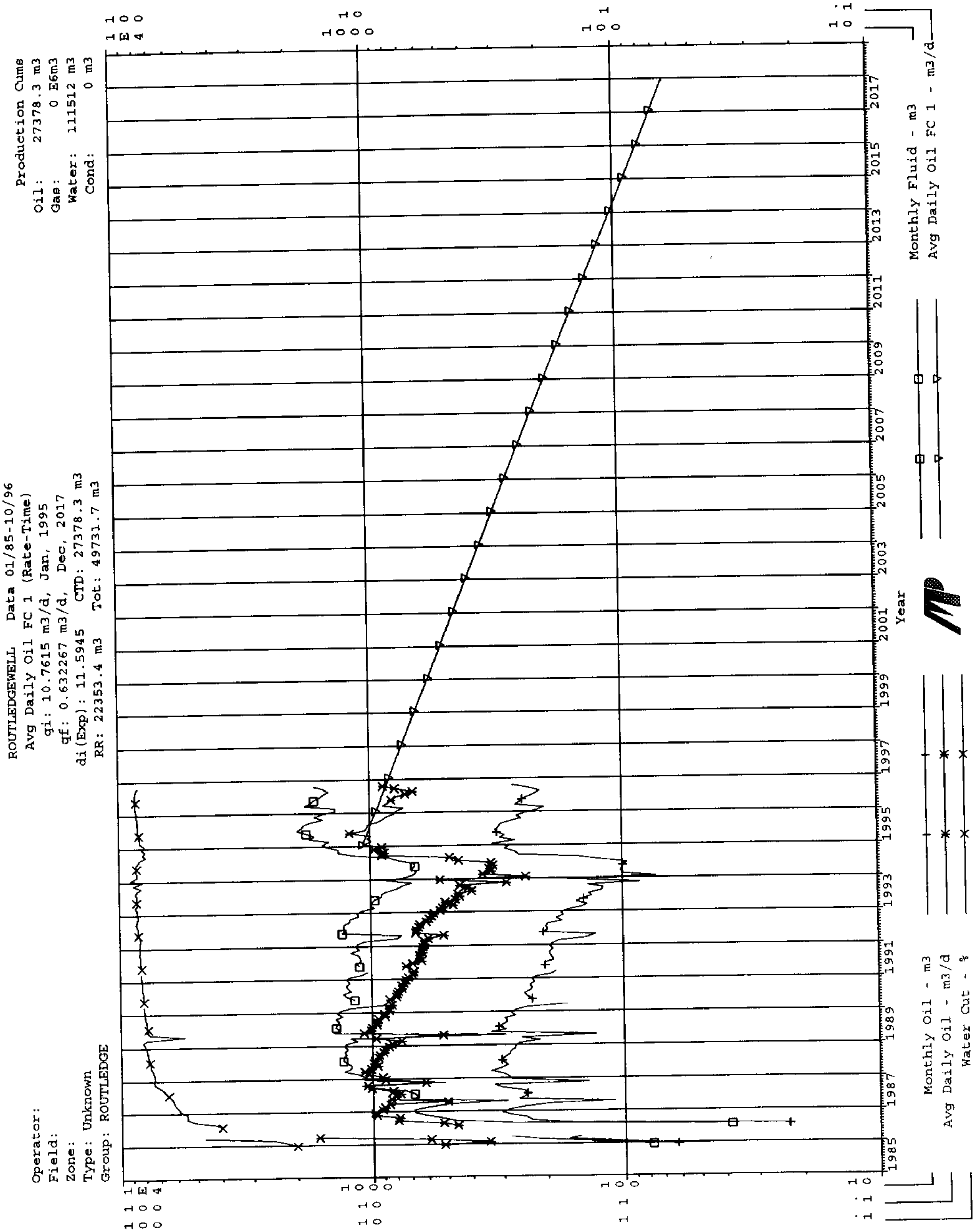


FIGURE NO.5



CROUTPH.XLC

FIGURE NO.6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Oil: 27378.3 m3
Gas: 0 E6m3
Water: 111512 m3
Cond: 0 m3
ROUTLEDGEWELL Data 01/85-10/96
Avg Daily Oil FC 1 (Rate-Time)
qi: 10.7615 m3/d, Jan, 1995
qf: 0.632267 m3/d, Dec, 2017
di(Exp): 11.5945 CTD: 27378.3 m3
RR: 22353.4 m3 Tot: 49731.7 m3
Operator:
Field:
Zone:
Type: Unknown
Group: ROUTLEDGE
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
Year
Monthly Oil - m3
Avg Daily Oil - m3/d
Water Cut - %
Monthly Fluid - m3
Avg Daily Oil FC 1 - m3/d

FIGURE NO.7

CROTUROC.XLC

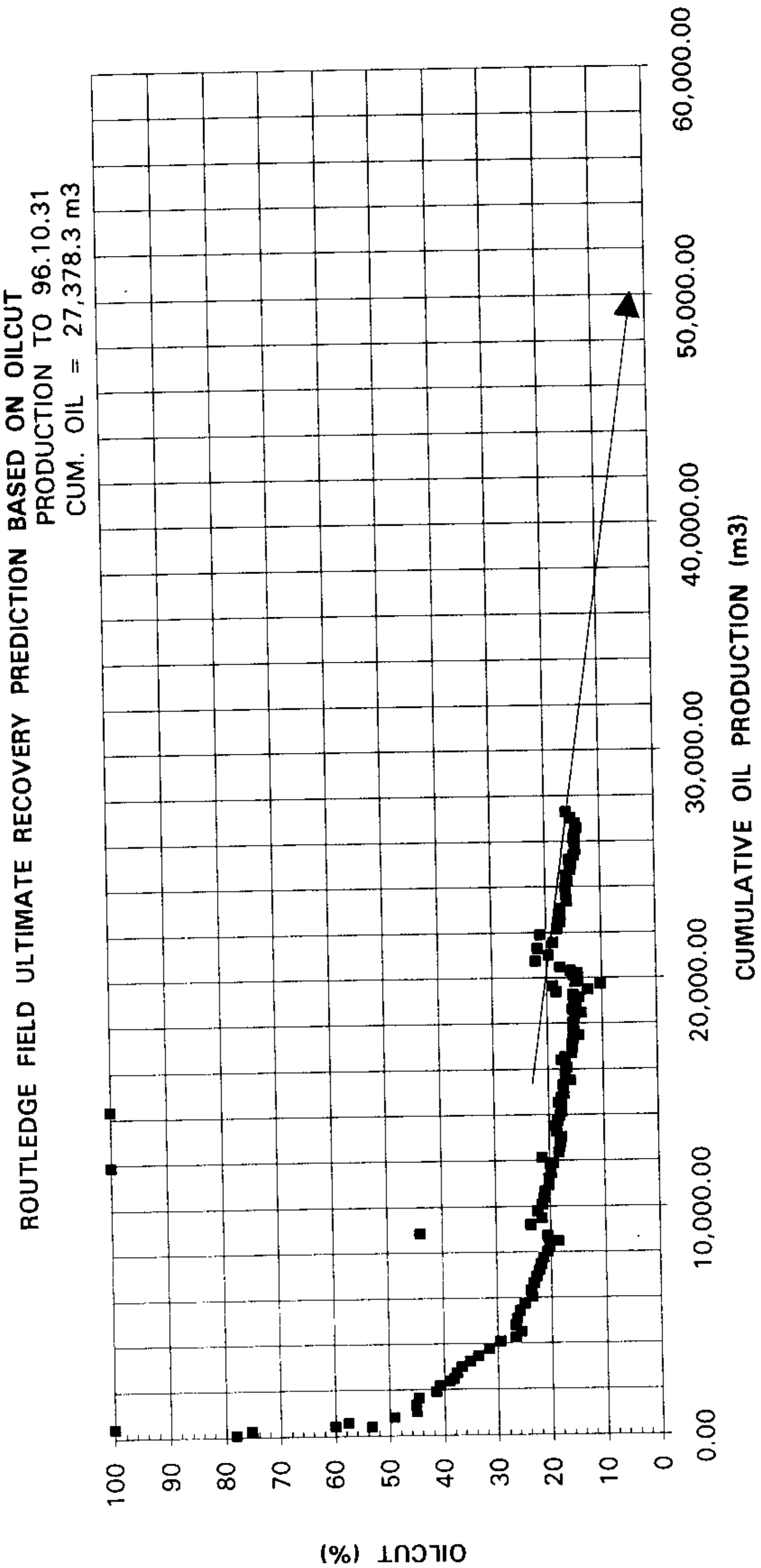


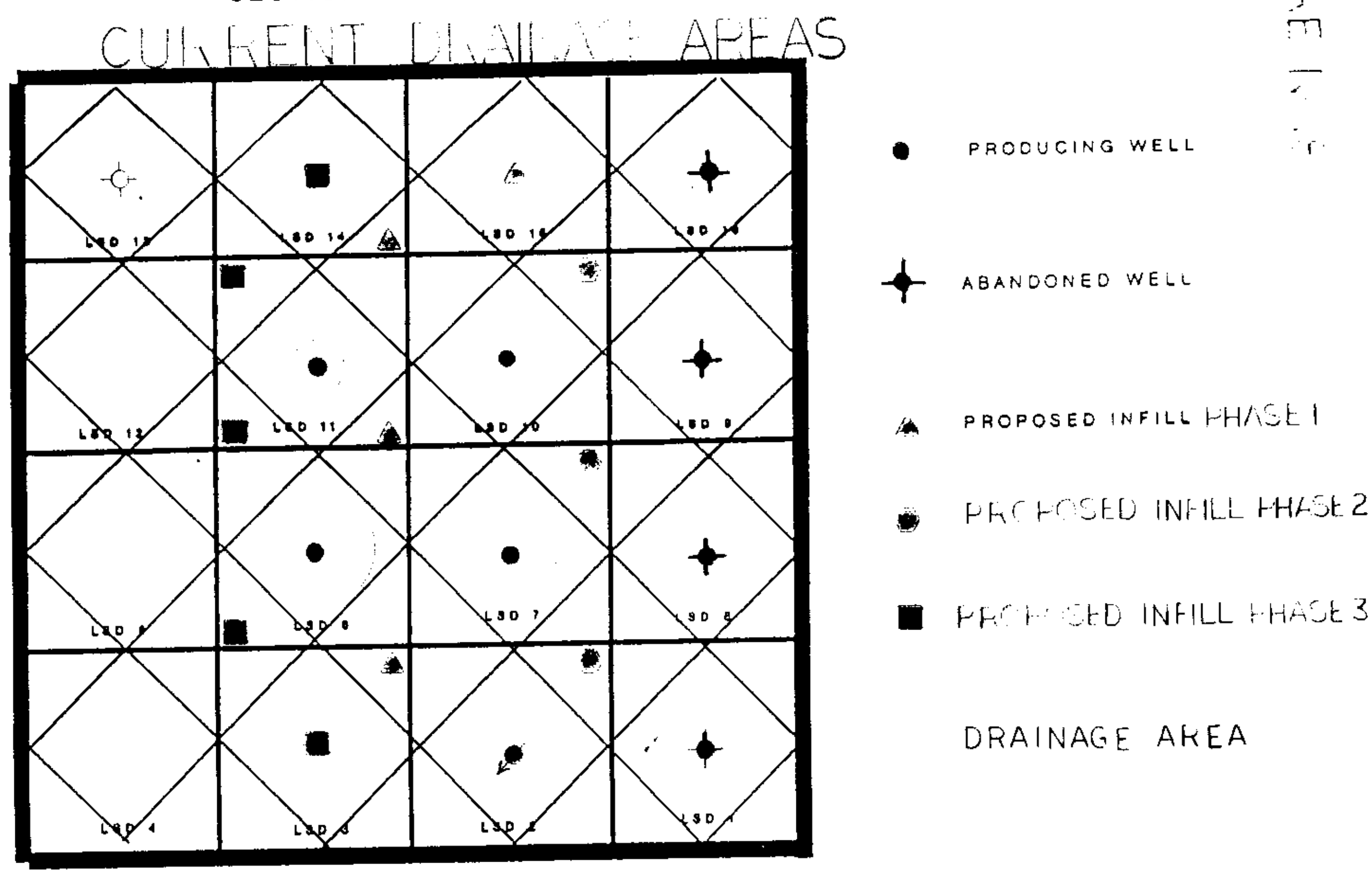
FIGURE I

ROUTLEDGE FIELD

INFILL DRILLING PROGRAM

20 ACRE SPACING

SECTION 29-9-25

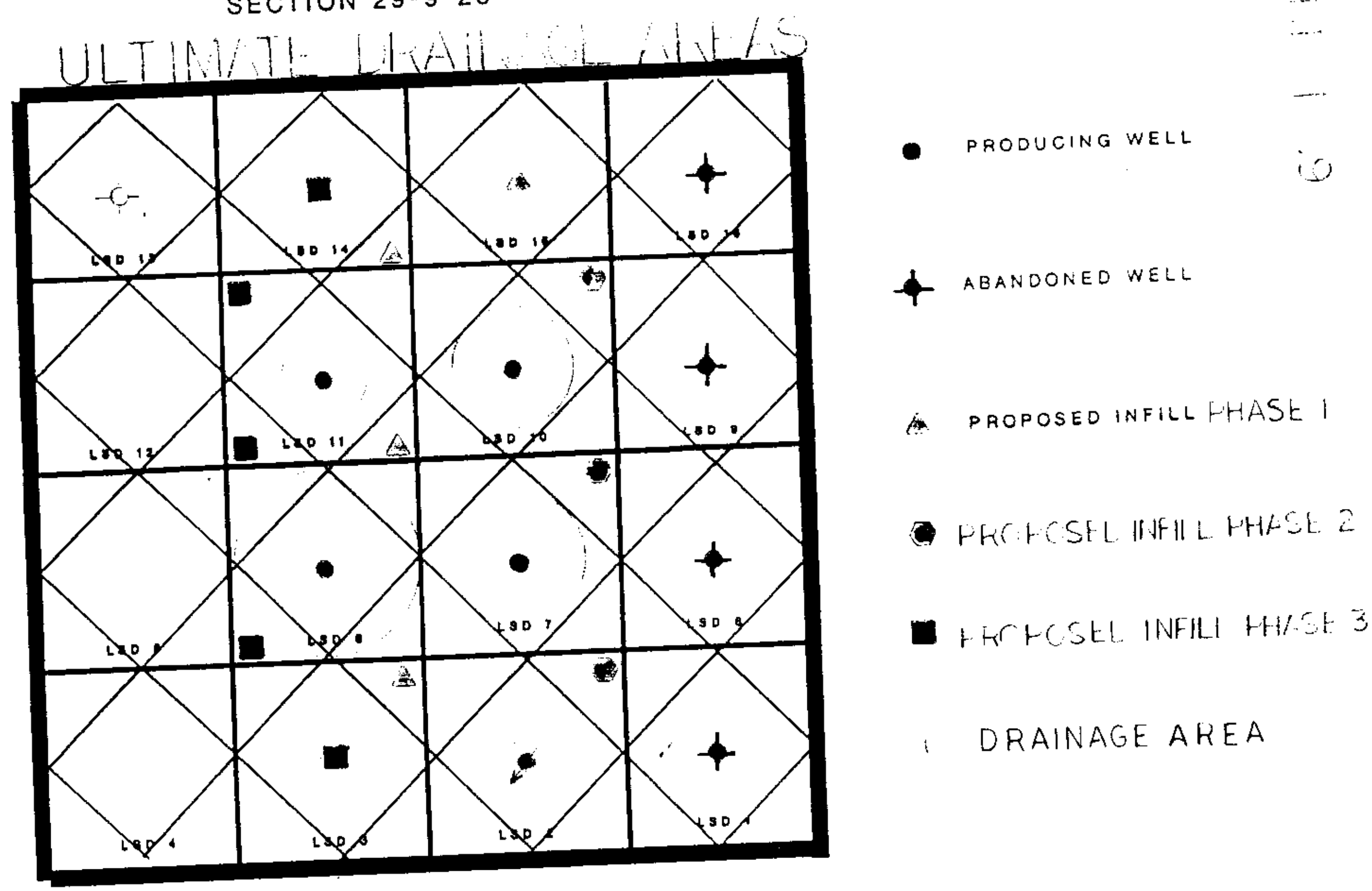


ROUTLEDGE FIELD

INFILL DRILLING PROGRAM

20 ACRE SPACING

SECTION 29-9-25



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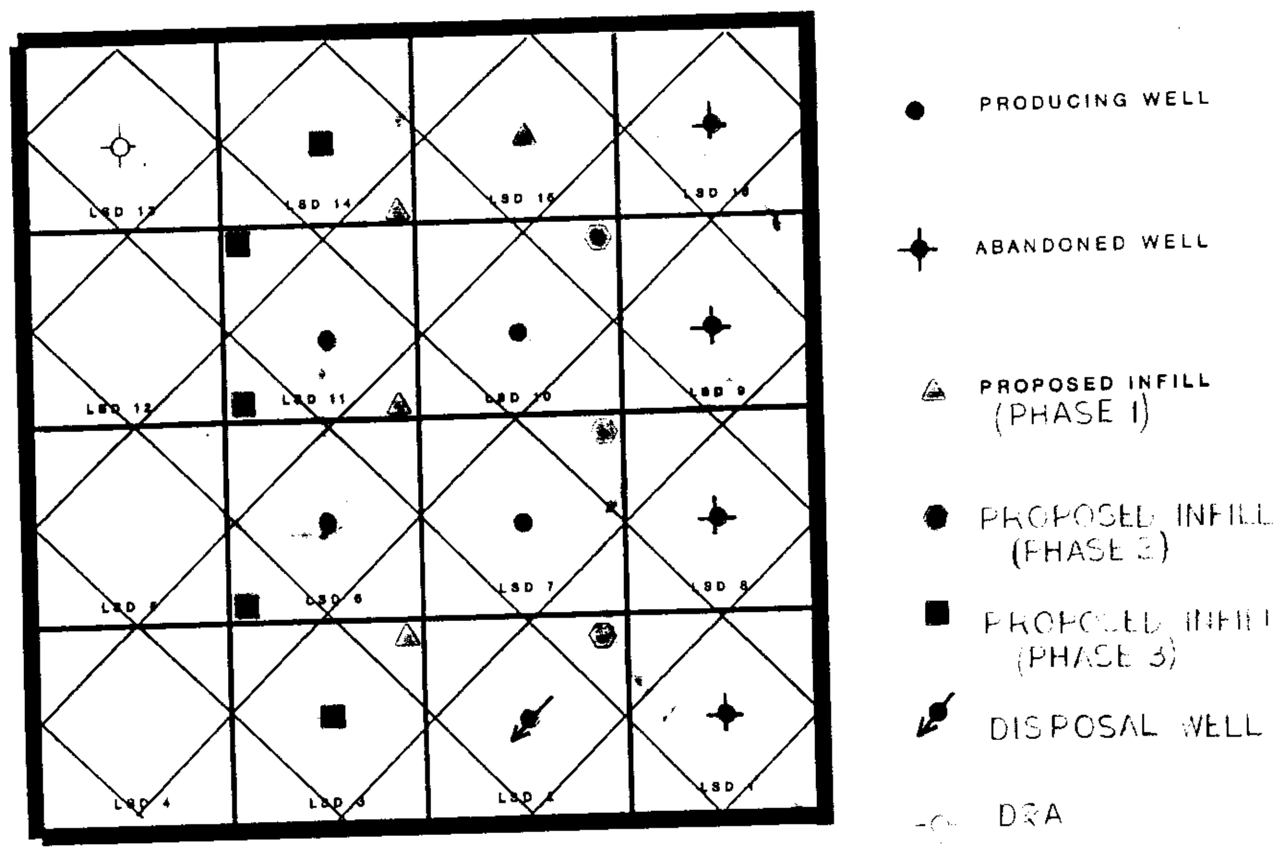
ROUTLEDGE FIELD

INFILL DRILLING PROGRAM

20 ACRE SPACING

SECTION 29-9-25



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LIST OF TABLES

TABLE NO.1

List of Field Wells

Well	Status
2-29-9-25 W1M	Water Disposal Well
6-29-9-25 W1M	Producer
7-29-9-25 W1M	Producer
10-29-9-25 W1M	Producer
11-29-9-25 W1M	Producer

TABLE NO.2

ROUTLEDGE FIELD

DETERMINATION OF RESERVES AND RECOVERY PROFILES

PRODUCING LANDS ONLY

WELL	Constant	Area (hectares)	PHI-h (fraction)	Sw (fraction)	(1-Sw)	Boi (Rm3/m3)	OOIP (m3)	OOIP (STB)	Cum. Oil (m3) 96.10.31	Current Recovery (%)	Ultimate Recovery (m3)	Ultimate Recovery (%of OOIP)
2-29-9-25	10,000	16.19	0.56	0.3	0.7	1.06	59,872	376,598	2,153.9	4	2,200	4
6-29-9-25	10,000	16.19	0.52	0.3	0.7	1.06	55,596	349,698	10,563.2	19	17,490	31
7-29-9-25	10,000	16.19	0.53	0.3	0.7	1.06	56,665	356,423	6,987.1	12	10,315	18
10-29-9-25	10,000	16.19	0.58	0.3	0.7	1.06	62,011	390,048	4,884.8	8	11,550	19
11-29-9-25	10,000	16.19	0.48	0.3	0.7	1.06	51,319	322,798	2,687.0	5	8,150	16
							285,463	**1,795,564**	**27,276**	10	**49,705**	17

TABLE NO.3

ROUTLEDGE FIELD

DETERMINATION OF RESERVES AND RECOVERY PROFILES

PRODUCING AND UNDEVELOPED LANDS (EXCLUDING ROUTLEDGE UNIT NO.1)

WELL	Constant	Area (hectares)	PHI-h (fraction)	Sw (fraction)	(1-Sw)	Boi (Rm3/m3)	OOIP (m3)	OOIP (STB)	Cum. Oil (m3) 96.10.31	Current Recovery (%)	Ultimate Recovery (m3)	Ultimate Recovery (%of OOIP)
2-29-9-25	10,000	16.19	0.56	0.3	0.7	1.06	59,872	376,598	2,153.9	4	2,200	4
3-29-9-25	10,000	16.19	0.60	0.5	0.5	1.06	45,630	287,012	0	0	0	0
6-29-9-25	10,000	16.19	0.52	0.3	0.7	1.06	55,596	349,698	10,563.2	19	17,490	31
7-29-9-25	10,000	16.19	0.53	0.3	0.7	1.06	56,665	356,423	6,987.1	12	10,315	18
10-29-9-25	10,000	16.19	0.58	0.3	0.7	1.06	62,011	390,048	4,884.8	8	11,550	19
11-29-9-25	10,000	16.19	0.48	0.3	0.7	1.06	51,319	322,798	2,687.0	5	8,150	16
14-29-9-25	10000	16.19	0.39	0.5	0.5	1.06	29,974	188,539	0	0	0	0
15-29-9-25	10000	16.19	0.48	0.35	0.65	1.06	47,654	299,741	0	0	0	0
Totals							**408,721**	**2,570,856**	**27,276**	**7**	**49,705**	**12**

TABLE NO.4

ROUTLEDGE FIELD

DETERMINATION OF RESERVES AND RECOVERY PROFILES

TOTAL PRODUCING AND UNDEVELOPED LANDS

WELL	Constant	Area (hectares)	PHI-h (fraction)	Sw (fraction)	(1-Sw)	Boi (Rm3/m3)	OOIP (m3)	OOIP (STB)	Cum. Oil (m3) 96.10.31	Current Recovery (%)	Ultimate Recovery (m3)	Ultimate Recovery (%of OOIP)
1-29-9-25	10,000	16.19	0.48	0.5	0.5	1.06	36,657	230,570	1,390	4	1,390	4
2-29-9-25	10,000	16.19	0.56	0.3	0.7	1.06	59,872	376,598	2,153.9	4	2,200	4
3-29-9-25	10,000	16.19	0.60	0.5	0.5	1.06	45,630	287,012	0	0	0	0
6-29-9-25	10,000	16.19	0.52	0.3	0.7	1.06	55,596	349,698	10,563.2	19	17,490	31
7-29-9-25	10,000	16.19	0.53	0.3	0.7	1.06	56,665	356,423	6,987.1	12	10,315	18
8-29-9-25	10,000	16.19	0.46	0.5	0.5	1.06	34,747	218,561	2,375.5	7	2,376	7
9-29-9-25	10,000	16.19	0.50	0.45	0.55	1.06	41,792	262,874	1,874.2	4	1,874	4
10-29-9-25	10,000	16.19	0.58	0.3	0.7	1.06	62,011	390,048	4,884.8	8	11,550	19
11-29-9-25	10,000	16.19	0.48	0.3	0.7	1.06	51,319	322,798	2,687.0	5	8,150	16
14-29-9-25	10000	16.19	0.39	0.5	0.5	1.06	29,974	188,539	0	0	0	0
15-29-9-25	10000	16.19	0.48	0.35	0.65	1.06	47,654	299,741	0	0	0	0
16-29-9-25	10000	16.19	0.44	0.5	0.5	1.06	33,793	212,557	376.8	1	377	1
Totals							**555,710**	**3,495,418**	**33,292**	**6**	**55,722**	**10**

TABLE NO.5

ROUTLEDGE FIELD

SECTION 29-9-25

DRAINAGE AREAS BASED ON CURRENT RECOVERY

Well	CONSTANT	AREA (ha)	PHI-h (%-m)	Sw (fraction)	1-Sw (fraction)	Boi (Rm3/m3)	OOIP (m3)	Theoretical Rec. Factor (%)	Cum. Oil to 96.10.31 (m3)	Current Rec. Factor (%)	DRAINAGE AREA (ha)	DRAINAGE AREA (acres)
2-29-9-25	10,000	16.19	0.56	0.30	0.70	1.06	59,872	35	2,256	4	1.74	4.31
6-29-9-25	10,000	16.19	0.52	0.30	0.70	1.06	55,596	35	10,563	19	8.79	21.71
7-29-9-25	10,000	16.19	0.53	0.30	0.70	1.06	56,665	35	6,987	12	5.70	14.09
10-29-9-25	10,000	16.19	0.58	0.30	0.70	1.06	62,011	35	4,885	8	3.64	9.00
11-29-9-25	10,000	16.19	0.48	0.30	0.70	1.06	51,319	35	2,687	5	2.42	5.98
TOTAL							285,463		27,378	10		

TABLE NO.6

ROUTLEDGE FIELD

SECTION 29-9-25

DRAINAGE AREAS BASED ON PREDICTED ULTIMATE RECOVERY

Well	CONSTANT	AREA (ha)	PHI-h (%-m)	Sw (fraction)	1-Sw (fraction)	Boi (Rm3/m3)	OOIP (m3)	Theoretical Rec. Factor (%)	Ultimate Recovery (m3)	Actual Ult. Rec. Factor (%)	DRAINAGE AREA (ha)	DRAINAGE AREA (acres)
2-29-9-25	10,000	16.19	0.56	0.30	0.70	1.06	59,872	35	2,256	4	1.74	4.31
6-29-9-25	10,000	16.19	0.52	0.30	0.70	1.06	55,596	35	17,490	31	14.55	35.95
7-29-9-25	10,000	16.19	0.53	0.30	0.70	1.06	56,665	35	10,315	18	8.42	20.80
10-29-9-25	10,000	16.19	0.58	0.30	0.70	1.06	62,011	35	11,550	19	8.62	21.29
11-29-9-25	10,000	16.19	0.48	0.30	0.70	1.06	51,319	35	8,150	16	7.36	18.15
TOTAL							285,463		49,761	17		

TABLE NO.7

ROUTLEDGE FIELD

INCREMENTAL RECOVERY WITH INFILL DRILLING

LSD	OOIP (STB)	Infill Well	Risk	OOIP in 8 ha Drainage Area (STB)	ROIP 8 Ha Spacing (STB)		LSD	ROIP 16 Ha Spacing (STB)	Existing Well Ult. Rec. (STB)	Infill Well Increm. Rec. (STB)	Total Rec. Factor (% OOIP)
LSD 1-29	230,570	11a-29-9-25	Low	177,371	53,211		LSD 1-29	80,700	8,740	0	4
LSD 2-29	376,598	3d-29-9-25	Low	171,216	51,365		LSD 2-29	131,809	14,190	51,719	18
LSD 3-29	287,012	14a-29-9-25	Low	150,141	45,042		LSD 3-29	100,454	0	94,417	33
LSD 6-29	349,698	15-29-9-25	Low	149,871	44,961		LSD 6-29	122,394	110,000	11,283	35
LSD 7-29	356,423	7d-29-9-25	Medium	153,488	58,326		LSD 7-29	124,748	64,900	58,326	35
LSD 8-29	218,561	10d-29-9-25	Medium	145,653	58,261		LSD 8-29	76,496	14,945	0	7
LSD 9-29	262,874	2d-29-9-25	Medium	147,769	51,719		LSD 9-29	92,006	11,800	0	4
LSD 10-29	390,048	3-29-9-25	High	143,506	43,052		LSD 10-29	136,517	72,650	58,261	34
LSD 11-29	322,798	14-29-9-25	High	188,539	20,739		LSD 11-29	112,979	51,300	62,090	35
LSD 14-29	188,539	6b-29-9-25	High	159,178	11,283		LSD 14-29	65,989	0	65,782	35
LSD 15-29	299,741	11b-29-9-25	High	168,124	5,044		LSD 15-29	104,909	0	44,961	15
LSD 16-29	212,557	11c-29-9-25	High	127,834	3,835		LSD 16-29	74,395	2,370	0	1
TOTAL	**3,495,419**			**1,882,689**	**446,838**			**1,223,397**	**350,895**	**446,838**	**23**
verage / Wel	**291,285**			**156,891**	**37,236**			**101,950**	**38,988**	**37,236**	

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Appendices

APPENDIX A

ROUTLEDGE FIELD PRODUCTION HISTORY

Production Report

Group	:	ROUTLEDGE	Date	:	December 18, 1996 3:56:45 pm
Well	:	ROUTLEDGEWELL	User	:	GEORGE
	:	000000001			
Hist.Data	:	01/85-10/96	On Prod	:	02/09
Operator	:		Status	:	Unknown
Field	:		Zone	:	

Production Data from January, 1985 to October, 1996

Year	Monthly Oil m3	Cum Oil m3	Avg Daily Oil m3/d	Water Cut %	Monthly Water m3	Cum Water m3
Jan., 1985						
Feb., 1985						
Mar., 1985						
Apr., 1985						
May., 1985						
Jun., 1985						
Jul., 1985						
Aug., 1985						
Sep., 1985						
Oct., 1985						
Nov., 1985						
Dec., 1985	62.1	62.1	5.175	20.0702	15.6	15.6
Jan., 1986	105.4	167.5	3.4	21.9184	29.6	45.2
Feb., 1986	165.2	332.7	5.9	24.7298	54.3	99.5
Mar., 1986	148.9	481.6	16.3927	46.7153	130.6	230.1
Apr., 1986						
May., 1986						
Jun., 1986						
Jul., 1986	22.9	504.5	4.58	40.0418	15.3	245.4
Aug., 1986	160.3	664.8	5.22008	42.4309	118.2	363.6
Sep., 1986	230.7	895.5	7.90971	50.7782	238.1	601.7
Oct., 1986	241.1	1136.6	7.83004	54.9658	294.4	896.1
Nov., 1986	280.3	1416.9	9.63782	54.874	341	1237.1
Dec., 1986	304	1720.9	9.80645	55.3029	376.3	1613.4
Jan., 1987	283.6	2004.5	9.14839	58.5576	400.9	2014.3
Feb., 1987	247	2251.5	8.98182	59.2572	359.4	2373.7
Mar., 1987	194.1	2445.6	8.54752	61.0058	303.8	2677.5
Apr., 1987	109.4	2555	5.02027	61.911	177.9	2855.4
May., 1987	260.9	2815.9	8.41613	62.4123	433.4	3288.8
Jun., 1987	242.6	3058.5	8.08667	63.2878	418.4	3707.2
Jul., 1987	240.2	3298.7	7.74839	64.8473	443.3	4150.5
Aug., 1987	247.6	3546.3	8.31105	66.3671	488.8	4639.3
Sep., 1987	302.8	3849.1	10.0933	68.406	655.9	5295.2
Oct., 1987	325.4	4174.5	10.4968	70.5082	778.3	6073.5
Nov., 1987	137.7	4312.2	6.14275	73.357	379.3	6452.8
Dec., 1987	276.2	4588.4	8.90968	74.3725	801.9	7254.7
Jan., 1988	282.8	4871.2	9.12258	73.3849	780.1	8034.8

Group : ROUTLEDGE
Well : ROUTLEDGEWELL
: 000000001

Date : December 18, 1996 3:56:47 pm
User : GEORGE

Production Data from January, 1985 to October, 1996 (cont.)

Year	Monthly Oil m3	Cum Oil m3	Avg Daily Oil m3/d	Water Cut %	Monthly Water m3	Cum Water m3
Feb., 1988	299.7	5170.9	10.3345	73.6535	838.2	8873
Mar., 1988	334.5	5505.4	10.7903	74.2311	964	9837
Apr., 1988	304.7	5810.1	10.1567	75.0756	918.2	10755.2
May., 1988	286.5	6096.6	9.52355	76.4544	930.7	11685.9
Jun., 1988	296.6	6393.2	9.88667	76.3076	955.7	12641.6
Jul., 1988	303.7	6696.9	9.79677	76.8001	1005.8	13647.4
Aug., 1988	293.3	6990.2	9.46129	77.4151	1005.8	14653.2
Sep., 1988	280.5	7270.7	9.35	77.9319	991	15644.2
Oct., 1988	280.1	7550.8	9.03548	78.2894	1010.5	16654.7
Nov., 1988	267.5	7818.3	8.91667	78.6932	988.4	17643.1
Dec., 1988	265.5	8083.8	8.56452	79.4321	1025.8	18668.9
Jan., 1989	258.8	8342.6	8.34839	79.782	1021.7	19690.6
Feb., 1989	213.5	8556.1	7.625	81.3974	934.6	20625.2
Mar., 1989	250.799	8806.9	9.6307	79.4372	969.3	21594.5
Apr., 1989	128.9	8935.8	5.19934	55.9356	163.699	21758.2
May., 1989	334.2	9270	10.7806	76.4237	1083.8	22842
Jun., 1989	291.3	9561.3	10.1175	78.4579	1061.4	23903.4
Jul., 1989	311.4	9872.7	10.0452	77.74	1088	24991.4
Aug., 1989	295.8	10168.5	9.54192	78.5981	1086.8	26078.2
Sep., 1989	286.401	10454.9	9.54669	78.8608	1068.9	27147.1
Oct., 1989	292.2	10747.1	9.42581	79.0914	1105.8	28252.9
Nov., 1989	265.8	11012.9	8.86001	79.8245	1052.1	29305
Dec., 1989	276.9	11289.8	8.93224	79.8708	1099.2	30404.2
Jan., 1990	264.299	11554.1	8.52578	80.3059	1078.2	31482.4
Feb., 1990	239.8	11793.9	8.56427	80.1634	969.501	32451.9
Mar., 1990	166	11959.9	8.30002	80.7802	698	33149.9
Apr., 1990						
May., 1990	228.399	12188.3	8.45924	80.5117	943.999	34093.9
Jun., 1990	239.7	12428	7.99	81.0476	1025.5	35119.4
Jul., 1990	244.499	12672.5	7.92971	81.216	1057.6	36177
Aug., 1990	231.6	12904.1	7.82874	80.8353	977.3	37154.3
Sep., 1990	227.6	13131.7	7.58666	81.8073	1023.9	38178.2
Oct., 1990	233.2	13364.9	7.58373	81.5499	1031.2	39209.4
Nov., 1990	222.601	13587.5	7.42002	81.8516	1004.4	40213.8
Dec., 1990	226.901	13814.4	7.31938	81.8878	1026.3	41240.1
Jan., 1991	221.6	14036	7.14838	82.0531	1013.6	42253.7
Feb., 1991	191.8	14227.8	6.84999	82.4793	903.299	43157
Mar., 1991	182.799	14410.6	6.77034	82.3625	854	44011
Apr., 1991						
May., 1991	202.399	14613	7.28273	81.8946	915.901	44926.9
Jun., 1991	202.1	14815.1	6.85084	82.4151	947.6	45874.5

Production Report

Group	:	ROUTLEDGE	Date	:	December 18, 1996 3:56:48 pm
Well	:	ROUTLEDGEWELL	User	:	GEORGE
	:	000000001			

Production Data from January, 1985 to October, 1996 (cont.)

Year	Monthly Oil m3	Cum Oil m3	Avg Daily Oil m3/d	Water Cut %	Monthly Water m3	Cum Water m3
Jul., 1991	187.199	15002.3	6.31009	82.9896	913.7	46788.2
Aug., 1991	190.001	15192.3	6.40451	82.8286	916.9	47705.1
Sep., 1991	193.299	15385.6	6.44331	82.7595	928.3	48633.4
Oct., 1991	193.599	15579.2	6.24514	83.9782	1015.2	49648.6
Nov., 1991	188	15767.2	6.30169	83.1751	929.8	50578.4
Dec., 1991	193	15960.2	6.22582	83.1143	950.4	51528.8
Jan., 1992	189	16149.2	6.12972	83.4368	952.5	52481.3
Feb., 1992	177.6	16326.8	6.12415	83.3084	886.8	53368.1
Mar., 1992	138.199	16465	5.91227	82.4645	650.2	54018.3
Apr., 1992	127.6	16592.6	5.12964	83.1467	629.8	54648.1
May., 1992	204.7	16797.3	6.63894	84.3407	1103	55751.1
Jun., 1992	196.4	16993.7	6.61095	84.4734	1069	56820.1
Jul., 1992	199.799	17193.5	6.44514	84.5215	1091.5	57911.6
Aug., 1992	196.3	17389.8	6.38372	84.7276	1089.5	59001.1
Sep., 1992	172.601	17562.4	6.01221	85.8064	1043.9	60045
Oct., 1992	182.101	17744.5	5.87422	84.9534	1028.6	61073.6
Nov., 1992	170.7	17915.2	5.72978	84.6821	944.1	62017.7
Dec., 1992	173.3	18088.5	5.59031	84.6797	958.3	62976
Jan., 1993	164.1	18252.6	5.29355	84.8783	921.5	63897.5
Feb., 1993	144.8	18397.4	5.17142	84.9596	818.3	64715.8
Mar., 1993	137.5	18534.9	4.6676	86.2173	860.501	65576.3
Apr., 1993	151.201	18686.1	5.04002	84.6642	835.101	66411.4
May., 1993	141.699	18827.8	4.57095	85.2694	820.6	67232
Jun., 1993	132.2	18960	4.40667	85.3333	769.5	68001.5
Jul., 1993	135.4	19095.4	4.47603	85.0231	769	68770.5
Aug., 1993	120.8	19216.2	3.92844	85.8842	735.3	69505.8
Sep., 1993	118.7	19334.9	4.05812	84.7958	662.299	70168.1
Oct., 1993	136.001	19470.9	4.38711	81.7236	608.4	70776.5
Nov., 1993	85.3	19556.2	2.84333	87.5608	600.7	71377.2
Dec., 1993	163.501	19719.7	5.27421	81.0915	701.501	72078.7
Jan., 1994	74.0001	19793.7	2.3871	89.8115	652.599	72731.3
Feb., 1994	99.1001	19892.8	3.53929	85.2671	573.799	73305.1
Mar., 1994	101.301	19994.1	3.26776	84.4835	551.8	73856.9
Apr., 1994	100.101	20094.2	3.33669	85.4005	585.801	74442.7
May., 1994	99.7999	20194	3.21935	84.9371	563.001	75005.7
Jun., 1994	95.8008	20289.8	3.26594	85.6853	573.7	75579.4
Jul., 1994	119.9	20409.7	4.41348	84.321	645.1	76224.5
Aug., 1994	146.9	20556.6	4.80328	82.5034	693.001	76917.5
Sep., 1994	254.7	20811.3	8.96307	78.0298	904.999	77822.5
Oct., 1994	261.8	21073.1	8.78768	80.3987	1074.3	78896.8
Nov., 1994	287.4	21360.5	9.58001	78.4935	1049.4	79946.2

Production Report

Group : ROUTLEDGE
Well : ROUTLEDGEWELL
: 000000001

Date : December 18, 1996 3:56:50 pm
User : GEORGE

Production Data from January, 1985 to October, 1996 (cont.)

Year	Monthly Oil m3	Cum Oil m3	Avg Daily Oil m3/d	Water Cut %	Monthly Water m3	Cum Water m3
Dec., 1994	278	21638.5	8.96775	81.3356	1212	81158.2
Jan., 1995	323.7	21962.2	10.5986	79.0113	1219.1	82377.3
Feb., 1995	261.8	22224	9.87925	82.0546	1197.6	83574.9
Mar., 1995	301.4	22525.4	10.1882	82.6669	1438.1	85013
Apr., 1995	287.7	22813.1	9.92069	82.7393	1379.7	86392.7
May., 1995	310.3	23123.4	12.07	82.752	1489.4	87882.1
Jun., 1995	314.4	23437.8	10.48	83.8867	1637.5	89519.6
Jul., 1995	302.9	23740.7	10.2823	83.8273	1570.7	91090.3
Aug., 1995	299.3	24040	10.1889	83.7091	1538.6	92628.9
Sep., 1995	275.7	24315.7	9.33258	84.1	1458.9	94087.8
Oct., 1995	247.2	24562.9	8.82857	83.9066	1289.4	95377.2
Nov., 1995	257	24819.9	8.56667	84.5523	1407.3	96784.5
Dec., 1995	238.3	25058.2	7.97657	84.7646	1326.4	98110.9
Jan., 1996	213.7	25271.9	7.75915	84.4298	1159.3	99270.2
Feb., 1996	200.5	25472.4	7.33537	85.3946	1172.8	100443
Mar., 1996	260.8	25733.2	8.81577	85.6689	1559.7	102003
Apr., 1996	248.9	25982.1	8.40169	85.553	1474.6	103477
May., 1996	245.1	26227.2	8.17	85.338	1427.2	104904
Jun., 1996	227.8	26455	7.78803	85.5117	1345.1	106250
Jul., 1996	215.8	26670.8	7.19333	85.9177	1317.2	107567
Aug., 1996	208.4	26879.2	6.72258	85.6952	1249	108816
Sep., 1996	232.5	27111.7	7.90368	84.8032	1298	110114
Oct., 1996	266.6	27378.3	8.81322	83.9782	1398	111512

APPENDIX B

INDIVIDUAL WELL PRODUCTION HISTORIES

Production Report

Group	:	ROUTLEDGE	Date	:	December 18, 1996 4:03:38 pm
Well	:	Tundra Virden Prov. SWD R//E02-29-09-25W1	User	:	GEORGE
	:	00/02-29-009-25W1/0			
Hist.Data	:	03/89-04/96	On Prod	:	02/09
Operator	:		Status	:	Unknown
Field	:	5	Zone	:	59C

Production Data from March, 1989 to October, 1996

Year	Monthly Oil m3	Cum Oil m3	Avg Daily Oil m3/d	Water Cut %	Monthly Water m3	Cum Water m3
Mar., 1989	28.9995	28.9995	2.63632	58.3232	40.6003	40.6003
Apr., 1989	104.1	133.1	3.47001	40.2644	70.1992	110.8
May., 1989	97.7996	230.899	3.15482	41.2154	68.5999	179.399
Jun., 1989	71.0995	301.999	2.84398	42.7888	53.1995	232.599
Jul., 1989	71.6001	373.599	2.30968	58.5782	101.3	333.899
Aug., 1989	61.2995	434.899	1.9774	51.9859	66.3996	400.299
Sep., 1989	56.7007	491.599	1.89002	52.8957	63.7001	463.999
Oct., 1989	61.7	553.299	1.99032	53.5979	71.2994	535.298
Nov., 1989	43.7003	597	1.45668	57.0198	58.0007	593.299
Dec., 1989	58.4995	655.499	1.88708	51.9199	63.1993	656.498
Jan., 1990	48.3992	703.898	1.56127	60.0559	72.8001	729.298
Feb., 1990	43.0996	746.998	1.53927	59.7471	64.0006	793.299
Mar., 1990	56.5005	803.498	2.82502	83.5981	288.1	1081.4
Apr., 1990						
May., 1990	77.9994	881.498	2.88887	83.3415	390.399	1471.8
Jun., 1990	50.3999	931.898	1.68	78.4449	183.499	1655.3
Jul., 1990	41.5995	973.497	1.38665	61.2201	65.7001	1721
Aug., 1990	43.7003	1017.2	1.40969	61.4873	69.8002	1790.8
Sep., 1990	41.8998	1059.1	1.39666	75.489	129.1	1919.9
Oct., 1990	37.6998	1096.8	1.21612	77.7112	131.5	2051.4
Nov., 1990	37.1007	1133.9	1.23669	75.6317	115.2	2166.6
Dec., 1990	42.7007	1176.6	1.37744	73.5514	118.799	2285.4
Jan., 1991	41.7997	1218.4	1.34838	73.7189	117.3	2402.7
Feb., 1991	38.8996	1257.3	1.38927	70.8306	94.4993	2497.2
Mar., 1991	32.9993	1290.3	1.22219	64.7341	60.6	2557.8
Apr., 1991						
May., 1991	40.0993	1330.4	1.29353	64.2507	72.1006	2629.9
Jun., 1991	34.7997	1365.2	1.15999	65.9726	67.4997	2697.4
Jul., 1991	33.0994	1398.3	1.06772	68.3464	71.4997	2768.9
Aug., 1991	34.1005	1432.4	1.10002	67.4207	70.5998	2839.5
Sep., 1991	30.1993	1462.6	1.00664	71.447	75.5998	2915.1
Oct., 1991	30.1993	1492.79	0.97417	73.2425	82.6998	2997.8
Nov., 1991	27.0004	1519.79	0.900013	73.6753	75.5998	3073.4
Dec., 1991	39.7005	1559.5	1.28066	64.0946	70.9003	3144.3
Jan., 1992	44.5997	1604.09	1.4387	60.6946	68.9003	3213.2
Feb., 1992	27.0004	1631.1	0.931048	73.9546	76.6999	3289.9
Mar., 1992	32.9993	1664.09	1.06449	61.7956	53.3998	3343.3

Production Report

Group	:	ROUTLEDGE	Date	:	December 18, 1996 4:03:40 pm
Well	:	Tundra Virden Prov. SWD R//E02-29-09-25W1	User	:	GEORGE
	:	00/02-29-009-25W1/0			

Production Data from March, 1989 to October, 1996 (cont.)

Year	Monthly Oil m3	Cum Oil m3	Avg Daily Oil m3/d	Water Cut %	Monthly Water m3	Cum Water m3
Apr., 1992	25.0998	1689.19	0.865512	60.9537	39.1997	3382.5
May., 1992	32.7005	1721.9	1.09002	62.2297	53.9006	3436.4
Jun., 1992	25.5003	1747.4	0.87932	65.4836	48.3999	3484.8
Jul., 1992	28.8994	1776.29	0.932238	62.6517	48.5	3533.3
Aug., 1992	24.7995	1801.09	0.855155	82.627	118	3651.3
Sep., 1992	24.3005	1825.39	0.810017	83.7068	124.899	3776.2
Oct., 1992	20.3008	1845.7	0.654863	70.3981	48.2997	3824.5
Nov., 1992	16.5997	1862.3	0.592848	81.8119	74.6999	3899.2
Dec., 1992	14.9995	1877.29	0.483855	70.8655	36.5002	3935.7
Jan., 1993	14.2002	1891.49	0.458071	71.1872	35.0996	3970.8
Feb., 1993	17.9997	1909.49	0.642848	63.33	31.0997	4001.9
Mar., 1993	19.2996	1928.79	0.622568	64.25	34.7006	4036.6
Apr., 1993	18.8006	1947.59	0.626688	62.8353	31.8008	4068.4
May., 1993	17.6994	1965.29	0.570948	63.7942	31.1998	4099.6
Jun., 1993	16.9001	1982.19	0.563336	63.4096	29.3	4128.9
Jul., 1993	16.6999	1998.89	0.556662	63.447	28.9995	4157.9
Aug., 1993	15.0996	2013.99	0.487085	64.9554	27.9996	4185.9
Sep., 1993	11.2	2025.19	0.50909	62.5306	18.6992	4204.59
Oct., 1993	17.3005	2042.49	0.558082	57.1665	23.0998	4227.69
Nov., 1993	9.79998	2052.29	0.326666	68.172	20.9997	4248.69
Dec., 1993	18.8006	2071.09	0.606472	56.7707	24.7007	4273.39
Jan., 1994	8.5001	2079.59	0.274197	72.9206	22.8995	4296.29
Feb., 1994	12.7001	2092.29	0.453575	63.1773	21.7993	4318.09
Mar., 1994	11.7005	2104	0.377437	62.2468	19.3002	4337.39
Apr., 1994	11.9008	2115.9	0.396692	65.4964	22.6006	4359.99
May., 1994	13.8999	2129.8	0.448383	58.3734	19.5005	4379.49
Jun., 1994	13.3008	2143.1	0.443359	57.7657	18.2	4397.69
Jul., 1994	10.7995	2153.9	0.539976	53.4393	12.4004	4410.09
Aug., 1994	17.2004	2171.1	0.573347	50.5641	17.6007	4427.7
Sep., 1994	18.6004	2189.7	0.620014	51.4235	19.6992	4447.4
Oct., 1994	19.3997	2209.1	0.646658	53.7996	22.6006	4470
Nov., 1994	17.1003	2226.2	0.57001	57.0248	22.7008	4492.7
Dec., 1994	19.8002	2246	0.638716	56.7571	25.9996	4518.7
Jan., 1995	10.2004	2256.2	0.637527	54.6553	12.3003	4531
Feb., 1995						
Mar., 1995						
Apr., 1995						
May., 1995						
Jun., 1995						
Jul., 1995						
Aug., 1995						

Production Report

Group	:	ROUTLEDGE	Date	:	December 18, 1996 4:03:41 pm
Well	:	Tundra Virden Prov. SWD R//E02-29-09-25W1	User	:	GEORGE
	:	00/02-29-009-25W1/0			

Production Data from March, 1989 to October, 1996 (cont.)

Year	Monthly Oil m3	Cum Oil m3	Avg Daily Oil m3/d	Water Cut %	Monthly Water m3	Cum Water m3
Sep., 1995						
Oct., 1995						
Nov., 1995						
Dec., 1995						
Jan., 1996						
Feb., 1996						
Mar., 1996						
Apr., 1996						
May., 1996						
Jun., 1996						
Jul., 1996						
Aug., 1996						
Sep., 1996						
Oct., 1996						

Production Report

Group	:	ROUTLEDGE	Date	:	December 18, 1996 4:10:28 pm
Well	:	Tundra Virden Prov. R//E06-29-09-25W1	User	:	GEORGE
	:	00/06-29-009-25W1/0			
Hist.Data	:	01/85-10/96	On Prod	:	02/09
Operator	:		Status	:	Unknown
Field	:	5	Zone	:	59C

Production Data from January, 1985 to October, 1996

Year	Monthly Oil m3	Cum Oil m3	Avg Daily Oil m3/d	Water Cut %	Monthly Water m3	Cum Water m3
Jan., 1985						
Feb., 1985						
Mar., 1985						
Apr., 1985						
May., 1985						
Jun., 1985						
Jul., 1985						
Aug., 1985						
Sep., 1985						
Oct., 1985						
Nov., 1985						
Dec., 1985	62.1	62.1	5.175	20.0702	15.6	15.6
Jan., 1986	105.4	167.5	3.4	21.9184	29.6	45.2
Feb., 1986	165.2	332.7	5.9	24.7298	54.3	99.5
Mar., 1986	116.8	449.5	14.6	43.7813	91	190.5
Apr., 1986						
May., 1986						
Jun., 1986						
Jul., 1986	22.9	472.4	4.58	40.0418	15.3	205.8
Aug., 1986	158.8	631.2	5.12258	41.521	112.8	318.6
Sep., 1986	140.9	772.1	4.69667	46.3333	121.7	440.3
Oct., 1986	143.2	915.3	4.61935	47.8594	131.5	571.8
Nov., 1986	125.3	1040.6	4.17667	51.3854	132.5	704.3
Dec., 1986	128.3	1168.9	4.13871	53.5204	147.8	852.1
Jan., 1987	125.9	1294.8	4.06129	55.6425	158	1010.1
Feb., 1987	109.6	1404.4	3.91429	56.7886	144.1	1154.2
Mar., 1987	86.7	1491.1	2.79677	59.4375	127.1	1281.3
Apr., 1987	83.2	1574.3	3.46667	58.4723	117.2	1398.5
May., 1987	113.9	1688.2	3.67419	61.9214	185.3	1583.8
Jun., 1987	105.5	1793.7	3.51667	62.6974	177.4	1761.2
Jul., 1987	105.8	1899.5	3.4129	64.379	191.3	1952.5
Aug., 1987	98.7	1998.2	3.18387	63.1889	169.5	2122
Sep., 1987	101.1	2099.3	3.37	64.0879	180.5	2302.5
Oct., 1987	103.6	2202.9	3.34194	66.7638	208.2	2510.7
Nov., 1987	33	2235.9	2.2	74.5287	96.6	2607.3
Dec., 1987	90.2	2326.1	2.90968	70.2611	213.2	2820.5
Jan., 1988	92.9	2419	2.99677	69.2188	209	3029.5

Production Report

Group	: ROUTLEDGE		Date	:	December 18, 1996 4:10:30 pm
Well	: Tundra Virden Prov. R//E06-29-09-25W1		User	:	GEORGE
	: 00/06-29-009-25W1/0				

Production Data from January, 1985 to October, 1996 (cont.)

Year	Monthly Oil m3	Cum Oil m3	Avg Daily Oil m3/d	Water Cut %	Monthly Water m3	Cum Water m3
Feb., 1988	145.7	2564.7	5.02414	70.1097	341.9	3371.4
Mar., 1988	158.8	2723.5	5.12258	71.4914	398.4	3769.8
Apr., 1988	148.4	2871.9	4.94667	73.6607	415.2	4185
May., 1988	120.6	2992.5	4.02	71.9967	310.2	4495.2
Jun., 1988	143.9	3136.4	4.79667	73.1092	391.4	4886.6
Jul., 1988	134.1	3270.5	4.32581	75.4942	413.3	5299.9
Aug., 1988	138.9	3409.4	4.48064	73.6297	388	5687.9
Sep., 1988	132.9	3542.3	4.43	75.4489	408.6	6096.5
Oct., 1988	129.5	3671.8	4.17742	76.6335	424.9	6521.4
Nov., 1988	127.8	3799.6	4.26	75.1666	387	6908.4
Dec., 1988	129.9	3929.5	4.19032	77.6766	452.2	7360.6
Jan., 1989	113.9	4043.4	3.67419	78.9934	428.5	7789.1
Feb., 1989	96.9	4140.3	3.46071	80.3419	396.2	8185.3
Mar., 1989	102.7	4243	3.66786	79.6924	403.2	8588.5
Apr., 1989	11.3	4254.3	3.76667	77.7483	39.5	8628
May., 1989	90.3	4344.6	2.9129	83.0488	442.6	9070.6
Jun., 1989	81.3	4425.9	2.71	83.9712	426.1	9496.7
Jul., 1989	112.1	4538	3.61613	78.6768	413.8	9910.5
Aug., 1989	109.7	4647.7	3.53871	79.492	425.4	10335.9
Sep., 1989	101.4	4749.1	3.38	80.3266	414.2	10750.1
Oct., 1989	110.5	4859.6	3.56452	79.4614	427.7	11177.8
Nov., 1989	98.7	4958.3	3.29	80.2412	401	11578.8
Dec., 1989	95.4	5053.7	3.07742	78.4673	347.8	11926.6
Jan., 1990	99.9	5153.6	3.22258	80.7372	418.9	12345.5
Feb., 1990	91.3	5244.9	3.26071	80.5427	378.1	12723.6
Mar., 1990	58.3	5303.2	2.915	83.0658	286.1	13009.7
Apr., 1990						
May., 1990	80.4	5383.6	2.97778	82.8142	387.6	13397.3
Jun., 1990	92.3	5475.9	3.07667	81.1757	398.2	13795.5
Jul., 1990	95.3	5571.2	3.07419	82.6822	455.2	14250.7
Aug., 1990	96.8	5668	3.12258	82.8671	468.4	14719.1
Sep., 1990	86.8	5754.8	2.89333	82.5709	411.4	15130.5
Oct., 1990	91.1	5845.9	2.93871	81.7807	409.1	15539.6
Nov., 1990	89.7	5935.6	2.99	82.8754	434.3	15973.9
Dec., 1990	85.5	6021.1	2.75806	84.575	469	16442.9
Jan., 1991	83.5	6104.6	2.69355	84.7208	463.2	16906.1
Feb., 1991	72.3	6176.9	2.58214	84.3245	389.1	17295.2
Mar., 1991	71	6247.9	2.62963	84.2583	380.2	17675.4
Apr., 1991						
May., 1991	77	6324.9	2.85185	83.9957	404.3	18079.7
Jun., 1991	87	6411.9	2.9	83.2534	432.7	18512.4

Production Report

Group	:	ROUTLEDGE	Date	:	December 18, 1996 4:10:31 pm
Well	:	Tundra Virden Prov. R//E06-29-09-25W1	User	:	GEORGE
	:	00/06-29-009-25W1/0			

Production Data from January, 1985 to October, 1996 (cont.)

Year	Monthly Oil m3	Cum Oil m3	Avg Daily Oil m3/d	Water Cut %	Monthly Water m3	Cum Water m3
Jul., 1991	87.3	6499.2	2.81613	83.378	438.1	18950.5
Aug., 1991	86.8	6586	2.8	83.3783	435.6	19386.1
Sep., 1991	81.5	6667.5	2.71667	83.7525	420.3	19806.4
Oct., 1991	81.7	6749.2	2.63548	84.9039	459.7	20266.1
Nov., 1991	70.2	6819.4	2.34	85.6768	420.1	20686.2
Dec., 1991	75.7	6895.1	2.44194	85.16	434.6	21120.8
Jan., 1992	70.7	6965.8	2.28065	85.8405	428.8	21549.6
Feb., 1992	76	7041.8	2.62069	85.2257	438.6	21988.2
Mar., 1992	53	7094.8	2.52381	85.8726	322.3	22310.5
Apr., 1992	46.1	7140.9	2.19524	85.6466	275.2	22585.7
May., 1992	85.2	7226.1	2.74839	86.2395	534.2	23119.9
Jun., 1992	95.9	7322	3.19667	86.8074	631.3	23751.2
Jul., 1992	93	7415	3	86.8203	612.9	24364.1
Aug., 1992	99.8	7514.8	3.21935	85.5601	591.6	24955.7
Sep., 1992	91.6	7606.4	3.05333	86.4805	586.2	25541.9
Oct., 1992	94.8	7701.2	3.05806	84.9468	535.2	26077.1
Nov., 1992	88.9	7790.1	2.96333	85.977	545.3	26622.4
Dec., 1992	86.2	7876.3	2.78065	86.7395	564.1	27186.5
Jan., 1993	81.7	7958	2.63548	86.9041	542.4	27728.9
Feb., 1993	67.4	8025.4	2.40714	86.3428	426.3	28155.2
Mar., 1993	62.5	8087.9	2.15517	87.68	445	28600.2
Apr., 1993	70.4	8158.3	2.34667	86.0652	435	29035.2
May., 1993	65.9	8224.2	2.12581	86.6386	427.5	29462.7
Jun., 1993	61.9	8286.1	2.06333	86.6169	400.8	29863.5
Jul., 1993	64.7	8350.8	2.0871	86.3938	411	30274.5
Aug., 1993	56.2	8407	1.8129	87.1991	383	30657.5
Sep., 1993	57.1	8464.1	1.90333	85.9168	348.5	31006
Oct., 1993	63.7	8527.8	2.05484	83.2571	316.9	31322.9
Nov., 1993	36.1	8563.9	1.20333	88.8845	288.8	31611.7
Dec., 1993	69.2	8633.1	2.23226	82.9662	337.2	31948.9
Jan., 1994	31.3	8664.4	1.00968	90.9239	313.7	32262.6
Feb., 1994	46.4	8710.8	1.65714	86.5573	298.9	32561.5
Mar., 1994	42.9	8753.7	1.38387	86.0752	265.3	32826.8
Apr., 1994	31.1	8784.8	1.03667	87.1225	210.5	33037.3
May., 1994	27.2	8812	0.877419	87.9706	199	33236.3
Jun., 1994	26.5	8838.5	0.883333	89.0993	216.7	33453
Jul., 1994	23.7	8862.2	1.07727	87.2188	161.8	33614.8
Aug., 1994	35.6	8897.8	1.14839	85.8114	215.4	33830.2
Sep., 1994	33.6	8931.4	1.24444	86.2524	210.9	34041.1
Oct., 1994	38.9	8970.3	1.29667	87.3241	268.1	34309.2
Nov., 1994	34.1	9004.4	1.13667	88.7711	269.7	34578.9

Production Report

Group	:	ROUTLEDGE	Date	:	December 18, 1996 4:10:32 pm
Well	:	Tundra Virden Prov. R/E06-29-09-25W1	User	:	GEORGE
	:	00/06-29-009-25W1/0			

Production Data from January, 1985 to October, 1996 (cont.)

Year	Monthly Oil m3	Cum Oil m3	Avg Daily Oil m3/d	Water Cut %	Monthly Water m3	Cum Water m3
Dec., 1994	39.5	9043.9	1.27419	88.6483	308.6	34887.5
Jan., 1995	39.5	9083.4	1.27419	87.751	283.1	35170.6
Feb., 1995	40.4	9123.8	1.4963	90.1207	368.7	35539.3
Mar., 1995	58.9	9182.7	1.9	90.6143	568.9	36108.2
Apr., 1995	53.5	9236.2	1.84483	90.9039	534.9	36643.1
May., 1995	57	9293.2	1.83871	91.5572	618.4	37261.5
Jun., 1995	63.7	9356.9	2.12333	91.9518	728.1	37989.6
Jul., 1995	56.3	9413.2	2.08519	92.1128	657.8	38647.4
Aug., 1995	59.8	9473	2.06207	91.8618	675.3	39322.7
Sep., 1995	61.1	9534.1	2.18214	90.9041	610.9	39933.6
Oct., 1995	61.4	9595.5	2.79091	89.349	515.3	40448.9
Nov., 1995	79.8	9675.3	2.66	89.3487	669.7	41118.6
Dec., 1995	67.1	9742.4	2.48519	89.7171	585.7	41704.3
Jan., 1996	72.8	9815.2	2.51034	89.416	615.3	42319.6
Feb., 1996	76.8	9892	2.74286	88.8813	614.2	42933.8
Mar., 1996	99.7	9991.7	3.32333	88.2922	752.2	43686
Apr., 1996	91.7	10083.4	3.16207	88.1845	684.7	44370.7
May., 1996	92.6	10176	3.08667	87.9725	677.6	45048.3
Jun., 1996	85.6	10261.6	3.05714	88.1869	639.3	45687.6
Jul., 1996	84.6	10346.2	2.82	88.4586	648.7	46336.3
Aug., 1996	81.7	10427.9	2.63548	88.2704	615.1	46951.4
Sep., 1996	86.5	10514.4	2.98276	87.2857	594.1	47545.5
Oct., 1996	48.8	10563.2	1.80741	86.3939	310	47855.5

Production Report

Group	:	ROUTLEDGE	Date	:	December 18, 1996 4:23:36 pm
Well	:	Tundra Virden Prov. R//E07-29-09-25W1	User	:	GEORGE
	:	00/07-29-009-25W1/0			
Hist.Data	:	09/86-10/96	On Prod	:	02/09
Operator	:		Status	:	Unknown
Field	:	5	Zone	:	59C

Production Data from September, 1986 to December, 1996

Year	Monthly Oil m3	Cum Oil m3	Avg Daily Oil m3/d	Water Cut %	Monthly Water m3	Cum Water m3
Sep., 1986	21.6	21.6	1.02857	62.7483	36.4	36.4
Oct., 1986	52.3	73.9	1.74333	56.2966	67.4	103.8
Nov., 1986	128.9	202.8	4.60357	44.6672	104.1	207.9
Dec., 1986	133	335.8	4.29032	51.8877	143.5	351.4
Jan., 1987	120.3	456.1	3.88065	56.2914	155	506.4
Feb., 1987	106	562.1	3.78571	58.0423	146.7	653.1
Mar., 1987	84.9	647	5.66	59.3479	124	777.1
Apr., 1987	5.4	652.4	2.7	59.9894	8.1	785.2
May., 1987	111.2	763.6	3.5871	59.4054	162.8	948
Jun., 1987	101.5	865.1	3.38333	61.5863	162.8	1110.8
Jul., 1987	97.3	962.4	3.13871	63.9395	172.6	1283.4
Aug., 1987	79.4	1041.8	2.73793	70.3086	188.1	1471.5
Sep., 1987	133.6	1175.4	4.45333	70.8142	324.3	1795.8
Oct., 1987	151.9	1327.3	4.9	73.6656	425.1	2220.9
Nov., 1987	84.7	1412	3.52917	71.9262	217.1	2438
Dec., 1987	125.8	1537.8	4.05806	77.7229	439.1	2877.1
Jan., 1988	127	1664.8	4.09677	76.8634	422.1	3299.2
Feb., 1988	101.8	1766.6	3.51034	78.5294	372.5	3671.7
Mar., 1988	114.6	1881.2	3.69677	79.1108	434.2	4105.9
Apr., 1988	107.6	1988.8	3.58667	77.7057	375.2	4481.1
May., 1988	96	2084.8	3.09677	77.5467	331.7	4812.8
Jun., 1988	99.8	2184.6	3.32667	78.8933	373.2	5186
Jul., 1988	96.5	2281.1	3.1129	81.4535	424	5610
Aug., 1988	95.7	2376.8	3.0871	82.3596	447	6057
Sep., 1988	91.5	2468.3	3.05	83.7965	473.4	6530.4
Oct., 1988	93.4	2561.7	3.0129	81.973	424.9	6955.3
Nov., 1988	83.2	2644.9	2.77333	82.8426	401.9	7357.2
Dec., 1988	90.9	2735.8	2.93226	83.0507	445.6	7802.8
Jan., 1989	91.1	2826.9	2.93871	82.5549	431.3	8234.1
Feb., 1989	74	2900.9	2.64286	83.7731	382.2	8616.3
Mar., 1989	73.2	2974.1	2.61429	83.2356	363.6	8979.9
Apr., 1989	8.5	2982.6	2.83333	81.7531	38.1	9018
May., 1989	100.9	3083.5	3.25484	79.6419	394.9	9412.9
Jun., 1989	98.3	3181.8	3.27667	80.6959	411.1	9824
Jul., 1989	74.7	3256.5	2.40968	83.5533	379.1	10203.1
Aug., 1989	66.7	3323.2	2.15161	85.4471	391.8	10594.9
Sep., 1989	77.6	3400.8	2.58667	83.0172	379.5	10974.4

Production Report

Group	: ROUTLEDGE		Date	: December 18, 1996 4:23:38 pm
Well	: Tundra Virden Prov. R/E07-29-09-25W1		User	: GEORGE
	: 00/07-29-009-25W1/0			

Production Data from September, 1986 to December, 1996 (cont.)

Year	Monthly Oil m3	Cum Oil m3	Avg Daily Oil m3/d	Water Cut %	Monthly Water m3	Cum Water m3
Oct., 1989	66.6	3467.4	2.14839	85.6287	397	11371.4
Nov., 1989	70.9	3538.3	2.36333	84.5139	387.1	11758.5
Dec., 1989	73.8	3612.1	2.38065	82.1804	340.5	12099
Jan., 1990	67.6	3679.7	2.18065	85.3909	395.3	12494.3
Feb., 1990	62	3741.7	2.21429	85.2466	358.4	12852.7
Mar., 1990	26.5	3768.2	1.325	72.2425	69	12921.7
Apr., 1990						
May., 1990	35.9	3804.1	1.32963	71.8563	91.7	13013.4
Jun., 1990	57.8	3861.9	1.92667	84.5603	316.7	13330.1
Jul., 1990	64.5	3926.4	2.08065	85.4248	378.2	13708.3
Aug., 1990	47.3	3973.7	1.97083	85.9591	289.7	13998
Sep., 1990	56.9	4030.6	1.89667	85.9522	348.3	14346.3
Oct., 1990	58	4088.6	1.93333	85.6701	346.9	14693.2
Nov., 1990	58.7	4147.3	1.95667	84.2061	313.1	15006.3
Dec., 1990	62.5	4209.8	2.01613	83.9024	325.9	15332.2
Jan., 1991	61	4270.8	1.96774	84.0589	321.8	15654
Feb., 1991	47.3	4318.1	1.68929	85.3278	275.2	15929.2
Mar., 1991	50.8	4368.9	1.88148	85.4094	297.5	16226.7
Apr., 1991						
May., 1991	55	4423.9	2.03704	85.1856	316.4	16543.1
Jun., 1991	46.4	4470.3	1.54667	87.7136	331.4	16874.5
Jul., 1991	51.2	4521.5	1.65161	86.8634	338.7	17213.2
Aug., 1991	49.6	4571.1	1.6	86.9732	331.3	17544.5
Sep., 1991	57.4	4628.5	1.91333	84.6835	317.5	17862
Oct., 1991	57.5	4686	1.85484	85.7866	347.2	18209.2
Nov., 1991	59.4	4745.4	1.98	84.[illegible]	314.3	18523.5
Dec., 1991	45.1	4790.5	1.45484	87.5915	318.5	18842
Jan., 1992	33.2	4823.7	1.10667	90.5456	318.1	19160.1
Feb., 1992	41.7	4865.4	1.43793	85.332	242.7	19402.8
Mar., 1992	29.3	4894.7	1.39524	85.989	179.9	19582.7
Apr., 1992	26.9	4921.6	1.22273	85.6861	161.1	19743.8
May., 1992	48.6	4970.2	1.56774	86.2621	305.3	20049.1
Jun., 1992	40.2	5010.4	1.34	86.7407	263.1	20312.2
Jul., 1992	41.7	5052.1	1.34516	85.959	255.4	20567.6
Aug., 1992	40.5	5092.6	1.30645	86.8584	267.8	20835.4
Sep., 1992	34.7	5127.3	1.23929	87.7034	247.6	21083
Oct., 1992	38.8	5166.1	1.25161	86.3[illegible]	246.1	21329.1
Nov., 1992	36.6	5202.7	1.22	86.6616	237.9	21567
Dec., 1992	40.9	5243.6	1.31935	88.1024	303	21870
Jan., 1993	38.7	5282.3	1.24839	88.2[illegible]17	291.4	22161.4
Feb., 1993	36.1	5318.4	1.28929	87.5682	253	22414.4

Production Report

Group	:	ROUTLEDGE	Date	: December 18, 1996 4:23:39 pm
Well	:	Tundra Virden Prov. R/E07-29-09-25W1	User	: GEORGE
	:	00/07-29-009-25W1/0		

Production Data from September, 1986 to December, 1996 (cont.)

Year	Monthly Oil m3	Cum Oil m3	Avg Daily Oil m3/d	Water Cut %	Monthly Water m3	Cum Water m3
Mar., 1993	33.4	5351.8	1.15172	88.7725	264.2	22678.6
Apr., 1993	37.6	5389.4	1.25333	87.2881	258.3	22936.9
May., 1993	35.3	5424.7	1.13871	87.7807	253.7	23190.6
Jun., 1993	33.8	5458.5	1.12667	87.5136	237	23427.6
Jul., 1993	32.3	5490.8	1.11379	87.6007	228.3	23655.9
Aug., 1993	30.1	5520.9	1.00333	88.3061	227.4	23883.3
Sep., 1993	30.6	5551.5	1.02	87.1108	206.9	24090.2
Oct., 1993	34.7	5586.2	1.11935	84.3706	187.4	24277.6
Nov., 1993	27.9	5614.1	0.93	88.6078	217.1	24494.7
Dec., 1993	53.5	5667.6	1.72581	82.567	253.5	24748.2
Jan., 1994	24.2	5691.8	0.780645	90.6922	235.9	24984.1
Feb., 1994	25.3	5717.1	0.903571	87.4704	176.7	25160.8
Mar., 1994	33.1	5750.2	1.06774	85.7581	199.4	25360.2
Apr., 1994	39.1	5789.3	1.30333	86.9834	261.4	25621.6
May., 1994	35.9	5825.2	1.15806	87.1691	244	25865.6
Jun., 1994	34.9	5860.1	1.16333	86.5459	224.6	26090.2
Jul., 1994	41.2	5901.3	1.42069	84.287	221.1	26311.3
Aug., 1994	45.4	5946.7	1.51333	82.6323	216.1	26527.4
Sep., 1994	45.9	5992.6	1.63929	83.156	226.7	26754.1
Oct., 1994	49.7	6042.3	1.71379	84.3849	268.7	27022.8
Nov., 1994	45.1	6087.4	1.50333	86.1007	279.5	27302.3
Dec., 1994	52.3	6139.7	1.6871	85.9431	319.9	27622.2
Jan., 1995	52.2	6191.9	1.68387	84.8902	293.4	27915.6
Feb., 1995	42.9	6234.8	1.58889	86.1067	266	28181.6
Mar., 1995	48.9	6283.7	1.57742	85.3406	284.8	28466.4
Apr., 1995	44.3	6328	1.52759	85.7959	267.7	28734.1
May., 1995	57.1	6385.1	1.84194	80.0628	229.4	28963.5
Jun., 1995	57.3	6442.4	1.91	78.1222	204.7	29168.2
Jul., 1995	56.4	6498.8	1.88	78.4576	205.5	29373.7
Aug., 1995	55.8	6554.6	1.86	77.8671	196.4	29570.1
Sep., 1995	47.3	6601.9	1.57667	78.5511	173.3	29743.4
Oct., 1995	21.6	6623.5	0.72	87.1077	150	29893.4
Nov., 1995	20.6	6644.1	0.686667	87.3958	142.9	30036.3
Dec., 1995	19.9	6664	0.641935	87.8091	143.4	30179.7
Jan., 1996	11	6675	0.647059	87.481	76.9	30256.6
Feb., 1996	15.4	6690.4	0.7	86.81	101.4	30358
Mar., 1996	40.4	6730.8	1.34667	83.3821	202.8	30560.8
Apr., 1996	38.4	6769.2	1.28	83.2472	190.9	30751.7
May., 1996	37.6	6806.8	1.25333	82.9261	182.7	30934.4
Jun., 1996	37.1	6843.9	1.23667	83.2595	184.6	31119
Jul., 1996	34.3	6878.2	1.14333	83.5982	174.9	31293.9

Group : ROUTLEDGE
Well : Tundra Virden Prov. R/E07-29-09-25W1
: 00/07-29-009-25W1/0

Date : December 18, 1996 4:23:40 pm
User : GEORGE

Production Data from September, 1986 to December, 1996 (cont.)

Year	Monthly Oil m3	Cum Oil m3	Avg Daily Oil m3/d	Water Cut %	Monthly Water m3	Cum Water m3
Aug., 1996	33.1	6911.3	1.06774	83.3607	165.9	31459.8
Sep., 1996	36.2	6947.5	1.20667	82.0639	165.7	31625.5
Oct., 1996	39.6	6987.1	1.27742	83.1284	195.2	31820.7
Nov., 1996		7023.36				
Dec., 1996		7059.28				

Production Report

Group	:	ROUTLEDGE	Date	:	December 18, 1996 4:27:39 pm
Well	:	Tundra Virden Prov. R/E10-29-09-25W1	User	:	GEORGE
	:	00/10-29-009-25W1/0			
Hist.Data	:	03/86-10/96	On Prod	:	02/09
Operator	:		Status	:	Unknown
Field	:	5	Zone	:	59C

Production Data from March, 1986 to October, 1996

Year	Monthly Oil m3	Cum Oil m3	Avg Daily Oil m3/d	Water Cut %	Monthly Water m3	Cum Water m3
Mar., 1986	32.1	32.1	2.46923	55.2192	39.6	39.6
Apr., 1986						
May., 1986						
Jun., 1986						
Jul., 1986						
Aug., 1986	1.5	33.6	0.75	78.2534	5.4	45
Sep., 1986	68.2	101.8	2.27333	53.9702	80	125
Oct., 1986	45.6	147.4	1.47097	67.6729	95.5	220.5
Nov., 1986	26.1	173.5	0.87	79.993	104.4	324.9
Dec., 1986	42.7	216.2	1.37742	66.5525	85	409.9
Jan., 1987	37.4	253.6	1.20645	70.1424	87.9	497.8
Feb., 1987	31.4	285	1.30833	68.5905	68.6	566.4
Mar., 1987	22.5	307.5	1.125	70.0706	52.7	619.1
Apr., 1987	20.8	328.3	1.15556	71.6532	52.6	671.7
May., 1987	35.8	364.1	1.15484	70.4285	85.3	757
Jun., 1987	35.6	399.7	1.18667	68.7076	78.2	835.2
Jul., 1987	37.1	436.8	1.19677	68.145	79.4	914.6
Aug., 1987	69.5	506.3	2.39655	65.3612	131.2	1045.8
Sep., 1987	68.1	574.4	2.27	68.923	151.1	1196.9
Oct., 1987	69.9	644.3	2.25484	67.4636	145	1341.9
Nov., 1987	20	664.3	0.714286	76.6276	65.6	1407.5
Dec., 1987	60.2	724.5	1.94194	71.297	149.6	1557.1
Jan., 1988	62.9	787.4	2.02903	70.307	149	1706.1
Feb., 1988	52.2	839.6	1.8	70.3317	123.8	1829.9
Mar., 1988	61.1	900.7	1.97097	68.2502	131.4	1961.3
Apr., 1988	48.7	949.4	1.62333	72.3991	127.8	2089.1
May., 1988	69.9	1019.3	2.41034	80.5061	288.8	2377.9
Jun., 1988	52.9	1072.2	1.76333	78.3122	191.1	2569
Jul., 1988	73.1	1145.3	2.35806	69.7341	168.5	2737.5
Aug., 1988	58.7	1204	1.89355	74.4143	170.8	2908.3
Sep., 1988	56.1	1260.1	1.87	66.0107	109	3017.3
Oct., 1988	57.2	1317.3	1.84516	73.7409	160.7	3178
Nov., 1988	56.5	1373.8	1.88333	77.9221	199.5	3377.5
Dec., 1988	44.7	1418.5	1.44194	74.1085	128	3505.5
Jan., 1989	53.8	1472.3	1.73548	75.0497	161.9	3667.4
Feb., 1989	42.6	1514.9	1.52143	78.564	156.2	3823.6
Mar., 1989	45.9	1560.8	1.63929	77.9039	161.9	3985.5

Production Report

Group	:	ROUTLEDGE	Date	:	December 18, 1996 4:27:41 pm
Well	:	Tundra Virden Prov. R//E10-29-09-25W1	User	:	GEORGE
	:	00/10-29-009-25W1/0			

Production Data from March, 1986 to October, 1996 (cont.)

Year	Monthly Oil m3	Cum Oil m3	Avg Daily Oil m3/d	Water Cut %	Monthly Water m3	Cum Water m3
Apr., 1989	5	1565.8	1.66667	76.0685	15.9	4001.4
May., 1989	45.2	1611	1.45806	79.7147	177.7	4179.1
Jun., 1989	40.6	1651.6	1.35333	80.806	171	4350.1
Jul., 1989	53	1704.6	1.70968	78.5177	193.8	4543.9
Aug., 1989	58.1	1762.7	1.87419	77.7574	203.2	4747.1
Sep., 1989	50.7	1813.4	1.69	80.6567	211.5	4958.6
Oct., 1989	53.4	1866.8	1.72258	79.7041	209.8	5168.4
Nov., 1989	52.5	1919.3	1.75	79.6834	206	5374.4
Dec., 1989	49.2	1968.5	1.5871	87.5992	347.7	5722.1
Jan., 1990	48.4	2016.9	1.56129	79.7926	191.2	5913.3
Feb., 1990	43.4	2060.3	1.55	79.5597	169	6082.3
Mar., 1990	24.7	2085	1.235	68.9214	54.8	6137.1
Apr., 1990						
May., 1990	34.1	2119.1	1.26296	68.5329	74.3	6211.4
Jun., 1990	39.2	2158.3	1.30667	76.4202	127.1	6338.5
Jul., 1990	43.1	2201.4	1.39032	78.6136	158.5	6497
Aug., 1990	43.8	2245.2	1.4129	77.3215	149.4	6646.4
Sep., 1990	42	2287.2	1.4	76.2766	135.1	6781.5
Oct., 1990	46.4	2333.6	1.49677	75.5837	143.7	6925.2
Nov., 1990	37.1	2370.7	1.23667	79.2549	141.8	7067
Dec., 1990	36.2	2406.9	1.16774	75.6639	112.6	7179.6
Jan., 1991	35.3	2442.2	1.13871	75.9128	111.3	7290.9
Feb., 1991	33.3	2475.5	1.18929	81.2644	144.5	7435.4
Mar., 1991	28	2503.5	1.03704	80.508	115.7	7551.1
Apr., 1991						
May., 1991	30.3	2533.8	1.12222	80.2407	123.1	7674.2
Jun., 1991	33.9	2567.7	1.25556	77.3772	116	7790.2
Jul., 1991	15.6	2583.3	1.04	80.7339	65.4	7855.6
Aug., 1991	19.5	2602.8	1.08333	80.2761	79.4	7935
Sep., 1991	24.2	2627	0.806667	82.5961	114.9	8049.9
Oct., 1991	24.2	2651.2	0.780645	83.8392	125.6	8175.5
Nov., 1991	31.4	2682.6	1.08276	79.2256	119.8	8295.3
Dec., 1991	32.5	2715.1	1.04839	79.5397	126.4	8421.7
Jan., 1992	40.5	2755.6	1.30645	77.1367	136.7	8558.4
Feb., 1992	32.9	2788.5	1.13448	79.6465	128.8	8687.2
Mar., 1992	22.9	2811.4	1.09048	80.5037	94.6	8781.8
Apr., 1992	29.5	2840.9	0.983333	83.944	154.3	8936.1
May., 1992	38.2	2879.1	1.23226	84.5786	209.6	9145.7
Jun., 1992	34.8	2913.9	1.2	78.3776	126.2	9271.9
Jul., 1992	36.2	2950.1	1.16774	82.8292	174.7	9446.6
Aug., 1992	31.2	2981.3	1.00645	78.22	112.1	9558.7

Production Report

Group	:	ROUTLEDGE	Date	:	December 18, 1996 4:27:42 pm
Well	:	Tundra Virden Prov. R//E10-29-09-25W1	User	:	GEORGE
	:	00/10-29-009-25W1/0			

Production Data from March, 1986 to October, 1996 (cont.)

Year	Monthly Oil m3	Cum Oil m3	Avg Daily Oil m3/d	Water Cut %	Monthly Water m3	Cum Water m3
Sep., 1992	22	3003.3	0.956522	79.4704	85.2	9643.9
Oct., 1992	28.2	3031.5	0.909678	87.5832	199	9842.9
Nov., 1992	28.6	3060.1	0.953333	75.0789	86.2	9929.1
Dec., 1992	31.2	3091.3	1.00645	63.6685	54.7	9983.8
Jan., 1993	29.5	3120.8	0.951613	64.0581	52.6	10036.4
Feb., 1993	23.3	3144.1	0.832143	82.2344	107.9	10144.3
Mar., 1993	22.3	3166.4	0.743333	83.9393	116.6	10260.9
Apr., 1993	24.4	3190.8	0.813333	81.8387	110	10370.9
May., 1993	22.8	3213.6	0.735484	82.5891	108.2	10479.1
Jun., 1993	19.6	3233.2	0.653333	83.9285	102.4	10581.5
Jul., 1993	21.7	3254.9	0.723333	82.2648	100.7	10682.2
Aug., 1993	19.4	3274.3	0.625806	83.3129	96.9	10779.1
Sep., 1993	19.8	3294.1	0.66	81.6601	88.2	10867.3
Oct., 1993	20.3	3314.4	0.654839	79.9535	81	10948.3
Nov., 1993	11.5	3325.9	0.383333	86.513	73.8	11022.1
Dec., 1993	22	3347.9	0.709677	79.6413	86.1	11108.2
Jan., 1994	10	3357.9	0.322581	88.8969	80.1	11188.3
Feb., 1994	14.7	3372.6	0.525	83.8579	76.4	11264.7
Mar., 1994	13.6	3386.2	0.43871	83.2863	67.8	11332.5
Apr., 1994	18	3404.2	0.6	83.5255	91.3	11423.8
May., 1994	22.8	3427	0.735484	81.5019	100.5	11524.3
Jun., 1994	21.1	3448.1	0.781482	84.3992	114.2	11638.5
Jul., 1994	44.2	3492.3	1.47333	84.9604	249.8	11888.3
Aug., 1994	48.7	3541	1.57097	83.35	243.9	12132.2
Sep., 1994	51.1	3592.1	1.70333	83.8385	265.2	12397.4
Oct., 1994	53.3	3645.4	1.77667	85.0602	303.6	12701
Nov., 1994	46.9	3692.3	1.56333	86.6786	305.3	13006.3
Dec., 1994	54.2	3746.5	1.74839	86.5591	349.2	13355.5
Jan., 1995	54.1	3800.6	1.74516	85.5486	320.4	13675.9
Feb., 1995	44.5	3845.1	1.64815	86.7113	290.5	13966.4
Mar., 1995	50.6	3895.7	1.63226	85.9975	310.9	14277.3
Apr., 1995	46.1	3941.8	1.58966	86.3759	292.4	14569.7
May., 1995	53.1	3994.9		86.4316	338.4	14908.1
Jun., 1995	58.5	4053.4	1.95	87.6038	413.6	15321.7
Jul., 1995	57.6	4111	1.92	87.8125	415.2	15736.9
Aug., 1995	56.9	4167.9	1.89667	87.4566	396.9	16133.8
Sep., 1995	55.5	4223.4	1.85	86.5403	357	16490.8
Oct., 1995	45.9	4269.3	1.53	84.4822	250	16740.8
Nov., 1995	43.8	4313.1	1.46	84.4623	238.2	16979
Dec., 1995	42.3	4355.4	1.36452	84.9731	239.3	17218.3
Jan., 1996	23.5	4378.9	1.38235	84.5031	128.2	17346.5

Production Report

Group	:	ROUTLEDGE	Date	:	December 18, 1996 4:27:43 pm
Well	:	Tundra Virden Prov. R//E10-29-09-25W1	User	:	GEORGE
	:	00/10-29-009-25W1/0			

Production Data from March, 1986 to October, 1996 (cont.)

Year	Monthly Oil m3	Cum Oil m3	Avg Daily Oil m3/d	Water Cut %	Monthly Water m3	Cum Water m3
Feb., 1996	39.1	4418	1.44815	84.3103	210.2	17556.7
Mar., 1996	56.1	4474.1	2.07778	86.3285	354.4	17911.1
Apr., 1996	59.3	4533.4	1.97667	86.2073	370.8	18281.9
May., 1996	57.9	4591.3	1.93	85.9617	354.7	18636.6
Jun., 1996	57.3	4648.6	1.91	86.2174	358.6	18995.2
Jul., 1996	52.8	4701.4	1.76	86.5392	339.6	19334.8
Aug., 1996	51	4752.4	1.64516	86.3182	321.9	19656.7
Sep., 1996	55.9	4808.3	1.86333	85.1904	321.7	19978.4
Oct., 1996	76.5	4884.8	2.46774	82.3628	357.4	20335.8

Production Report

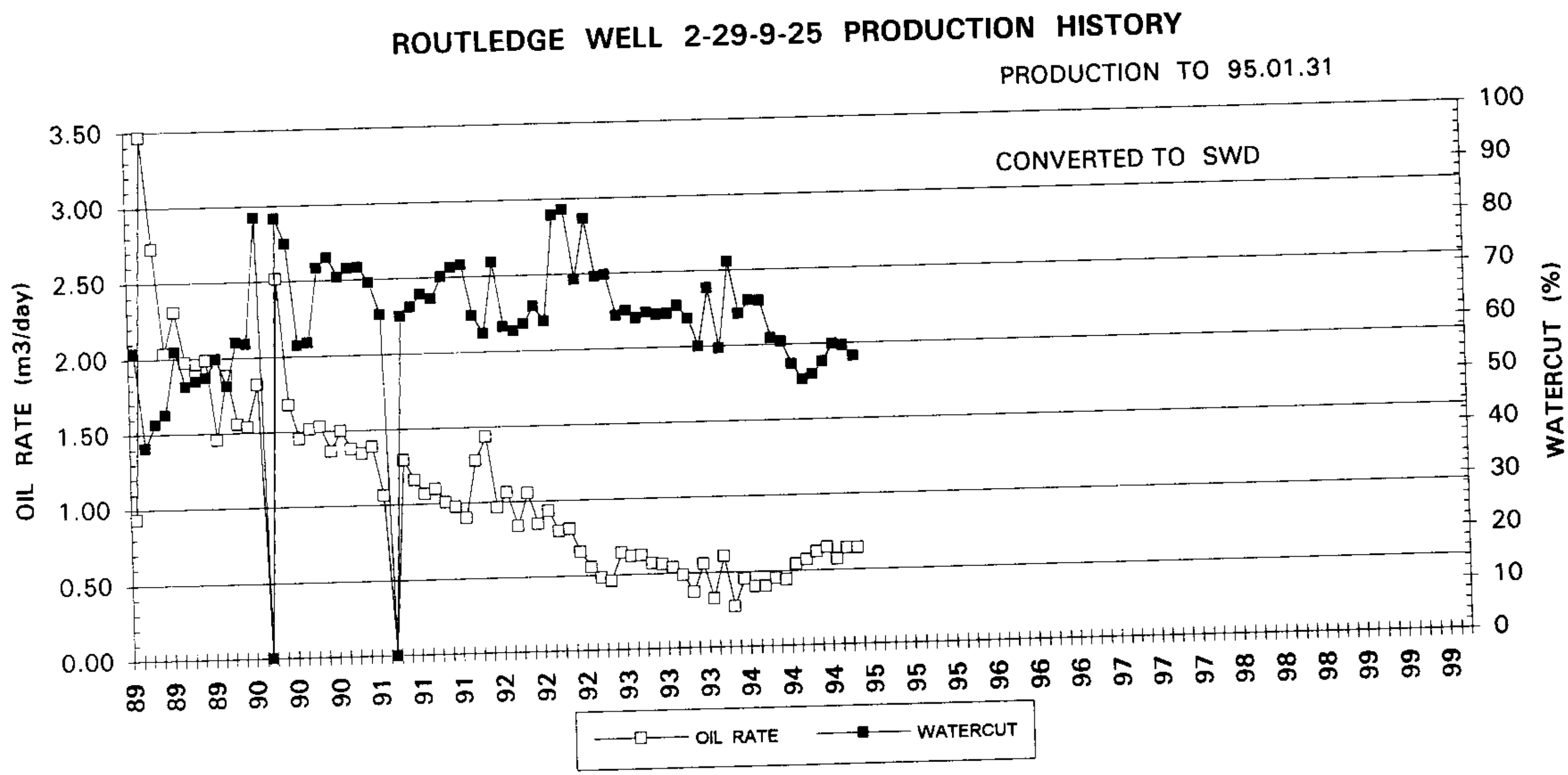
Group	:	ROUTLEDGE	Date	:	December 18, 1996 4:33:07 pm
Well	:	Tundra Virden Prov. R//E11-29-09-25W1	User	:	GEORGE
	:	00/11-29-009-25W1/0			
Hist.Data	:	09/94-10/96	On Prod	:	02/09
Operator	:		Status	:	Unknown
Field	:	5	Zone	:	59C

Production Data from September, 1994 to October, 1996

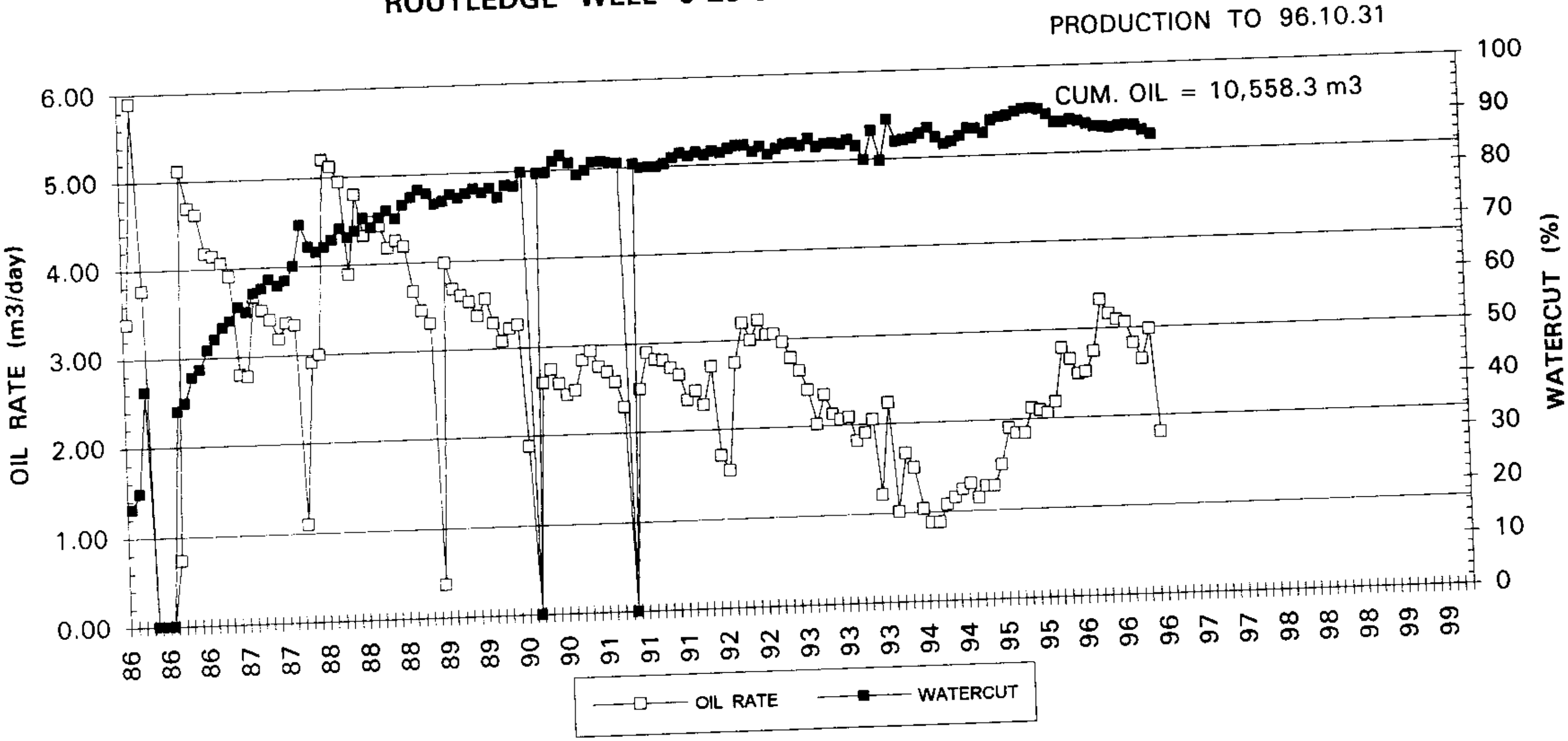
Year	Monthly Oil m3	Cum Oil m3	Avg Daily Oil m3/d	Water Cut %	Monthly Water m3	Cum Water m3
Sep., 1994	105.5	105.5	3.76786	63.3578	182.5	182.5
Oct., 1994	100.5	206	3.35	67.7582	211.3	393.8
Nov., 1994	144.2	350.2	4.80667	54.4139	172.2	566
Dec., 1994	112.2	462.4	3.61935	64.9822	208.3	774.3
Jan., 1995	167.7	630.1	5.40968	64.8769	309.9	1084.2
Feb., 1995	134	764.1	5.15385	67.0178	272.4	1356.6
Mar., 1995	143	907.1	5.10714	65.6563	273.5	1630.1
Apr., 1995	143.8	1050.9	4.95862	66.4313	284.7	1914.8
May., 1995	143.1	1194	4.61613	67.9268	303.2	2218
Jun., 1995	134.9	1328.9	4.49667	68.3238	291.1	2509.1
Jul., 1995	132.6	1461.5	4.42	68.7759	292.2	2801.3
Aug., 1995	126.8	1588.3	4.37241	68.0348	270	3071.3
Sep., 1995	111.8	1700.1	3.72667	73.9613	317.7	3389
Oct., 1995	118.3	1818.4	3.94333	75.9668	374.1	3763.1
Nov., 1995	112.8	1931.2	3.76	75.9562	356.5	4119.6
Dec., 1995	109	2040.2	3.51613	76.6516	358	4477.6
Jan., 1996	106.4	2146.6	3.54667	76.098	338.9	4816.5
Feb., 1996	69.2	2215.8	2.47143	78.1076	247	5063.5
Mar., 1996	64.6	2280.4	2.08387	79.4784	250.3	5313.8
Apr., 1996	59.5	2339.9	1.98333	79.3115	228.2	5542
May., 1996	57	2396.9	1.9	78.8188	212.2	5754.2
Jun., 1996	47.8	2444.7	1.59333	77.2736	162.6	5916.8
Jul., 1996	44.1	2488.8	1.47	77.7309	154	6070.8
Aug., 1996	42.6	2531.4	1.37419	77.4168	146.1	6216.9
Sep., 1996	53.9	2585.3	1.85862	80.0595	216.5	6433.4
Oct., 1996	101.7	2687	3.28065	84.0311	535.4	6968.8

APPENDIX C

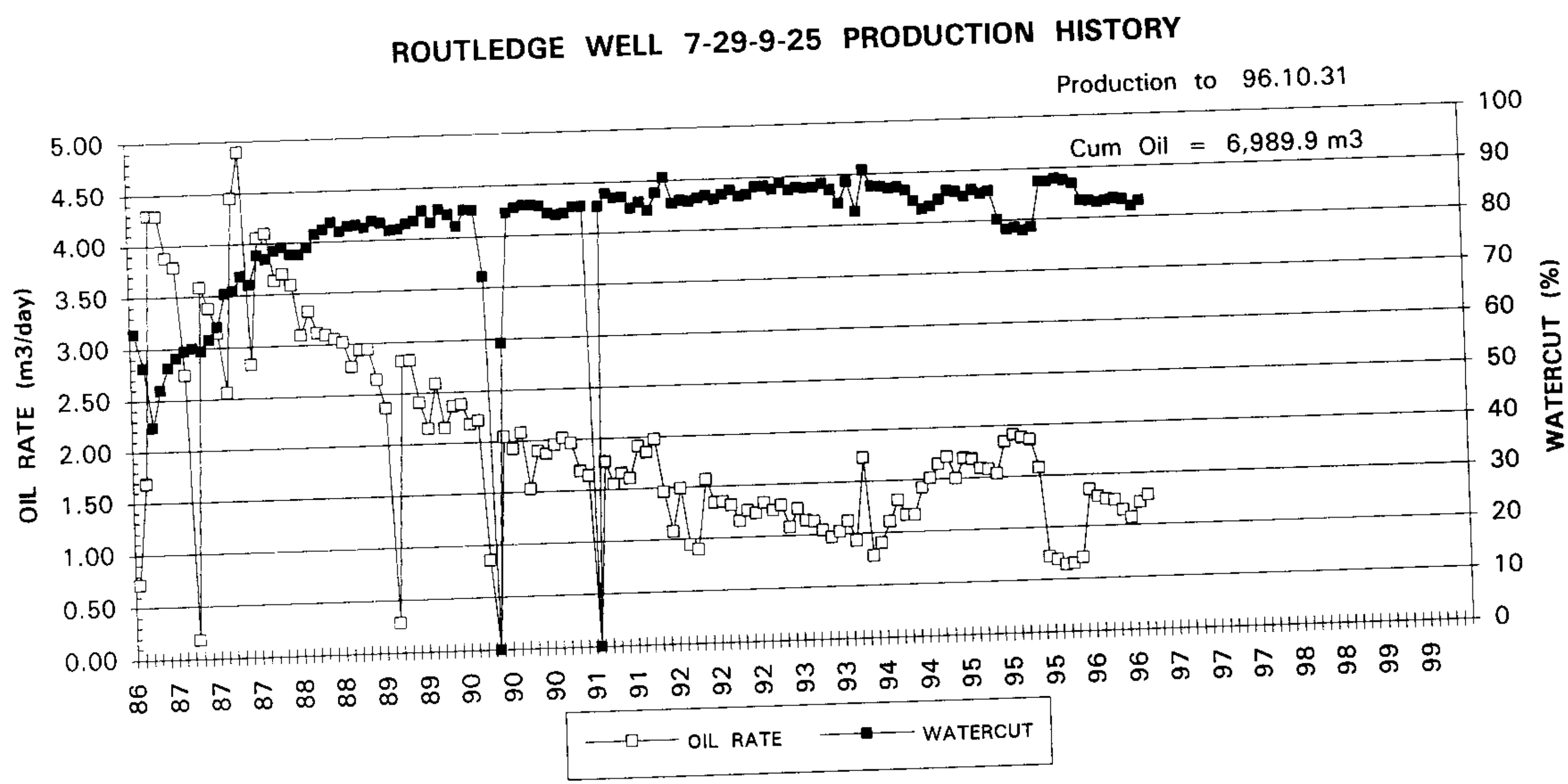
INDIVIDUAL WELL PRODUCTION PLOTS


ROUTLEDGE WELL 2-29-9-25 PRODUCTION HISTORY
PRODUCTION TO 95.01.31
CONVERTED TO SWD
OIL RATE (m3/day)
WATERCUT (%)
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
100
90
80
70
60
50
40
30
20
10
0
89 89 89 89 90 90 90 91 91 91 92 92 92 93 93 93 94 94 94 95 95 95 96 96 96 97 97 97 98 98 98 99 99 99
OIL RATE
WATERCUT

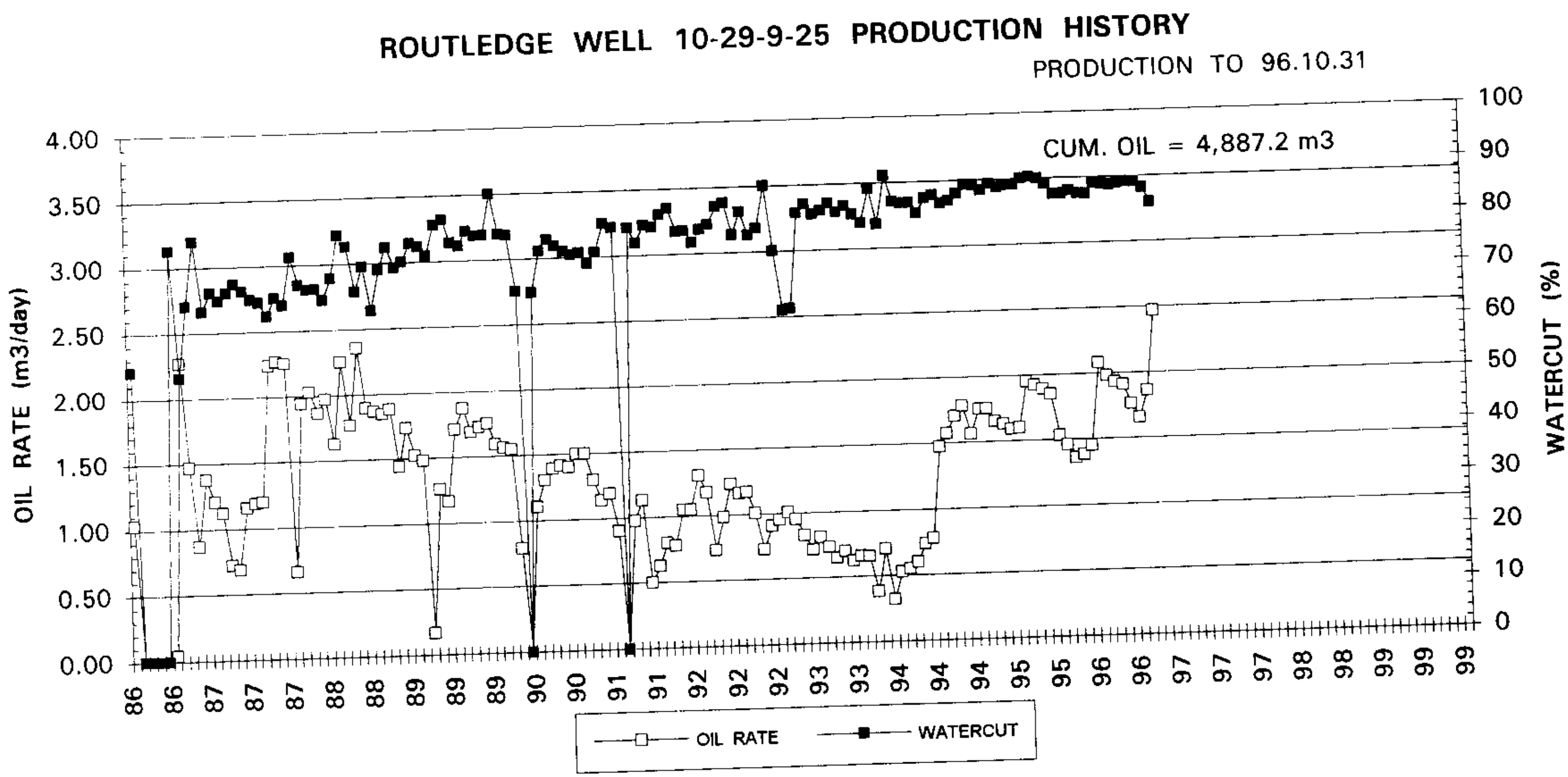
ROUTLEDGE WELL 6-29-9-25 PRODUCTION HISTORY



C729PH.XLC

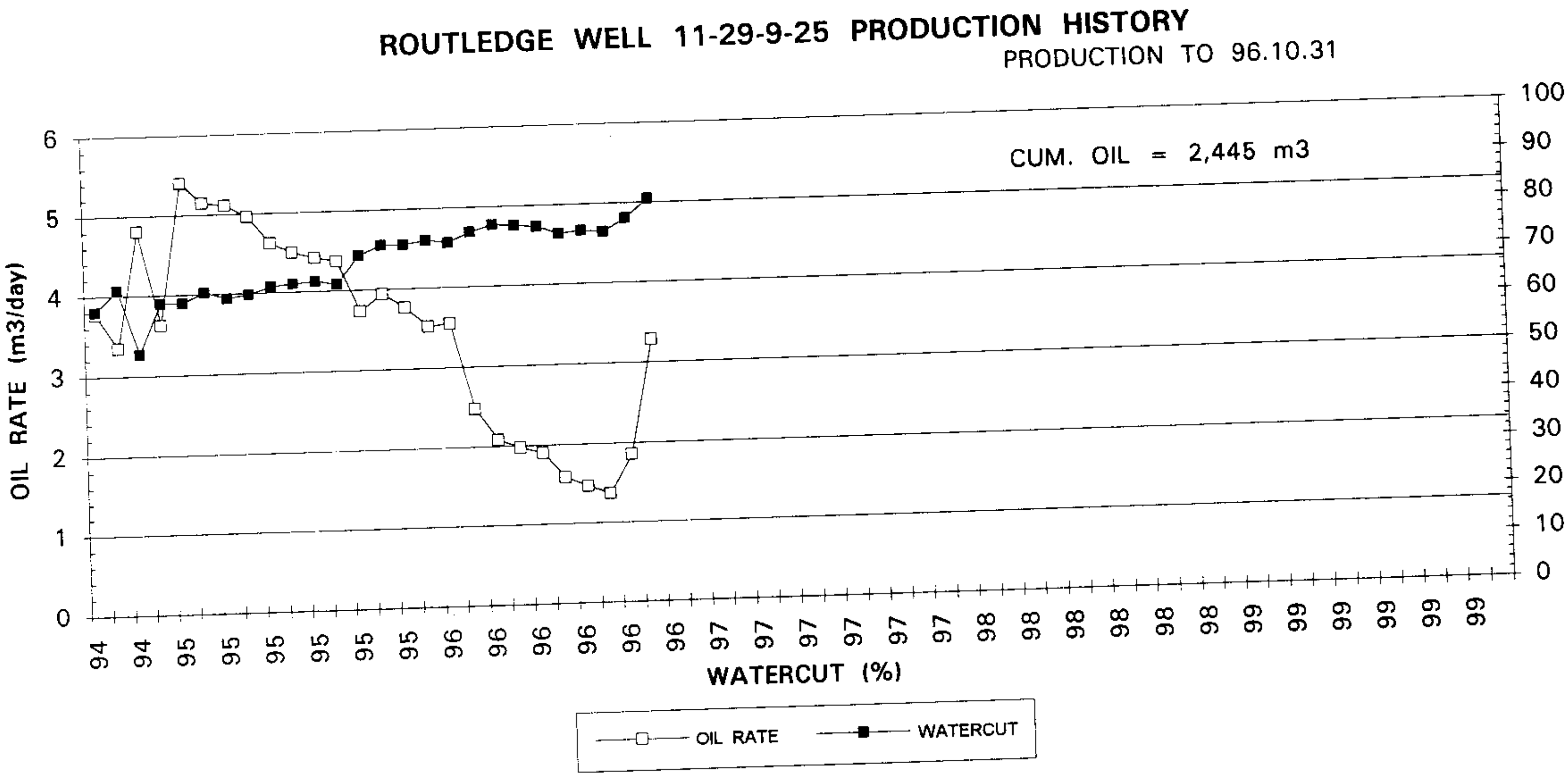


ROUTLEDGE WELL 7-29-9-25 PRODUCTION HISTORY
Production to 96.10.31
Cum Oil = 6,989.9 m3
OIL RATE (m3/day)
WATERCUT (%)
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
100
90
80
70
60
50
40
30
20
10
0
86 87 87 87 88 88 89 89 90 90 90 91 91 92 92 92 93 93 94 94 95 95 95 96 96 97 97 97 98 98 99 99
OIL RATE
WATERCUT



ROUTLEDGE WELL 10-29-9-25 PRODUCTION HISTORY
PRODUCTION TO 96.10.31
CUM. OIL = 4,887.2 m3
OIL RATE (m3/day)
WATERCUT (%)
OIL RATE
WATERCUT

C1129PH.XLC



ROUTLEDGE WELL 11-29-9-25 PRODUCTION HISTORY
PRODUCTION TO 96.10.31
CUM. OIL = 2,445 m3
OIL RATE (m3/day)
0
1
2
3
4
5
6
100
90
80
70
60
50
40
30
20
10
0
94 94 95 95 95 95 95 95 96 96 96 96 96 96 97 97 97 97 97 97 98 98 98 98 98 98 99 99 99 99 99 99
WATERCUT (%)
OIL RATE
WATERCUT

APPENDIX D

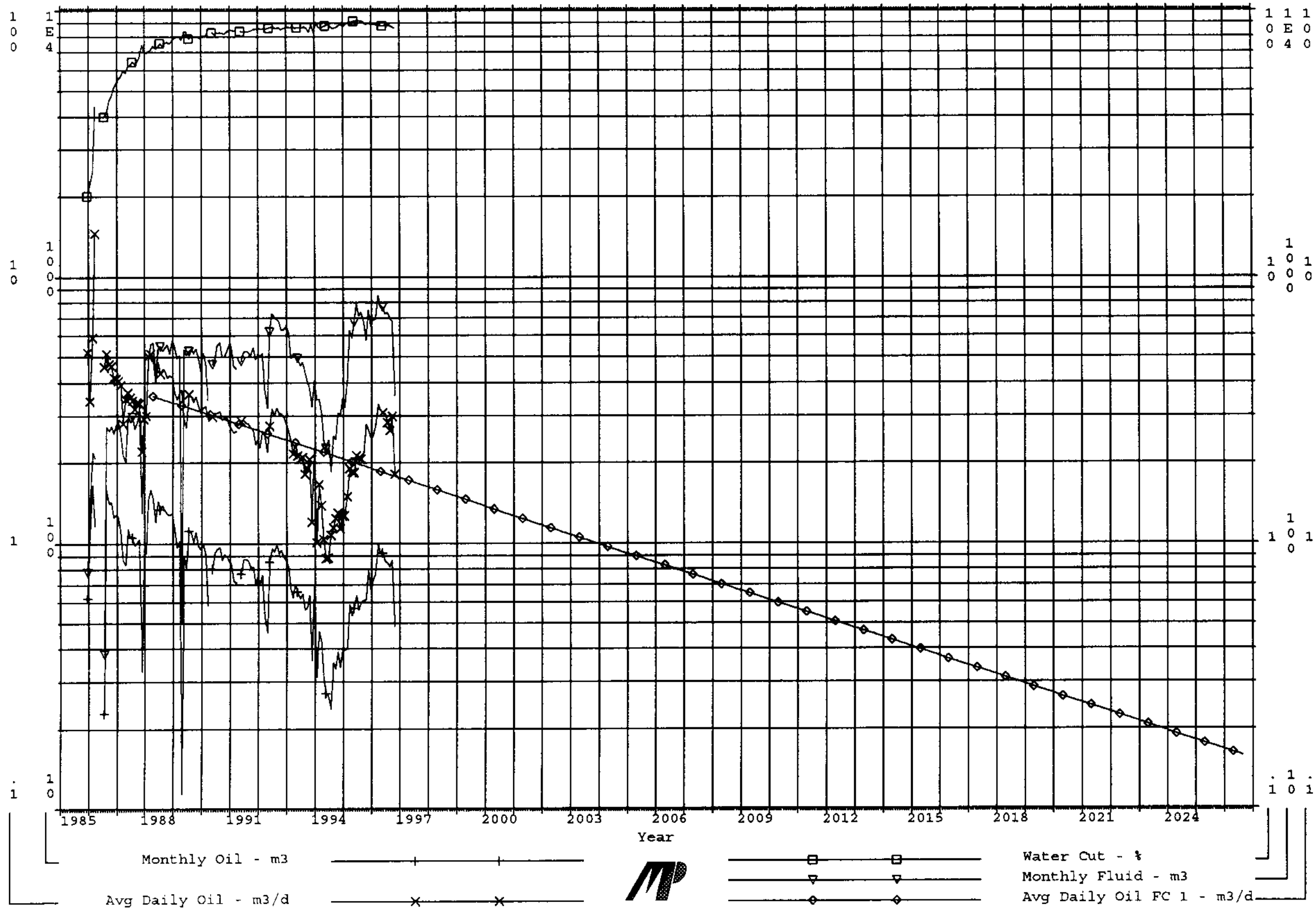
INDIVIDUAL WELL ULTIMATE RECOVERY PREDICTIONS
DECLINE ANALYSIS (Oil Rate vs Cumulative Oil Production)

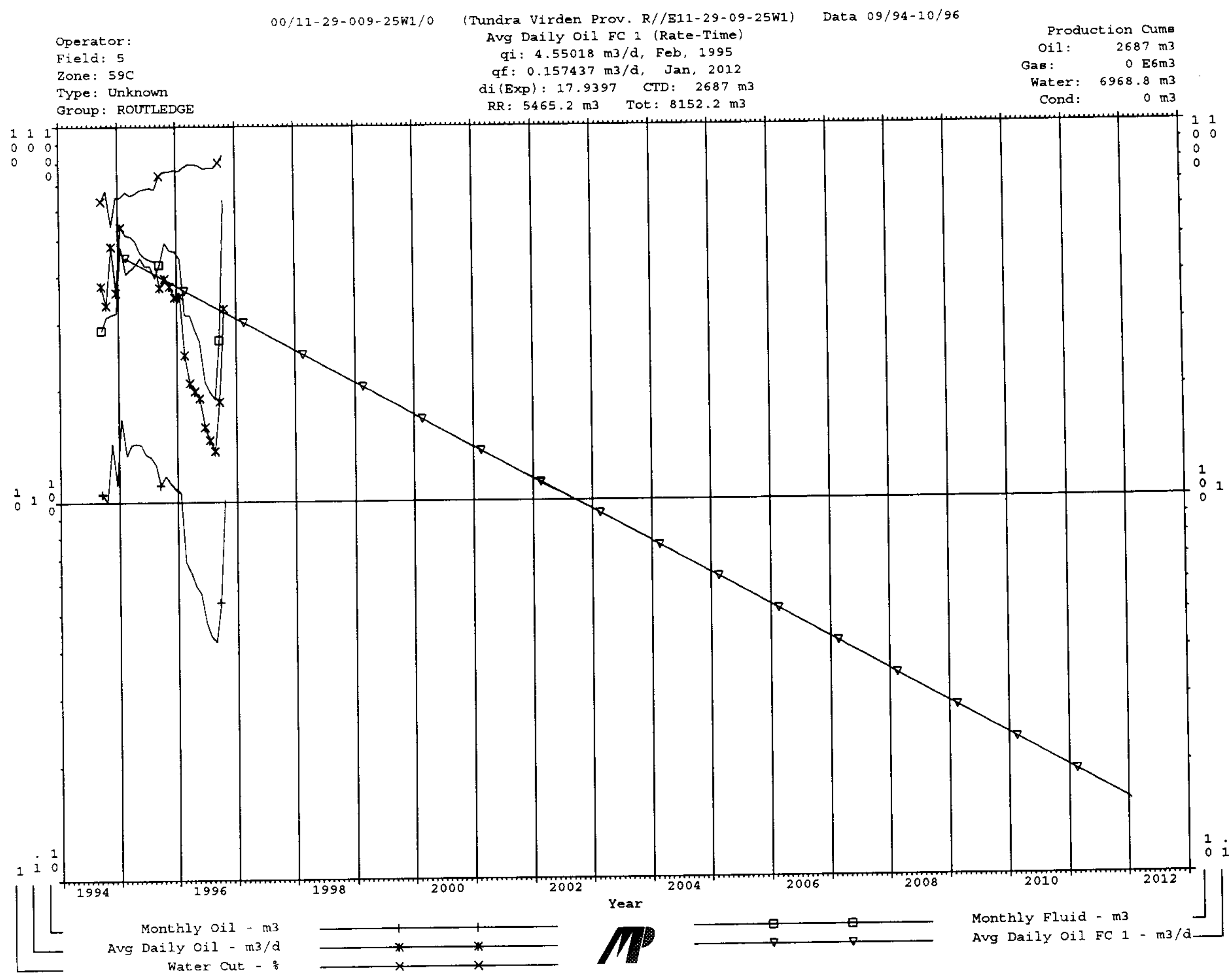
00/06-29-009-25W1/0 (Tundra Virden Prov. R//E06-29-09-25W1) Data 01/85-10/96

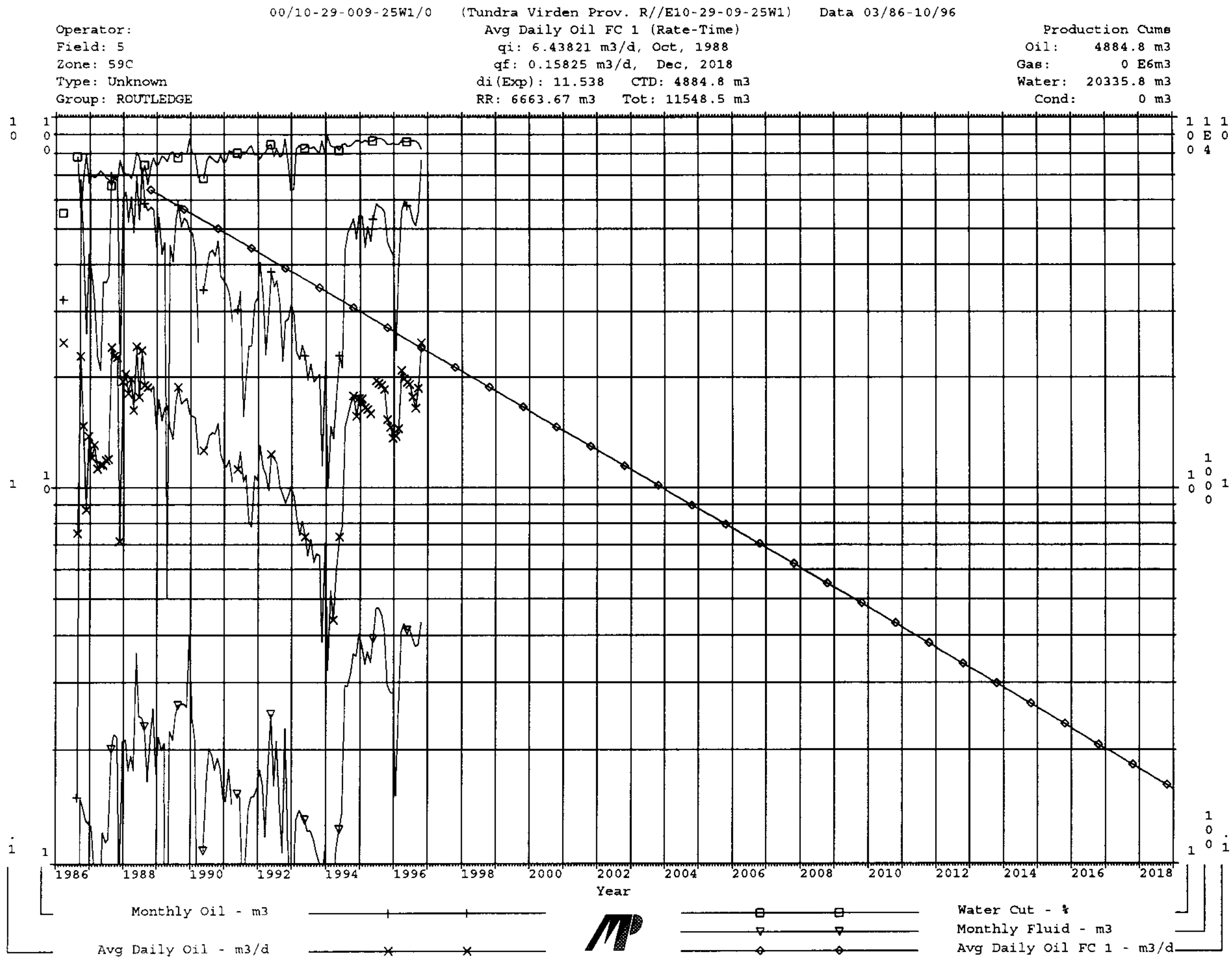
Operator:
Field: 5
Zone: 59C
Type: Unknown
Group: ROUTLEDGE

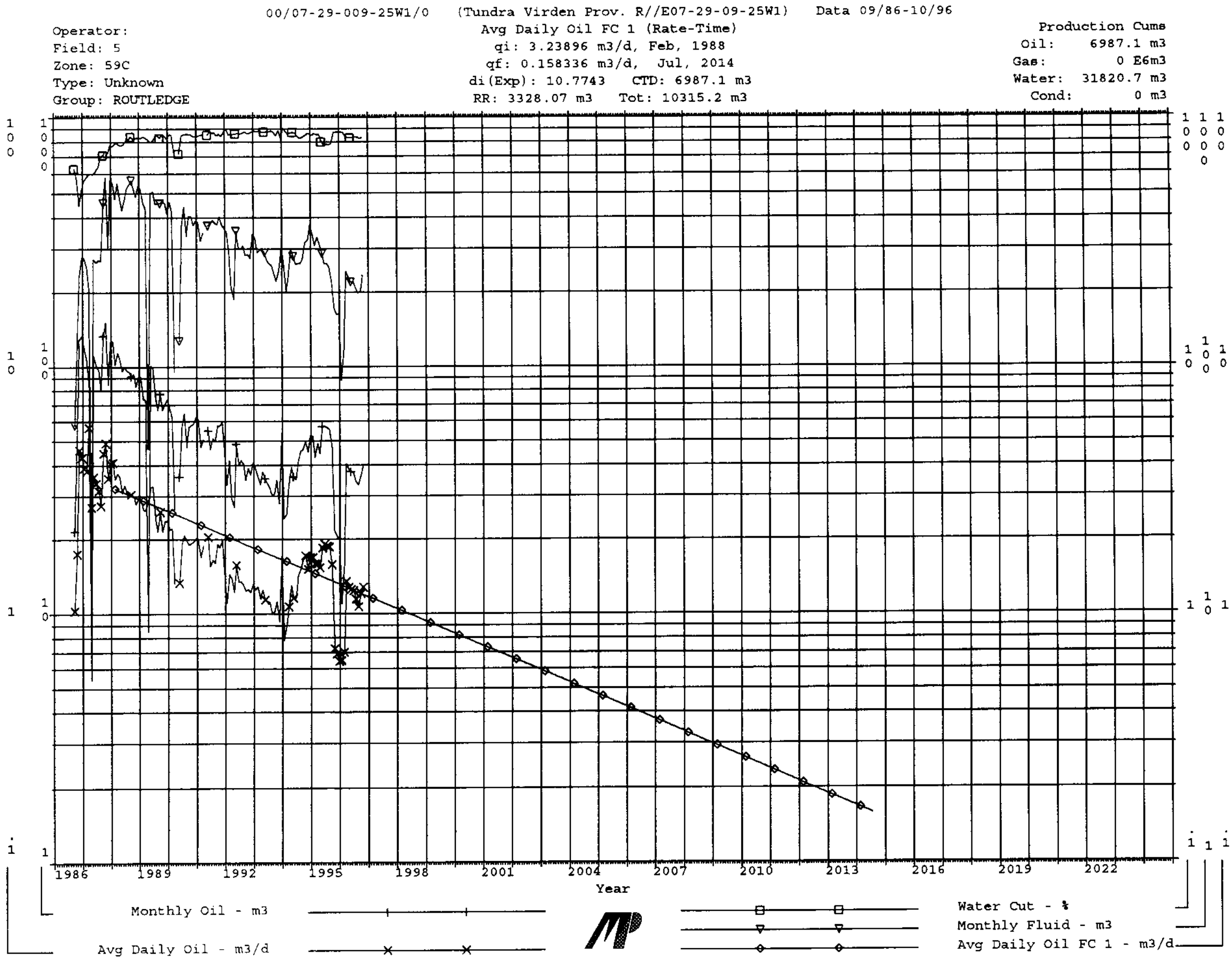
Avg Daily Oil FC 1 (Rate-Time)
qi: 3.57919 m3/d, Apr, 1988
qf: 0.158018 m3/d, Aug, 2026
di(Exp): 7.80744 CTD: 10563.2 m3
RR: 6923.02 m3 Tot: 17486.2 m3

Production Cums
Oil: 10563.2 m3
Gas: 0 E6m3
Water: 47855.5 m3
Cond: 0 m3




00/11-29-009-25W1/0
(Tundra Virden Prov. R//E11-29-09-25W1)
Data 09/94-10/96
Avg Daily Oil FC 1 (Rate-Time)
qi: 4.55018 m3/d, Feb, 1995
qf: 0.157437 m3/d, Jan, 2012
di(Exp): 17.9397 CTD: 2687 m3
RR: 5465.2 m3 Tot: 8152.2 m3
Operator:
Field: 5
Zone: 59C
Type: Unknown
Group: ROUTLEDGE
Production Cums
Oil: 2687 m3
Gas: 0 E6m3
Water: 6968.8 m3
Cond: 0 m3
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Year
Monthly Oil - m3
Avg Daily Oil - m3/d
Water Cut - %
Monthly Fluid - m3
Avg Daily Oil FC 1 - m3/d


00/10-29-009-25W1/0 (Tundra Virden Prov. R//E10-29-09-25W1) Data 03/86-10/96
Operator:
Field: 5
Zone: 59C
Type: Unknown
Group: ROUTLEDGE
Avg Daily Oil FC 1 (Rate-Time)
qi: 6.43821 m3/d, Oct, 1988
qf: 0.15825 m3/d, Dec, 2018
di(Exp): 11.538 CTD: 4884.8 m3
RR: 6663.67 m3 Tot: 11548.5 m3
Production Cums
Oil: 4884.8 m3
Gas: 0 E6m3
Water: 20335.8 m3
Cond: 0 m3
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Year
Monthly Oil - m3
Avg Daily Oil - m3/d
Water Cut - %
Monthly Fluid - m3
Avg Daily Oil FC 1 - m3/d

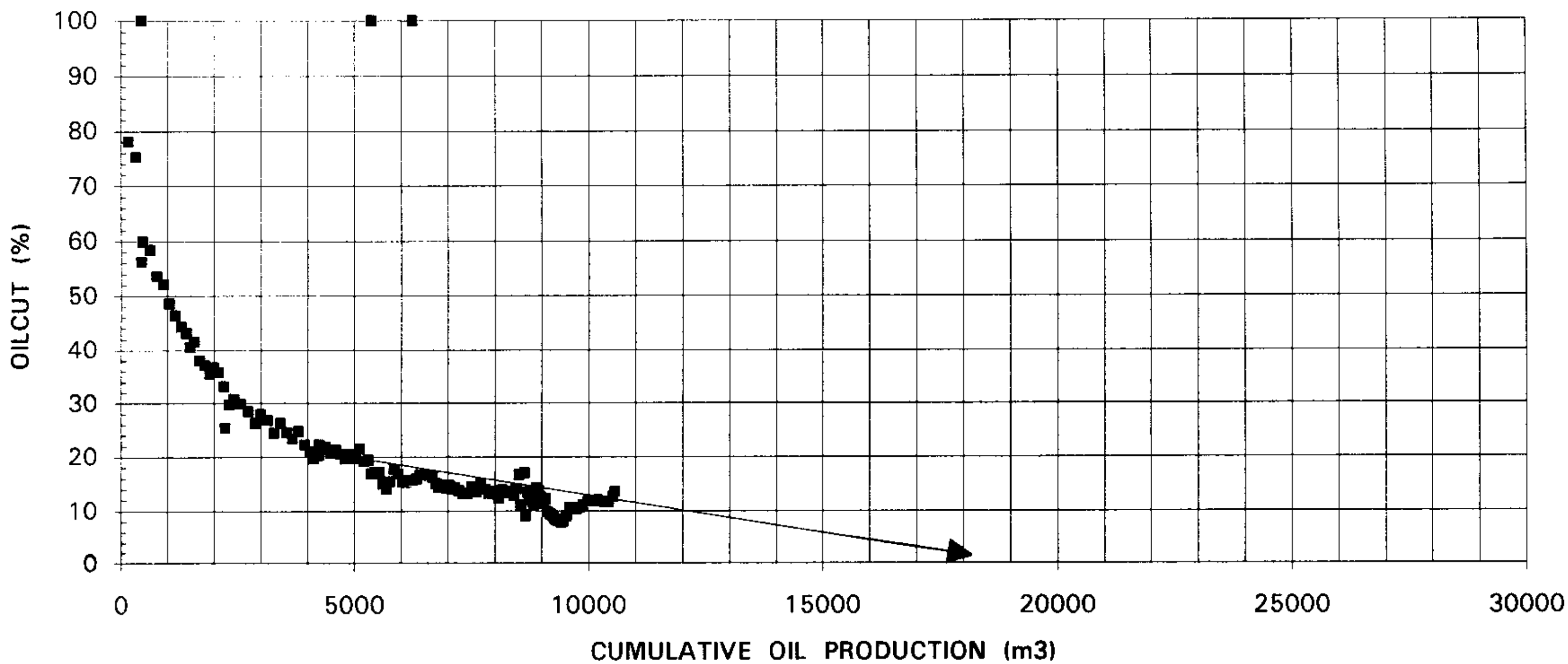

00/07-29-009-25W1/0
(Tundra Virden Prov. R//E07-29-09-25W1)
Data 09/86-10/96
Operator:
Field: 5
Zone: 59C
Type: Unknown
Group: ROUTLEDGE
Avg Daily Oil FC 1 (Rate-Time)
qi: 3.23896 m3/d, Feb, 1988
qf: 0.158336 m3/d, Jul, 2014
di(Exp): 10.7743 CTD: 6987.1 m3
RR: 3328.07 m3 Tot: 10315.2 m3
Production Cums
Oil: 6987.1 m3
Gas: 0 E6m3
Water: 31820.7 m3
Cond: 0 m3
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
2019
2022
Year
Monthly Oil - m3
Avg Daily Oil - m3/d
Water Cut - %
Monthly Fluid - m3
Avg Daily Oil FC 1 - m3/d

APPENDIX E

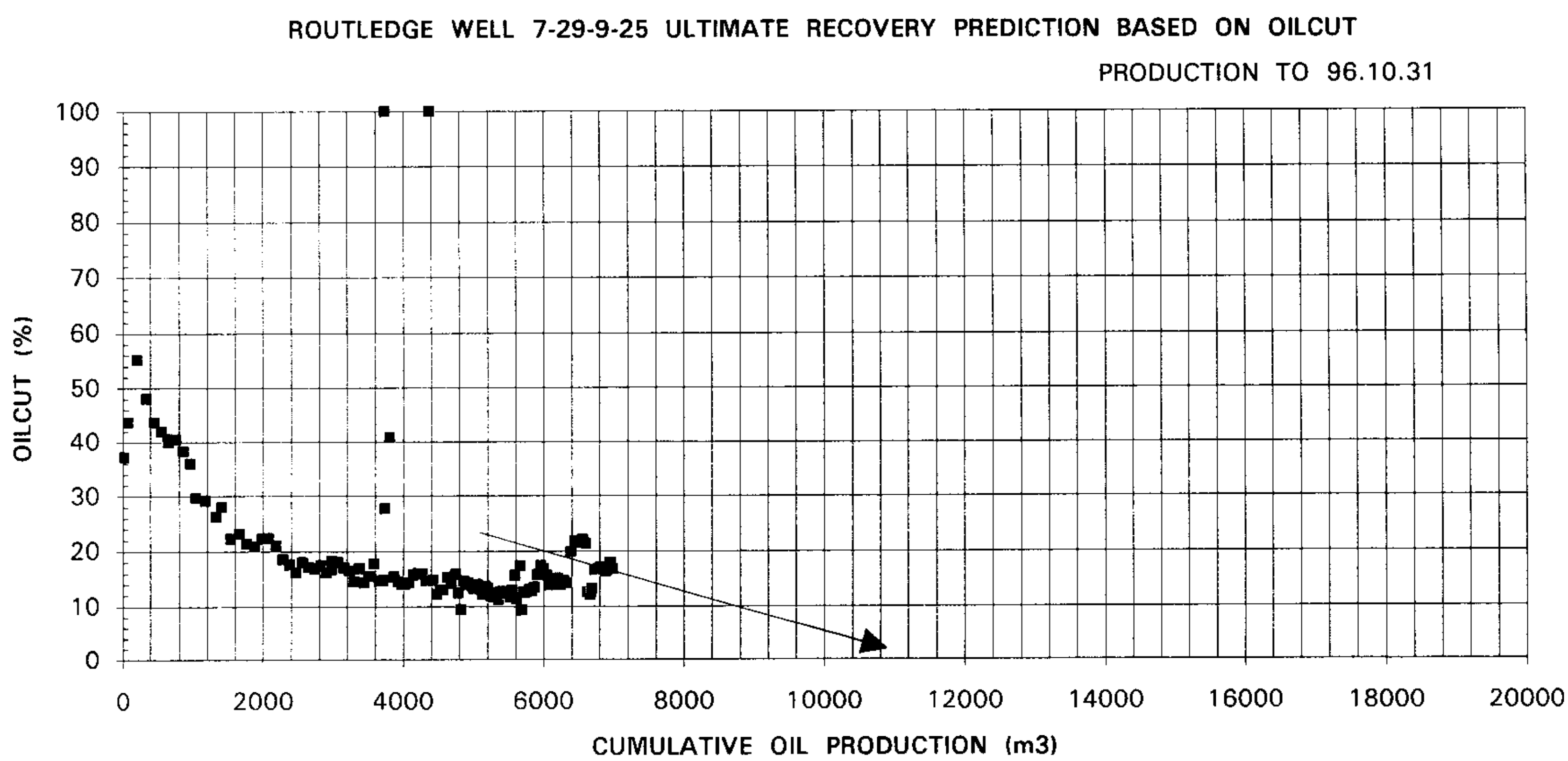
INDIVIDUAL WELL ULTIMATE RECOVERY PREDICTIONS BASED ON OIL-CUT

ROUTLEDGE WELL 6-29-9-25 ULTIMATE RECOVERY PREDICTION BASED ON OILCUT

PRODUCTION TO 96.10.31



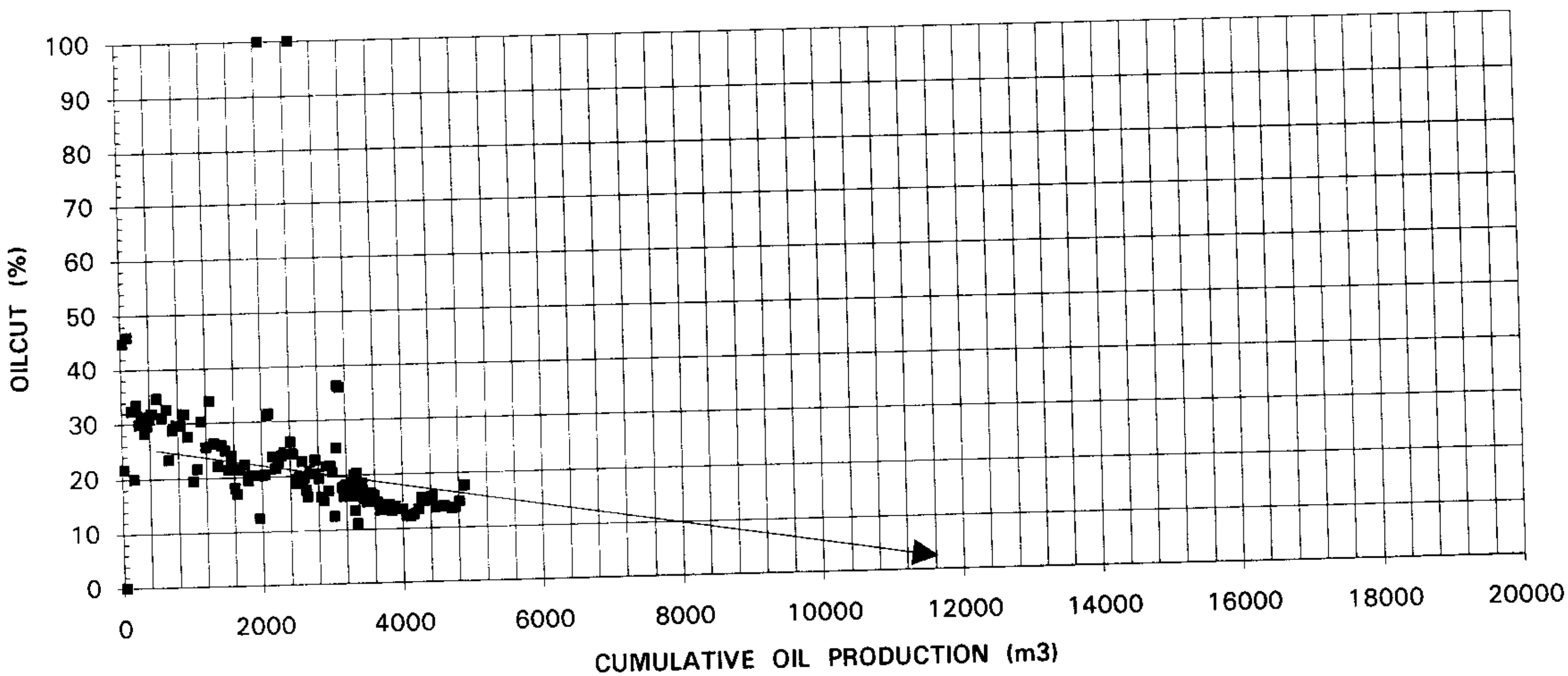
C729UROC.XLC



C1029UOC.XLC

ROUTLEDGE WELL 10-29-9-25 ULTIMATE RECOVERY PREDICTION BASED ON OILCUT

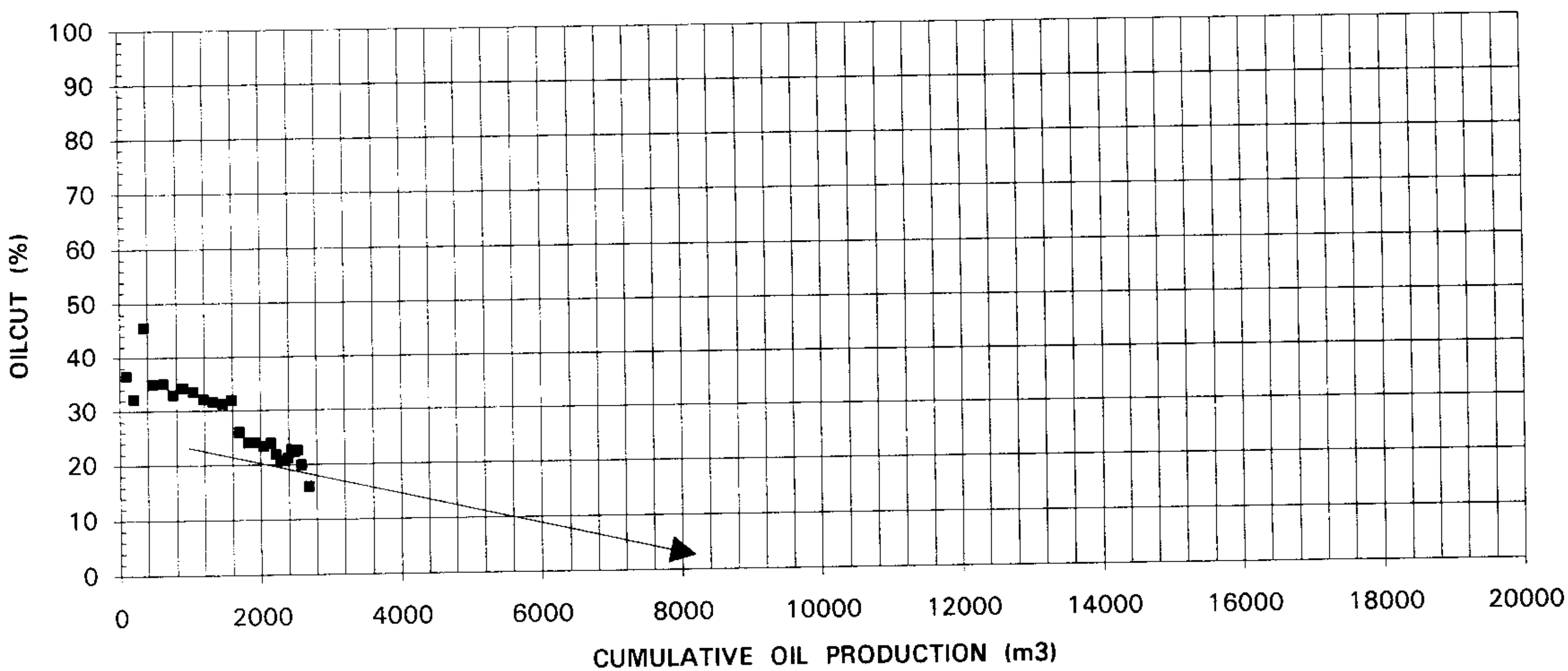
Production to 96.10.31



C1129UOC.XLC

ROUTLEDGE WELL 11-29-9-25 ULTIMATE RECOVERY PREDICTION BASED ON OILCUT

PRODUCTION TO 96.10.31



APPENDIX F

CORE REPORTS

COMPANY : SASKATCHEWAN OIL AND GAS CORPORATION
WELL : SASKOIL VIRDEN PROV. 6-29-9-25 W1
FORMATION: LODGEPOLE-VIRDEN
CORED INTERVAL: 619.00 - 655.30

LAB NO: S86-142
PAGE : 5
DATE : 1986-01-23

CORE ANALYSIS DATA REPORT

SMPL NO.	INTERVAL TOP M	INTERVAL BASE M	REP THICK M	SAMPLE LENGTH M	GAS PERMEABILITY - Md KMAX	K90	KV	PORO-SITY	DENSITY,KG/M3 BULK	GRAIN	RESIDUAL SAT. FRAC OF PV OIL	WATER	VISUAL EXAMINATION
			CORE NO. 1		619.00 - 637.40		RECEIVED IN LAB		18.40 METRES				
1	619.00	619.20	0.20	0.10	0.24	0.21	<.01	0.081	2590	2820	0.285	0.713	LS,DOL/ANHY,VUG POR
2	619.20	619.30	0.10	0.08	0.09	0.05	0.02	0.070	2630	2830	0.230	0.769	LS,DOL/ANHY,VUG POR
3	619.30	619.45	0.15		0.70			0.084	2580	2810	0.230	0.769	SP,LS,DOL/ANHY,VUG POR
4	619.45	619.70	0.25	0.11	0.24	0.24	0.02	0.071	2640	2840	0.200	0.799	LS,DOL/ANHY,VUG POR
DE	619.70	619.85	0.15										ANHY,MAS
5	619.85	620.15	0.30	0.11	0.08	0.08	<.01	0.063	2660	2840	0.200	0.799	LS,DOL/ANHY,VUG POR
6	620.15	620.30	0.15	0.11	0.21	0.15	0.04	0.072	2620	2830	0.200	0.799	LS,DOL/ANHY,VUG POR
7	620.30	620.45	0.15	0.07	0.23	0.21	0.11	0.088	2580	2820	0.280	0.719	LS,DOL/ANHY,VUG POR,VF
8	620.45	620.75	0.30	0.14	0.07	0.03	0.06	0.069	2650	2850	0.250	0.749	LS,DOL/ANHY,VUG POR,VF
DE	620.75	621.40	0.65										LS,DOL/ANHY
9	621.40	621.50	0.10	0.07	0.14	0.09	0.01	0.105	2500	2790	0.330	0.593	LS,DOL,VUG POR
10	621.50	621.60	0.10		0.57			0.081	2560	2790	0.350	0.649	SP,LS,DOL,VUG POR
DE	621.60	624.30	2.70										SLTST,DOL
11	624.30	624.40	0.10		0.64			0.047	2560	2690	0.184	0.378	SP,LS,SL ARG,F-P POR
DE	624.40	625.00	0.60										LS/MNR ANHY
12	625.00	625.20	0.20		6.70			0.099	2420	2680	0.175	0.135	SP,LS/MNR CHT,VUG POR
13	625.20	625.35	0.15	0.09	2.40	2.30	0.67	0.069	2510	2700	0.251	0.193	LS/MNR ANHY,VUG POR
DE	625.35	626.00	0.65										LS/MNR ANHY
14	626.00	626.25	0.25	0.11	7.30	6.20	3.60	0.109	2400	2700	0.159	0.204	LS/MNR ANHY,VUG POR
15	626.25	626.40	0.15	0.08	2.50	2.40	1.30	0.119	2390	2710	0.194	0.280	LS/MNR ANHY,VUG POR
16	626.40	626.60	0.20	0.09	3.10	3.10	2.20	0.118	2390	2710	0.196	0.264	LS/MNR ANHY,VUG POR
17	626.60	626.80	0.20		3.10			0.122	2370	2700	0.260	0.328	SP,LS/MNR ANHY,VUG POR
18	626.80	627.05	0.25	0.14	3.60	3.50	2.10	0.126	2360	2700	0.229	0.335	LS/MNR ANHY,VUG POR
19	627.05	627.30	0.25	0.12	4.00	4.00	2.70	0.132	2350	2700	0.131	0.354	LS/MNR ANHY,VUG POR
20	627.30	627.40	0.10		38.00			0.156	2270	2700	0.111	0.157	SP,LS/MNR ANHY,VUG POR
21	627.40	627.60	0.20	0.07	2.50	2.40	0.97	0.138	2350	2700	0.126	0.209	LS/MNR ANHY,VUG POR

COMPANY : SASKATCHEWAN OIL AND GAS CORPORATION
WELL : SASKOIL VIRDEN PROV. 6-29-9-25 W1
FORMATION: LODGEPOLE-VIRDEN
CORED INTERVAL: 619.00 - 655.30

LAB NO: S86-142
PAGE : 6
DATE : 1986-01-23

CORE ANALYSIS DATA REPORT

SMPL NO.	INTERVAL TOP M	INTERVAL BASE M	REF THICK M	SAMPLE LENGTH M	GAS PERMEABILITY - Md KMAX	GAS PERMEABILITY - Md K90	GAS PERMEABILITY - Md KV	PORO-SITY	DENSITY,KG/M3 BULK	DENSITY,KG/M3 GRAIN	RESIDUAL SAT. FRAC OF PV OIL	RESIDUAL SAT. FRAC OF PV WATER	VISUAL EXAMINATION
22	627.60	627.85	0.25	0.13	4.20	4.20	1.50	0.114	2390	2700	0.177	0.370	LS/MNR ANHY,VUG POR
DE	627.85	628.15	0.30										LS
23	628.15	628.30	0.15	0.10	0.37	0.31	0.17	0.077	2500	2700	0.113	0.577	LS/MNR ANHY,VUG POR
24	628.30	628.50	0.20	0.10	0.64	0.59	0.71	0.107	2430	2720	0.081	0.478	LS/MNR ANHY,VUG POR
25	628.50	628.75	0.25	0.14	14.00	14.00	17.00	0.141	2320	2700	0.451	0.268	LS/MNR ANHY,VUG POR
26	628.75	628.95	0.20		3.60			0.113	2390	2700	0.650	0.349	SP,LS/MNR ANHY,VUG POR
27	628.95	629.10	0.15	0.11	1.80	1.50	0.52	0.089	2470	2710	0.640	0.359	LS/MNR ANHY,VUG POR
DE	629.10	629.80	0.70										LS/MNR ANHY
28	629.80	629.90	0.10	0.08	0.63	0.63	0.24	0.092	2460	2710	0.220	0.507	LS/MNR ANHY,VUG POR
29	629.90	630.15	0.25	0.11	1.80	1.70	1.40	0.108	2420	2720	0.134	0.370	LS/MNR ANHY,VUG POR,RF
30	630.15	630.30	0.15	0.10	119.00	55.00	22.00	0.147	2320	2720	0.157	0.317	LS/MNR ANHY,VUG POR,RF
31	630.30	630.50	0.20	0.11	23.00	15.00	13.00	0.077	2510	2720	0.200	0.799	LS/MNR ANHY,VUG POR,RF
32	630.50	630.65	0.15	0.07	48.00	44.00	32.00	0.158	2280	2710	0.110	0.422	LS/MNR ANHY,VUG POR,HF
33	630.65	630.85	0.20	0.09	55.00	4.20	0.58	0.100	2430	2700	0.058	0.111	LS/MNR ANHY,VUG POR,RF
DE	630.85	631.90	1.05										LS/MNR ANHY
34	631.90	632.15	0.25		2.80			0.084	2470	2690	0.138	0.397	SP,LS,DOL,VUG POR
35	632.15	632.35	0.20		71.00			0.130	2350	2700	0.089	0.256	SP,LS/MNR ANHY,VUG POR
36	632.35	632.50	0.15		28.00			0.145	2310	2700	0.040	0.153	SP,LS/MNR ANHY,VUG POR
37	632.50	632.65	0.15		22.00			0.147	2310	2700	0.039	0.151	SP,LS/MNR ANHY,VUG POR
38	632.65	632.80	0.15		2.60			0.105	2410	2690	0.028	0.296	SP,LS,DOL,VUG POR
39	632.80	632.95	0.15		44.00			0.125	2360	2700	0.139	0.338	SP,LS/MNR ANHY,VUG POR
DE	632.95	634.40	1.45										LS,PT DOL/MNR ANHY
40	634.40	634.60	0.20		2.00			0.084	2470	2700	Trace	0.450	SP,LS/MNR ANHY,P-P POR
41	634.60	635.00	0.40	0.13	1.20	1.20	0.46	0.065	2510	2690	0.222	0.308	LS,FOS,VUG POR
42	635.00	635.15	0.15	0.08	1.00	0.98	0.44	0.057	2540	2690	0.152	0.117	LS,FOS,VUG POR
DE	635.15	635.30	0.15										LS/MNR ANHY
43	635.30	635.50	0.20	0.10	2.70	2.70	0.96	0.069	2510	2700	0.126	0.064	LS/MNR ANHY,VUG POR
DE	635.50	635.65	0.15										LS,MNR ANHY
44	635.65	635.85	0.20	0.12	3.80	3.80	2.40	0.101	2430	2700	0.172	0.066	LS/MNR ANHY,VUG POR

CF IC... & GEOLOGICAL LABORATORIES LTD.

COMPANY : SASKATCHEWAN OIL AND GAS CORPORATION
WELL : SASKOIL VIRDEN PROV. 6-29-9-25 W1
FORMATION: LODGEPOLE-VIRDEN
CORED INTERVAL: 619.00 - 655.30

LAB NO: S86-142
PAGE : 7
DATE : 1986-01-23

CORE ANALYSIS DATA REPORT

SMPL NO.	INTERVAL TOP M	INTERVAL BASE M	REF THICK M	SAMPLE LENGTH M	GAS PERMEABILITY - Md KMAX	K90	KV	PORO-SITY	DENSITY,KG/M3 BULK	GRAIN	RESIDUAL SAT. FRAC OF PV OIL	WATER	VISUAL EXAMINATION
45	635.85	636.00	0.15		19.00			0.139	2320	2690	0.208	0.080	SP,LS,GRAN,VUG POR
46	636.00	636.15	0.15	0.08	64.00	63.00	36.00	0.144	2310	2700	0.201	0.108	LS/MNR ANHY,VUG POR
47	636.15	636.25	0.10		15.00			0.131	2340	2690	0.154	0.051	SP,LS,GRAN,VUG POR
48	636.25	636.45	0.20	0.11	15.00	12.00	10.00	0.115	2380	2690	0.100	0.155	LS,GRAN,VUG POR
49	636.45	636.70	0.25	0.11	2.80	2.70	1.50	0.122	2420	2750	0.071	0.328	LS,SL DOL,P-P POR,VF
50	636.70	636.95	0.25	0.08	5.70	4.40	2.20	0.135	2380	2750	0.043	0.510	LS,SL DOL,VUG POR
51	636.95	637.20	0.25		11.00			0.133	2360	2720	0.239	0.167	SP,LS,SL DOL,P-P POR
52	637.20	637.30	0.10		11.00			0.134	2340	2710	0.237	0.249	SP,LS/MNR ANHY,VUG POR
53	637.30	637.40	0.10		18.00			0.143	2310	2690	0.222	0.233	SP,LS,GRAN,VUG POR

CHEMICAL & GEOLOGICAL LABORATORIES LTD.

COMPANY : SASKATCHEWAN OIL AND GAS CORPORATION
WELL : SASKOIL VIRDEN PROV. 6-29-9-25 W1
FORMATION: LODGEPOLE-SCALLION
CORED INTERVAL: 619.00 - 655.30

LAB NO: S86-142
PAGE : 8
DATE : 1986-01-23

CORE ANALYSIS DATA REPORT

SMPL NO.	INTERVAL TOP M	INTERVAL BASE M	REP THICK M	SAMPLE LENGTH M	GAS PERMEABILITY - Md KMAX	K90	KV	PORO-SITY	DENSITY, KG/M3 BULK	GRAIN	RESIDUAL SAT. FRAC OF PV OIL	WATER	VISUAL EXAMINATION	
	CORE NO. 2				637.00 - 655.30		RECEIVED IN LAB		18.30 METRES					
1	637.40	637.70	0.30	0.11	7.90	7.90	5.20	0.120	2390	2710	0.120	0.074	LS/MNR ANHY,VUG POR	.036 2.37
2	637.30	637.55	0.25	0.12	17.00	16.00	23.00	0.148	2290	2690	0.176	0.345	LS/MNR QTZ,VUG POR	.037 4.25
3	637.55	637.60	0.05		16.00			0.136	2320	2690	0.149	0.229	SP,LS/MNR QTZ,VUG POR,VF	.007 0.8
4	637.60	637.70	0.10		22.00			0.143	2300	2680	0.182	0.062	SP,LS/MNR QTZ,VUG POR	.014 2.2
5	637.70	637.90	0.20	0.09	18.00	13.00	6.90	0.127	2370	2720	0.136	0.157	LS/MNR ANHY,VUG POR	.025 2.6
DE	637.90	638.50	0.60										LS	
6	638.50	638.65	0.15	0.08	14.00	9.70	7.00	0.124	2370	2710	0.116	0.143	LS/MNR ANHY,VUG POR	
7	638.65	638.75	0.10		24.00			0.146	2300	2690	0.099	0.213	SP,LS/MNR QTZ,VUG POR	
DE	638.75	639.00	0.25										LS	
8	639.00	639.15	0.15	0.10	28.00	27.00	3.40	0.144	2320	2710	0.160	0.093	LS/MNR ANHY,VUG POR	
9	639.15	639.25	0.10		23.00			0.135	2340	2700	0.171	0.099	SP,LS/MNR ANHY,INTGRAN POR	
10	639.25	639.40	0.15	0.08	30.00	30.00	18.00	0.132	2340	2700	0.153	0.168	LS/MNR ANHY,VUG POR	
11	639.40	639.55	0.15	0.07	32.00	29.00	17.00	0.130	2340	2690	0.156	0.171	LS/MNR QTZ,VUG POR	
12	639.55	639.70	0.15	0.07	36.00	35.00	17.00	0.122	2370	2700	0.166	0.164	LS/MNR QTZ,VUG POR	
13	639.70	639.80	0.10	0.08	23.00	19.00	17.00	0.095	2450	2710	0.152	0.117	LS/MNR ANHY,VUG POR,VF	
14	639.80	640.00	0.20	0.13	10.00	6.10	5.30	0.090	2460	2700	0.193	0.123	LS/MNR ANHY,VUG POR,RF	
15	640.00	640.15	0.15		16.00			0.086	2440	2680	0.201	0.129	SP,LS/MNR QTZ,P-P POR	
16	640.15	640.35	0.20		6.40			0.085	2460	2690	0.204	0.183	SP,LS/MNR QTZ,P-P POR	
17	640.35	640.60	0.25		2.70			0.089	2440	2680	0.162	0.449	SP,LS/MNR CHT,VUG POR	
18	640.60	640.75	0.15	0.12	6.60	4.60	1.60	0.113	2390	2700	0.153	0.629	LS/MNR ANHY,CHT,VUG POR	
19	640.75	641.00	0.25	0.09	4.90	4.90	3.00	0.138	2380	2760	0.063	0.419	LS/PT DOL,P-P POR	
20	641.00	641.25	0.25	0.07	9.70	9.00	4.90	0.150	2350	2770	0.058	0.489	LS/PT DOL,P-P POR	
21	641.25	642.00	0.75	0.10	28.00	8.60	5.40	0.162	2310	2760	0.107	0.439	LS,PT DOL,P-P POR,HF	
22	642.00	642.75	0.75	0.12	16.00	15.00	10.00	0.162	2280	2730	0.036	0.343	LS,PT DOL/CHT,P-P POR	
23	642.75	643.60	0.85	0.16	6.60	6.40	3.10	0.138	2360	2740	0.000	0.918	LS,PT DOL/CHT,P-P POR	
24	643.60	644.20	0.60	0.10	8.20	4.60	5.50	0.119	2410	2740	0.000	0.990	LS,PT DOL/CHT,P-P POR,RF	

...ICAL LABORATORIES LTD.

WELL : SASKATCHEWAN OIL AND GAS CORPORATION
: SASKOIL VIRDEN PROV. 6-29-9-25 W1
FORMATION: LODGEPOLE-SCALLION
CORED INTERVAL: 619.00 - 655.30

LAB NO: S86-142
PAGE : 9
DATE : 1986-01-23

CORE ANALYSIS DATA REPORT

SMPL NO.	INTERVAL TOP M	INTERVAL BASE M	REF THICK M	SAMPLE LENGTH M	GAS PERMEABILITY - Md KMAX	K90	KV	PORO-SITY	DENSITY,KG/M3 BULK	GRAIN	RESIDUAL SAT. FRAC OF PV OIL	WATER	VISUAL EXAMINATION
25	644.20	644.30	0.10	0.08	4.80	2.40	0.95	0.093	2450	2710	0.000	0.502	LS,PT DOL/ANHY,P-P POR
NA	644.30	645.20	0.90										
26	645.20	645.60	0.40	0.10	0.48	0.12	0.04	0.067	2500	2670	Trace	0.999	LS,PT DOL/MNR CHT
27	645.60	646.60	1.00		3.80			0.132	2380	2740	0.000	0.999	LS/CHT,VUG POR
28	646.60	648.20	1.60	0.17	1.40	1.30	0.21	0.102	2420	2700	0.000	0.999	SP,LS,PT DOL,P-P POR
29	648.20	649.80	1.60	0.10	2.10	1.80	2.50	0.132	2380	2740	0.000	0.556	LS,PT DOL/CHT,P-P POR
30	649.80	652.15	2.35	0.10	0.33	0.29	0.04	0.065	2510	2680	0.000	0.308	LS,PT DOL/MNR CHT,P-P POR,
31	652.15	653.80	1.65		6.50			0.161	2320	2760	Trace	0.524	LS/CHT,P-P POR,VF
32	653.80	655.30	1.50	0.15	1.80	0.93	0.19	0.137	2390	2770	Trace	0.649	SP,LS,PT DOL,P-P POR
													LS,PT DOL,P-P POR

COMPANY	SASKATCHEWAN OIL AND GAS CORPORATION	FORMATION	LOWER VIRDEN	PAGE	1
WELL	SASKOIL ET AL VIRDEN PROV. 7-29-9-25	CORING EQUIPMENT	DIAMOND	FILE	70175-ES-T8685
FIELD	VIRDEN, MANITOBA	CORE DIAMETER,(mm)	89	DATE	1986 02 26
LOCATION	LSD XX/07-29-009-25 W1M/X	CORING FLUID	WATER BASE MUD	ANALYSTS	DL

FULL DIAMETER ANALYSIS

Sample Number	Depth Metres (m)	m Rep.	Sample Length	Permeability to Air Millidarcys mD Max.	mD 90 deg.	mD V	Perm. X m	Porosity	Porosity X m	Density:kg/m3 Bulk	Grain	Residual Saturation (Frac of Pore Vol) Oil	Water	VISUAL EXAMINATION
CORE NO. 1	623.00 m - 641.00	(core received	18.40 m)	(14 Boxes)										
-	623.00-23.96	0.96	-	-	-	-	-	-	-	-	-	-	-	dol anhy
-	623.96-25.89	1.93	-	-	-	-	-	-	-	-	-	-	-	dol anhy ls
SP 1	625.89-25.99	0.10	-	1.01	-	-	0.101	0.092	0.009	-	2710	0.092	0.345	ls i ppv
2	625.99-26.19	0.20	.14	0.65	0.52	0.21	0.130	0.092	0.018	2470	2720	0.251	0.199	ls i ppv
3	626.19-26.36	0.17	.10	4.83	4.16	2.86	0.821	0.130	0.022	2370	2720	0.192	0.421	ls i ppv sv
SP 4	626.36-26.44	0.08	-	4.31	-	-	0.345	0.118	0.009	-	2710	0.186	0.385	ls i ppv
5	626.44-26.58	0.14	.10	2.73	2.21	2.28	0.382	0.127	0.018	2380	2720	0.141	0.424	ls i ppv sv
SP 6	626.58-26.67	0.09	-	3.17	-	-	0.285	0.140	0.013	-	2720	0.134	0.479	ls i ppv mv
7	626.67-26.92	0.25	.10	0.68	0.68	0.47	0.170	0.125	0.031	2380	2720	0.150	0.455	ls i ppv anhy
8	626.92-27.14	0.22	.16	1.05	1.02	0.87	0.231	0.121	0.027	2400	2730	0.162	0.395	ls i ppv
9	627.14-27.38	0.24	.12	1.60	1.47	1.23	0.384	0.123	0.030	2380	2710	0.180	0.358	ls i ppv
SP 10	627.38-27.49	0.11	-	1.82	-	-	0.200	0.119	0.013	-	2720	0.153	0.500	ls i
11	627.49-27.68	0.19	.09	0.49	0.48	0.43	0.093	0.113	0.021	2430	2740	0.098	0.561	ls i ppv anhy
SP 12	627.68-27.82	0.14	-	1.32	-	-	0.185	0.138	0.019	-	2710	0.188	0.467	ls i
SP 13	627.82-27.95	0.13	-	2.01	-	-	0.261	0.114	0.015	-	2700	0.208	0.364	ls i
14	627.95-28.19	0.24	.09	2.47	2.43	2.27	0.593	0.122	0.029	2380	2710	0.244	0.244	ls i ppv
SP 15	628.19-28.30	0.11	-	0.95	-	-	0.105	0.094	0.010	-	2700	0.222	0.353	ls i
-	628.30-28.50	0.20	-	-	-	-	-	-	-	-	-	-	-	ls anhy
16	628.50-28.69	0.19	.10	0.39	0.39	0.22	0.074	0.091	0.017	2480	2720	0.127	0.563	ls i ppv
17	628.69-28.93	0.24	.13	0.88	0.82	0.28	0.211	0.102	0.024	2450	2720	0.165	0.401	ls i ppv
18	628.93-29.15	0.22	.09	4.54	4.46	2.71	0.999	0.136	0.030	2350	2720	0.131	0.370	ls i ppv
SP 19	629.15-29.23	0.08	-	1.11	-	-	0.089	0.121	0.010	-	2720	0.168	0.376	ls i
SP 20	629.23-29.35	0.12	-	1.20	-	-	0.144	0.106	0.013	-	2710	0.151	0.445	ls i

COMPANY	SASKATCHEWAN OIL AND GAS CORPORATION
WELL	SASKOIL ET AL VIRDEN PROV. 7-29-9-25

FORMATION LOWER VIRDEN
CORING EQUIPMENT DIAMOND

FULL DIAMETER ANALYSIS

Sample Number	Depth Metres (m)	m Rep.	Sample Length	Permeability to Air Millidarcys: mD Max.	mD 90 deg.	mD V	Perm. X m	Porosity	Porosity X m	Density: kg/m3 Bulk	Grain	Residual Saturation (Frac of Pore Vol) Oil	Water	VISUAL EXAMINATION
CORE NO. 1 CONTINUED														
SP 21	629.35-29.45	0.10	-	0.16	-	-	0.016	0.072	0.007	-	2710	0.061	0.562	ls i
-	629.45-30.21	0.76	-	-	-	-	-	-	-	-	-	-	-	ls anhy dol
SP 22	630.21-30.41	0.20	-	0.32	-	-	0.064	0.095	0.019	-	2710	0.076	0.679	ls i
SP 23	630.41-30.51	0.10	-	0.77	-	-	0.077	0.111	0.011	-	2720	0.130	0.644	ls i
24	630.51-30.85	0.34	.14	14.7	14.2	13.5	4.998	0.145	0.049	2330	2720	0.168	0.482	ls i ppv
25	630.85-31.04	0.19	.08	4.99	4.72	4.53	0.948	0.154	0.029	2300	2720	0.192	0.381	ls i ppv
SP 26	631.04-31.14	0.10	-	1.67	-	-	0.167	0.117	0.012	-	2710	0.145	0.453	ls i
27	631.14-31.26	0.12	.08	0.09	0.07	0.01	0.011	0.057	0.007	2540	2690	0.114	0.355	ls i ppv
-	631.26-32.21	0.95	-	-	-	-	-	-	-	-	-	-	-	ls anhy
28	632.21-32.41	0.20	.15	6.07	4.23	1.14	1.214	0.088	0.018	2470	2700	0.123	0.352	ls i ppv sv
29	632.41-32.67	0.26	.11	20.0	8.15	6.49	5.201	0.112	0.029	2410	2720	0.133	0.344	ls i ppv sv
SP 30	632.67-32.77	0.10	-	126.	-	-	12.602	0.145	0.015	-	2720	0.153	0.477	ls i ppv
31	632.77-32.98	0.21	.12	12.0	10.4	12.3	2.520	0.135	0.028	2350	2710	0.113	0.364	ls i ppv vfrac
SP 32	632.98-33.08	0.10	-	8.31	-	-	0.831	0.117	0.012	-	2720	0.113	0.501	ls i ppv
SP 33	633.08-33.19	0.11	-	1.40	-	-	0.154	0.101	0.011	-	2710	0.115	0.457	ls i ppv
34	633.19-33.33	0.14	.10	1.33	1.27	0.21	0.186	0.091	0.013	2460	2710	0.116	0.415	ls i ppv sv
-	633.33-34.71	1.38	-	-	-	-	-	-	-	-	-	-	-	ls anhy
35	634.71-34.87	0.16	.11	0.16	0.09	0.05	0.026	0.047	0.008	2570	2690	0.127	0.189	ls i ppv sv
SP 36	634.87-35.01	0.14	-	3.30	-	-	0.462	0.079	0.011	-	2700	0.258	0.202	ls i
SP 37	635.01-35.09	0.08	-	0.93	-	-	0.074	0.070	0.006	-	2700	0.146	0.460	ls i ppv
38	635.09-35.28	0.19	.08	1.48	1.39	0.94	0.281	0.070	0.013	2510	2690	0.184	0.158	ls i ppv
SP 39	635.28-35.38	0.10	-	0.46	-	-	0.046	0.056	0.006	-	2700	0.253	0.156	ls i
40	635.38-35.61	0.23	.12	0.28	0.27	0.19	0.064	0.051	0.012	2560	2690	0.162	0.138	ls i ppv sty
SP 41	635.61-35.71	0.10	-	2.65	-	-	0.265	0.067	0.007	-	2700	0.229	0.199	ls i ppv
42	635.71-35.88	0.17	.10	0.48	0.40	0.21	0.082	0.065	0.011	2540	2710	0.141	0.243	ls i ppv sty frac

COMPANY SASKATCHEWAN OIL AND GAS CORPORATION
WELL SASKOIL ET AL VIRDEN PROV, 7-29-9-25

FORMATION LOWER VIRDEN
CORING EQUIPMENT DIAMOND

PAGE 3
FILE 70175-ES-T8685

FULL DIAMETER ANALYSIS

Sample Number	Depth Metres (m)	m Rep.	Sample Length	Permeability to Air Millidarcys: mD Max.	mD 90 deg.	mD V	Perm. X m	Porosity	Porosity X m	Density:kg/m3 Bulk	Grain	Residual Saturation (Frac of Pore Vol) Oil	Water	VISUAL EXAMINATION
CORE NO. 1 CONTINUED														
43	635.88-36.11	0.23	.16	2.33	2.12	1.63	0.536	0.097	0.022	2450	2720	0.297	0.141	ls i ppv sv sty
44	636.11-36.21	0.10	-	11.4	-	-	1.140	0.108	0.011	-	2700	0.311	0.200	ls i ppv
45	636.21-36.33	0.12	.11	10.3	9.91	10.2	1.236	0.120	0.014	2380	2700	0.293	0.102	ls i ppv vfrac
46	636.33-36.46	0.13	-	4.94	-	-	0.642	0.108	0.014	-	2700	0.190	0.333	ls i ppv
47	636.46-36.95	0.49	.22	2.89	2.71	2.06	1.416	0.120	0.059	2420	2750	0.110	0.497	ls i ppv anhy
48	636.95-37.21	0.26	.18	5.38	4.64	3.04	1.399	0.145	0.038	2360	2760	0.255	0.358	ls i ppv anhy
49	637.21-37.36	0.15	.10	9.48	9.28	5.25	1.422	0.126	0.019	2380	2720	0.274	0.292	ls i ppv anhy
50	637.36-37.52	0.16	-	17.1	-	-	2.736	0.144	0.023	-	2700	0.242	0.370	ls i ppv
51	637.52-37.73	0.21	.09	14.0	12.9	9.14	2.940	0.134	0.028	2360	2720	0.160	0.559	ls i ppv anhy hfrac
52	637.73-37.83	0.10	-	13.6	-	-	1.360	0.104	0.010	-	2710	0.300	0.150	ls i ppv
-	637.83-37.89	0.06	-	-	-	-	-	-	-	-	-	-	-	ls anhy
53	637.89-38.01	0.12	-	4.56	-	-	0.547	0.105	0.013	-	2710	0.177	0.405	ls i
-	638.01-38.04	0.03	-	-	-	-	-	-	-	-	-	-	-	anhy
54	638.04-38.36	0.32	.15	10.6	10.5	10.3	3.392	0.136	0.044	2340	2710	0.260	0.304	ls i ppv foss
-	638.36-39.07	0.71	-	-	-	-	-	-	-	-	-	-	-	dol anhy lmy
55	639.07-39.22	0.15	-	6.21	-	-	0.932	0.114	0.017	-	2710	0.153	0.398	ls i ppv
-	639.22-39.30	0.08	-	-	-	-	-	-	-	-	-	-	-	dol ls anhy
56	639.30-39.37	0.07	-	4.84	-	-	0.339	0.098	0.007	-	2710	0.294	0.214	ls i
-	639.37-39.46	0.09	-	-	-	-	-	-	-	-	-	-	-	ls dol anhy
57	639.46-39.56	0.10	-	11.7	-	-	1.170	0.133	0.013	-	2730	0.273	0.222	ls i
58	639.56-39.79	0.23	.16	11.7	10.0	2.92	2.691	0.117	0.027	2400	2710	0.356	0.116	ls i ppv sty
59	639.79-40.01	0.22	.13	24.3	15.9	9.92	5.347	0.115	0.025	2390	2690	0.226	0.165	ls i ppv anhy foss
60	640.01-40.19	0.18	.13	37.5	37.5	20.1	6.750	0.114	0.021	2390	2690	0.330	0.173	ls i ppv hfrac
61	640.19-40.26	0.07	-	12.9	-	-	0.903	0.084	0.006	-	2710	0.188	0.330	ls i ppv
-	640.26-40.29	0.03	-	-	-	-	-	-	-	-	-	-	-	anhy

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COMPANY	SASKATCHEWAN OIL AND GAS CORPORATION	FORMATION	LOWER VIRDEN	PAGE	4
WELL	SASKOIL ET AL VIRDEN PROV. 7-29-9-25	CORING EQUIPMENT	DIAMOND	FILE	70175-ES-T8685

FULL DIAMETER ANALYSIS

mple mber	Depth Metres (m)	m Rep.	Sample Length	Permeability to Air Millidarcys mD Max.	mD 90 deg.	mD V	Perm. X m	Porosity	Porosity X m	Density(kg/m3) Bulk	Grain	Residual Saturation (Frac of Pore Vol) Oil	Water	VISUAL EXAMINATION
	CORE NO. 1 CONTINUED													
62	640.29-40.47	0.18	.08	16.3	16.3	2.62	2.934	0.108	0.019	2410	2700	0.233	0.153	ls i ppv
-	640.47-40.49	0.02	-	-	-	-	-	-	-	-	-	-	-	dol anhy
63	640.49-40.67	0.18	.09	22.7	22.7	8.72	4.086	0.118	0.021	2380	2700	0.203	0.150	ls i ppv sty
64	640.67-40.78	0.11	-	132.	-	-	14.522	0.140	0.015	-	2690	0.225	0.178	ls i mv
65	640.78-40.94	0.16	.08	36.1	30.1	16.7	5.775	0.126	0.020	2350	2690	0.256	0.160	ls i ppv
66	640.94-41.04	0.10	-	46.0	-	-	4.600	0.129	0.013	-	2690	0.220	0.321	ls i mv
67	641.04-41.12	0.08	-	524.	-	-	41.931	0.171	0.014	-	2700	0.227	0.188	ls i ppv
-	641.12-41.15	0.03	-	-	-	-	-	-	-	-	-	-	-	ls anhy
68	641.15-41.31	0.16	-	179.	-	-	28.636	0.167	0.027	-	2710	0.226	0.132	ls i ppv
-	641.31-41.40	0.09	-	-	-	-	-	-	-	-	-	-	-	ls anhy

COMPANY SASKATCHEWAN OIL AND GAS CORPORATION
WELL SASKOIL ET AL VIRDEN PROV. 10-29-9-25
FIELD VIRDEN, MANITOBA
LOCATION LSD XX/10-29-009-25 W1M/X

FORMATION LOWER VIRDEN
CORING EQUIPMENT DIAMOND
CORE DIAMETER.(mm) 89
CORING FLUID WATER BASE MUD

PAGE 1
FILE 7008-86-91
DATE 1986 03 02
ANALYSTS BB

FULL DIAMETER ANALYSIS

Sample Number	Depth Metres (m)	m Rep.	Sample Length	Permeability to Air Millidarcys mD Max.	mD 90 deg.	mD V	Perm. X m	Porosity	Porosity X m	Density (kg/m3) Bulk	Grain	Residual Saturation (Frac of Pore Vol) Oil	Water	VISUAL EXAMINATION
CORE NO. 1	616.00 m - 634.00	(core received	18.15 m)	(14 Boxes)										
-	616.00-27.29	11.29	-	-	-	-	-	-	-	-	-	-	-	dol anhy lmy
1	627.29-27.40	0.11	.07	1.20	1.07	0.79	0.132	0.080	0.009	2490	2700	0.091	0.586	ls i ppv
-	627.40-27.47	0.07	-	-	-	-	-	-	-	-	-	-	-	ls
2	627.47-27.82	0.35	.14	6.14	6.14	2.33	2.149	0.086	0.030	2470	2700	0.310	0.163	ls i ppv mv
-	627.82-30.53	2.71	-	-	-	-	-	-	-	-	-	-	-	ls dol anhy
3	630.53-30.66	0.13	.10	1.14	1.05	1.44	0.148	0.107	0.014	2420	2710	0.084	0.509	ls i ppv mv ool vfrac
4	630.66-30.75	0.09	-	2.16	-	-	0.194	0.130	0.012	-	2730	0.107	0.551	ls i ppv
5	630.75-31.03	0.28	.18	3.59	3.34	3.40	1.005	0.117	0.033	2400	2720	0.120	0.595	ls i ppv mv ool vfrac
-	631.03-31.93	0.90	-	-	-	-	-	-	-	-	-	-	-	ls dol anhy
6	631.93-32.09	0.16	.11	0.50	0.47	0.27	0.080	0.092	0.015	2470	2720	trace	0.820	ls i ppv ool
7	632.09-32.25	0.16	.12	0.59	0.53	0.47	0.094	0.105	0.017	2430	2710	0.160	0.349	ls i ppv ool
8	632.25-32.43	0.18	.12	7.69	4.86	9.47	1.384	0.138	0.025	2340	2710	0.064	0.723	ls i ppv ool vfrac
9	632.43-32.59	0.16	.10	6.44	1.19	1.08	1.030	0.129	0.021	2360	2710	0.090	0.657	ls i ppv ool
10	632.59-32.73	0.14	.09	3.68	3.68	3.33	0.515	0.131	0.018	2360	2720	0.155	0.601	ls i ppv ool
11	632.73-32.86	0.13	.09	0.03	0.01	<0.01	0.004	0.041	0.005	2580	2700	0.081	0.522	ls i ppv
-	632.86-33.77	0.91	-	-	-	-	-	-	-	-	-	-	-	ls anhy
12	633.77-33.87	0.10	.08	1.39	0.98	0.48	0.139	0.077	0.008	2500	2710	0.152	0.375	ls i ppv ool
13	633.87-34.15	0.28	.15	5.62	3.52	2.19	1.574	0.103	0.027	2430	2710	0.124	0.320	ls i ppv ool

APPENDIX G

PRESSURE SURVEYS

ROUTLEDGE FIELD

WELL 6-29-9-25

PRESSURE BUILDUP DATA

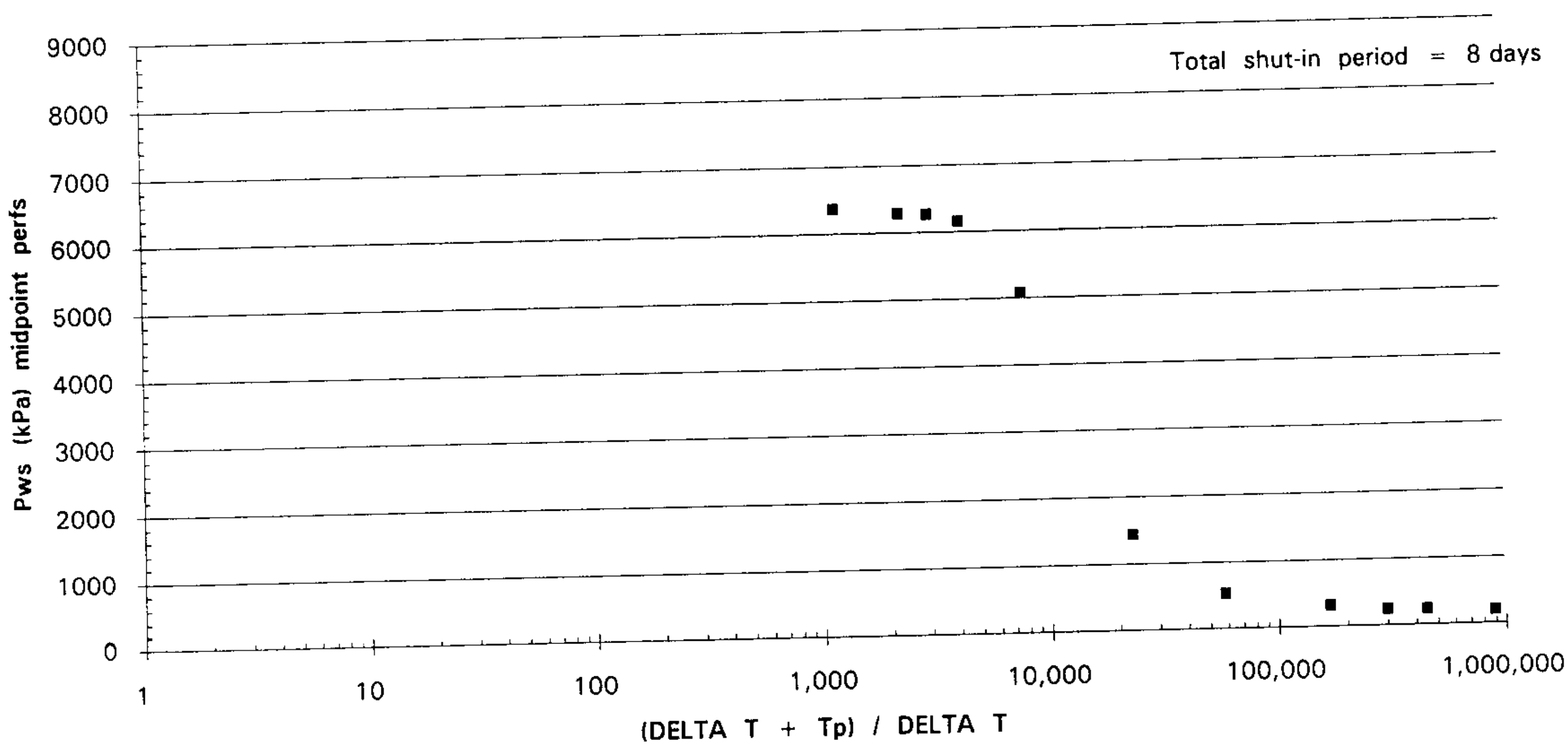
HORNER PLOT

Tp = { (8820) / 0.95} * 24 = 222,821 hrs

DATE	TIME (hours)	DELTA TIME (hours)	Days	(DELTA T + Tp) / DELTA T	JOINTS TO FLUID	FLUID LEVEL (m)	FLUID PRESSURE (kPa)	CASING PRESSURE (kPa)	ADJ. CASING PRESSURE (kPa)	TOTAL PRESSURE (kPa)	TOTAL PRESSURE (psig)
11-Jul	9:10 AM	0	0.00	-	65	618	101	41	43	144	21
	9:25 AM	0.25	0.01	891,285	64.5	613	147	41	43	190	28
	9:40 AM	0.5	0.02	445,643	64.125	609	182	41	43	224	33
	9:55 AM	0.75	0.03	297,096	64	608	193	41	43	236	34
	10:30 AM	1.33	0.06	167,536	63.25	601	262	41	43	305	44
	1:00 PM	3.83	0.16	58,179	61	580	469	59	61	530	77
	6:55 PM	9.75	0.41	22,854	51.5	489	1340	93	96	1436	208
12-Jul	2:35 PM	29.42	1.23	7,575	15.5	147	4644	418	422	5066	735
13-Jul	3:50 PM	54.67	2.28	4,077	7	67	5424	724	727	6151	892
14-Jul	12:30 PM	75.34	3.14	2,959	6	57	5516	745	748	6264	908
15-Jul	1:55 PM	100.75	4.20	2,213	5.75	55	5539	745	748	6287	912
19-Jul	11:30 AM	194.33	8.10	1,148	5	48	5608	758	760	6368	924

PRESSURE BUILDUP ROUTLEDGE WELL 6-29-9-25 HORNER PLOT

Data to July 19, 1994



ROUTLEDGE FIELD

WELL 6-29-9-25

DETERMINATION OF PERMEABILITY AND SKIN FACTOR

PERMEABILITY

CONSTANT	OIL RATE (STB/day)	Boi R STB/STB	u (cp)	m (psi/cycle)	h (feet)	k (md)
162.6	6	1.06	5	102	13	4

k = (162.6*q*Boi*u) / m * h

SKIN FACTOR

CONSTANT	p1hr (psi)	pwf (psi)	Chge p (psi)	m (psi/cycle)	Chge p / m (A)	k (md)	porosity (fraction)	u (cp)	ct (1/psi)	rw (feet)	k/phi*u*ct*r2w (B)	Log(B) (C)	(A-C) (D)	s 1.151*(D+3.23)
1.151	754	144	610	102	5.98	4	0.13	5	0.000017513	0.1875	9,743,784.91	6.99	-1.01	2.6

s = 1.151 * ((p1hr - pwf) / m - log(k/phi*u*ct*r2w) + 3.23)

APPENDIX H

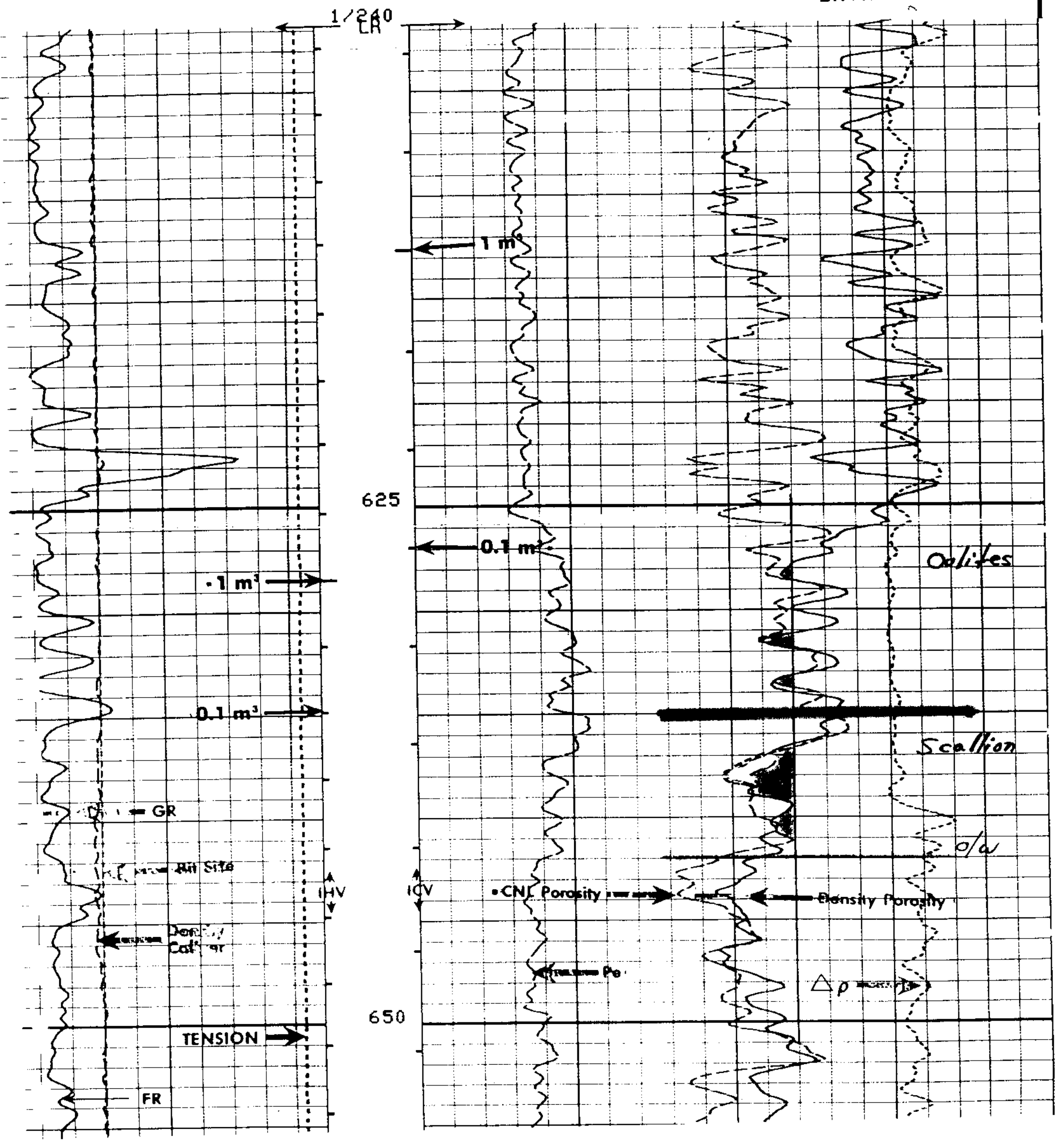
OPEN-HOLE LOGS

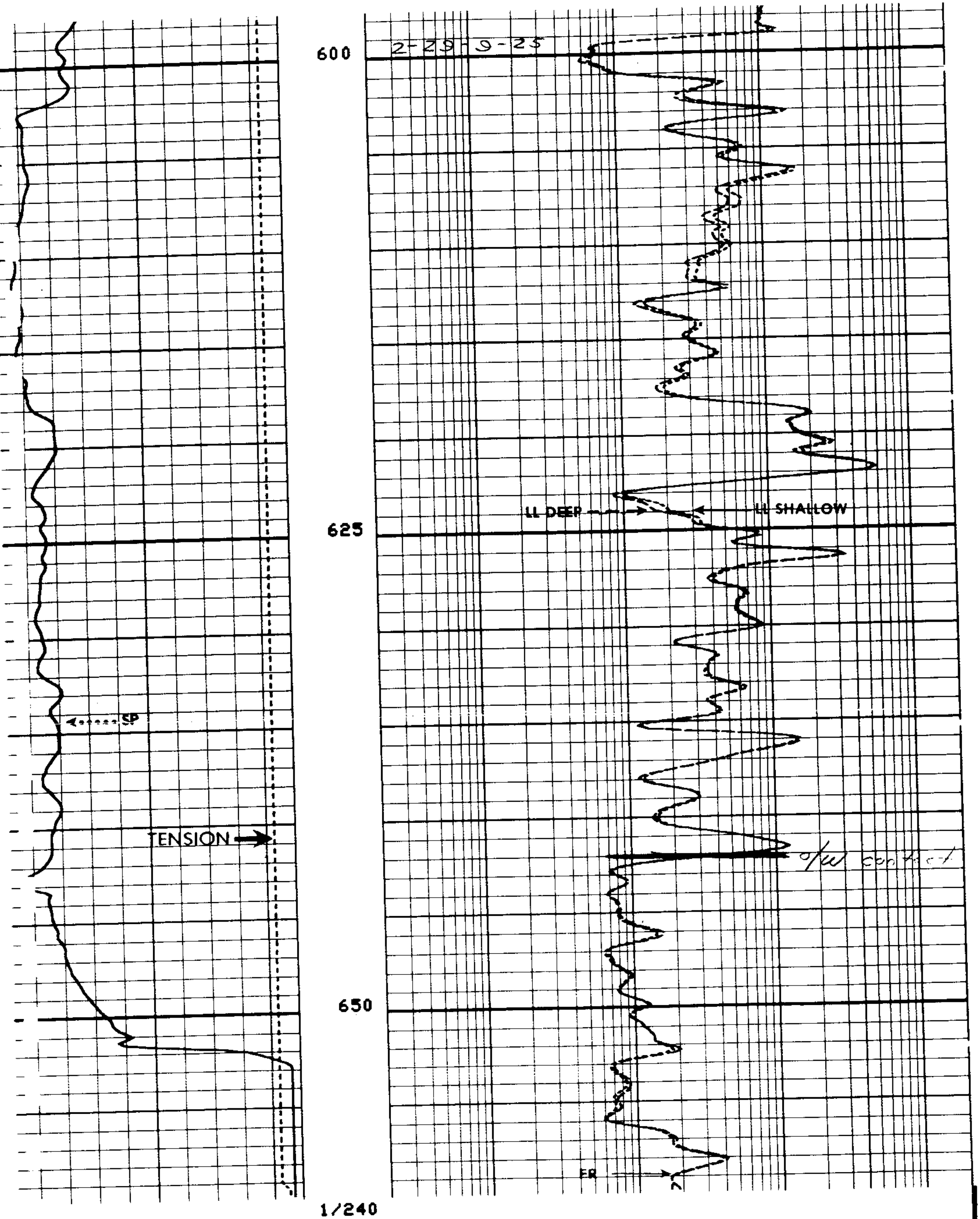
25.00	375.00	.45000	-.1500
GR (GAPI)		NPHI	
0.0	150.00	.45000	-.1500

2-29-9-25

CP 32.2 FILE 9 01-MAR-1989 17:37 **REPEAT SECTION**

LIMESTONE




2-29-9-25
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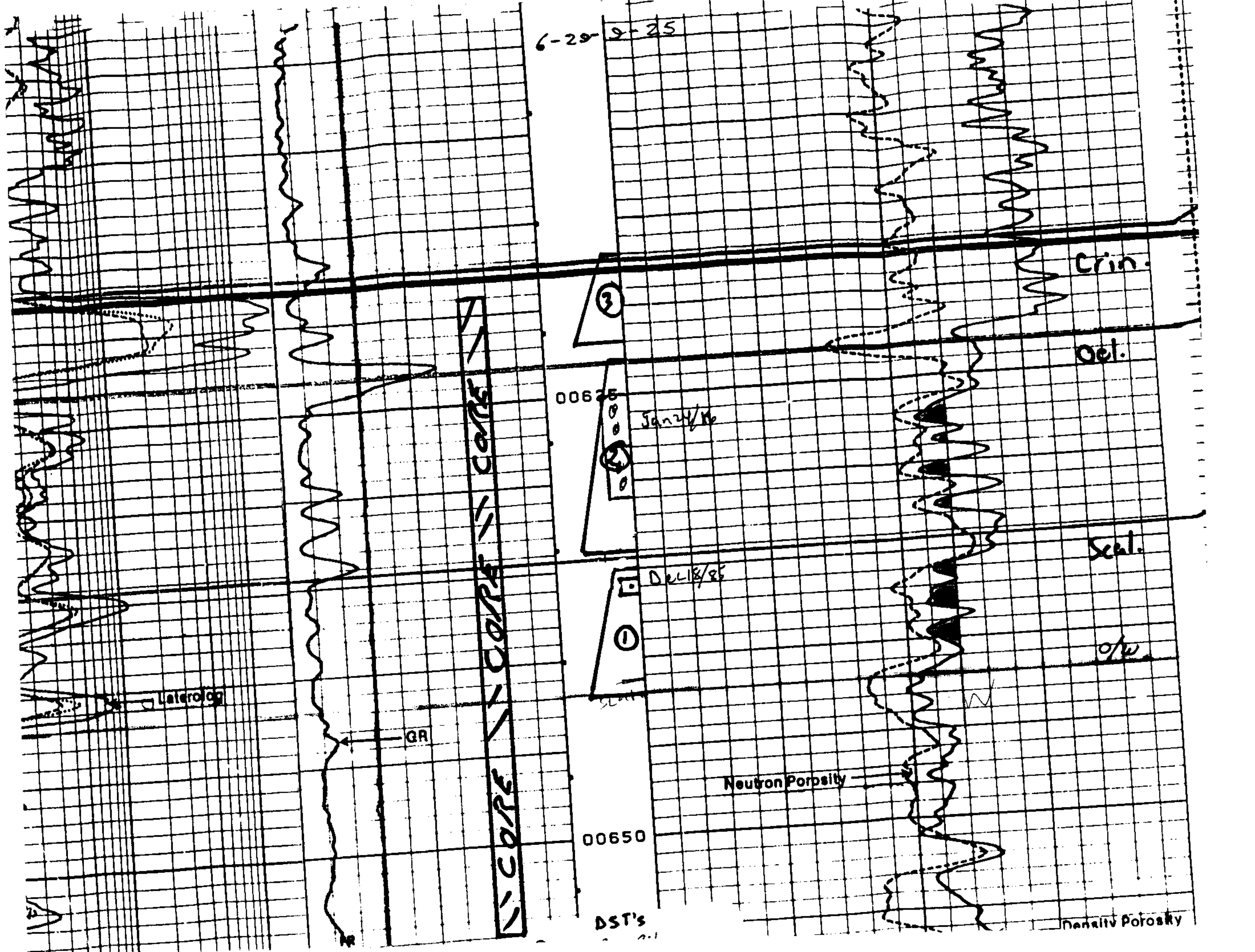
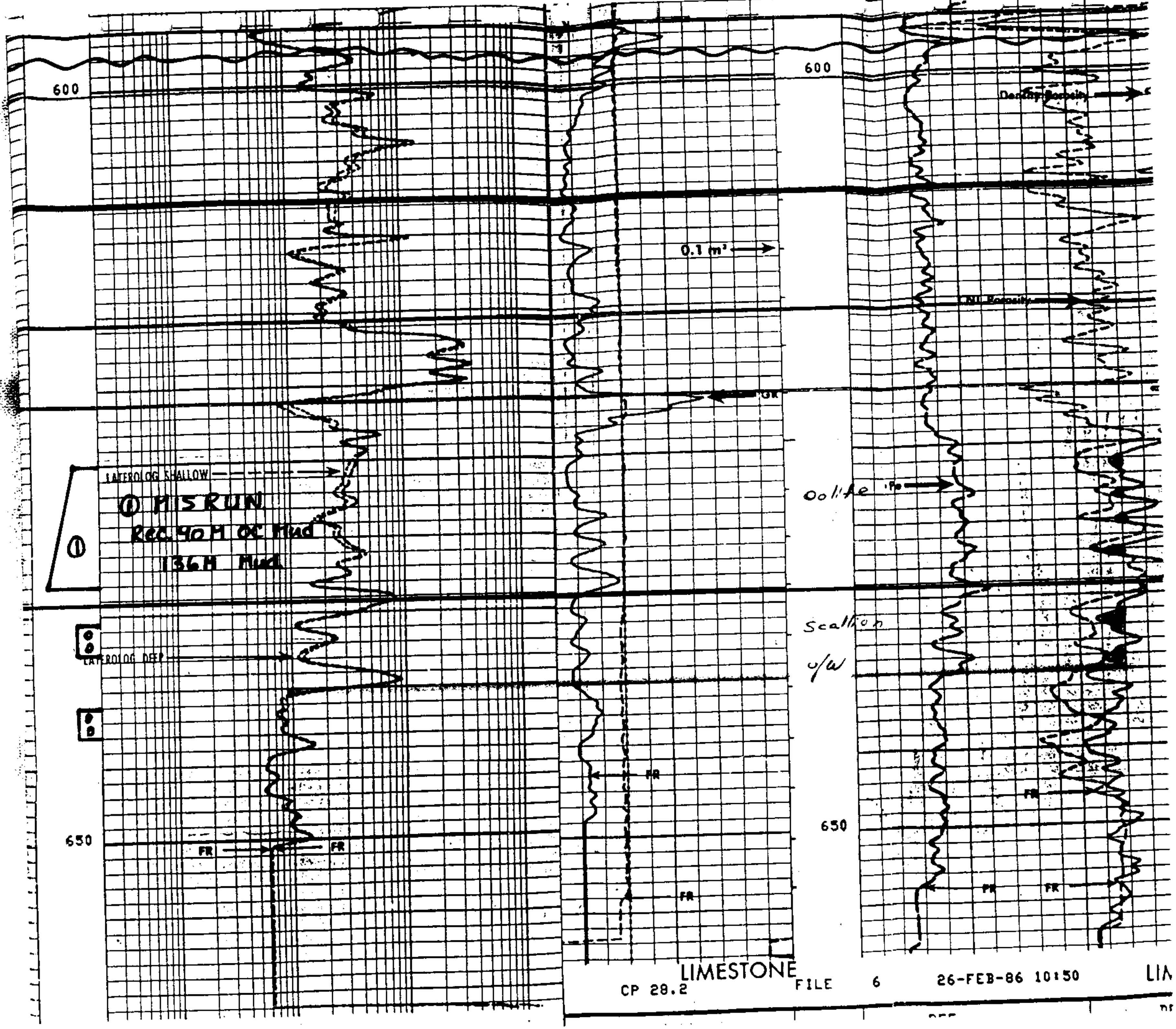
LL SHALLOW
625
SP
TENSION
o/w contact
650
FR
1/240



6-29-9-25
Crin.
Oel.
Scal.
O/W
00625
Jan24/86
Dec18/85
00650
Laterolog
GR
Neutron Porosity
Density Porosity
DST's
CORE

7-29-9-25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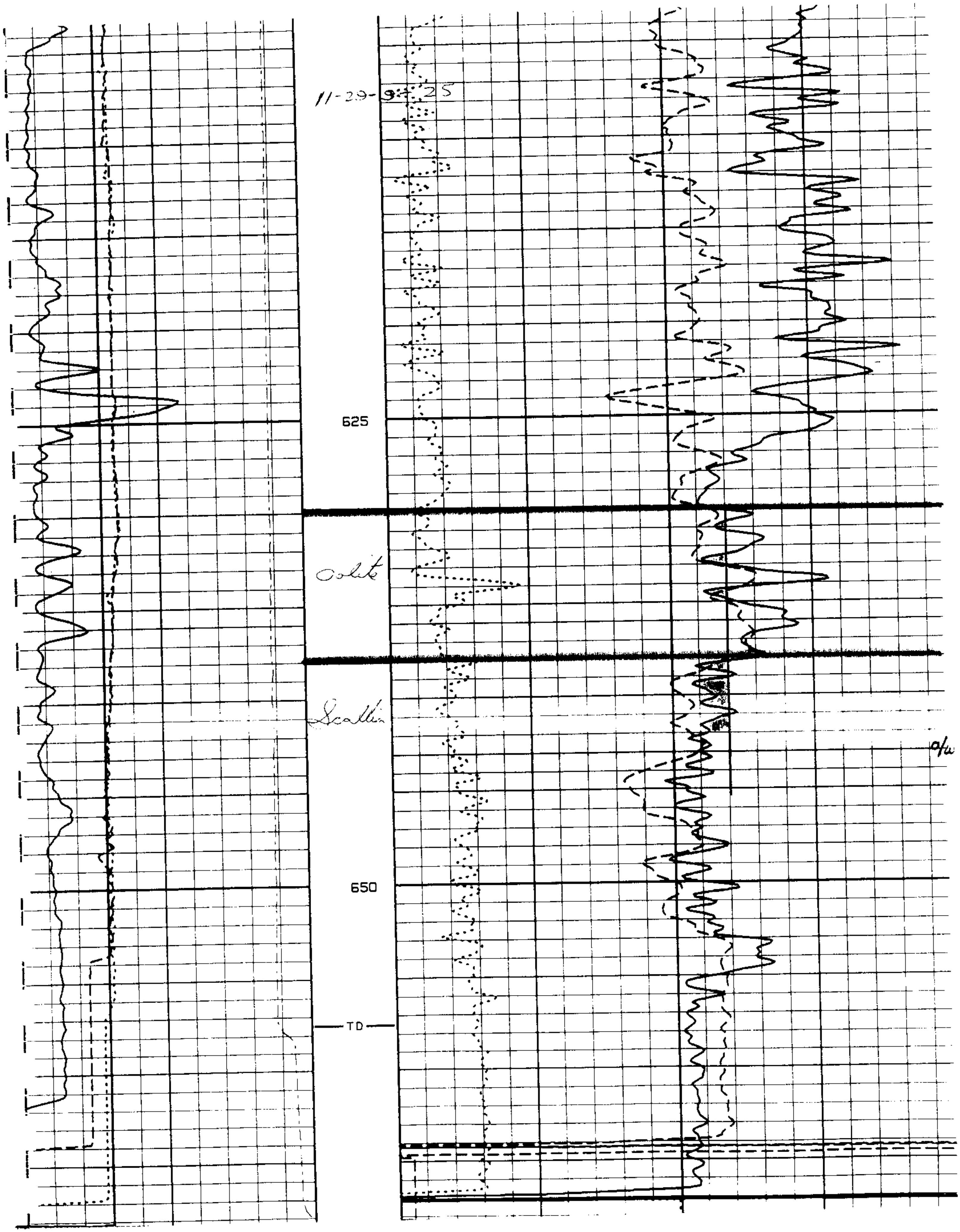
600
Density Porosity
CNL Porosity
0.1 m³
GR
LATEROLOG SHALLOW
① MISRUN
Rec. 90M OC Mud
136M Mud
①
Oolite
Pe
Scallion
u/w
LATEROLOG DEEP
FR
650
650
LIMESTONE
CP 28.2
FILE 6
26-FEB-86 10:50
LIM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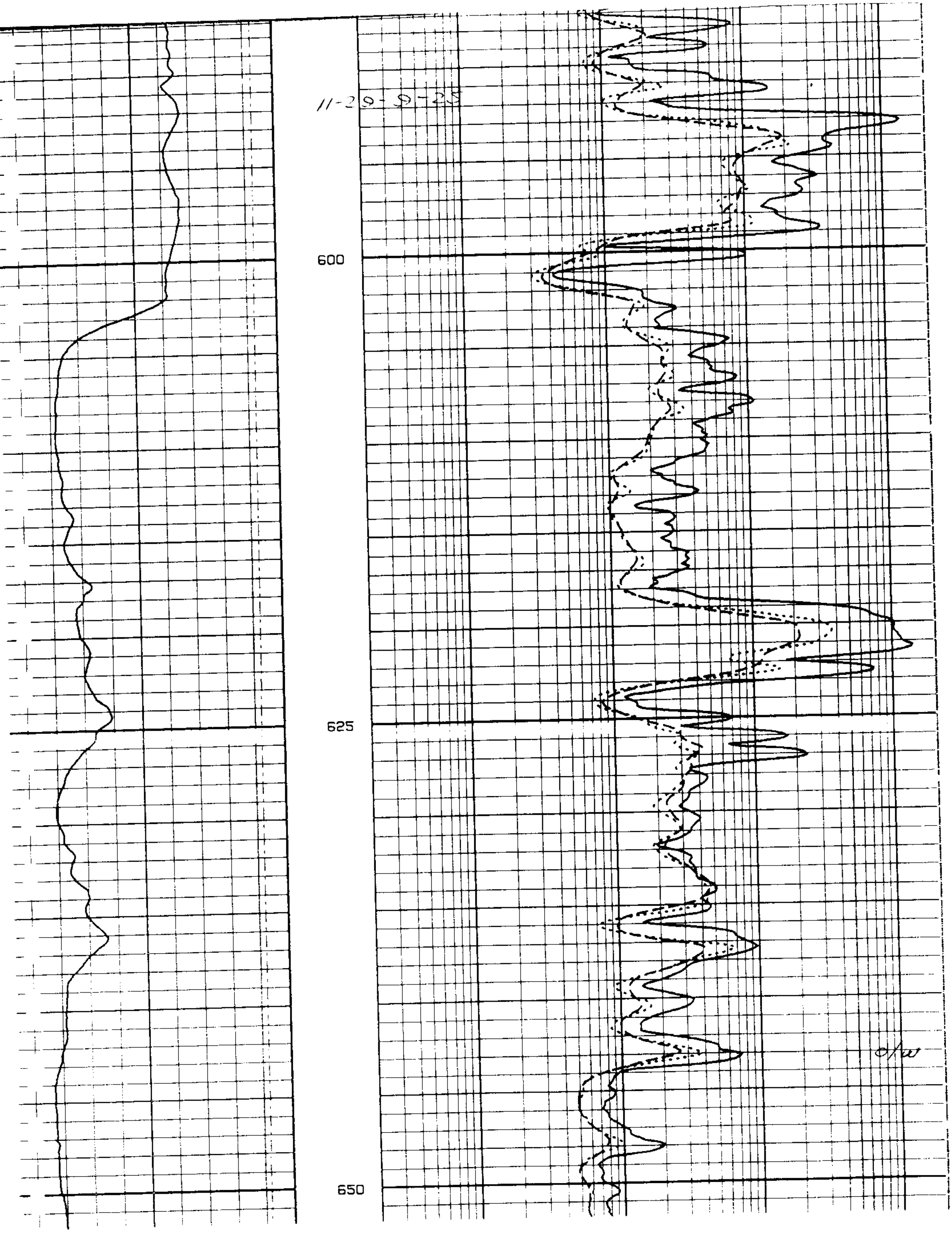
625
Oolite
Scallin
o/w
650
TD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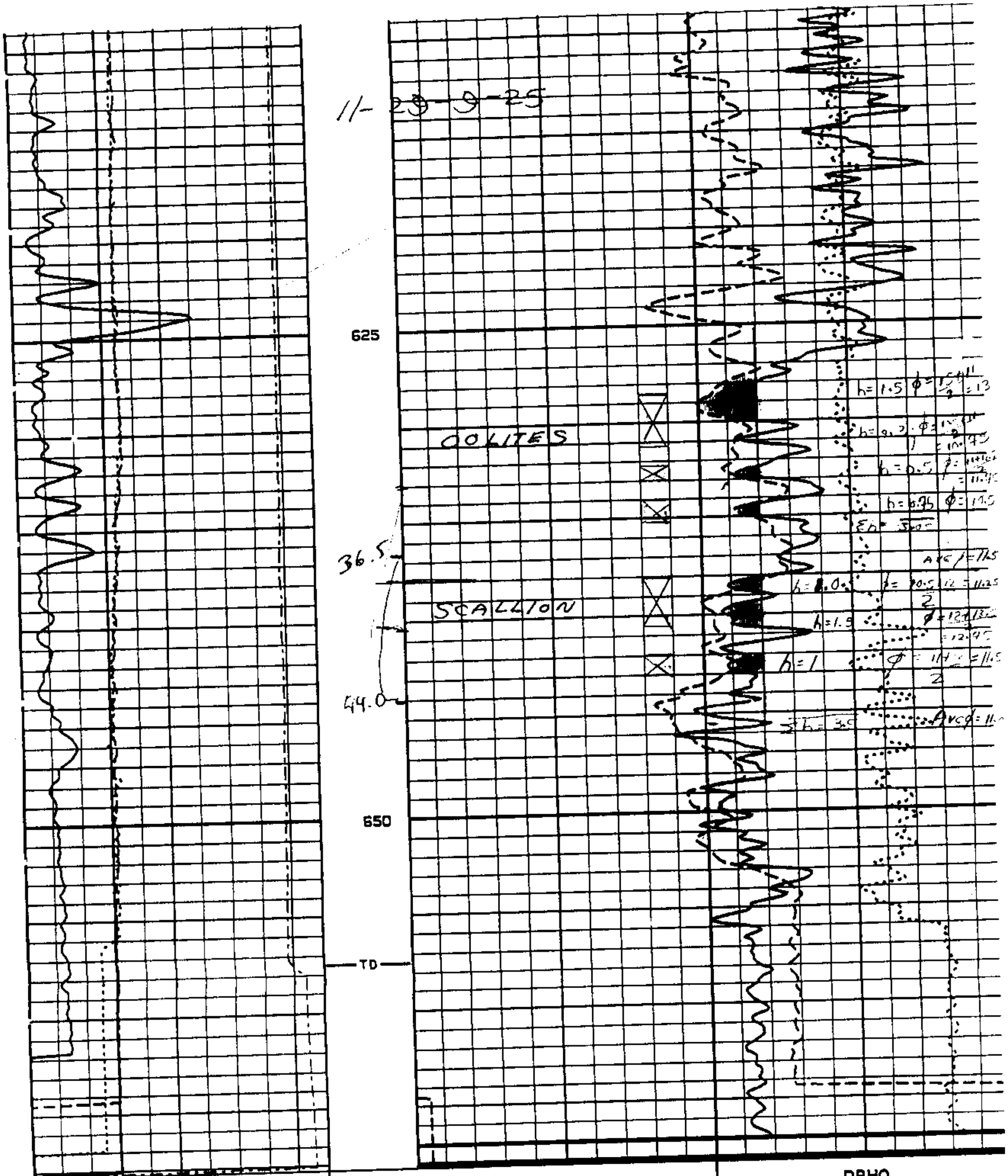
625
650
o/w



	X CALIPER	
125	(mm)	375
	Y CALIPER	
125	(mm)	375
	GR	
0	(API)	150
	TENSION	
10000	(lbs)	0

	DRHO	
-250	(kg/m3)	250
	N. POROSITY (LS)	
	% Porosity	-15
	NEUT. POROSITY (LS)	
.3	% Porosity	-15

START DEPTH: 658.0 METERS DIRECTION: UP DATE: 08/24/94 TIME: 20:48 MODE: ORIGINAL

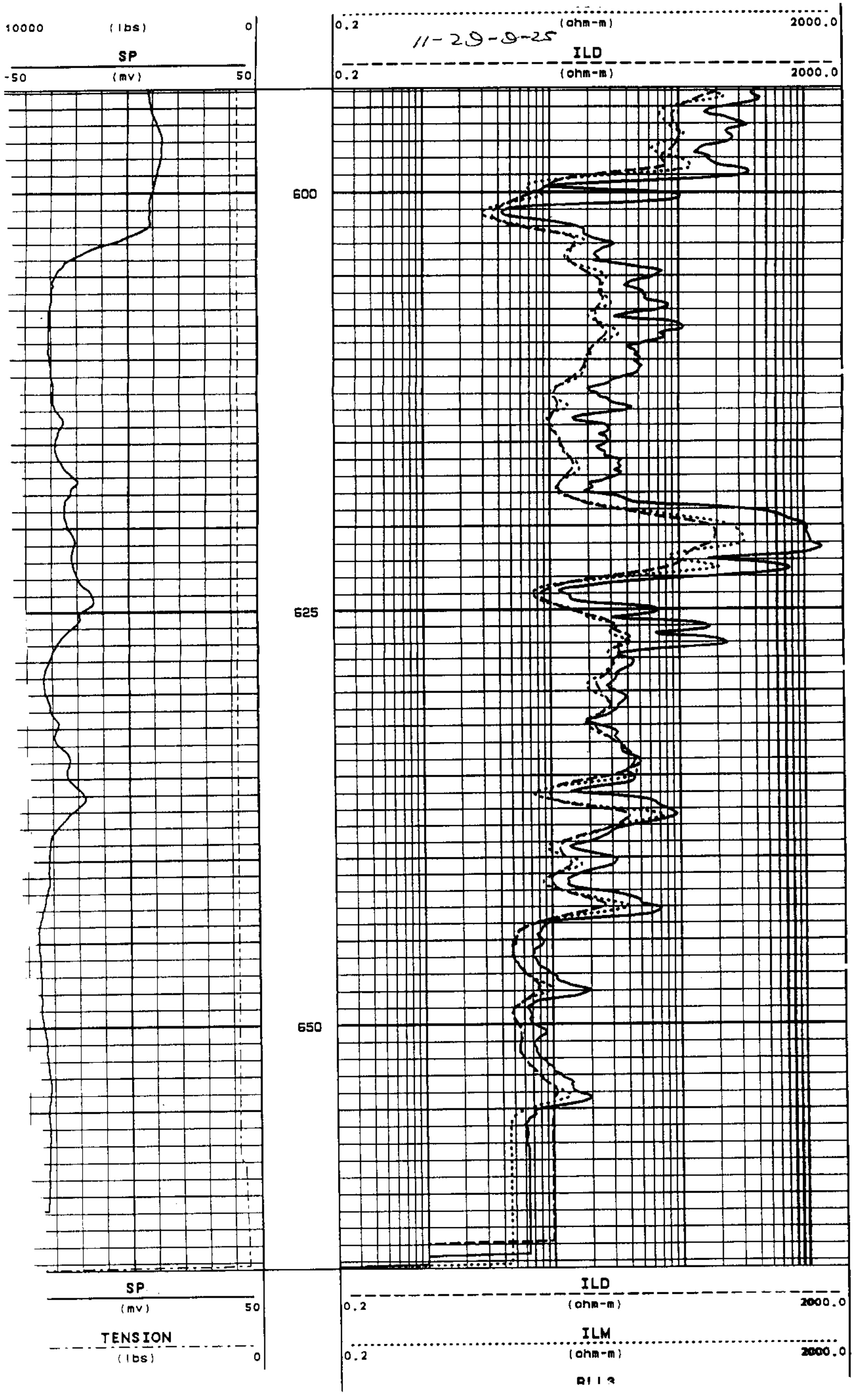
23671BAS2

K.B. 437.84

VERSION: 1.61

SYSTEM CONSTANTS

NAME	DESCRIPTION	VALUE	UNITS



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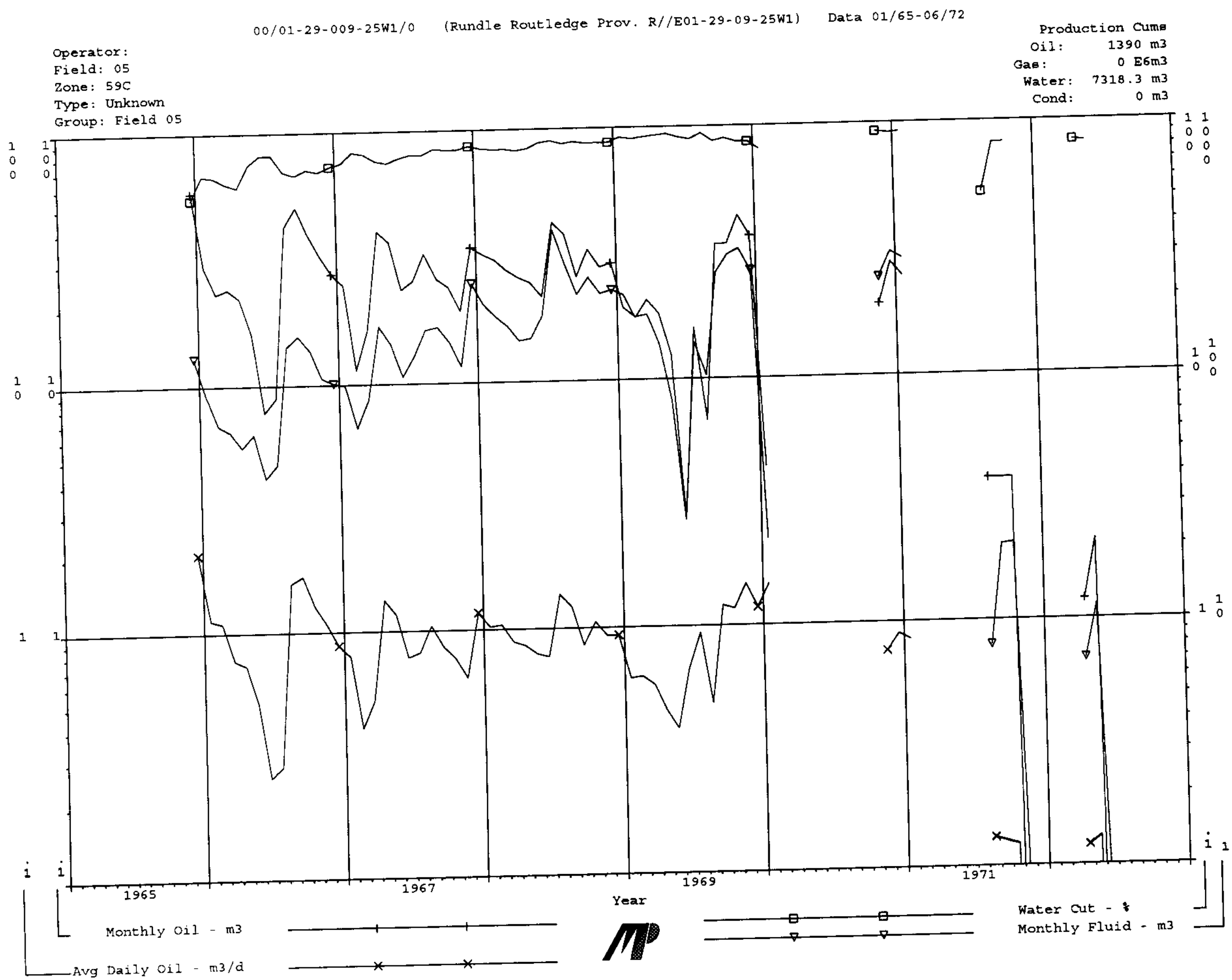
SP
-50 (mv) 50
0.2 (ohm-m) 2000.0
11-29-9-25
ILD
0.2 (ohm-m) 2000.0
600
625
650
SP
(mv) 50
TENSION
(lbs) 0
ILD
0.2 (ohm-m) 2000.0
ILM
0.2 (ohm-m) 2000.0

APPENDIX I

PRODUCTION HISTORIES ROUTLEDGE UNIT NO.1
SECTION 29-9-25 WELLS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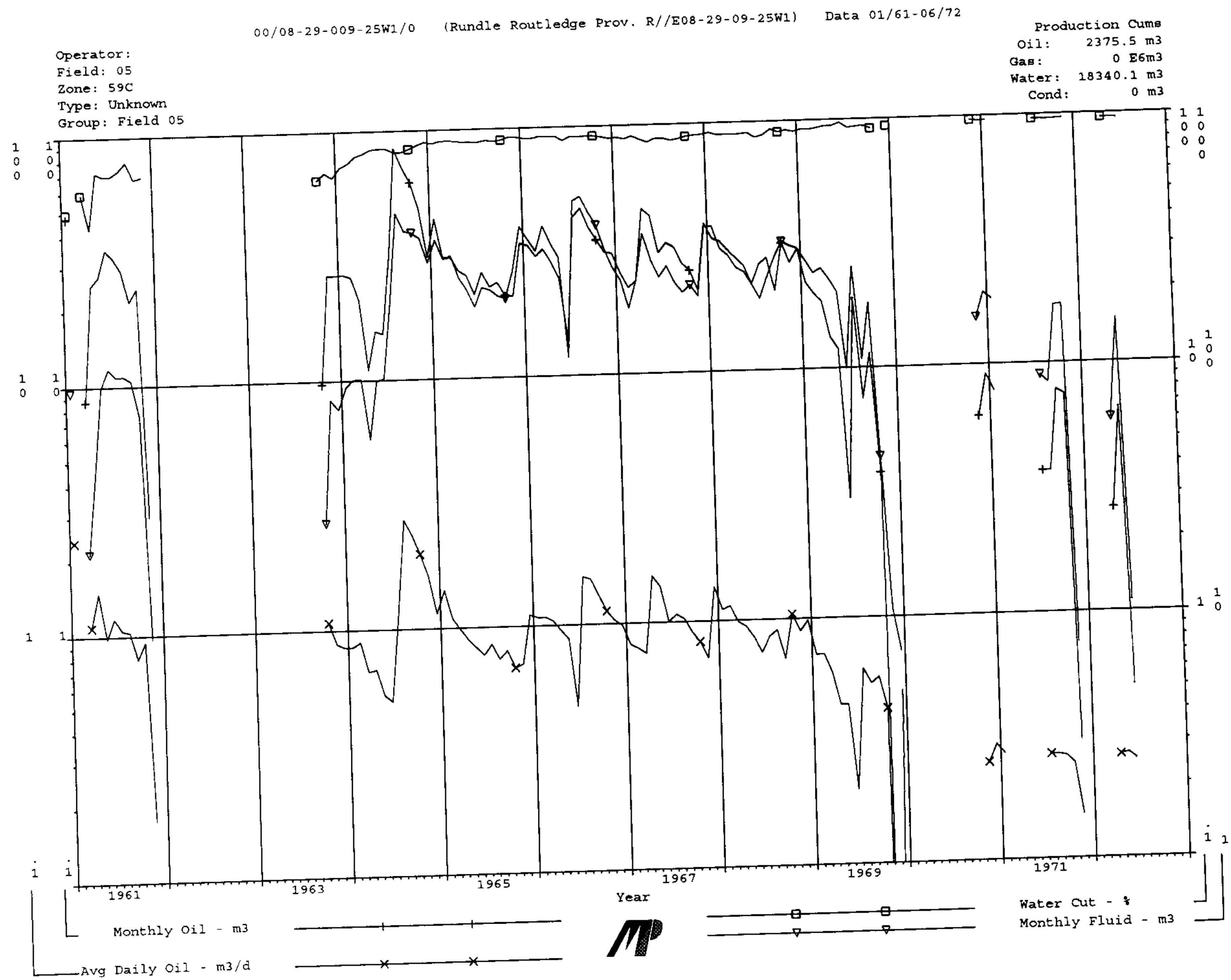
Operator:
Field: 05
Zone: 59C
Type: Unknown
Group: Field 05
Production Cums
Oil: 1390 m3
Gas: 0 E6m3
Water: 7318.3 m3
Cond: 0 m3
1965
1967
1969
1971
Year
Monthly Oil - m3
Avg Daily Oil - m3/d
Water Cut - %
Monthly Fluid - m3



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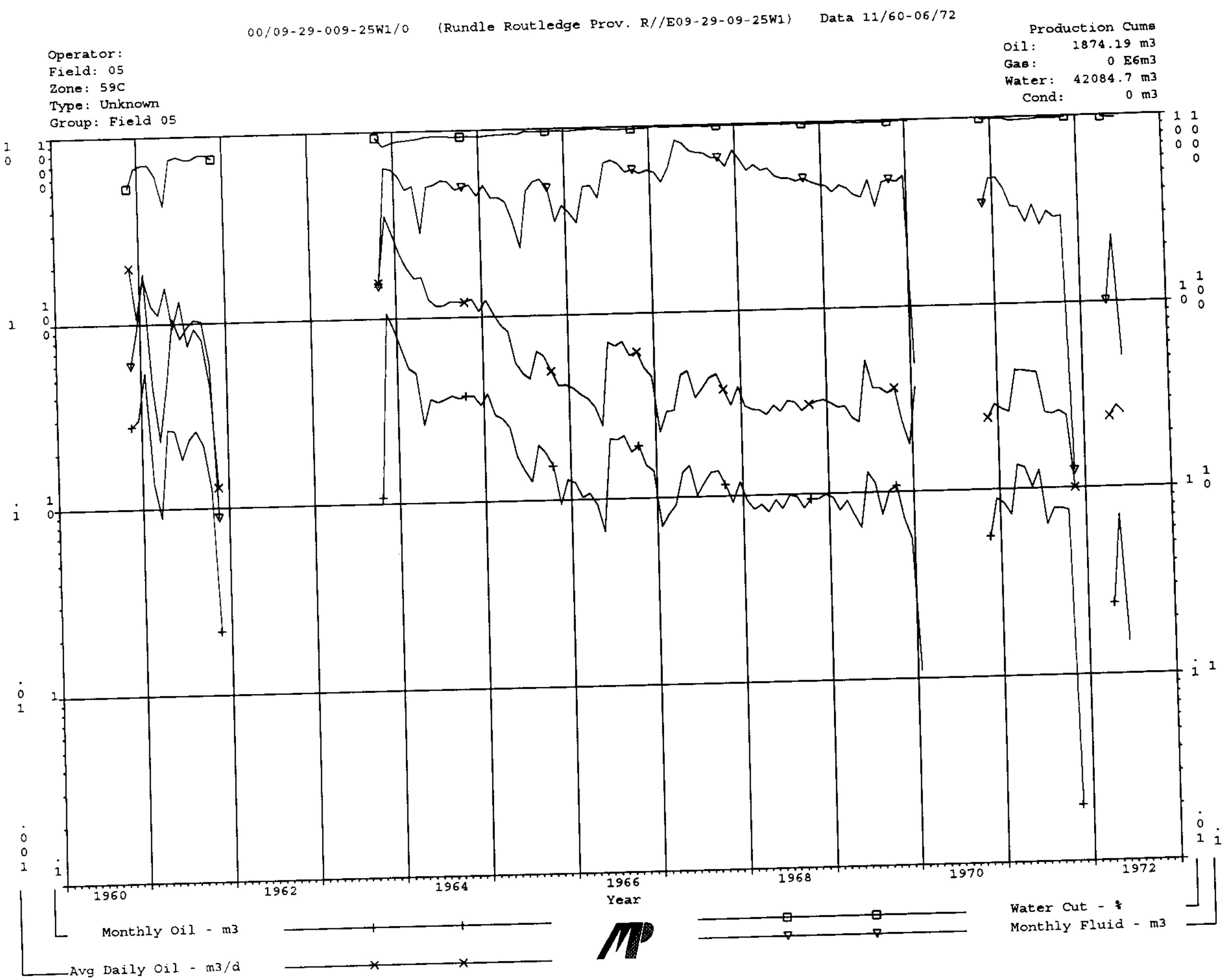
Operator:
Field: 05
Zone: 59C
Type: Unknown
Group: Field 05
Production Cums
Oil: 2375.5 m3
Gas: 0 E6m3
Water: 18340.1 m3
Cond: 0 m3
1961
1963
1965
1967
1969
1971
Year
Monthly Oil - m3
Avg Daily Oil - m3/d
Water Cut - %
Monthly Fluid - m3



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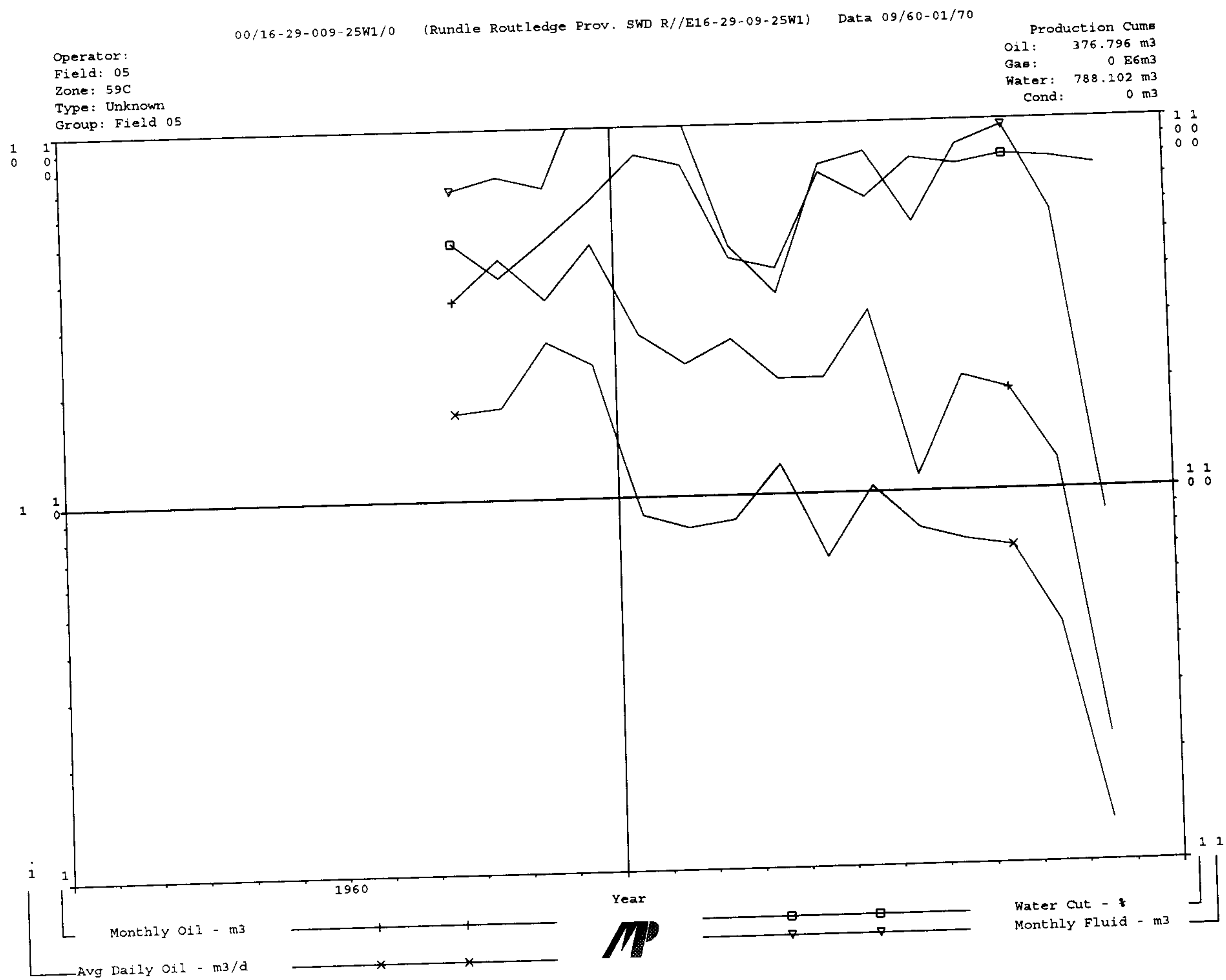
(Rundle Routledge Prov. R//E09-29-09-25W1)
Data 11/60-06/72
Operator:
Field: 05
Zone: 59C
Type: Unknown
Group: Field 05
Production Cums
Oil: 1874.19 m3
Gas: 0 E6m3
Water: 42084.7 m3
Cond: 0 m3
1960
1962
1964
1966
1968
1970
1972
Year
Monthly Oil - m3
Avg Daily Oil - m3/d
Water Cut - %
Monthly Fluid - m3



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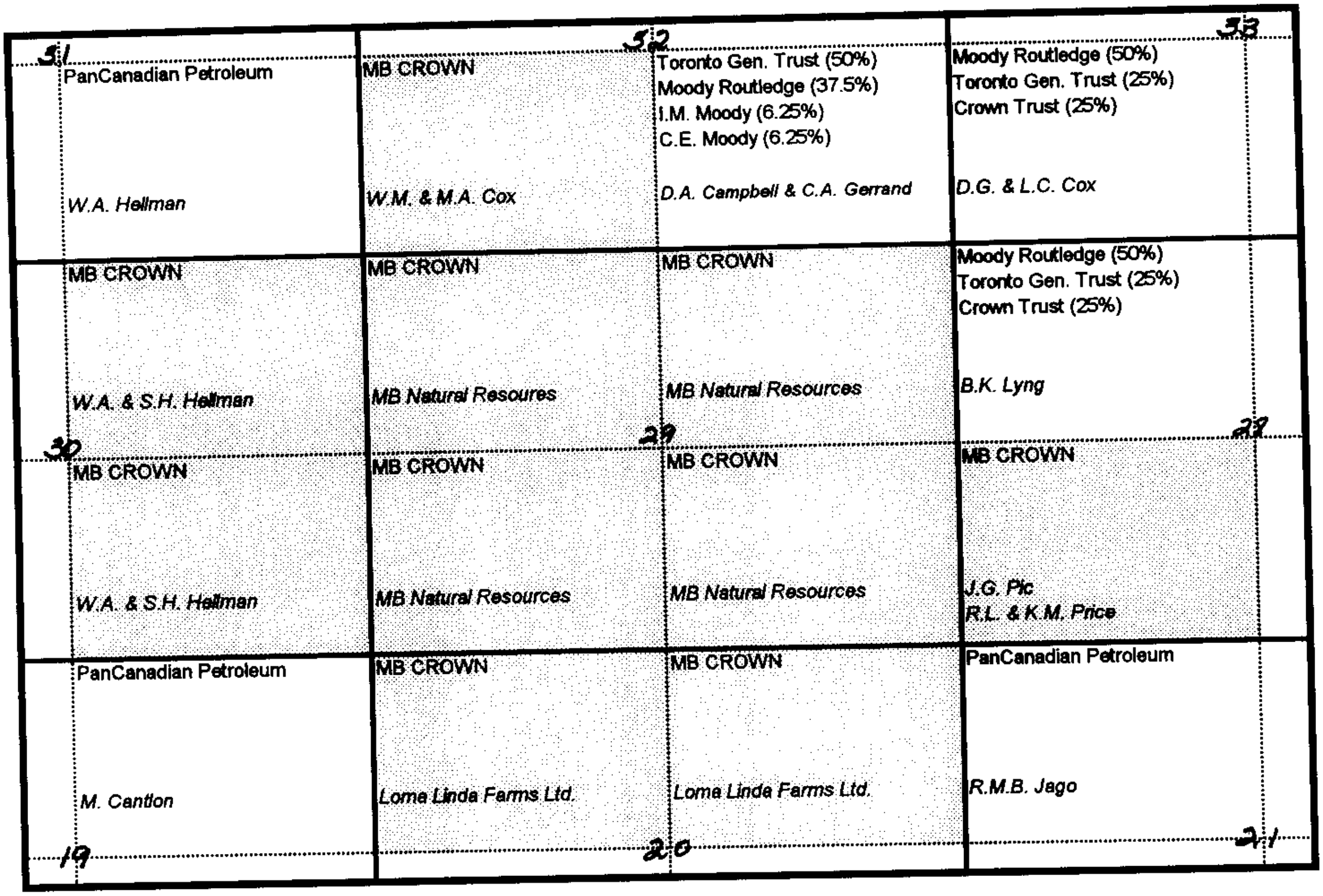
Operator:
Field: 05
Zone: 59C
Type: Unknown
Group: Field 05
Production Cums
Oil: 376.796 m3
Gas: 0 E6m3
Water: 788.102 m3
Cond: 0 m3
1960
Year
Monthly Oil - m3
Avg Daily Oil - m3/d
Water Cut - %
Monthly Fluid - m3

APPENDIX J

MINERAL OWNERS REDUCED SPACING AREA

Routledge Reduced Spacing



TWP 9 RGE 25 WPM

Mineral Ownership

Surface Ownership

ROUTLEDGE REDUCED SPACING
Surface & Mineral Owners

Duncan A. Campbell & Catherine A. Gerrand
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Oak Lake, MB R0M 1P0
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David Glenn & Lynn Colette Cox
General Delivery
Rivers, MB
(204) 855-2146

Walter Murray & Margaret Ann Cox
P.O. Box 509
Virden, MB R0M 2C0
(204) 855-2437

Crown Trust and Toronto General Trust
c/o Montreal Trust
7th Floor, 530 Eighth Avenue SW
Calgary, AB T2P 3S8

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Ruth Mary Boleyn Jago
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Loma Linda Farms Ltd.
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Barry Kelvin Lyng
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Manitoba Natural Resources
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(204) 476-3441

Charlotte Elizabeth Moody
P.O. Box 1378
Virden, MB R0M 2C0

Ivy May Moody
P.O. Box 1178
Virden, MB R0M 2C0

Moody Routledge Ltd.
P.O. Box 1378
Virden, MB R0M 2C0

PanCanadian Petroleums Ltd.
P.O. Box 2850
Calgary, AB T2P 2S5

Janusz George Pic
P.O. Box 1597
Virden, MB R0M 2C0
(204) 748-2581

Roderick L. Price & Kerrie Mae Price
P.O. Box 2274
Virden, MB R0M 2C0
(204) 748-1518

TUNDRA OIL AND GAS LTD.

INFILL DRILLING PROGRAM

FLORA AND FAUNA INVESTIGATION

NOVEMBER, 1996

PREPARED BY
UMA ENGINEERING LTD.
ENGINEERS AND PLANNERS
1479 BUFFALO PLACE
WINNIPEG, MANITOBA
R3T 1L7
IN ASSOCIATION WITH
AGASSIZ NORTH ASSOCIATES LIMITED
1214-B CHEVRIER BOULEVARD
WINNIPEG, MANITOBA, R3T 1Y3

UMA JOB NO. 41 01 C880 001 01 01

UMA Engineering Ltd.
Engineers and Planners

1479 Buffalo Place, Winnipeg, Manitoba, Canada R3T 1L7
Telephone: (204) 284-0580 Fax: (204) 475-3646

Our File: 41 01 C880 001 01 01

November 22, 1996

Tundra Oil & Gas Limited
1111 - One Lombard Place
Winnipeg, Manitoba
R3B 0X4

Attention: Mr. George Czyzewski, P.Eng.
Senior Reservoir Engineer

Dear Sir:

Reference: Infill Drilling Program
Flora and Fauna Investigation

UMA Engineering Ltd. in association with Agassiz North Associates Ltd. are pleased to submit our Infill Drilling Program - Flora and Fauna Investigation Report.

We have enjoyed working with you on this very interesting assignment and look forward to being of assistance to you in the future.

Yours truly,

UMA ENGINEERING LTD.

R. D. Fromson, M.A., MCIP
Vice President & Manager
Manitoba & Northwestern Ontario

T. Wingrove, P.Eng.
Director
Earth & Environmental Division

/dh
306B

TABLE OF CONTENTS

LIMITATIONS

The information and data contained in this report, including without limitation the results of any sampling and analyses conducted by UMA Engineering Ltd. ("UMA") pursuant to its Agreement with the Client, have been developed or obtained through the exercise of UMA's professional judgement and are set forth to the best of UMA's knowledge, information and belief. Although every effort has been made to confirm that such information and data is factual, complete and accurate, UMA makes no guarantees or warranties whatsoever, whether expressed or implied, with respect to such information or data.

UMA shall not by the act of issuing this report be deemed to have represented thereby that any sampling and analyses conducted by it have been exhaustive or will identify all contamination at the site, and persons relying on the results thereof do so at their own risk.

Except as required by law, this report and the information and data contained herein are to be treated as confidential and may be used and relied upon only by the Client, their officers and employees, and others having legitimate business relations with the Client. Any such use and reliance shall be subject to the limitations set forth in the preceding paragraphs.

EXECUTIVE SUMMARY

Tundra Oil and Gas has proposed an infill oil drilling program on a section of crown land (29-9-25 WPM) in the Routledge area of Manitoba. Section 29-9-25 WPM has sandy soils, natural areas, and is habitat for the Western Spiderwort (*Tradescantia occidentalis*), a plant which is protected under the Endangered Species Act in Manitoba. Because of these features, Tundra Oil and Gas has been requested by Manitoba Energy and Mines to conduct a survey of flora and fauna on the site and to prepare a development plan for the site which minimizes the overall adverse environmental impact and avoids adverse impacts on endangered species.

This report presents the results of a flora and fauna investigation and natural resources impact assessment conducted on Section 29-9-25 WPM. The investigation included a site survey on September 6 and 7, 1996, to assess the potential for the occurrence of rare and protected species, like the Western Spiderwort, and to identify the occurrence of any critical wildlife habitat. Existing published and file information sources were reviewed and impact issues were discussed with representatives of Manitoba Natural Resources and the Canadian Wildlife Service. Where the investigation identified the potential for significant adverse impacts on natural resources, measures for the avoidance or mitigation of those impacts to acceptable levels are detailed.

The infill drilling program should not have an unacceptable impact on natural resources provided that industry standard drilling and extraction processes are used, the area of disturbance is kept to a minimum, and a few specific timing constraints and restoration practices are followed. No protected plant or wildlife species will be affected by any project component. Timing constraints may be necessary to avoid impacts on nesting migratory birds and interference with recreational land use during hunting season. Drilling during the period from early spring (late April or early May), when bird nesting begins, to about mid-July when the young birds have fledged should be avoided. Pre-drilling nesting bird surveys will be necessary prior to any drilling which may be started during this early spring to mid-July period. Restoration of all disturbed areas should include removal or treatment of contaminated soils and grading to

pre-drilling contours. No specific revegetation measures are necessary at wooded or pasture sites. All meadow areas which are disturbed by the project should be seeded with appropriate seed mixes.

SECTION 1.0

INTRODUCTION

Tundra Oil and Gas has proposed an infill oil drilling program on a section of crown land (29-9-25 WPM) in the Routledge area of Manitoba. Section 29-9-25 WPM has sandy soils, natural areas, and is habitat for the Western Spiderwort (*Tradescantia occidentalis*), a plant which is protected under the Endangered Species Act in Manitoba. Because of these features, Tundra Oil and Gas has been requested by Manitoba Energy and Mines to conduct a survey of flora and fauna on the site and to prepare a development plan for the site which minimizes the overall adverse environmental impact and avoids adverse impacts on endangered species.

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1.1 Project Description

The proposed drilling program will be conducted on a section of crown land (29-9-25 WPM) in the Routledge area of Manitoba. As many as 12 wells will be drilled in two phases. Phase I will involve up to 4 wells, including 3 wells drilled on 20 acre spacing along the centre axis of the section and one drilled on 40 acre spacing. Favourable results from the Phase I drilling would lead to the drilling of up to 8 additional wells in Phase II. The Phase II wells would include 6 drilled on 20 acre spacing and 2 drilled on 40 acre spacing. The well identifiers and well locations on which this assessment are based are shown in Figure 1. The well identifiers include the phase of the drilling program (I or II) in which the well is planned and a unique alphabetic designator (i.e., A, B, C, ...) for each well included in that phase.

1.2 Study Team

The study was conducted by UMA Engineering Ltd. in association with Agassiz North Associates Limited. Primary authors of the report were Doug Ramsey and Gwenn Kruszynski, both of Agassiz North. The Project Manager was Ron Typliski, P.Eng. of UMA Engineering Ltd. The field survey and existing information review were conducted by the primary authors and Sara Goulet, who was retained by Agassiz North for her expert knowledge of Western Spiderwort identification and ecology.

1.3 Acknowledgments

Many thanks to those who kindly provided information on local natural resources and impact assessment issues, including: Janet Moore (Critical Wildlife Habitat Program, Winnipeg), Jason Greenall and Randy Boychuk (Manitoba Conservation Data Centre, Winnipeg), Bob Jones and Diane Kunec (Manitoba Natural Resources, Wildlife Branch, Winnipeg),Tom Moran (Manitoba Natural Resources, Wildlife Branch, Boissevain), and Rolly Wickstrom (Canadian Wildlife Service, Winnipeg).

SECTION 2.0

BASELINE ENVIRONMENTAL DESCRIPTION

The assessment of project impacts on environmental resources is based on the current status of natural resources on the site (i.e., the baseline environmental description) and the location and nature of any project-related disturbances to these resources.

The baseline environmental description was developed from a review of published natural resource information for the area, discussions with resource managers, and a site survey conducted on September 6 and 7, 1996. The specific goals of the survey were to investigate the potential occurrence of western spiderwort at or near the proposed drill sites, to characterize the plant communities which occurred at the drill sites, and to identify critical wildlife habitat at or near the drill sites.

2.1 Land Use

Section 29-9-25 WPM currently supports several land uses, including: agriculture, oil production, and recreation. Agricultural land uses include wild hay production from the native grassland which dominates the NE quarter of the section, and cattle pasture in native grassland along the north-eastern margin of the section (Figure 1).

Current oil production activity on the section includes four producing wells in the centre of the section (6-29, 7-29, 10-29, and 11-29), a disposal well in the south-central part of section (2-29), and a field battery located adjacent to well 6-29 (Figure 1). All of the producing wells are located on 40 acre spacing. An all weather access road runs from the road allowance along the south margin of the section to the battery and well 6-29. A system of prairie trails runs from the battery to the five active wells on the section, and to the northwest corner of the section. Previous oil exploration and production activity on the section included 4 abandoned 40 acre wells along the eastern side of the section, and one drilled and abandoned well in the northwest corner of the section.

Recreational land uses include the hunting of deer and upland game birds in autumn and snowmobiling in winter. The western half of the section will be designated as part of a Wildlife Management Area in the near future (Tom Moran, Regional Wildlife Technician, Manitoba Natural Resources, pers. com.).

2.2 Topography and Soils

The topography of the Virden area is generally level to very gently sloping with isolated areas of sand dunes (Ehrlich et al. 1956). Sand dunes occur along the northwest margin of the section and in the south central portion of the section. The southern dunes run 300-400 m northwest from the south margin of the

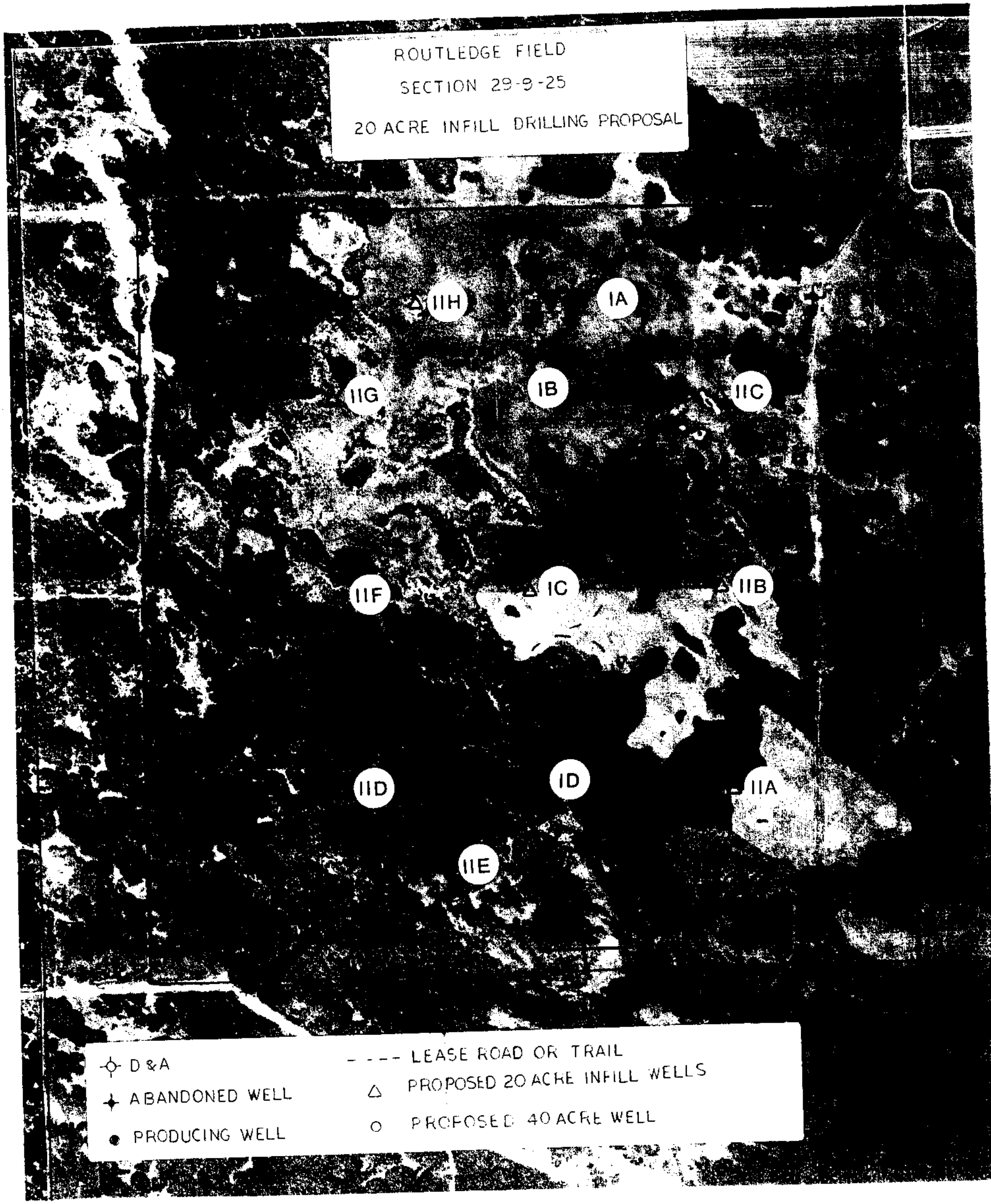


Figure 1. Aerial photograph of Section 29-9-25 WPM indicating the locations of proposed infill drilling sites, currently producing wells and access routes, and abandoned wells.

section, between the battery access road and well 2-29. Extensive micro-dune topography is evident in the SW quarter, in the western half of the SE quarter, and in the northwestern portion of the NW quarter.

Soils on the site belong to the loamy fine sand phase of the Souris association of the Blackearth soil zone (Ehrlich et al. 1956). The Souris loamy fine sand phase consists of four associated members: moderately well-drained soils in areas of micro-dune topography; imperfectly drained soils on smooth topography; poorly drained meadow soils in flat depressional areas; and excessively drained lithosolic soils in areas of duned sand. All four phase members occur on the section. Imperfectly drained soils occur in the northeastern part of the section. Poorly drained meadow soils occur in the flat north-central portion of the section.

2.3 Vegetation

Southwestern Manitoba is part of the Transitional Grassland ecoclimatic region (Environment Canada 1989). Although there are indications the prevailing vegetation originally was tall grass prairie, woodland invasion has created a mosaic of trembling aspen groves and rough fescue grassland (Environment Canada 1989, Ehrlich *et al.* 1956). Aspen is the dominant forest species and occurs near depressions or locally humid locations (Ehrlich *et al.* 1956). In trembling aspen stands, the understory consists of saskatoon, red-osier dogwood, rose, reed-grass, and bedstraw. Shrub and mixed grass prairie communities occupy increasingly drier sites (Environment Canada 1989). Shrub communities are dominated by saskatoon, wolf-willow, rose, and snowberry. Imperfectly drained sites support willow and sedge communities. Within the Virden area, the native vegetation varies with the soil and substrate moisture conditions (Ehrlich *et al.* 1956). Mixed prairie grasses thrive on the imperfectly drained soils, while meadow grasses, sedges, and reeds occupy the lower sites. Xerophytic grass species, ground cedar, and purple pin-cushion cactus occupy the drier sites in duned areas. Scrub oak and aspen grow along slopes and in depressions.

Section 29-9-25 supports a range of vegetation communities, reflecting the variety of soil conditions on the section. Aspen forest predominates in the southern half and northwest corner of the section (Figure 1). Meadow and mixed grass prairie predominate the north half of the section and occur in the SE quarter as well. The majority of the vegetation on the section is undisturbed by development, with about a quarter of the section (primarily the NE quarter) utilized for the production of livestock feed (hay) and cattle pasture and approximately 4 ha under lease for oil production.

The proposed infill drilling program will be undertaken primarily in the meadow areas, with 3 wells planned on wooded sites (Figure 1). No drilling will be conducted in duned areas. Vegetation surveys were conducted at all of the proposed drilling locations. These surveys emphasized identification of rare and protected species and a qualitative characterization of community dominants.

A number of characteristic vegetation community types were found at the drilling sites, with a particular distinction among the well-drained meadow, poorly-drained meadow, and forested communities (Table 1). The species characterizing these community types are listed in Table 2.

Table 1. Vegetation community types occurring at the proposed infill drilling sites. See Figure 1 for site locations and Table 2 for the species which characterize each community type.

Community Type	Drilling Sites
well-drained meadow margin	IIA, IIF
well-drained meadow (hayed)	IA, IC, IIB
well-drained meadow (pasture)	IIC
poorly drained meadow	IB, IIG, IIH
wooded forest	ID, IID
cleared forest	IIE

Table 2. Vascular plant species characterizing the proposed drilling sites on Section 29-9-25.

Species	Cleared Forest	Wooded Forest	Well-Drained Meadow Margin	Well-Drained Meadow (Hayed)	Well-Drained Meadow (Pasture)	Poorly Drained Meadow
Trees						
Populus tremuloides	✓	✓	✓			
Shrubs						
Amelanchier alnifolia			✓			
Betula occidentalis			✓			✓
Comus stolonifera		✓				
Elaeagnus commutata			✓			
Prunus virginiana	✓	✓	✓			
Rosa acicularis	✓	✓				
Rubus idaeus	✓	✓				
Salix sp.			✓			✓
Symphoricarpos occidentalis	✓	✓	✓			
Grass-like Plants						
Agropyron sp.				✓		
Agrostis scabra			✓	✓		
Andropogon gerardi			✓	✓		
Andropogon scoparius				✓		
Calamogrostis neglecta						✓
Carex sp.		✓		✓		✓
Elymus sp.						✓
Hordeum jubatum					✓	
Juncus sp.						✓
Phragmites communis						✓
Scolochloa festucacea						✓
Setaria viridis	✓					
Spartina gracilis			✓			
Triglochin maritima						✓
Wildflowers						
Amaranthus retroflexus	✓					
Anemone canadensis		✓				
Artemisia sp.	✓		✓			
Aster spp.		✓		✓		✓
Cirsium sp.		✓	✓			✓
Convolvulus sp.	✓					
Galium boreale		✓				
Helianthus sp.			✓			
Lycopus sp.		✓				
Mentha arvensis	✓					
Mianthemum canadensis		✓				
Rhus radicans	✓	✓				
Smilacina stellata		✓				
Solidago spp.			✓	✓		✓
Sonchus arvensis	✓			✓		✓
Thalictrum dasycarpum		✓				

The rare vascular plant species which are known to occur in the general vicinity of the study area are listed in Table 3. Two of these plants, the **Western Spiderwort** (*Tradescantia occidentalis*) and the **Purple Pin-Cushion Cactus** (*Coryphantha vivipara*) have been found to occur either on Section 29-9-25 or on adjacent lands. The Western spiderwort is considered a rare vascular plant in Canada (Argus and Pryer 1990), a threatened species under COSEWIC (1994), and recently has been granted protection under the Manitoba Endangered Species Act.

No spiderwort plants were found at any of the proposed drilling sites. None of the sites offers suitable habitat for the plant, which only occurs in sand dunes. Our survey of the sand dunes located on the southern margin of Section 29-9-25, and of the northward extensions of these dunes, found many of the vascular plant species known to be associated with the occurrence of the Western Spiderwort. No spiderworts were found although their occurrence in this area cannot be ruled out because the survey was conducted late in the growing season. The plants finish their growing season earlier in areas with more sun exposure (Sara Goulet, Agassiz North Associates Limited, Winnipeg, pers. com.), such as in the dunes on the southern margin of the section. Inspection of the duned area along the north-west margin of the section, which has more shaded areas, revealed several spiderwort plants in the last stages of the fall die-off.

Among the species associated with the spiderwort found on the dunes, both to the south and the northwest of the drilling sites, is the purple pin-cushion cactus (*Coryphantha vivipara*). The pin-cushion cactus, while not rare across Canada, is considered a rare vascular plant in Manitoba (White and Johnson 1980). This species did not occur at any of the drilling locations, again due to the lack of suitable habitat.

Table 3. Rare vascular plants with the potential to occur in the vicinity of Section 29-9-25. Sources: Argus and Pryer (1990); White and Johnson (1980); Looman and Best (1979).

Species	Common Name	Habitat	Canadian Priority
Ambrosia acanthicarpa	Bur-ragweed	wind eroded sandhills	None
Andropogon hallii	Sand bluestem	dry prairies and sandhills	P5
Astragalus gilviflorus	Cushion milk-vetch	dry prairies	None
Chamaesyce geyeri	Prostrate spurge	active sand dunes	P4
Chenopodium subglabrum		active sand dunes	P2
Coryphantha vivipara	Purple pin-cushion cactus	dry plains and sandhills	None
Cyclocoma atriplicifolium	Winged pigweed	sandy places	None
Dicanthelium oligosanthes var. wilcoxianum	Sand millet	dry prairie, sandhills, and sandy clearings	P4
Heliotropium curassavicum		alkaline shores	None
Musineon divaricatum	Leafy musineon	dry hillsides	None
Orobanche ludoviciana	Louisiana broom-rape	dry hills and sand dune, parasitic on *Artemisia*	None
Oryzoposis hymenoides	Indian rice grass	dry prairie and sandhills	None
Oryzopsis micrantha	Little-seed rice grass	open woods and rocky ridges or slopes	None
Penstemon nitidus	Smooth blue beardtongue	sandy or gravelly prairies	None
Penstemon procerus	Slender beardtongue	moist prairies	None
Poa cusickii	Early blue grass	dry prairie and sandhills	None
Townsendia exscapa	Low townsendia	sandhills	None
Tradescantia occidentalis	Western spiderwort	sandy places	P3 (threatened)[1]

Priority Definitions

P1 critically imperiled because of extreme rarity (5 or fewer occurrences in Canada)
P2 imperiled because of rarity (6 to 20 occurrences)
P3 rare or uncommon (21 to 100 occurrences)
P4 apparently secure, with many occurrences
P5 abundant and demonstrably secure, with many occurrences
None considered rare in Manitoba but no Canadian priority established
1. Listed as threatened under the Manitoba Endangered Species Act

The occurrence of the Seaside Arrow-Grass (*Triglochin maritima*) at the poorly drained sites IB and IIH also is noteworthy. Although not a concern as a rare vascular plant species in either Manitoba or Canada, the Seaside Arrow-Grass is considered poisonous to cattle and sheep (Looman and Best 1979), making these areas of questionable quality for livestock feed or pasture.

2.4 Wildlife

Wildlife which are characteristic of the transitional grassland region include white-tailed deer, coyote, snowshoe hare, Franklin's ground squirrel, and thirteen-lined ground squirrel (Environment Canada 1989). No attempt was made to provide a complete survey of the wildlife species occurring on the section. Instead, the survey focused on identifying locations of any critical wildlife habitat, such as denning areas or raptor nests.

Rare and protected wildlife species with some potential to occur on section 29-9-25 are listed in Table 4. Notably, all of the these species are grassland birds, whose existence has become threatened by the loss of native grassland areas to agriculture and other development.

Table 4. Wildlife species with special conservation status which may occur on Section 29-9-25.

Species	Status[1]	Habitat Preference[2]
Ferruginous Hawk	Threatened	Dry prairie and open grassland regions. Usually nests 3 to 10 m above ground in tree tops. Also may nest in a bush or on a ledge, riverbank, or hillside.
Loggerhead Shrike	Endangered	Open country with high perches and thorny shrubs. Nests 1.5 to 6 m above ground in shrubs or trees.
Burrowing Owl	Endangered	Nests in abandoned badger and ground squirrel burrows.
Baird's Sparrow	Endangered[3]	Dry areas with long grass and scattered shrubs. Nests on the ground with or without overhead cover.

1. J. Moore (Manitoba Natural Resources, pers. com), Committee on the Status of Endangered Wildlife in Canada (COSEWIC), 1996.
2. Godfrey (1986)
3. Endangered in Manitoba, delisted elsewhere in Canada.

Although the section supports a substantial area of native grassland and meadow, previous study by Manitoba Natural Resources (DeSmet 1992) found it did not represent high quality habitat for the rare and protected grassland birds like the burrowing owl, loggerhead shrike, Baird's sparrow or ferruginous hawk. Other, drier locations in the area offer better quality habitat. Given the rarity of these birds, and the occurrence of better quality habitat in the surrounding area, it is unlikely that any of these important grassland bird species will take up summer residence on the section.

Wooded areas on the section were surveyed for the occurrence of raptor nests, both at the drilling sites in wooded areas and along potential access routes to the wooded drilling sites. No nests were observed. A Swainson's hawk was found hunting in the meadow during the survey, although its nesting site was not in the areas which will be disturbed by drilling.

No natural waterfowl habitat occurs on the section. Examination of historical aerial photos for the area indicated a wetland occurred at one time on the central part of the section, where the meadow grasses presently are found (Sara Goulet, Agassiz North Associates Limited, Winnipeg, pers. com.). This wetland no longer exists, perhaps as a result of drainage for agricultural purposes.

The only ungulates occurring in the area are white tail deer. The Land Capability Rating (Canada Land Inventory 1970) for the section is Class 4 (moderate limitations) in the NE, SE, and SW quarters and Class 6 (severe limitations) for most of the NW quarter. This habitat classification is generally representative of overall habitat quality in the township. The only high quality deer habitat occurring on or near the section is Class 3W winter range which crosses the extreme northwest corner of the section and occurs in adjacent sections 30-9-25, 31-9-25, and 32-9-25.

The section occurs within the ranges of both the Ruffed grouse and the Sharptail grouse. Several sharptails were flushed in the course of the September site survey. Typical habitat for sharptails in the parkland region is grassland and grain-bearing land near brush or open woodland. The sharptails nest on the ground, under or near brush or trees. The Ruffed grouse is more of a woodland bird, inhabiting second growth deciduous and mixed woodland, wood edges and openings, and similar areas. Ruffed grouse nests are usually in wooded areas, often at the base of a tree, rock, log, or brushpile.

SECTION 3.0

IMPACT ASSESSMENT AND MITIGATION

The primary impact issues include the disturbance of rare and protected vascular plants and wildlife and their habitat. Such disturbance may occur at the proposed drill sites and in the development of access trails/roads, flowlines, and powerlines. Other issues include: the preservation of native grassland, meadow, and wooded habitat; minimization of the displacement and disturbance of wildlife; introduction of weeds; interference with other land uses; and, spills of contaminants.

Two rare or protected vascular plant species occur on the section, Western Spiderwort, and Purple Pin-Cushion Cactus. The project does not pose a threat to either species. None of the proposed drilling sites is located in duned areas and any access trails/roads, flowlines, and powerlines will not be routed through duned areas.

Potential impacts on wildlife include the loss or isolation of habitat, displacement of wildlife from habitat due to activity and noise, and increased access to wildlife for hunters due to the construction of access trails and roads. Particular concerns in this regard relate to the disturbance of birds during the nesting season and the displacement of deer from winter range.

Although some disturbance or displacement of wildlife by the drilling program is inevitable, this impact only becomes a serious concern when it affects rare/protected wildlife in any stage of their life history, or more common species during critical phases of their life history. The only rare/protected wildlife species which may be affected by the project are four grassland birds; the burrowing owl, loggerhead shrike, Baird's sparrow, and ferruginous hawk. While it is not possible to entirely rule out the potential for adverse impacts on these birds, it is highly unlikely that any of these species will be affected. The section does not offer any high quality habitat for them, making it unlikely that any will take up summer residence there.

The disturbance of raptor nests is an important impact to be avoided, because these birds will utilize the same nest over several years. Birds can be permanently displaced from a site as a result of the disturbance or destruction of a nest. This does not appear to be an impact issue for the proposed project as no raptor nests are located in areas which will be disturbed.

Nesting migratory birds are protected by the Migratory Birds Convention Act. Under this act it is unlawful to disturb any active migratory bird nest or their eggs. Impacts related to the disturbance of nesting birds can be avoided to a large degree through the careful scheduling of activities. In this regard, the drilling project has limited potential to affect nesting birds. Drilling is not practical during spring and early summer due to load restrictions on local roads which prevent the transport of drilling equipment. These road restrictions typically are in effect from late March to mid-June and will ensure that much of the nesting season is avoided. Once the load restrictions are lifted, drilling in wooded areas could start as long as any necessary clearing was completed outside the nesting season. Late winter is a good time for tree and brush clearing to be done. In grassland areas, a further delay in the start of drilling from the time that load restrictions are lifted until mid-July would ensure that impacts on birds nesting in these areas are kept to a minimum.

In cases where it is necessary to initiate drilling during the nesting season, a pre-construction nesting bird survey is required. This involves the survey of access routes and drilling areas by a biologist for the presence of nests which are to be avoided by the drill crews. Any nests are flagged, and drilling can proceed as long as a sufficient buffer is provided between the drilling activities and the nesting areas.

The occurrence of deer winter range on and adjacent to the section introduces the potential for adverse impacts during a critical life phase if winter drilling is undertaken. Noise and activity during drilling could displace deer from the winter range, resulting in reduced survival. It is our understanding that winter drilling will not be used extensively, due to its higher cost (Mr. George Czyzewski, Tundra Oil and Gas Ltd., Winnipeg, MB, pers. com.). However, there is a possibility that the poorly drained sites (1B, IIG, and IIH) may be drilled in winter if ground conditions do not permit access in summer or autumn. Sites IIG and IIH are located approximately 400 to 500 m from the documented winter range habitat. This distance should provide an adequate buffer to prevent the displacement of deer from winter range. Consequently, no critical life stage impacts on deer are expected to occur.

The potential adverse impacts of oil drilling on native grassland, meadow, and wooded habitat are primarily related to clearing and grading of the drilling sites, and the development and use of access trails/roads. Such impacts are a necessary part of the oil exploration process, but need not be permanent if proper site restoration measures are undertaken. The standard requirements of drilling permits issued by the Province of Manitoba include the restoration of all disturbed areas as close to pre-project conditions as possible. Adherence to permit conditions should adequately address concerns in this regard.

Site restoration typically includes removal of all equipment, structures, and foundations, treatment or removal of any contaminated soils, regrading of the site to original contours, and, where necessary, site revegetation. The magnitude of the related impacts and the cost of restoration also can be minimized by keeping the areas of disturbance to an absolute minimum and avoiding work in wet conditions.

In the case of wooded areas, no specific revegetation measures will be necessary. The drilling sites and trail rights-of-way will be sufficiently small that the surrounding aspen forest will quickly reclaim the sites following termination of activity.

The meadow areas should be seeded with an appropriate seed mixture after recontouring in order to discourage weed growth and accelerate the return to pre-project conditions. Seed mixes appropriate to specific site conditions are shown in Table 5. Seeding should be done immediately on completion of the final site grading, and the progress of regeneration should be monitored periodically for about two years after seeding. Maintenance applications of herbicide may be necessary to control broad-leaved weeds during this monitoring period.

Table 5. Recommended seed mixes for restoration of meadow drilling sites on Section 29-9-25 WPM.

Well Drained Meadow (Sites IA, IC, IIA, IIB, IIC, IIF)		**Poorly Drained Meadow (Sites IB, IIG, IIH)**	
Northern Wheatgrass	25 %	Creeping Red Fescue	30%
Western Wheatgrass	20	Slender Wheatgrass	30
Slender Wheatgrass	30	Streambank Wheatgrass	20
Tufted Hairgrass	15	Green Needlegrass	20
Big or Little Bluestem	10		

Application: In summer, drill at 14 kg/ha or broadcast at 26 kg/ha. Certified Canada No. 1 seed should be used where available.

No specific revegetation measures beyond recontouring are necessary in the pasture area. This land use has dramatically altered the vegetation community, such that it is now dominated by a weed species (*Hordeum jubatum*, foxtail barley; Table 2) which will quickly reclaim any areas disturbed by drilling.

Another issue related to the disturbance of native vegetation is the potential for the introduction of weed species. A particular concern in this regard is leafy spurge (*Euphorbia esula*) which aggressively invades disturbed sites in sandy soils. Spurge seeds can be carried on to the site by equipment and vehicles which have been used in infested areas. Once introduced, the plant will quickly take over any disturbed soils. Should this occur, a biological control program, using Black dot leafy spurge beetles (*Aphthona nigriscutis*), may be necessary to treat infested areas and prevent further spread. Measures which can be used to minimize the potential for introduction of leafy spurge and other weeds include the washing of equipment undercarriages before moving onto the site and minimization of the area of disturbance.

The potential for displacement of wildlife from the section, and particularly of deer and upland gamebirds, may have an adverse effect on recreational hunting opportunities. The Department of Natural Resources may therefore require, as a condition of the drilling permit, the suspension of drilling activities during the hunting season in order to accommodate this other land use.

Contaminant discharges associated with oil drilling and production can include spills of crude oil and saline water, and leaks of fuels, lubricants, and coolants from vehicles and equipment. Measures for the containment and cleanup of these contaminants are standard conditions of drilling permits and adherence to these conditions should provide adequate environmental protection.

SECTION 4.0

CONCLUSIONS AND RECOMMENDATIONS

The proposed infill drilling program on Section 29-9-25 WPM should not have an unacceptable impact on natural resources provided that industry standard drilling and extraction processes are used, the area of disturbance is kept to a minimum, and a few specific timing constraints and restoration practices are followed. No protected plant or wildlife species will be affected by any project component. Timing constraints may be necessary to avoid impacts on nesting migratory birds and interference with recreational land use during hunting season. Drilling in the period from early spring (late April or early May), when bird nesting begins, to about mid-July when the young birds have fledged should be avoided. Pre-drilling nesting bird surveys will be necessary prior to any drilling which may be started during this early spring to mid-July period. Restoration of all disturbed areas should include removal or treatment of contaminated soils and grading to pre-drilling contours. No specific revegetation measures are necessary at wooded or pasture sites. All meadow areas which are disturbed by the project should be seeded with appropriate seed mixes.

Respectfully Submitted,
UMA ENGINEERING LTD.

D. Ramsey, M.Sc.
Agassiz North Associates Ltd.

R. Typliski, P.Eng.
UMA Engineering Ltd.

PROVINCE OF MANITOBA
R.L.V. TYPLISKI
96/11/22

REFERENCES

Argus, G.W., and K.M. Pryer. 1990. Rare vascular plants in Canada, our natural heritage. Canadian Museum of Nature, Ottawa, Ontario.

Canada Land Inventory. 1970. Land Capability for Wildlife - Ungulates. 62F - Virden. 1:250,000 map.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 1991. List of Species with Designated Status. COSEWIC, Ottawa, ON.

De Smet, K.D. 1992. Manitoba's threatened and endangered grassland birds: 1991 update and five year summary. Manitoba Department of Natural resources, Wildlife Branch, MS Report No. 92-03.

Ehrlich, W.A., L.E. Pratt, and E.A. Poyser.1956. Report of reconnaissance soil survey of Rossburn and Virden map sheet areas. Manitoba Soil Survey, Canada Department of Agriculture, Provincial Department of Agriculture, and Soils Department, University of Manitoba.

Environment Canada. 1989. Ecoclimatic regions of Canada, first approximation. Ecoregions Working Group of the Canada Committee on Ecological Land Classification. Ecological Land Classification Series, No. 23, Sustainable Development Branch, Canadian Wildlife Service, Conservation and Protection, Environment Canada, Ottawa, Ontario. 119 p and map at 1:7 500 000.

Godfrey. W.E. 1986. The birds of Canada, revised edition. National Museum of Natural Sciences. Ottawa, ON.

Looman, J., and K.F. Best. 1979. Budd's flora of the Canadian prairie provinces. Research Branch, Agriculture Canada, Publication 1662.

White, D.J., and K. L. Johnson. 1980. The rare vascular plants of Manitoba. Syllogeus Series No. 27, National Museum of Canada, Ottawa, Ontario.

Tundra
oil and gas ltd.

February 6, 1995

Manitoba Energy and Mines
Petroleum Branch
1395 Ellice Avenue, Suite 360
Winnipeg, Manitoba
R3G 0G3

CONFIDENTIAL

Attention: **Mr. J. Fox, P.Eng.**
Chief Petroleum Engineer

Dear John,

RE: Routledge Field
Section 29-9-25 W1M Reduced Spacing

Further to our meeting of 95.01.23 with the Manitoba Petroleum Branch pertaining to the referenced subject matter, Tundra Oil and Gas Ltd. is currently considering reduced spacing (20 acre) as the best method of maximizing oil recovery from Section 29-9-25. To that end, we are including the following documentation that you can use in your discussions with the Department of Natural Resources regarding any environmental issues with the proposed exploitation program:

1. **Attachment No.1**: Aerial photograph of Section 29 and current infra-structure. The 20 acre infill development program is outlined on the transparency. A total of 10 potential infill locations have been identified. The majority (8 locations) of the proposed infill wells would be drilled on existing cultivated land. This would cause minimal disruption to the existing flora and fauna in this area. Only 2 infill locations (6b-29 and 3d-29) would require removing surface cover to access these sites. However, Tundra has previously successfully adhered (new 1994 well at 11-29) to the DNR regulations required in developing environmentally sensitive areas. If 6b-29 and 3d-29 were drilled in the future, Tundra would again meet the environmental conditions set out by the Department of Natural Resources.

2. Individual well production histories and depletion analysis has previously been supplied to the Petroleum Branch.

3. **Attachment No.2**: A copy of the proposed infill drilling program for Section 29-9-25.

Tundra
oil and gas ltd.

4. **Attachment No.3**: Correspondence with Manitoba DNR outlining conditions that Tundra adhered to in the drilling of a recent well in the Routledge Field at 11-29-9-25. These conditions would be respected to minimize any environmental damage in future drilling programs.

5. **Attachment No.4**: Open-hole logs of the existing producing wells in Section 29. The intent of this information is to illustrate the degree of stratification in the Scallion and Oolite formations. Since both productive formations are highly stratified, the use of horizontal drilling in our opinion would not be the best technology to further increase oil recovery in the Routledge Field. Conventional vertical drilling is considered by Tundra to be the best method to contact all the producing layers and maximize oil recovery. Production in the Routledge Field is further complicated by natural fractures, which may adversely impact on oil production in a horizontal well.

Tundra will submit a formal application to the Crown to down space Section 29-9-25, after the Petroleum Branch has received some feedback from the DNR as to their position on further petroleum exploitation in this area. Tundra considers our plans at this time for Section 29-9-25 to be very confidential, and would be appreciative if this matter is handled accordingly by your department.

Should you have any questions or require our assistance, I can be reached at 934-5853.

Yours truly,

TUNDRA OIL AND GAS LTD.

George Czyzewski, P.Eng.
Senior Reservoir Engineer

cc: R. Puchniak
D. Barchyn

ATTACHMENT NO.1

AERIAL PHOTOGRAPH OF SECTION 29-9-25 W1M

Attachment 1


ROUTLEDGE FIELD
SECTION -9-25
20 ACRE INFILL DRILLING PROPOSAL
D&A
ABANDONED WELL
PRODUCING WELL
LEASE ROAD OR TRAIL
PROPOSED 20 ACRE INFILL WELLS
PROPOSED 40 ACRE WELL

ATTACHMENT NO.2

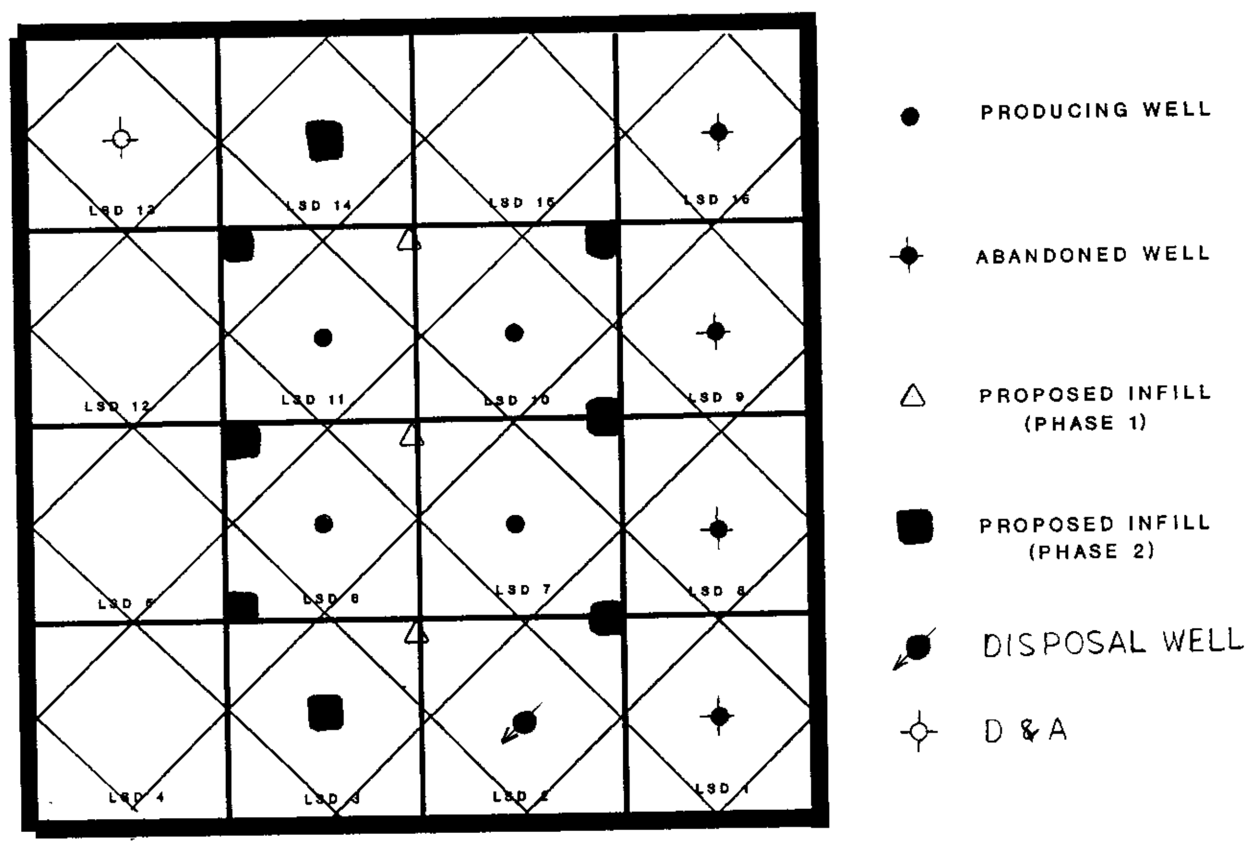
PROPOSED INFILL DRILLING PROGRAM SECTION 29-9-25 W1M

ROUTLEDGE FIELD

INFILL DRILLING PROGRAM

20 ACRE SPACING

SECTION 29-9-25

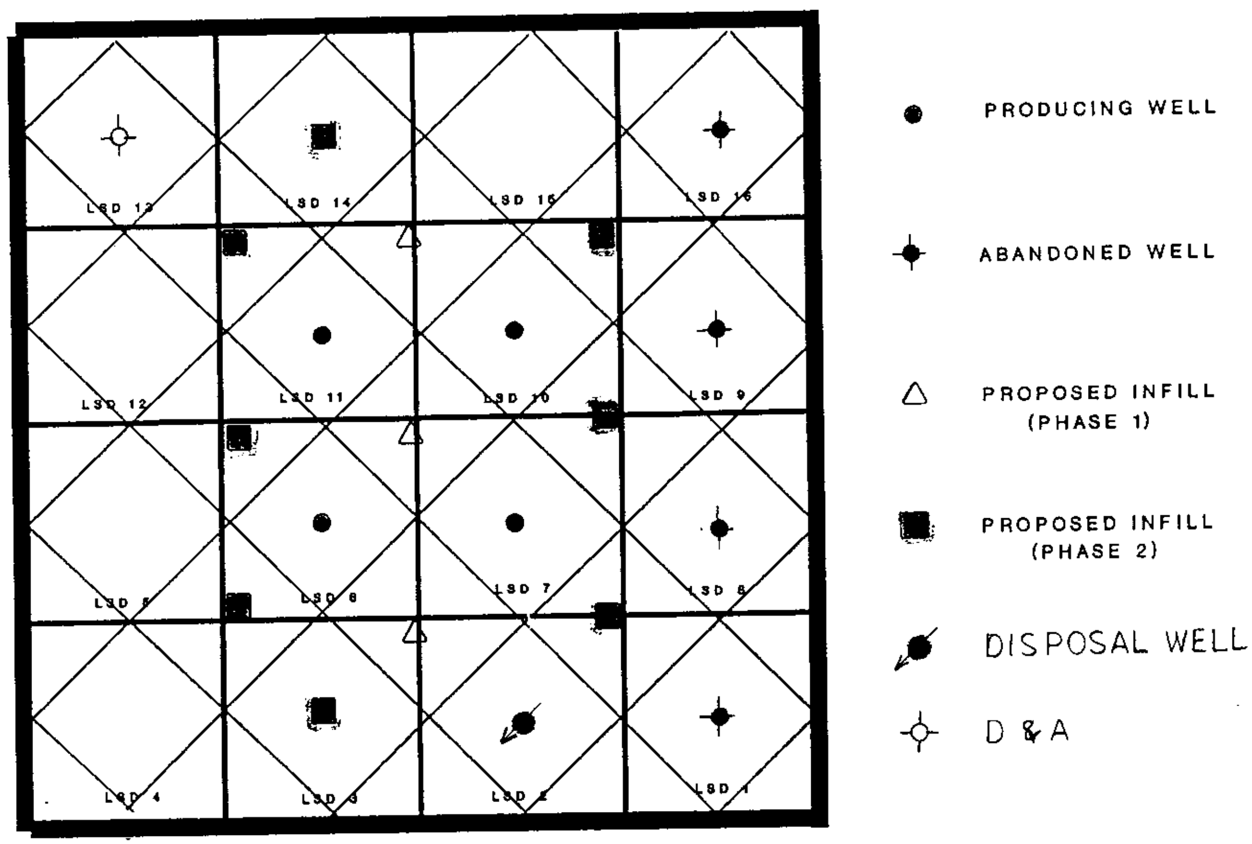


ROUTLEDGE FIELD

INFILL DRILLING PROGRAM

20 ACRE SPACING

SECTION 29-9-25



ATTACHMENT NO. 3

CORRESPONDENCE WITH MANITOBA DNR SECTION 29-9-25 W1M

ork Permit

Manitoba Natural Resources

Fee: No Charge

Permit No. WP 5688

This permit, issued under the authority of Section 9(1)(c) of The Crown Lands Act, and, subject to all Acts and regulations in effect from time to time, OR, in the case of other lands, under The Fires Prevention Act, authorizes

Name of permitee: TUNDRA OIL AND GAS LTD

Address: Box 1960 | City/Town: VIRDEN | Province: MANITOBA

to carry out an operation on the following described [X] Crown (Manitoba) lands [ ] Other lands

SW & NW 1/4 Sec 29 - T.9 Rg. 25

for the purpose of: (describe purpose or objective of operation)

DRILLING NEW WELLS ON 2 LOCATIONS.

Authority (enter # of permit, tender, contract, etc., if applicable)

Subject to the following conditions: (attach list if additional space is required)

1. You are required to maintain the following fire-fighting equipment in serviceable condition on the operation for the purpose of fire control:

a) [ ] Fire extinguisher: (a minimum of 1 for each of the following and of the size specified - must be ULC approved)

Bulldozers	Each power saw	Trucks	Draglines
Skidders	Loaders	Slashers	Other (Spec.)

b) [ ] Other equipment:

Fire Pumps (engines)	Pack Pumps	Shovels	Other (Spec.)
Hose (lin. ft.)	Pails	Axes	

c) [ ] Spark arrestors (one on each internal combustion engine - must be serviceable, in Officer's opinion.)

2. This permit must be available at all times on the operation site, produced at the request of an Officer, and may be cancelled by an Officer without advance notice.

3. [X] as per attached appendix dated 94/06/17.
[ ]

4. NOTE: AS PER DISCUSSION WITH TUNDRA OIL (TIM - HOWARD)
NO BATTERY OR TREATER STATION WAS PLANNED FOR

5. THESE SIGHTS. IF THERE ARE PLANS FOR THIS
FURTHER CONDITION MAY APPLY.

** THIS PERMIT AND THE RIGHTS AND PRIVILEGES GRANTED THEREUNDER ARE NOT TRANSFERABLE **
** PERMIT EXPIRES MARCH 31 UNLESS AN EARLIER EXPIRY DATE IS SPECIFIED **

I hereby certify that the information given to obtain this permit is true and that I understand the conditions set out herein.	Date Issued (yr/mo/da) 94/06/17	Signature of Issuing Authority ______ for Minister of Natural Resources
Not valid unless signed by permittee or authorized representative.	Expiry Date (yr/mo/da)	Issuing District or Office: VIRDEN.

WHITE-PERMITTEE CANARY-BRANCH PINK-DISTRICT GREEN-REGION

3M-06/86 MG 13161

APPENDIX
94/06/17

WELL SITES

WS 1 The maximum allowable size of clearings for well sites is 100 metres by 100 metres.

WS 2 No material is to be pushed into standing timber or streams. All leaning trees are to be removed from standing timber by felling with a power saw, limbing to lie flat and cutting into lengths not exceeding 8 feet in length.
All merchantable timber must be salvaged by felling with a power saw, limbing and skidding to a central location adjacent to permanent access.

WS 3 Access for drilling will be via existing trail which are not to be widened for rig access purposes unless authorized by DNR.

WS 4 Improved access routes will not be considered until the well is a proven producer.

WS 5 Access routes are to be marked indicating the company and well location [section/township/range] and telephone number of the well service contractor.

WS 6 All topsoil is to be stripped off well sites and piled separately from slash for future site reclamation projects.

WS 7 If the well is not productive, the site is to be re-contoured, stored topsoil is to be spread out and following seeding, the slash is to be rolled back and spread on the site. Seeding is to be done at a rate and seed mixture designated by Regional wildlife staff and be compatible with area management objectives.

WS 8 Slash is to be disposed of as prescribed by DNR and topsoil is to be spread about on the site and seeding is to occur. Seed mixture will be determined by Regional wildlife staff and be compatible with area management objectives.

WS 9 A legal survey and site plan will be required for all successful wells and this information supplied to the local Natural Resources officer who will attach it to the relevant permits.

WS 10 Site plans may be required for potential well sites indicating cover types, water courses, well locations, access and flow line locations.

WS 11 Circulating tanks are required for sump fluids and the fluids must be hauled to a safe disposal site approved by the
PETROLEUM INSPECTORS

WS 12 Sump locations must be approved by the Department of Natural Resources.

WS 13 Sump pits are to be fenced until clean up has been completed.

WS 14 Sumps must be located in stable, impermeable soil on the uphill side of a leasehold.

WS 15 Sumps will not be allowed in porous soils. Circulating tanks will be required.

WS 16 Burn pits will not be permitted.

WS 17 No discharge of contaminants including salt water allowed on crown lands or on any areas that could lead to surface or groundwater contamination. All contaminants are to be removed from the site and disposed OF AS PER REGULATIONS

WS 18 Once producing, the site is to be reduced in size by allowing trees and grass to re-establish on all but the access route and the actively used area immediately surrounding the well.

WS 19 Any fences which have been damaged are to be repaired immediately.

WS 20 Weather permitting, all reclamation work is to be completed within 30 days of completion of drilling.

WS 21 All refuse is to be removed to a designated landfill site. None is to be buried on site.

WS 22 PETROLEUM INSPECTORS IN VIRDEN ph: 748 1557 are to be notified prior to lease construction, drilling, and any other facility construction and immediately upon completion.

WS 23 To prevent seepage which can cause environmental damage, an impermeable berm, dike or diversion ditch must be constructed around the low side of a leasehold to retain surface water and other well site fluids. This may be accomplished by sloping the ground toward the centre on the uphill side of the lease.

Note: See section entitled *General Guidelines* for possible additional conditions.

94/06/17

CONSENT OF OCCUPANT

I, (we) LEONARD FISK of the district of Oak Lake in the Province of Manitoba, having an interest in the within lands by virtue of an Agreement or Instrument dated the 1st day of January A.D. 19 94, do hereby agree that all of my (our) rights, interests and estate which are, or may be affected by a Permit which may be issued by Crown Land, Manitoba Natural Resources Branch, DO HEREBY GRANT to the mineral producer, Tundra Oil and Gas Ltd., its successors and assigns, it contractors, servants and agents the right, license, liberty, privilege and easement to enter upon, over, under and through all portions of the following lands:

The South West Quarter of Section Twenty Nine (29)
Township Nine (9)
Range Twenty-five (25)
West of the Principal Meridian

The Mineral Producer, TUNDRA OIL AND GAS LTD. hereby covenants and agrees to compensate me (us) for damage done to my (our) buildings, growing crops, fences and livestock on the said land by reason of the exercise of the rights hereby granted;

If my (our) rights to occupy the said land terminates for any reason, this consent and agreements herein contained shall then and in that event cease and determine.

This consent shall be binding upon and shall enure to the benefit of my (our) heirs, executors, administrators and assigns.

IN WITNESS WHEREOF I (WE) HAVE EXECUTED THIS CONSENT AT Oak Lake IN THE PROVINCE OF MANITOBA, THIS 9 DAY OF June, 19 94

SIGNED AND DELIVERED IN THE PRESENCE OF:

WITNESS

Leonard 2 Fisk
OCCUPANT LEONARD FISK

THIS CONSENT IS HEREBY ACKNOWLEDGED AND ACCEPTED BY THE MINERAL PRODUCER

TUNDRA OIL AND GAS LTD.

DAVID H. TAYLOR
MANAGER, LAND & CONTRACTS

(THIS CONSENT IS ATTACHED TO AND FORMS PART OF PERMIT NO. ______

DATED THE ______ DAY OF ______, A.D. 19___)

Work Permit

Manitoba Natural Resources

Fee: No Charge

Permit No. ▶ WP 5688

This permit, issued under the authority of Section 9(1)(c) of The Crown Lands Act, and, subject to all Acts and regulations in effect from time to time, OR, in the case of other lands, under The Fires Prevention Act, authorizes

Name of permittee: TUNDRA OIL AND GAS LTD		
Address: Box 1960	City/Town: VIRDEN	Province: MANITOBA

to carry out an operation on the following described ☒ Crown (Manitoba) lands ☐ Other lands

SW & NW 1/4 Sec 29 - T.9 Rg. 25

for the purpose of: (describe purpose or objective of operation)

DRILLING NEW WELLS ON 2 LOCATIONS.

Authority (enter # of permit, tender, contract, etc., if applicable)

Subject to the following conditions: (attach list if additional space is required)

1. You are required to maintain the following fire-fighting equipment in serviceable condition on the operation for the purpose of fire control:

a) ☐ Fire extinguisher: (a minimum of 1 for each of the following and of the size specified - must be ULC approved)

Bulldozers	Each power saw	Trucks	Draglines
Skidders	Loaders	Slashers	Other (Spec.)

b) ☐ Other equipment:

Fire Pumps (engines)	Pack Pumps	Shovels	Other (Spec.)
Hose (lin. ft.)	Pails	Axes	

c) ☐ Spark arrestors (one on each internal combustion engine - must be serviceable, in Officer's opinion.)

2. This permit must be available at all times on the operation site, produced at the request of an Officer, and may be cancelled by an Officer without advance notice.

3. ☒ as per attached appendix dated 94/06/17.
   ☐

4. NOTE: AS PER DISCUSSION WITH TUNDRA OIL (TIM - HOWELL) NO BATTERY OR TREATER STATION WAS PLANNED FOR

5. THESE SIGHTS. IF THERE ARE PLANS FOR THIS FURTHER CONDITION MAY APPLY.

** THIS PERMIT AND THE RIGHTS AND PRIVILEGES GRANTED THEREUNDER ARE NOT TRANSFERABLE **
** PERMIT EXPIRES MARCH 31 UNLESS AN EARLIER EXPIRY DATE IS SPECIFIED **

I hereby certify that the information given to obtain this permit is true and that I understand the conditions set out herein.	Date Issued (yr/mo/da) 94/06/17	Signature of Issuing Authority — for Minister of Natural Resources
X ____ Not valid unless signed by permittee or authorized representative.	Expiry Date (yr/mo/da)	Issuing District or Office: VIRDEN.

3M-06/86 MG 13161

WHITE-PERMITTEE CANARY-BRANCH PINK-DISTRICT GREEN-REGION

APPENDIX
94/06/17

WELL SITES

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All merchantable timber must be salvaged by felling with a power saw, limbing and skidding to a central location adjacent to permanent access.

WS 3 Access for drilling will be via existing trail which are not to be widened for rig access purposes unless authorized by DNR.

WS 4 Improved access routes will not be considered until the well is a proven producer.

WS 5 Access routes are to be marked indicating the company and well location [section/township/range] and telephone number of the well service contractor.

WS 6 All topsoil is to be stripped off well sites and piled separately from slash for future site reclamation projects.

WS 7 If the well is not productive, the site is to be re-contoured, stored topsoil is to be spread out and following seeding, the slash is to be rolled back and spread on the site. Seeding is to be done at a rate and seed mixture designated by Regional wildlife staff and be compatible with area management objectives.

WS 8 Slash is to be disposed of as prescribed by DNR and topsoil is to be spread about on the site and seeding is to occur. Seed mixture will be determined by Regional wildlife staff and be compatible with area management objectives.

WS 9 A legal survey and site plan will be required for all successful wells and this information supplied to the local Natural Resources officer who will attach it to the relevant permits.

WS 10 Site plans may be required for potential well sites indicating cover types, water courses, well locations, access and flow line locations.

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WS 16 Burn pits will not be permitted.

WS 17 No discharge of contaminants including salt water allowed on crown lands or on any areas that could lead to surface or groundwater contamination. All contaminants are to be removed from the site and disposed of AS PER REGULATIONS.

WS 18 Once producing, the site is to be reduced in size by allowing trees and grass to re-establish on all but the access route and the actively used area immediately surrounding the well.

WS 19 Any fences which have been damaged are to be repaired immediately.

WS 20 Weather permitting, all reclamation work is to be completed within 30 days of completion of drilling.

WS 21 All refuse is to be removed to a designated landfill site. None is to be buried on site.

WS 22 PETROLEUM INSPECTORS IN VIRDEN: ph: 748 1557 are to be notified prior to lease construction, drilling, and any other facility construction and immediately upon completion.

WS 23 To prevent seepage which can cause environmental damage, an impermeable berm, dike or diversion ditch must be constructed around the low side of a leasehold to retain surface water and other well site fluids. This may be accomplished by sloping the ground toward the centre on the uphill side of the lease.

Note: See section entitled *General Guidelines* for possible additional conditions.

94/06/17

ACCESS ROADS

AR 1 A legal survey is required for all access routes. This information is to be provided to Regional wildlife staff and local NRO.

AR 2 Prairie trail access shall be used.

AR 3 Proper drainage (determined by the Regional DNR staff) shall be incorporated into road construction on the cut and fill slopes or in ditches to minimize erosion on the surface.

AR 4 Special erosion control measures will be required on cuts or fills greater than 6 metres to reduce bank erosion, including such measures as contour trenches or terracing.

AR 5 All roads must be maintained in such a manner as to allow proper drainage and to prevent erosion (determined by Regional DNR staff).

AR 6 Unused roads will be either retired in a manner approved by DNR which minimizes erosion or they shall be maintained for drainage to prevent erosion.

AR 7 No material is to be pushed into standing timber or streams. All leaning trees are to be removed from standing timber using a power saw, limbing to lie flat and cut into lengths not exceeding 2.4m.

AR 8 All merchantable timber is to be salvaged by felling with power saws, limbing and skidding to central locations along the access road. (See previous definition of merchantable timber.)

AR 9 Maximum width of the right-of-way for access routes is 15 metres. This can be extended to 20 metres if the access route and the flowline/pipeline route follow the same right-of-way.

AR 10 Topsoil is to be stripped off the right-of-way and piled separately then re-spread on ditches, backslopes and disturbed areas following construction. Non-travelled portions of rights-of-way are to be seeded at a rate of 25 kgs/ha with a seed mixture determined by Regional DNR staff and be compatible with local management objectives.

AR 11 Slash from access route rights-of-way is to be piled and burned.

AR 12 Crossings are to be installed on access routes as required to maintain natural drainage patterns.

AR 13 All river and stream crossings will follow the Stream Crossing Guidelines provided by the Manitoba Department of Natural Resources.

AR 14 Any fences which are damaged are to be repaired immediately.

AR 15 Weather permitting, all reclamation work is to be completed within 30 days of construction completion.

AR 16 All refuse is to be disposed of at a designated landfill site and not buried at the construction site.

AR 17 PETROLEUM INSPECTORS IN - VIRDEN ph: 748 1557 are to be notified prior to work commencing and immediately upon completion.

Note: The section on general guidelines should be consulted for additional conditions.

94/06/17

PIPELINES and FLOWLINES

PF 1 A legal survey will be required for all pipeline/flowline routes.

PF 2 The maximum width of all rights-of-way for pipeline/flowline routes is 15 metres unless otherwise authorized.

PF 3 No material is to be pushed into standing timber or streams. All leaning trees are to be removed from standing timber by felling with a power saw, limbing to lie flat and cutting with lengths not to exceed eight feet. All merchantable timber is to be salvaged by felling with a power saw, limbing and skidding to central locations adjacent to access. Refer to the previous definition of merchantable timber.

PF 4 Topsoil is to be stripped off and piled separately from slash and spoil pile for later use in reclamation.

PF 5 Following construction, topsoil is to be spread on the site and seeding done and the slash rolled back and spread along the line. (Note: If it is also the access right-of-way, the slash will be disposed of.) Seeding is to be done at a rate of 25 kg/ha and the mixture approved by regional wildlife staff.

PF 6 If any stream or river is to be crossed the Stream Crossing Guidelines provided by the Manitoba Department of Natural Resources will be adhered to. The use of erosion control blankets is recommended.

PF 7 When excavating a trench for the installation of a pipeline in the bed of a primary or secondary stream or river the excavated material must be removed from the watercourse before backfilling.

PF 8 The pipeline must have its location properly marked after burying.

PF 9 Any fences which are damaged are to be repaired immediately.

PF 10 Weather permitting, all reclamation work is to be completed within 30 days following completion of construction.

PF 11 All refuse is to be disposed of at designated landfill sites and not buried at the construction site.

PF 12 PETROLEUM INSPECTORS IN VIRDEN ph: 748/557 are to be notified prior to work commencing and immediately upon completion. The NRO in turn will attach this information to the work permit.

PF 13 Preliminary wildlife census will occur prior to trenching or work space preparation to determine if raptor nests or denning sites are located along the route. Time restrictions may apply to reduce disturbance.

PF 14 No off site land clearing or wetland drainage to be allowed by independent contractors for the duration of the contract.

PF 15 Tree replacement by off site mitigation in the form of tree planting will be required if habitat fragmentation is considered to be an important factor.

PF 16 Pipeline work in wetlands must employ swamp mats. Wetland basins must be re-contoured to allow basin to hold water after the work has been completed. Upland nest cover should be replanted.

PF 17 For test water withdrawls, water intakes must be screened to avoid fish impingement/entrapment. Withdrawls should not exceed 10% of the instantaneous flow of the water source. if withdrawls are from wetlands, no greater than 20% of the water volume should be removed.

PF 18 Hydrostatic test water should only be discharged into natural drainages after testing to determine presence and concentration of toxic substances. Hydrostatic water can be used to recharge natural wetlands with approval from regional DNR staff.

Note: Consult the section on general guidelines for possible additional conditions.

94/06/17

Work Permit

Manitoba Natural Resources

Fee: No Charge

Permit No. WP 5689

FILE - 11-29, 10-29, 7-29-9-25

This permit, issued under the authority of Section 9(1)(c) of The Crown Lands Act, and, subject to all Acts and regulations in effect from time to time, OR, in the case of other lands, under The Fires Prevention Act, authorizes

Name of permitee	City/Town	Province
TUNDRA OIL AND GAS LTD.		
Address: BOX 1960	VIRDEN	MANITOBA

to carry out an operation on the following described [X] Crown (Manitoba) lands [ ] Other lands

SECTION 29-9-25

for the purpose of: (describe purpose or objective of operation)

HYDRO POWER AND OIL FLOWLINES

Authority (enter # of permit, tender, contract, etc., if applicable)

CROWN PERMIT NOT

Subject to the following conditions: (attach list if additional space is required) [illegible] [illegible] AT TIME WORK PERMIT ISSUED.

1. You are required to maintain the following fire-fighting equipment in serviceable condition on the operation for the purpose of fire control:

a) [ ] Fire extinguisher: (a minimum of 1 for each of the following and of the size specified - must be ULC approved)

Bulldozers	Each power saw	Trucks	Draglines
Skidders	Loaders	Slashers	Other (Spec.)

b) [ ] Other equipment:

Fire Pumps (engines)	Pack Pumps	Shovels	Other (Spec.)
Hose (lin. ft.)	Pails	Axes	

c) [ ] Spark arrestors (one on each internal combustion engine - must be serviceable, in Officer's opinion.)

2. This permit must be available at all times on the operation site, produced at the request of an Officer, and may be cancelled by an Officer without advance notice.

3. [ ] as per attached appendix dated 94/11/23
   [ ]

4.

5.

** THIS PERMIT AND THE RIGHTS AND PRIVILEGES GRANTED THEREUNDER ARE NOT TRANSFERABLE **
** PERMIT EXPIRES MARCH 31 UNLESS AN EARLIER EXPIRY DATE IS SPECIFIED **

I hereby certify that the information given to obtain this permit is true and that I understand the conditions set out herein.	Date Issued (yr/mo/da): 94/11/23	Signature of Issuing Authority — for Minister of Natural Resources
Not valid unless signed by permittee or authorized representative.	Expiry Date (yr/mo/da): 95/03/31	Issuing District or Office: VIRDEN

3M 06/86 MG 13151

WHITE-PERMITTEE CANARY-BRANCH PINK-DISTRICT GREEN-REGION

94/11/23

APPENDIX #1

CONDITIONS - WORK PERMIT #5689 (Refer to map #1)

- Clearing of cutlines for the flowline between well 11-29 and battery 6-29 will involve some mature poplar clearing. The right-of-way will be limited to one cat width through the bush. Once the line is in, the debris will be spread back over the cutline to make it impossible by vehicle traffic. Petroleum Division requires these lines to be surveyed and a copy submitted to them.

- Hydro will be permitted to well 10-29 over ground from the east side source. Hydro from well 10-29 to 11-29 and 7-29 and future demands will be underground.

- Trenches for flowlines and powerlines are dug by first clearing top sod to one side then dig trench and lay the line. Then, subsoil replaces and top soil and sod spread on surface.

Permittee Signature

Nov. 23/94

Date

March/84 Wildlife no concerns

May/84 sale SW - Sask. Oil & Gas Corp.
NW - Western Land Services

March/85 Wildlife no concerns

May/85 sale LSD's 2 & 7 - N.S. & MOGC no addendum
LSD's 10 & 15 - N.S.

NW 29 Renewable Hay Permit

1989 - no addendum no prob.

ATTACHMENT NO.4

OPEN-HOLE WELL LOGS SECTION 29-9-25 W1M

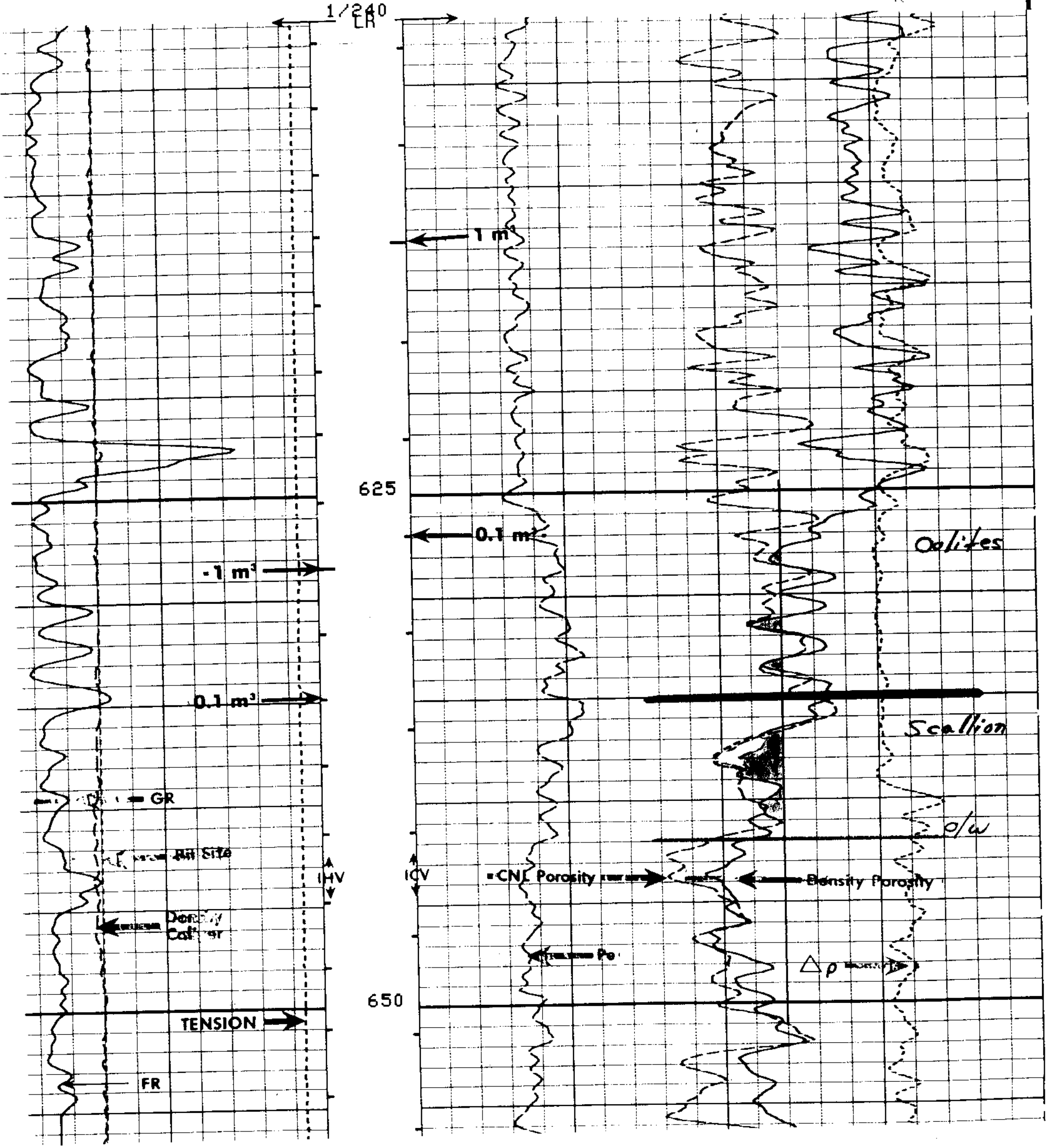
Attachment 4

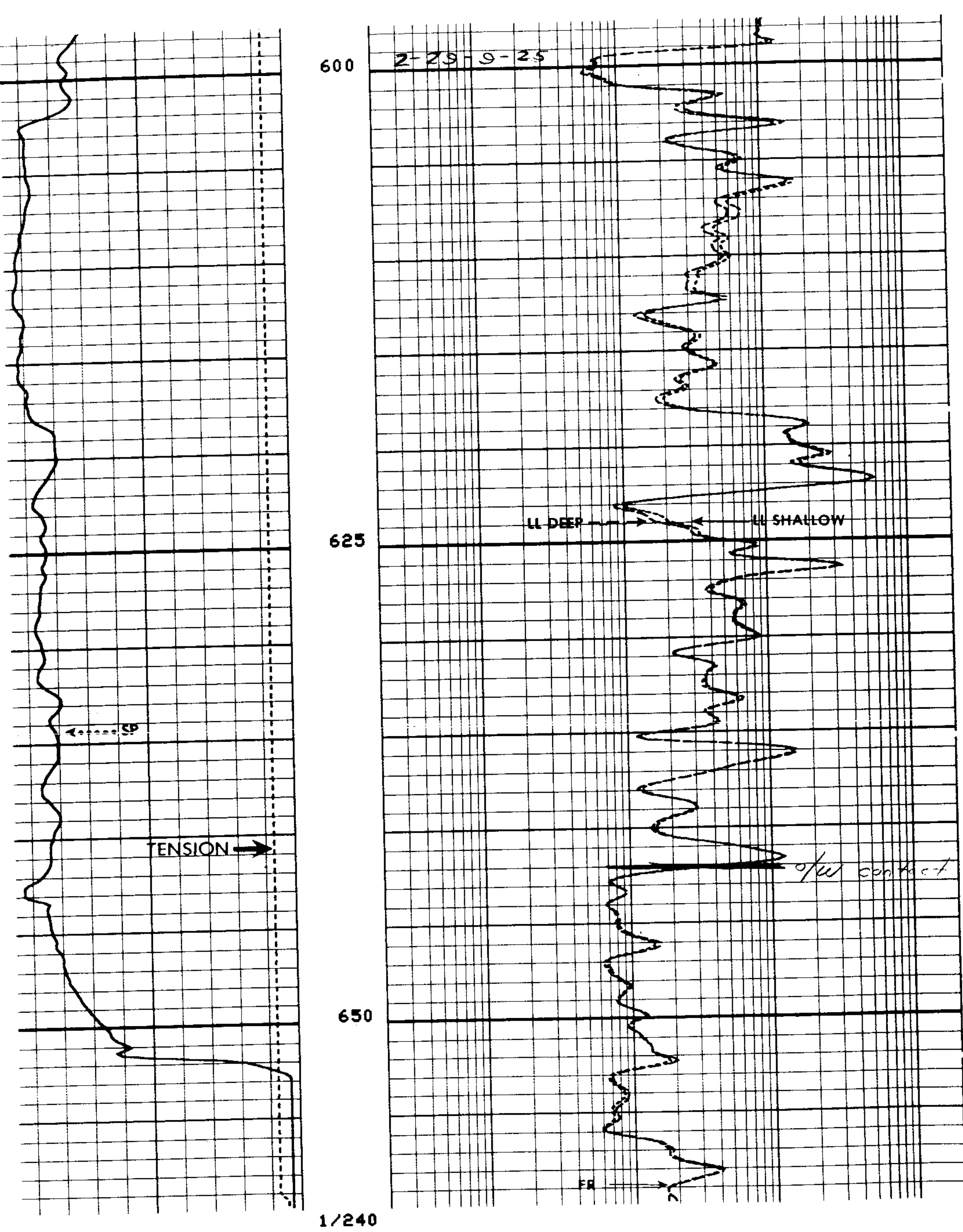
125.00	375.00		.45000	-.1500
GR (GAPI)			NPHI	
0.0	150.00		.45000	-.1500

2-29-9-25

CP 32.2 FILE 9 01-MAR-1989 17:37 **REPEAT SECTION**

LIMESTONE

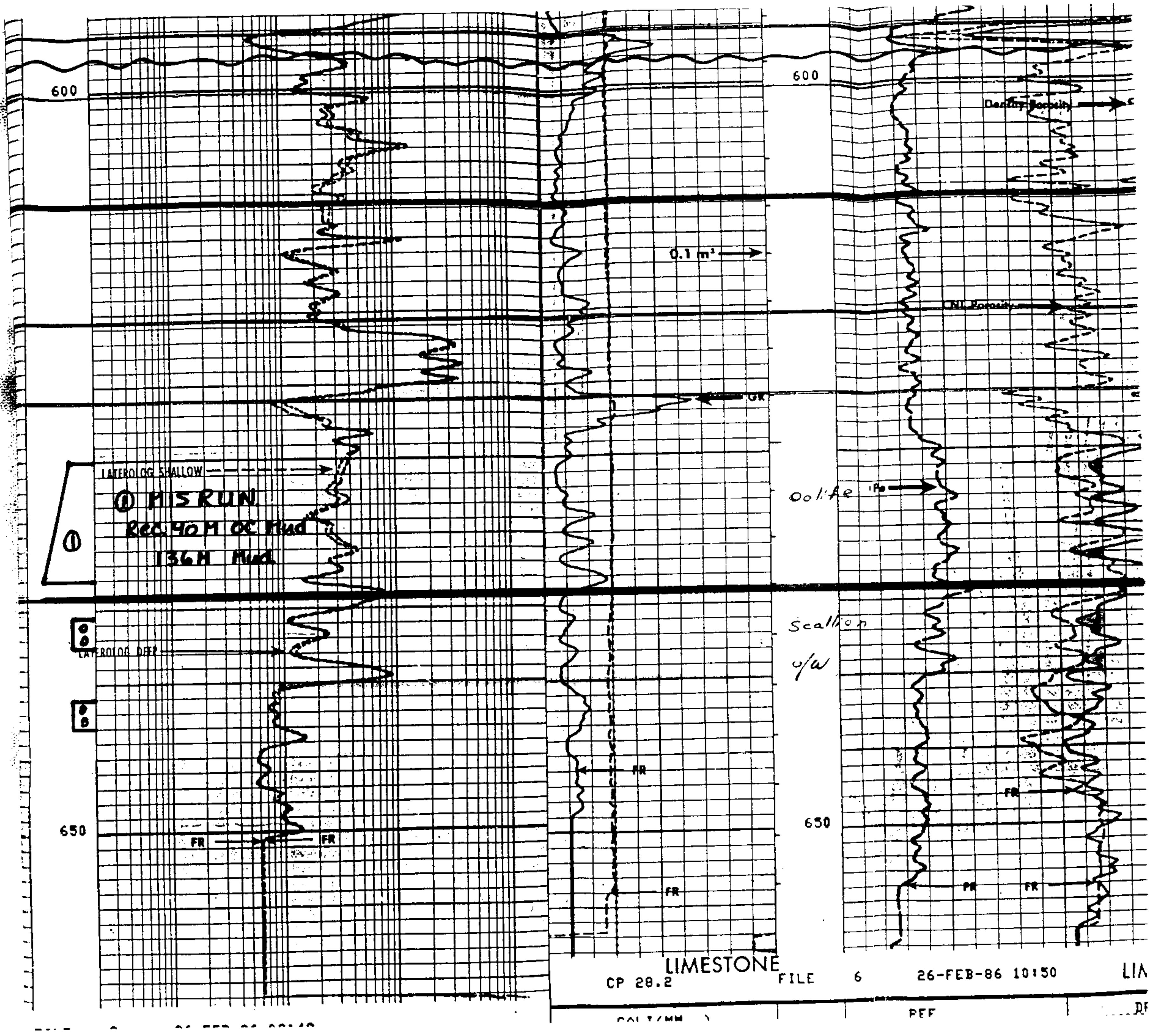


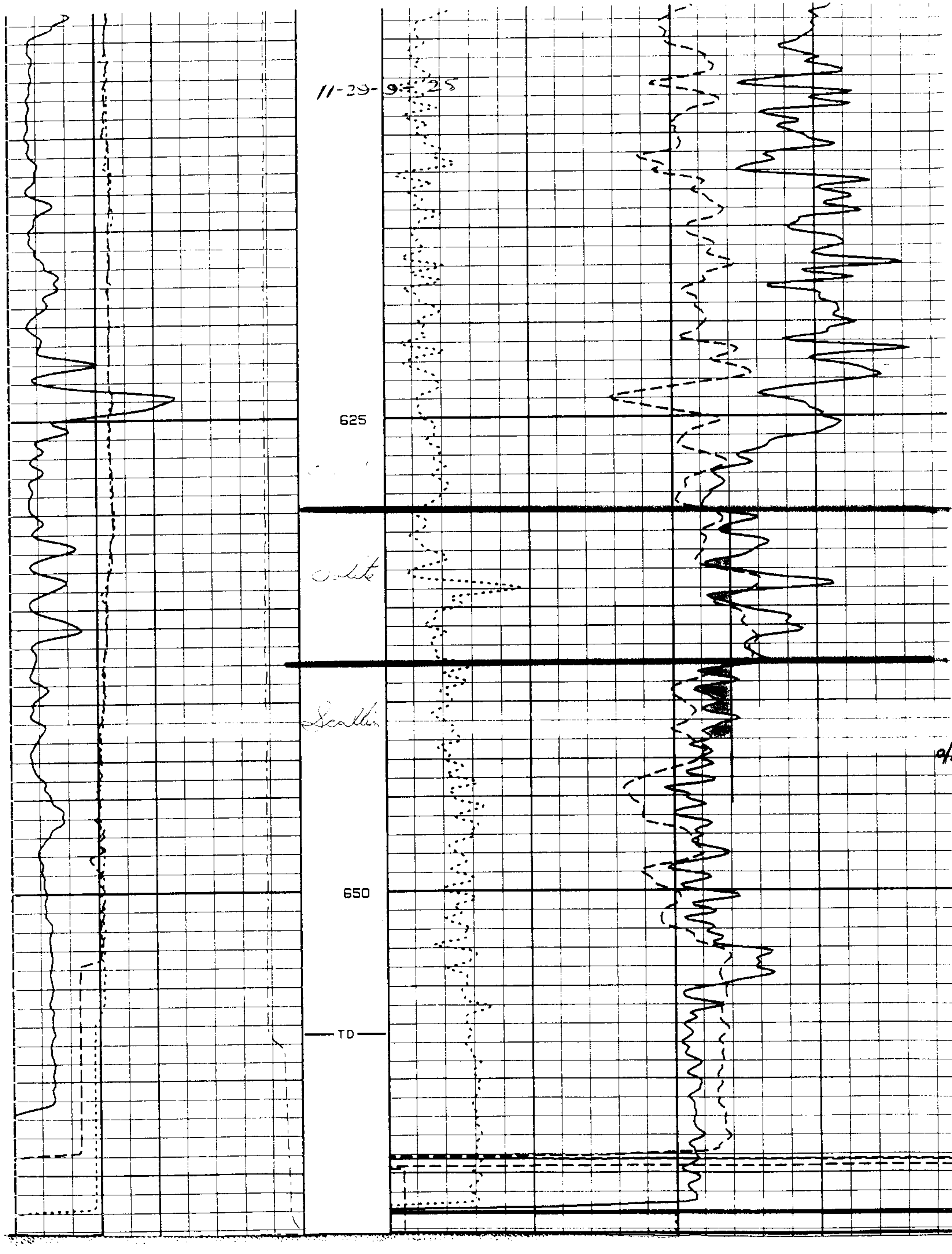


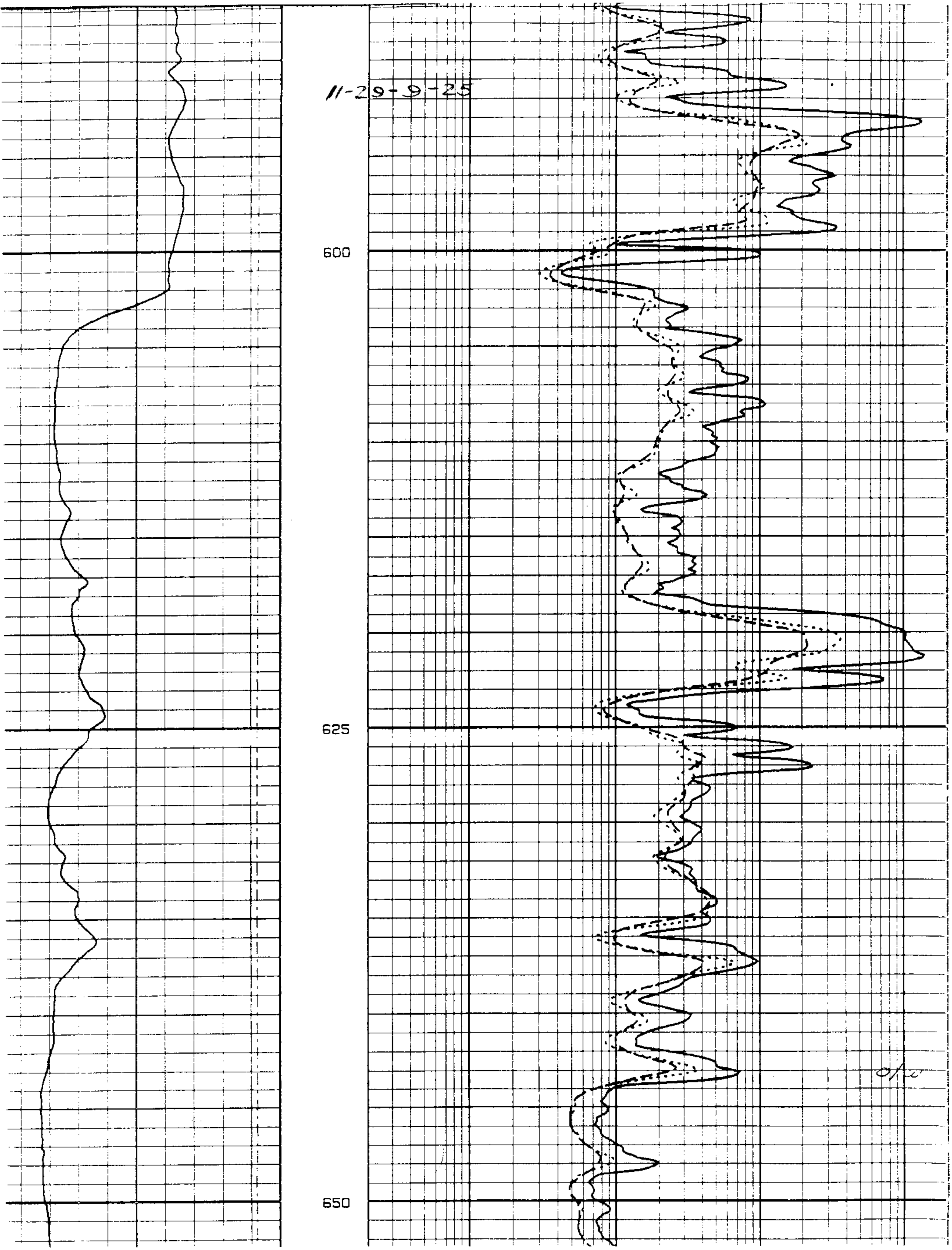
CP 32.2 FILE 3 01-MAR-1989 12:15 **REPEAT SECTION**

6-29-9-25
Crin.
Oel.
Scal.
o/w
00625
Jan 24/86
Dec 18/85
00650
CORE
CORE
CORE
CORE
GR
Laterolog
Neutron Porosity
Density Porosity
DST's

7-29-9-25


600
650
LATEROLOG SHALLOW
① MISRUN
Rec. 40M OC Mud
136M Mud
①
LATEROLOG DEEP
FR
0.1 m³
GR
Density Porosity
CNL Porosity
Pe
Oolite
Scallion
o/w
PR
LIMESTONE
CP 28.2
FILE 6
26-FEB-86 10:50
PEF


11-29-9:25
625
650
TD


11-29-9-25
600
625
650

1-29 ABD OCT/74 KB 1429'

PROD CSG @ 2050 OH completion TD 2082

CORE 2052-82

DST 2058-82 105' OCM . ISIP 916 (6316.8 KPa)

30' MUD FSIP 723

TOPS

LDGP 1978

CRIN 2014

1ST O 2058

2ND O 2068

3RD O 2070

4TH O 2077

TD 2082

-29 KB 436.5 O/W -203.5

MISS 601.0

UPPER VRDN 623.5 (CRIN)

LOWER VRDN 630.0 (OOLITES)

SCALLION 642

PERFS 627 28.5

629.5-632

631-32

633-34

636.3 38.3

CONVERTED TO SWD

DISPOSAL PERFS 646-47

652.5 55

6-29 KB 4[illegible] O/W -206.8

CORE 619-655

DST 635-42 117 m ... ISIP 6491

35-40 FSIP 6365

... EXTRAPOLATED 6550 KPa

@ 636 m

30 ... W

DST 623-34 ... 40 OCM 9664/4844

DST ... 622 ... 4752

625-28

PERFS 628-31

PERFS 635.5-636.3 m.

TOPS

LDGP 600.0

UPPER VRDN 624.0

LOWER VRDN 629.5

SCALLION 641.5

BP @ 634 [illegible] SEP/94

7-29 KB 437.55 O/W -202.5

CORE 623-641
DST 625-633 40 W OCM MISRUN
136 L DM

TOPS

LDGP 602.5
UPPER VRDN 615.5
LOWER VRDN 620
SCALLION 635

PERFS 641-43 (SQUEEZED) 629.3-30.4
635.6-37.5 631.1-32.5
625-27.4
retainer @ 639.5 [illegible] 627.8-28.7

8-29 KB 1434'
CORE 20[illegible]-2105'

ABRASIJET 2078-8.5

TOPS
LDGP 1796
CRIN 2021
OOLITIC ZONE 2050
1ST O 2064
2ND O 2070
3RD O 2076
4TH O 2084
CHERTY 2088

9-29-9-25 KB 1435'
CORE 2060-2110

ABRASIJET 2093-2096
2064-68
2072-75
2084-87

TOPS
LLDP 1981
1ST O 2061
2ND O 2067
3RD O 2073
4TH O 2080
CHERTY 2087
TD 2125'

10-29 KB 437.95

CORE 615-633

PERFS 636.8 - 38.6
639 - 40
634.2 - 35.2 (JUN/94)

TOPS

	604.5
LDGP	620.5
UPPER VRDN	636.5
LOWER VRDN	643.5
SCALLION	

11-29 KB 437.84 O/W -205.2

DST 636.5-644 63 m OSM 6451/6384
9 m OSM

PERFS 628.5 - 31.25
32.25 - 33.0
634 - 35.25
638.0 - 40.5
642 - 43

TOPS

FLOSSIE LK	601.5
UPPER WWL	612.0
LOWER WWL	621.5
UPPER VRDN	625
LOWER VRDN	631.5
SCALLION	638

13-29 KB 1434

TOP

LDGP	1992
CRIN	2048
OOLITIC ZONE	2070
1ST O	2082
2ND O	2086
3RD O	2094
4TH O	2102
5TH O	2107
CHERTY	2111

DST 2090-96 40' oil grading to OCM
2096-2102 25' Mud
2102-2112 75' SOCM
2111-2117 40 OFMSW

PERF'D 2092-96' 90-100% WC

16-29 KB 1431.6

PROD CSG 2068

TD 2085

CORE 2035-85

OH COMPLETION

TOPS

- approval to convert to SWD

LDGP	1967
CRIN	2004
OOLITIC ZONE	2028
1ST O	2046
2ND O	2050
3RD O	2057
4TH O	2064
CHERTY	2070

6·29 o/w -206.8

Oolites

h	ϕ	K
0.35	8.6	4.9
1.05	12.4	5.2
0.6	11.6	7.5
0.95	11.3	43.3
1.05	11.9	28.0
4.6	11.7	18

Scallion

h	ϕ	K
2.[illegible]	10.7	10
4.5	14.6	18.9
7.[illegible]	13.1	15.6

4·29 o/w - 202.5

Oolites

h	ϕ	k
[illegible]	12.[illegible]	3.8
0.[illegible]	[illegible].2	1[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	10.2	11.2
1.12	[illegible].2	20.3
3.22	12.4	10.[illegible]

Scallion

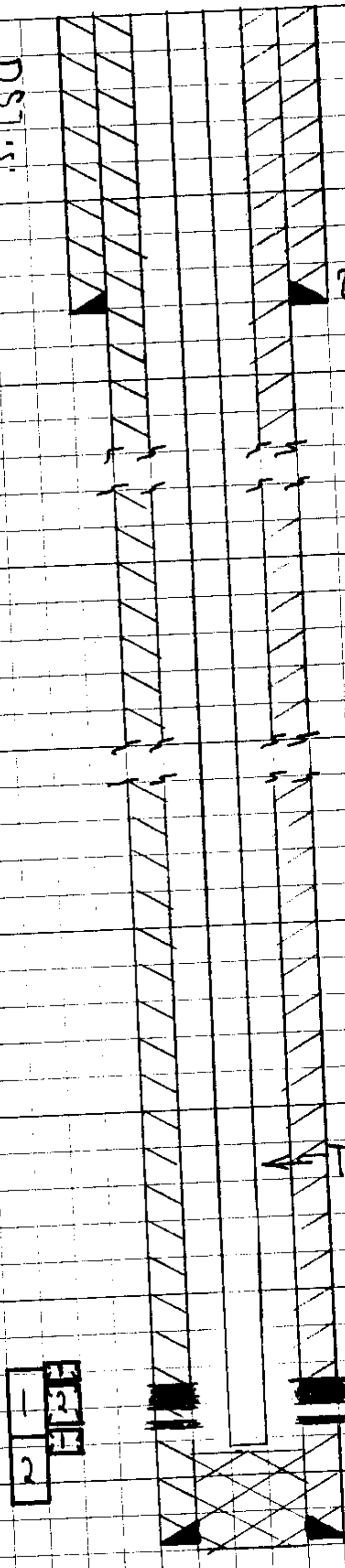
h	ϕ	k
3.16	12.2	9.2

LIC.# 3737
TUNDRA VIRDEN PROV.
6-29-9-25

K.B. - 435.20m
G.L. - 431.10m

DATE ON PROD - DEC 20/85

D.S.T.'s:
CORES:



219.1m - 35.72 kg/m @ 131.0m w/ 18t. + 3% $CaCl_2$ - RETURNS (2 m³)

150

CORES: #1 - 619.0m - 637.0m
#2 - 637.0m - 655.0m } FULL RECOVERY

D.S.T.'s: #1 - 635.0m - 642.0m VO 10/90 - SI 60/120 - REC. 117m G.O., 35m G.O., 55m GMCO & 30m D.S.W.

350

AIRMORE

#2 - 623.0m - 634.0m VO 10/90 SI 60/120 - REC. 55m GOCOM

#3 - 617.0 - 622.0m - VO 10/90 SI 60/150 - REC. 2m M.O.

PERFORATIONS: DEC. 17/85 - 635.5m - 636.3m w/ 13 SPM

JAN. 22/86 - SET BRIDGE PLUG @ 634.0m

DEPTH

500

(METRES)

JAN. 22/86 - 625.0m - 628.0m
- 628.0m - 631.0m } w/ 13 SPM

TUBING - 60.3m @ 641.41m

STIMULATION: DEC. 18/85 - 500 l. 15% MOA ACID

JAN. 23/86 - 1500 l. 15% BOA ACID

JAN. 27/86 - 1500 l. 28% HCL ACID

SEPT. 15/94 - 1 m³ 15% HCL ACID

600

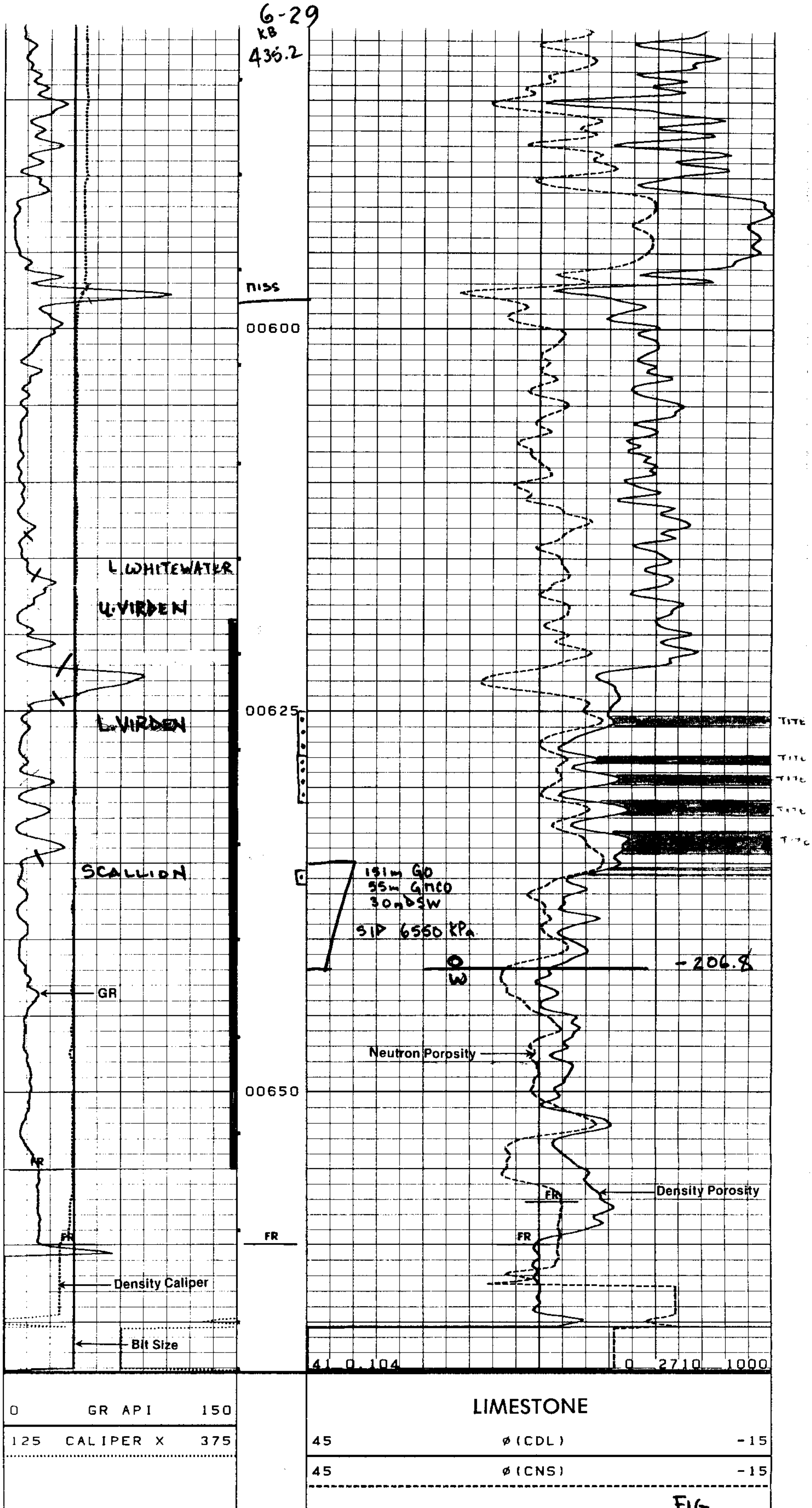
UPPER VIRDEN
LOWER VIRDEN
SCALLION

1
2
1
2
1

114.3m - 14.14 kg/m @ 658.0m w/ 18t. 2:1 Poz + 8% GEL + 8t. EXPANDO - RET'S (4m

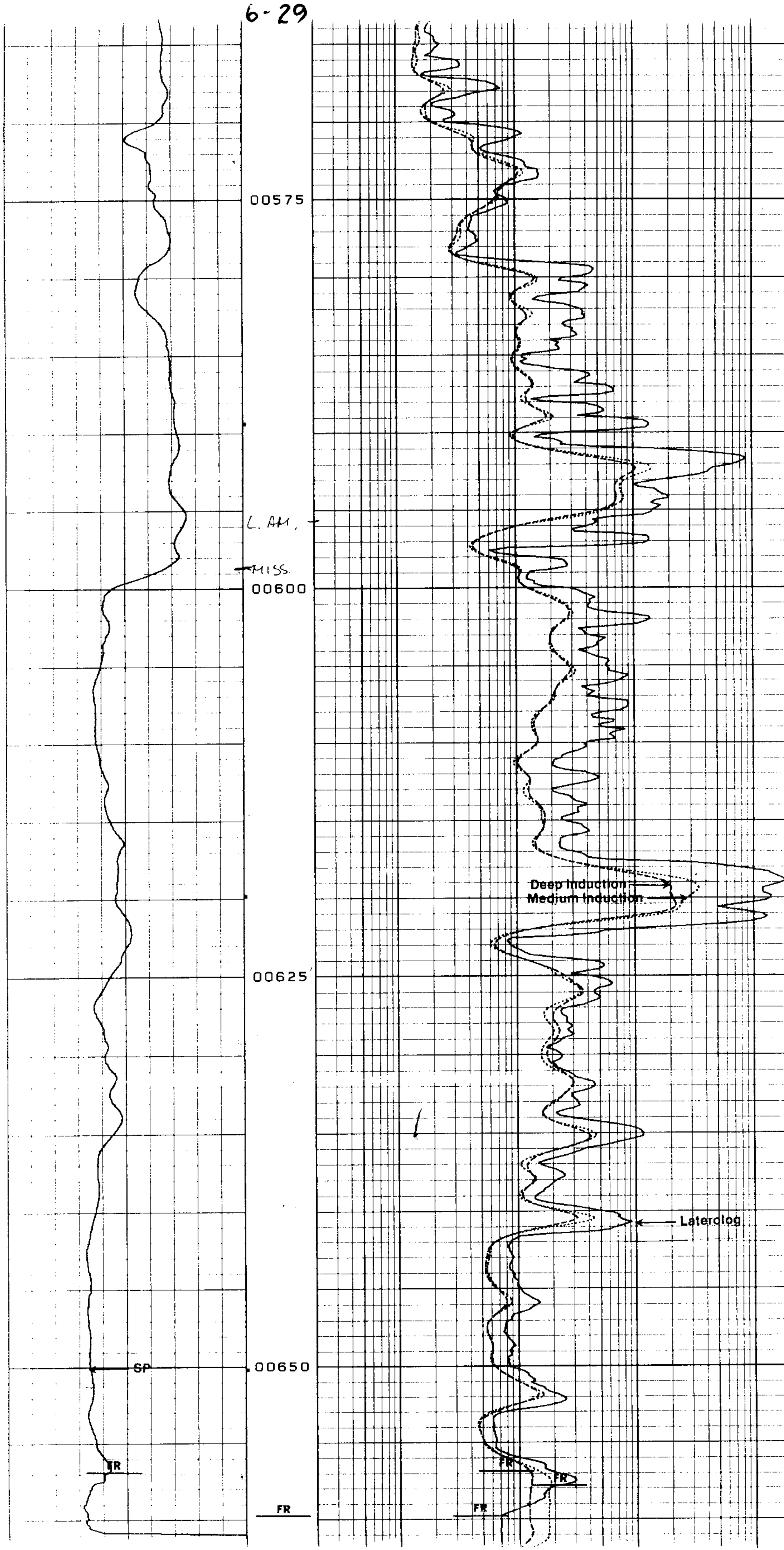
700

T.D. - 660.0m.
PBTD - 643.0m



6-29
KB
435.2
MISS
00600
L.WHITEWATER
U.VIRDEN
00625
L.VIRDEN
TITE
TITE
TITE
TITE
TITE
SCALLION
151m GO
55m GMCO
30m DSW
SIP 6550 KPa
O
W
-206.8
GR
Neutron Porosity
00650
FR
Density Porosity
FR
FR
FR
FR
Density Caliper
Bit Size
41 0 104
1 0 2710 1000
0 GR API 150
125 CALIPER X 375
LIMESTONE
45 ø(CDL) -15
45 ø(CNS) -15

FIG.


6-29
00575
L. AM.
MISS
00600
Deep Induction
Medium Induction
00625
Laterolog
SP
00650
FR
FR
FR
FR
FR

CHEMICAL & GEOLOGICAL LABORATORIES LTD.

COMPANY : SASKATCHEWAN OIL AND GAS CORPORATION
WELL : SASKOIL VIRDEN PROV. 6-29-9-25 W1
FORMATION: LODGEPOLE-VIRDEN

LAB NO: S86-142
PAGE : 3
DATE : 1986-01-23

SUMMARY OF CORE DATA REPORT

SUMMARY INTERVAL: 619.00 - 637.40 (18.40)

Thickness Not Analyzed: Rubble 0.00 Dense 8.55 Lost 0.00 Drilled 0.00 Not Tested 0.00 Total: 8.55

	PERMEABILITY RANGES, MILLIDARCY							
	TOTAL ALL SAMPLES	100.0 & Greater	10.-99.	1.0-9.9	.50-.99	.10-.49	.01-.09	Less Than .01
Thickness, Metres	9.850	0.150	2.600	4.750	0.650	1.000	0.700	0.000
Fraction of Analyzed Core	1.000	0.015	0.264	0.482	0.066	0.102	0.071	0.000
Porosity Thickness (Por-M)	1.036	0.022	0.338	0.493	0.056	0.080	0.047	0.000
Permeability Thickness (Md-M)	115.139	17.850	81.000	15.575	0.417	0.243	0.054	0.000
Wt. Avs. (Arith) Porosity	0.105	0.147	0.130	0.104	0.086	0.080	0.067	0.000
Wt. Avs. (Arith) KMAX, Md	11.689	119.000	31.154	3.279	0.642	0.243	0.077	0.000
Wt. Avs. Resid. Oil	0.186	0.157	0.173	0.184	0.185	0.235	0.227	0.000
Wt. Avs. Resid. Water	0.345	0.317	0.226	0.304	0.565	0.709	0.772	0.000

Wt. Avs. (Geom.) KMAX., Md for All Samples = 2.957
Wt. Avs. (Harm.) KMAX., Md for All Samples = 0.597

Thickness Not Analyzed: Rubble 0.00 Dense 0.85 Lost 0.00 Drilled 0.00 Not Tested 0.90 Total: 1.75

PERMEABILITY RANGES, MILLIDARCY

	TOTAL ALL SAMPLES	100.0 & Greater	10.-99.	1.0-9.9	.50-.99	.10-.49	.01-.09	Less Than .01
Thickness, Metres	16.550	0.000	3.500	10.300	0.000	2.750	0.000	0.000
Fraction of Analyzed Core	1.000	0.000	0.211	0.622	0.000	0.166	0.000	0.000
Porosity Thickness (Por-M)	2.012	0.000	0.493	1.340	0.000	0.180	0.000	0.000
Permeability Thickness (Md-M)	120.017	0.000	76.250	42.800	0.000	0.968	0.000	0.000
Wt. Avg. (Arith) Porosity	0.122	0.000	0.141	0.130	0.000	0.065	0.000	0.000
Wt. Avg. (Arith) KMAX, Md	7.252	0.000	21.786	4.155	0.000	0.352	0.000	0.000
Wt. Avg. Resid. Oil	0.037	0.000	0.116	0.014	0.000	0.000	0.000	0.000
Wt. Avg. Resid. Water	0.566	0.000	0.280	0.692	0.000	0.411	0.000	0.000

Wt. Avg. (Geom.) KMAX., Md for All Samples = 3.397
Wt. Avg. (Harm.) KMAX., Md for All Samples = 1.394

CORE ANALYSIS DATA REPORT

SMPL NO.	INTERVAL TOP M	INTERVAL BASE M	REP THICK M	SAMPLE LENGTH M	GAS PERMEABILITY - Md KMAX	K90	KV	PORO-SITY	DENSITY, KG/M3 BULK	GRAIN	RESIDUAL SAT. FRAC OF PV OIL	WATER	VISUAL EXAMINATION
		CORE NO. 1	619.00 -	637.40	RECEIVED IN LAB			18.40 METRES					
1	619.00	619.20	0.20	0.10	0.24	0.21	<.01	0.081	2590	2820	0.285	0.713	LS,DOL/ANHY,VUG POR
2	619.20	619.30	0.10	0.08	0.09	0.05	0.02	0.070	2630	2830	0.230	0.769	LS,DOL/ANHY,VUG POR
3	619.30	619.45	0.15		0.70			0.084	2580	2810	0.230	0.769	SP,LS,DOL/ANHY,VUG POR
4	619.45	619.70	0.25	0.11	0.24	0.24	0.02	0.071	2640	2840	0.200	0.799	LS,DOL/ANHY,VUG POR
DE	619.70	619.85	0.15										ANHY,MAS
5	619.85	620.15	0.30	0.11	0.08	0.08	<.01	0.063	2660	2840	0.200	0.799	LS,DOL/ANHY,VUG POR
6	620.15	620.30	0.15	0.11	0.21	0.15	0.04	0.072	2620	2830	0.200	0.799	LS,DOL/ANHY,VUG POR
7	620.30	620.45	0.15	0.07	0.23	0.21	0.11	0.088	2580	2820	0.280	0.719	LS,DOL/ANHY,VUG POR,VF
8	620.45	620.75	0.30	0.14	0.07	0.03	0.06	0.069	2650	2850	0.250	0.749	LS,DOL/ANHY,VUG POR,VF
DE	620.75	621.40	0.65										LS,DOL/ANHY
9	621.40	621.50	0.10	0.07	0.14	0.09	0.01	0.105	2500	2790	0.330	0.593	LS,DOL,VUG POR
10	621.50	621.60	0.10		0.57			0.081	2560	2790	0.350	0.649	SP,LS,DOL,VUG POR
DE	621.60	624.30	2.70										SLTST,DOL
11	624.30	624.40	0.10		0.64			0.047	2560	2690	0.184	0.378	SP,LS,SL ARG,P-P POR
DE	624.40	625.00	0.60										LS/MNR ANHY
12	625.00	625.20	0.20		6.70			0.099	2420	2680	0.175	0.135	SP,LS/MNR CHT,VUG POR
13	625.20	625.35	0.15	0.09	2.40	2.30	0.67	0.069	2510	2700	0.251	0.193	LS/MNR ANHY,VUG POR
DE	625.35	626.00	0.65										LS/MNR ANHY
14	626.00	626.25	0.25	0.11	7.30	6.20	3.60	0.109	2400	2700	0.159	0.204	LS/MNR ANHY,VUG POR
15	626.25	626.40	0.15	0.08	2.50	2.40	1.30	0.119	2390	2710	0.194	0.280	LS/MNR ANHY,VUG POR
16	626.40	626.60	0.20	0.09	3.10	3.10	2.20	0.118	2390	2710	0.196	0.264	LS/MNR ANHY,VUG POR
17	626.60	626.80	0.20		3.10			0.122	2370	2700	0.260	0.328	SP,LS/MNR ANHY,VUG POR
18	626.80	627.05	0.25	0.14	3.60	3.50	2.10	0.126	2360	2700	0.229	0.335	LS/MNR ANHY,VUG POR
19	627.05	627.30	0.25	0.12	4.00	4.00	2.70	0.132	2350	2700	0.131	0.354	LS/MNR ANHY,VUG POR
20	627.30	627.40	0.10		38.00			0.156	2270	2700	0.111	0.157	SP,LS/MNR ANHY,VUG POR
21	627.40	627.60	0.20	0.07	2.50	2.40	0.97	0.138	2350	2700	0.126	0.209	LS/MNR ANHY,VUG POR

CORE ANALYSIS DATA REPORT

SMPL NO.	INTERVAL TOP M	INTERVAL BASE M	REF THICK M	SAMPLE LENGTH M	GAS PERMEABILITY - Md KMAX	GAS PERMEABILITY - Md K90	GAS PERMEABILITY - Md KV	PORO-SITY	DENSITY, KG/M3 BULK	DENSITY, KG/M3 GRAIN	RESIDUAL SAT. FRAC OF PV OIL	RESIDUAL SAT. FRAC OF PV WATER	VISUAL EXAMINATION
22	627.60	627.85	0.25	0.13	4.20	4.20	1.50	0.114	2390	2700	0.177	0.370	LS/MNR ANHY,VUG POR
DE	627.85	628.15	0.30										LS
23	628.15	628.30	0.15	0.10	0.37	0.31	0.17	0.077	2500	2700	0.113	0.577	LS/MNR ANHY,VUG POR
24	628.30	628.50	0.20	0.10	0.64	0.59	0.71	0.107	2430	2720	0.081	0.478	LS/MNR ANHY,VUG POR
25	628.50	628.75	0.25	0.14	14.00	14.00	17.00	0.141	2320	2700	0.451	0.268	LS/MNR ANHY,VUG POR
26	628.75	628.95	0.20		3.60			0.113	2390	2700	0.650	0.349	SP,LS/MNR ANHY,VUG POR
27	628.95	629.10	0.15	0.11	1.80	1.50	0.52	0.089	2470	2710	0.640	0.359	LS/MNR ANHY,VUG POR
DE	629.10	629.80	0.70										LS/MNR ANHY
28	629.80	629.90	0.10	0.08	0.63	0.63	0.24	0.092	2460	2710	0.220	0.507	LS/MNR ANHY,VUG POR
29	629.90	630.15	0.25	0.11	1.80	1.70	1.40	0.108	2420	2720	0.134	0.370	LS/MNR ANHY,VUG POR,RF
30	630.15	630.30	0.15	0.10	119.00	55.00	22.00	0.147	2320	2720	0.157	0.317	LS/MNR ANHY,VUG POR,RF
31	630.30	630.50	0.20	0.11	23.00	15.00	13.00	0.077	2510	2720	0.200	0.799	LS/MNR ANHY,VUG POR,RF
32	630.50	630.65	0.15	0.07	48.00	44.00	32.00	0.158	2280	2710	0.110	0.422	LS/MNR ANHY,VUG POR,HF
33	630.65	630.85	0.20	0.09	55.00	4.20	0.58	0.100	2430	2700	0.058	0.111	LS/MNR ANHY,VUG POR,RF
DE	630.85	631.90	1.05										LS/MNR ANHY
34	631.90	632.15	0.25		2.80			0.084	2470	2690	0.138	0.397	SP,LS,DOL,VUG POR
35	632.15	632.35	0.20		71.00			0.130	2350	2700	0.089	0.256	SP,LS/MNR ANHY,VUG POR
36	632.35	632.50	0.15		28.00			0.145	2310	2700	0.040	0.153	SP,LS/MNR ANHY,VUG POR
37	632.50	632.65	0.15		22.00			0.147	2310	2700	0.039	0.151	SP,LS/MNR ANHY,VUG POR
38	632.65	632.80	0.15		2.60			0.105	2410	2690	0.028	0.296	SP,LS,DOL,VUG POR
39	632.80	632.95	0.15		44.00			0.125	2360	2700	0.139	0.338	SP,LS/MNR ANHY,VUG POR
DE	632.95	634.40	1.45										LS,PT DOL/MNR ANHY
40	634.40	634.60	0.20		2.00			0.084	2470	2700	Trace	0.450	SP,LS/MNR ANHY,P-P POR
41	634.60	635.00	0.40	0.13	1.20	1.20	0.46	0.065	2510	2690	0.222	0.308	LS,FOS,VUG POR
42	635.00	635.15	0.15	0.08	1.00	0.98	0.44	0.057	2540	2690	0.152	0.117	LS,FOS,VUG POR
DE	635.15	635.30	0.15										LS/MNR ANHY
43	635.30	635.50	0.20	0.10	2.70	2.70	0.96	0.069	2510	2700	0.126	0.064	LS/MNR ANHY,VUG POR
DE	635.50	635.65	0.15										LS,MNR ANHY
44	635.65	635.85	0.20	0.12	3.80	3.80	2.40	0.101	2430	2700	0.172	0.066	LS/MNR ANHY,VUG POR

SCALLION

COMPANY : SASK TCHEWAN OIL AND GAS CORPORATION
WELL : SASK. IL VIRDEN PROV. 6-29-9-25 W1
FORMATION: LODGEPOLE-VIRDEN
CORED INTERVAL: 619.00 - 655.30

LAB NO: S86-142
PAGE : 7
DATE : 1986-01

CORE ANALYSIS DATA REPORT

SMPL NO.	INTERVAL TOP M	INTERVAL BASE M	REF THICK M	SAMPLE LENGTH M	GAS PERMEABILITY - Md KMAX	K90	KV	PORO-SITY	DENSITY, KG/M3 BULK	GRAIN	RESIDUAL SAT. FRAC OF PV OIL	WATER	VISUAL EXAMINATION
45	635.85	636.00	0.15		19.00			0.139	2320	2690	0.208	0.080	SP,LS,GRAN,VUG POR
46	636.00	636.15	0.15	0.08	64.00	63.00	36.00	0.144	2310	2700	0.201	0.108	LS/MNR ANHY,VUG POR
47	636.15	636.25	0.10		15.00			0.131	2340	2690	0.154	0.051	SP,LS,GRAN,VUG POR
48	636.25	636.45	0.20	0.11	15.00	12.00	10.00	0.115	2380	2690	0.100	0.155	LS,GRAN,VUG POR
49	636.45	636.70	0.25	0.11	2.80	2.70	1.50	0.122	2420	2750	0.071	0.328	LS,SL DOL,P-P POR,VF
50	636.70	636.95	0.25	0.08	5.70	4.40	2.20	0.135	2380	2750	0.043	0.510	LS,SL DOL,VUG POR
51	636.95	637.20	0.25		11.00			0.133	2360	2720	0.239	0.167	SP,LS,SL DOL,P-P POR
52	637.20	637.30	0.10		11.00			0.134	2340	2710	0.237	0.249	SP,LS/MNR ANHY,VUG P
53	637.30	637.40	0.10		18.00			0.143	2310	2690	0.222	0.233	SP,LS,GRAN,VUG POR

6.27.

CORE ANALYSIS DATA REPORT

SMPL NO.	INTERVAL TOP M	INTERVAL BASE M	REP THICK M	SAMPLE LENGTH M	GAS PERMEABILITY - Md KMAX	K90	KV	PORO-SITY	DENSITY,KG/M3 BULK	GRAIN	RESIDUAL SAT. FRAC OF PV OIL	WATER	VISUAL EXAMINATION
	CORE NO.	2	637.00 -	655.30	RECEIVED IN LAB	18.30 METRES							
1	637.40	637.70	0.30	0.11	7.90	7.90	5.20	0.120	2390	2710	0.120	0.074	LS/MNR ANHY,VUG POR
2	637.30	637.55	0.25	0.12	17.00	16.00	23.00	0.148	2290	2690	0.176	0.345	LS/MNR QTZ,VUG POR
3	637.55	637.60	0.05		16.00			0.136	2320	2690	0.149	0.229	SP,LS/MNR QTZ,VUG POR,VF
4	637.60	637.70	0.10		22.00			0.143	2300	2680	0.182	0.062	SP,LS/MNR QTZ,VUG POR
5	637.70	637.90	0.20	0.09	18.00	13.00	6.90	0.127	2370	2720	0.136	0.157	LS/MNR ANHY,VUG POR LS
DE	~~637.90~~	~~638.50~~	~~0.60~~										
6	638.50	638.65	0.15	0.08	14.00	9.70	7.00	0.124	2370	2710	0.11[illegible]	0.143	LS/MNR ANHY,VUG POR
7	638.65	638.75	0.10		24.00			0.146	2300	2690	0.099	0.213	SP,LS/MNR QTZ,VUG POR LS
DE	~~638.75~~	~~639.00~~	~~0.25~~										
8	639.00	639.15	0.15	0.10	28.00	27.00	3.40	0.144	2320	2710	0.160	0.093	LS/MNR ANHY,VUG POR
9	639.15	639.25	0.10		23.00			0.135	2340	2700	0.171	0.099	SP,LS/MNR ANHY,INTGRAN POR
10	639.25	639.40	0.15	0.08	30.00	30.00	18.00	0.132	2340	2700	0.153	0.168	LS/MNR ANHY,VUG POR
11	639.40	639.55	0.15	0.07	32.00	29.00	17.00	0.130	2340	2690	0.156	0.171	LS/MNR QTZ,VUG POR
12	639.55	639.70	0.15	0.07	36.00	35.00	17.00	0.122	2370	2700	0.166	0.164	LS/MNR QTZ,VUG POR
13	639.70	639.80	0.10	0.08	23.00	19.00	17.00	0.095	2450	2710	0.152	0.117	LS/MNR ANHY,VUG POR,VF
14	639.80	640.00	0.20	0.13	10.00	6.10	5.30	0.090	2460	2700	0.193	0.123	LS/MNR ANHY,VUG POR,RF
15	640.00	640.15	0.15		16.00			0.086	2440	2680	0.201	0.129	SP,LS/MNR QTZ,P-P POR
16	640.15	640.35	0.20		6.40			0.085	2460	2690	0.204	0.183	SP,LS/MNR QTZ,P-P POR
17	640.35	640.60	0.25		2.70			0.089	2440	2680	0.162	0.449	SP,LS/MNR CHT,VUG POR
18	640.60	640.75	0.15	0.12	6.60	4.60	1.[illegible]0	0.113	2390	2700	0.153	0.629	LS/MNR ANHY,CHT,VUG POR
19	640.75	641.00	0.25	0.09	4.90	4.90	3.00	0.138	2380	2760	0.063	0.419	LS/PT DOL,P-P POR
20	641.00	641.25	0.25	0.07	9.70	9.00	4.90	0.150	2350	2770	0.058	0.489	LS/PT DOL,P-P POR
21	641.25	642.00	0.75	0.10	28.00	8.60	5.40	0.162	2310	2760	0.107	0.439	LS,PT DOL,P-P POR,HF
22	642.00	642.75	0.75	0.12	16.00	15.00	10.00	0.162	2280	2730	0.036	0.343	LS,PT DOL/CHT,P-P POR
23	642.75	643.60	0.85	[illegible]	[illegible].60	6.40	[illegible].10	0.138	2360	2740	0.000	0.918	LS,PT DOL/CHT,P-P POR
24	643.60	644.20	0.60	[illegible]	[illegible].20	4.60	[illegible].50	0.119	2410	2740	0.000	0.990	LS,PT DOL/CHT,P-P POR,RF

WELL : SASKOIL VIRDEN PROV. 6-29-9-25 W1
FORMATION: LODGEPOLE-SCALLION
CORED INTERVAL: 619.00 - 655.30

LAB NO: S86-142
PAGE : 9
DATE : 1986-01-23

CORE ANALYSIS DATA REPORT

SMPL NO.	INTERVAL TOP M	INTERVAL BASE M	REP THICK M	SAMPLE LENGTH M	GAS PERMEABILITY - Md KMAX	K90	KV	POROSITY	DENSITY, KG/M3 BULK	GRAIN	RESIDUAL SAT. FRAC OF PV OIL	WATER	VISUAL EXAMINATION
25	644.20	644.30	0.10	0.08	4.80	2.40	0.95	0.093	2450	2710	0.000	0.502	LS,PT DOL/ANHY,P-P POR
NA	644.30	645.20	0.90										
26	645.20	645.60	0.40	0.10	0.48	0.12	0.04	0.067	2500	2670	Trace	0.999	LS,PT DOL/MNR CHT
27	645.60	646.60	1.00		3.80			0.132	2380	2740	0.000	0.999	LS/CHT,VUG POR
28	646.60	648.20	1.60	0.17	1.40	1.30	0.21	0.102	2420	2700	0.000	0.999	SP,LS,PT DOL,P-P POR
29	648.20	649.80	1.60	0.10	2.10	1.80	2.50	0.132	2380	2740	0.000	0.556	LS,PT DOL/CHT,P-P POR
30	649.80	652.15	2.35	0.10	0.33	0.29	0.04	0.065	2510	2680	0.000	0.308	LS,PT DOL/MNR CHT,P-P POR,
31	652.15	653.80	1.65		6.50			0.161	2320	2760	Trace	0.524	LS/CHT,P-P POR,VF
32	653.80	655.30	1.50	0.15	1.80	0.93	0.19	0.137	2390	2770	Trace	0.649	SP,LS,PT DOL,P-P POR
													LS,PT DOL,P-P POR

COMPANY : SASKATCHEWAN OIL AND GAS CORPORATION
WELL : SASKOIL VIRDEN PROV. 6-29-9-25 W1
FORMATION: LODGEPOLE-SCALLION
INTERVAL: 637.00 - 655.30

STATISTICAL DATA FOR POROSITY AND PERMEABILITY HISTOGRAM

POROSITY-METRES OF STORAGE CAPACITY LOST FOR SELECTED POROSITY CUT OFF

Porosity Cut Off	Metres		Capacity Lost		Capacity Remaining		Wt. Avg. Arith.	
	Lost	Remaining	Por-M	%	Por-M	%	Mean	Median
0.000	0.00	16.55	0.000	0.00	2.012	100.00	0.122	0.127
0.020	0.00	16.55	0.000	0.00	2.012	100.00	0.122	0.127
0.040	0.00	16.55	0.000	0.00	2.012	100.00	0.122	0.127
0.060	0.00	16.55	0.000	0.00	2.012	100.00	0.122	0.127
0.080	2.75	13.80	0.180	8.92	1.833	91.08	0.133	0.131
0.100	3.75	12.80	0.269	13.34	1.744	86.66	0.136	0.133
0.120	6.10	10.45	0.520	25.85	1.492	74.15	0.143	
0.140	12.55	4.00	1.378	68.51	0.634	31.49	0.158	0.167
0.160	13.40	3.15	1.503	74.72	0.509	25.28	0.161	
0.180	16.55	0.00	2.012	100.00	0.000	0.00	0.000	

Total Storage Capacity in Porosity-Metres = 2.012

COMPANY : SASKATCHEWAN OIL AND GAS CORPORATION
WELL : SASKOIL VIRDEN PROV. 6-29-9-25 W1
FORMATION: LODGEPOLE-VIRDEN
INTERVAL: 619.00 - 637.40

LAB NO: S86 142
PAGE : 21
DATE : 1986-01-23

STATISTICAL DATA FOR POROSITY AND PERMEABILITY HISTOGRAM

MILLIDARCY-METRES OF FLOW CAPACITY LOST FOR SELECTED PERMEABILITY CUT OFF

Permeability	Metres		Capacity Lost		Capacity Remaining		Wt. Avg. Geom.	
Cut Off	Lost	Remaining	Md-Metres	%	Md-Metres	%	Mean	Median
0.000	0.00	9.85	0.000	0.00	115.139	100.00	2.957	3.448
0.005	0.00	9.85	0.000	0.00	115.139	100.00	2.957	3.448
0.010	0.00	9.85	0.000	0.00	115.139	100.00	2.957	3.448
0.020	0.00	9.85	0.000	0.00	115.139	100.00	2.957	3.448
0.040	0.00	9.85	0.000	0.00	115.139	100.00	2.957	3.448
0.080	0.30	9.55	0.021	0.02	115.139	100.00	2.957	3.448
0.160	0.80	9.05	0.068	0.06	115.118	99.98	3.326	3.580
0.320	1.55	8.30	0.242	0.21	115.071	99.94	4.057	3.913
0.640	1.90	7.95	0.417	0.36	114.897	99.79	5.254	4.191
1.250	2.90	6.95	1.344	1.17	114.722	99.64	5.834	4.380
2.500	3.65	6.20	2.824	2.45	113.795	98.83	7.644	4.969
5.000	6.40	3.45	11.699	10.16	112.315	97.55	9.012	7.071
10.000	7.10	2.75	16.289	14.15	103.440	89.84	20.688	18.549
20.000	8.25	1.60	32.789	28.48	98.850	85.85	27.756	25.937
40.000	8.85	1.00	48.689	42.29	82.350	71.52	45.189	47.086
80.000	9.70	0.15	97.289	84.50	66.450	57.71	62.992	
160.000	9.85	0.00	115.139	100.00	17.850	15.50	119.000	
					0.000	0.00	0.000	

Total Flow Capacity in Millidarcy-Metres (Arithmetic) = 115.139

CHEMICAL & GEOLOGICAL LABORATORI

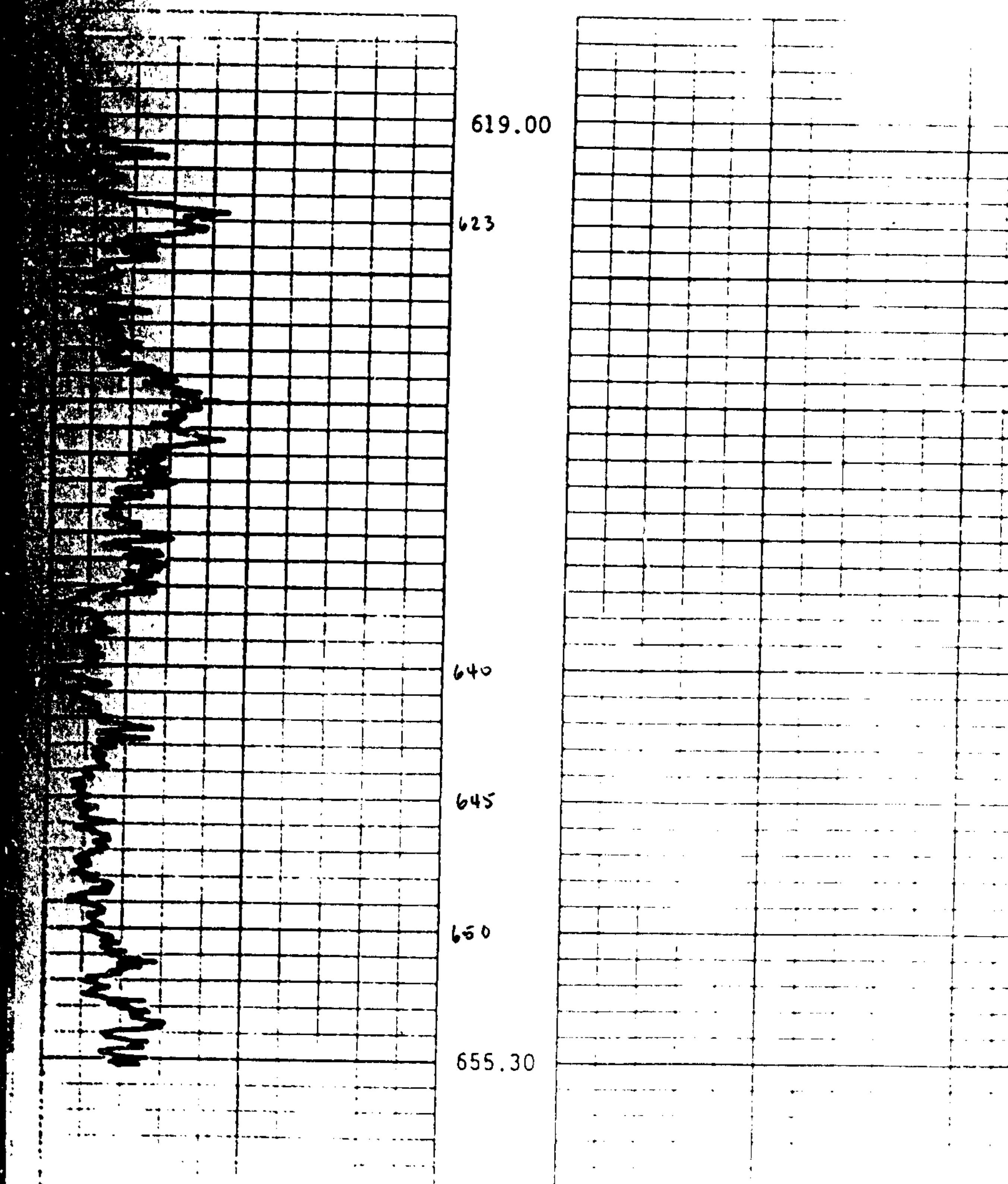
COMPANY: SASKATCHEWAN OIL AND GAS CORPORATION
WELL : SASKOIL VIRDEN PROV. 6-29-9-25 W1

LAB
DAT
FIG

GAMMA RAY LOG

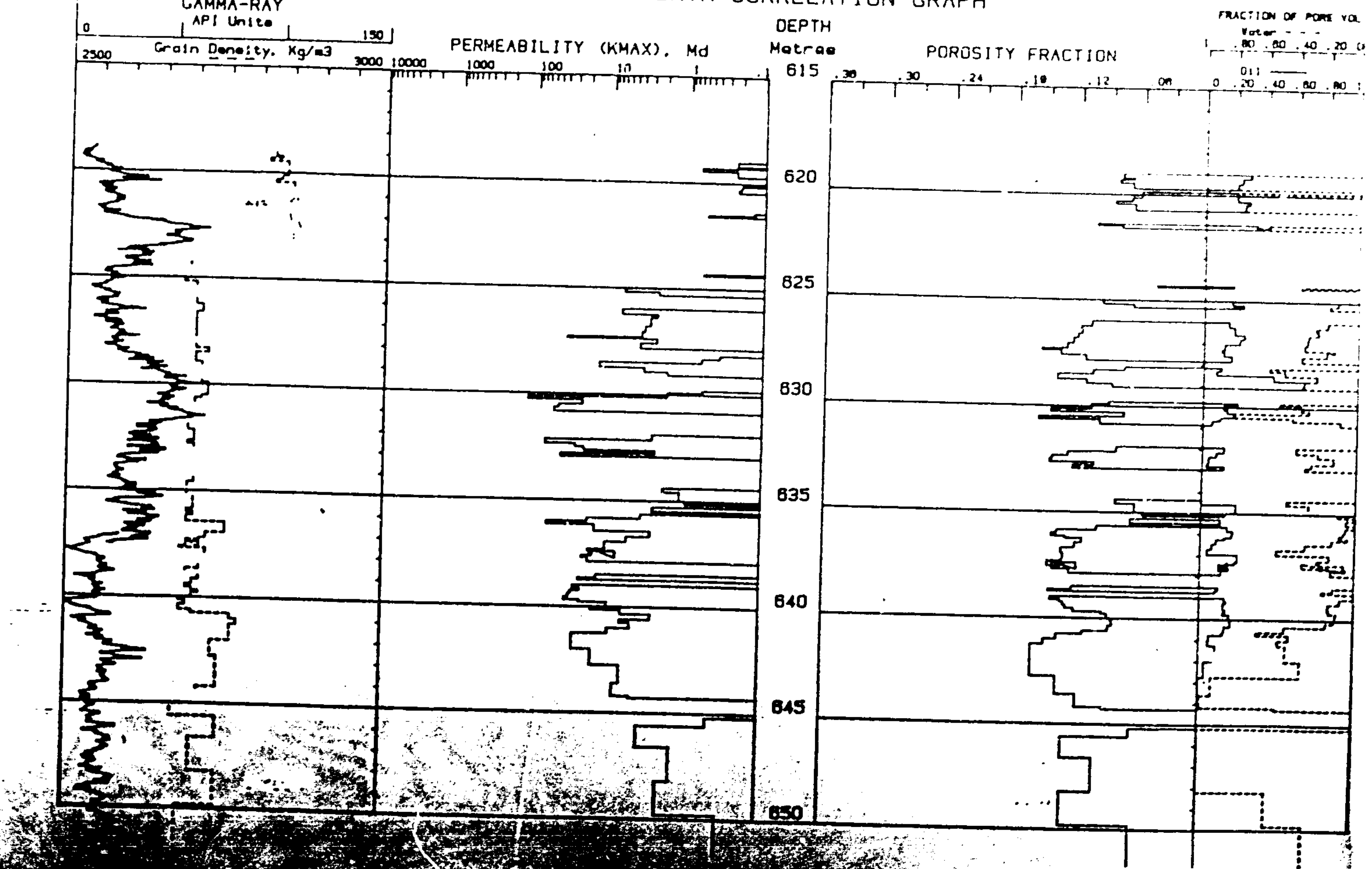
VERTICAL SCALE 1:240

T.C. 15 SEC.



CORE DATA CORRELATION GRAPH

Date : 1986-01-23

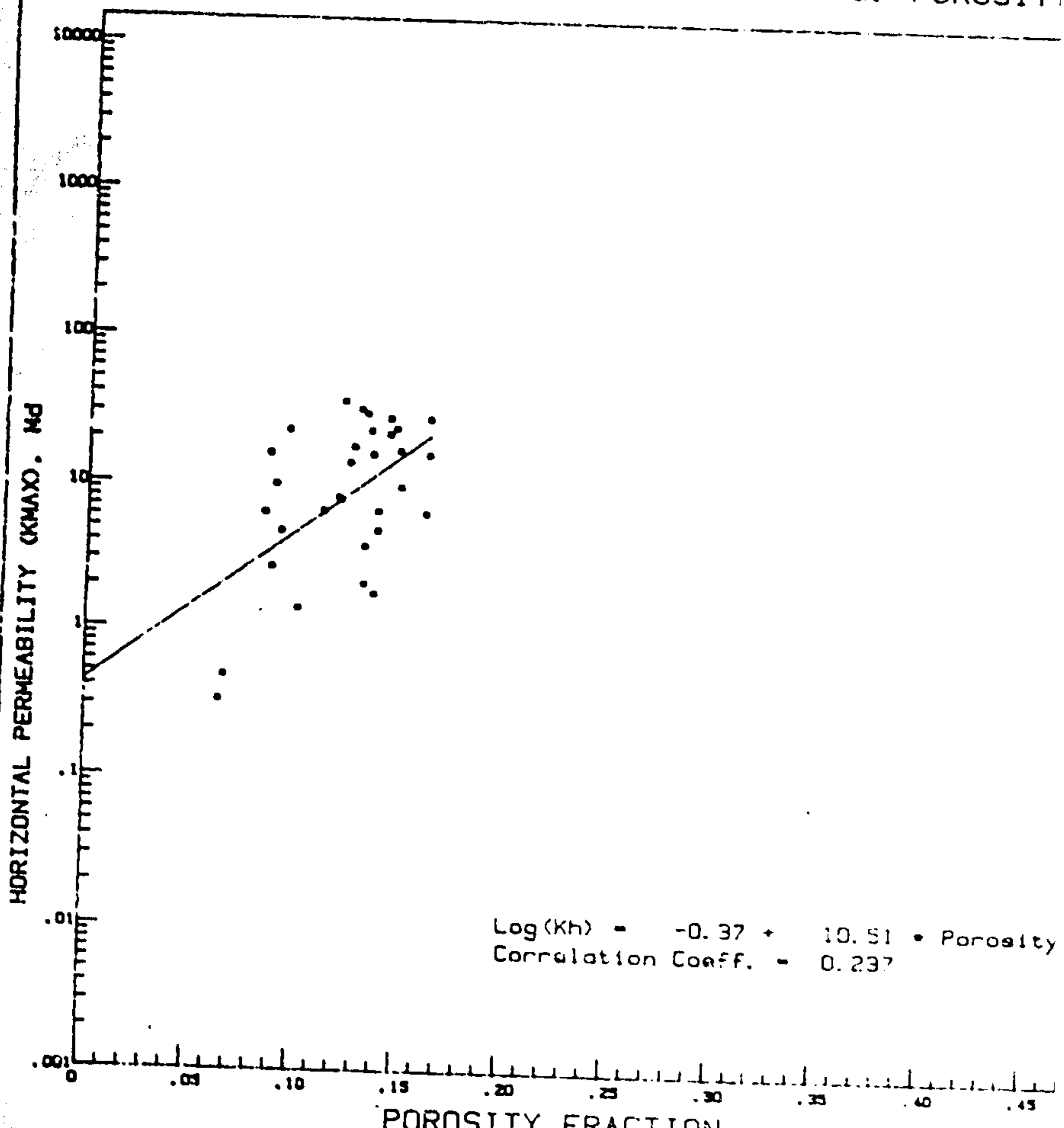


CHEMICAL & GEOLOGICAL LABS

Co: SASKATCHEWAN OIL AND GAS CORPORATION
Well: SASKOIL VIRDEN PROV. 6-29-9-25 W1
Formation : LODGEPOLE-SCALLION
Interval : 837.00 - 855.30

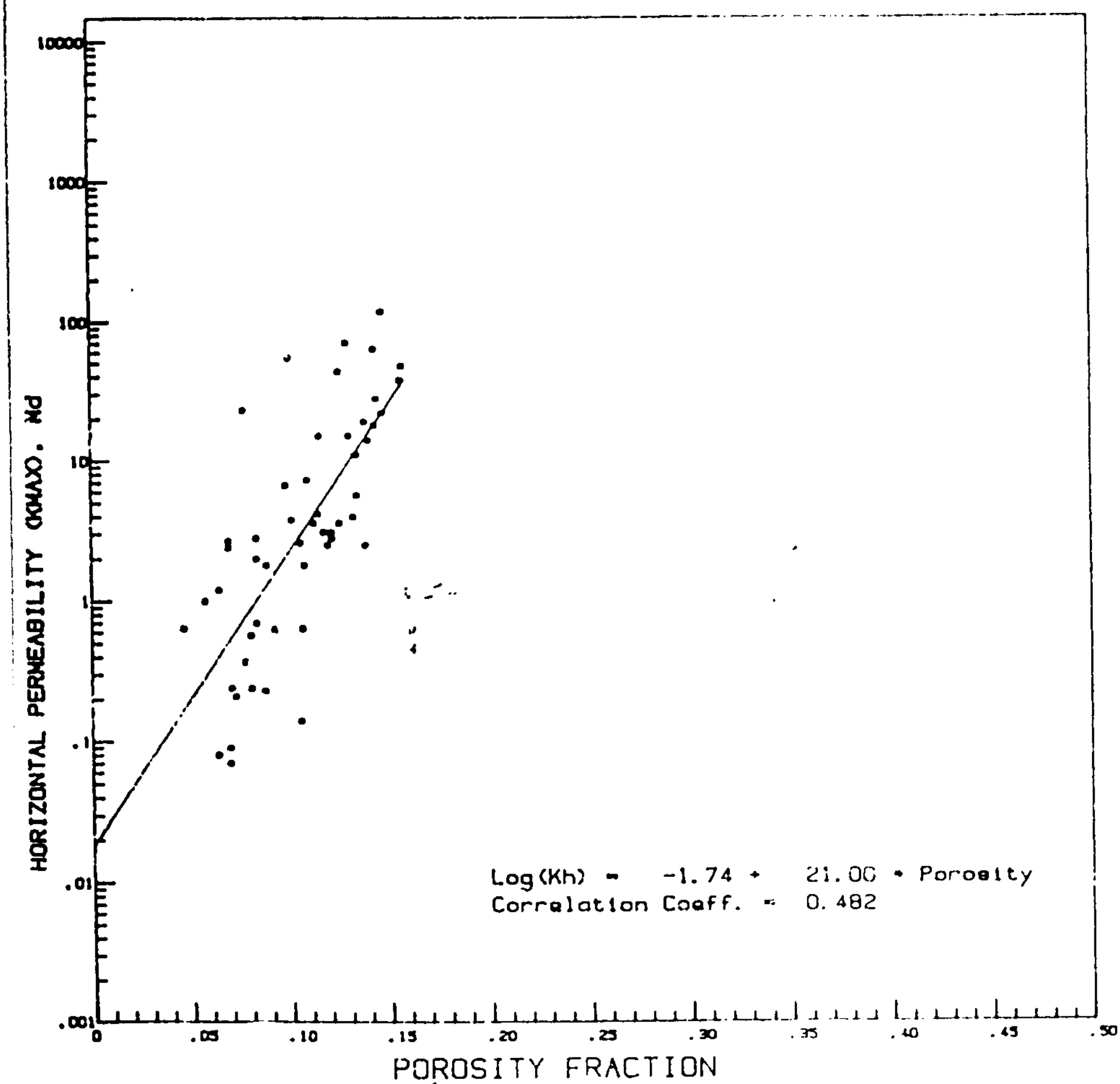
Lab No.: S8
Fig No.: 3.
Date : 1986-

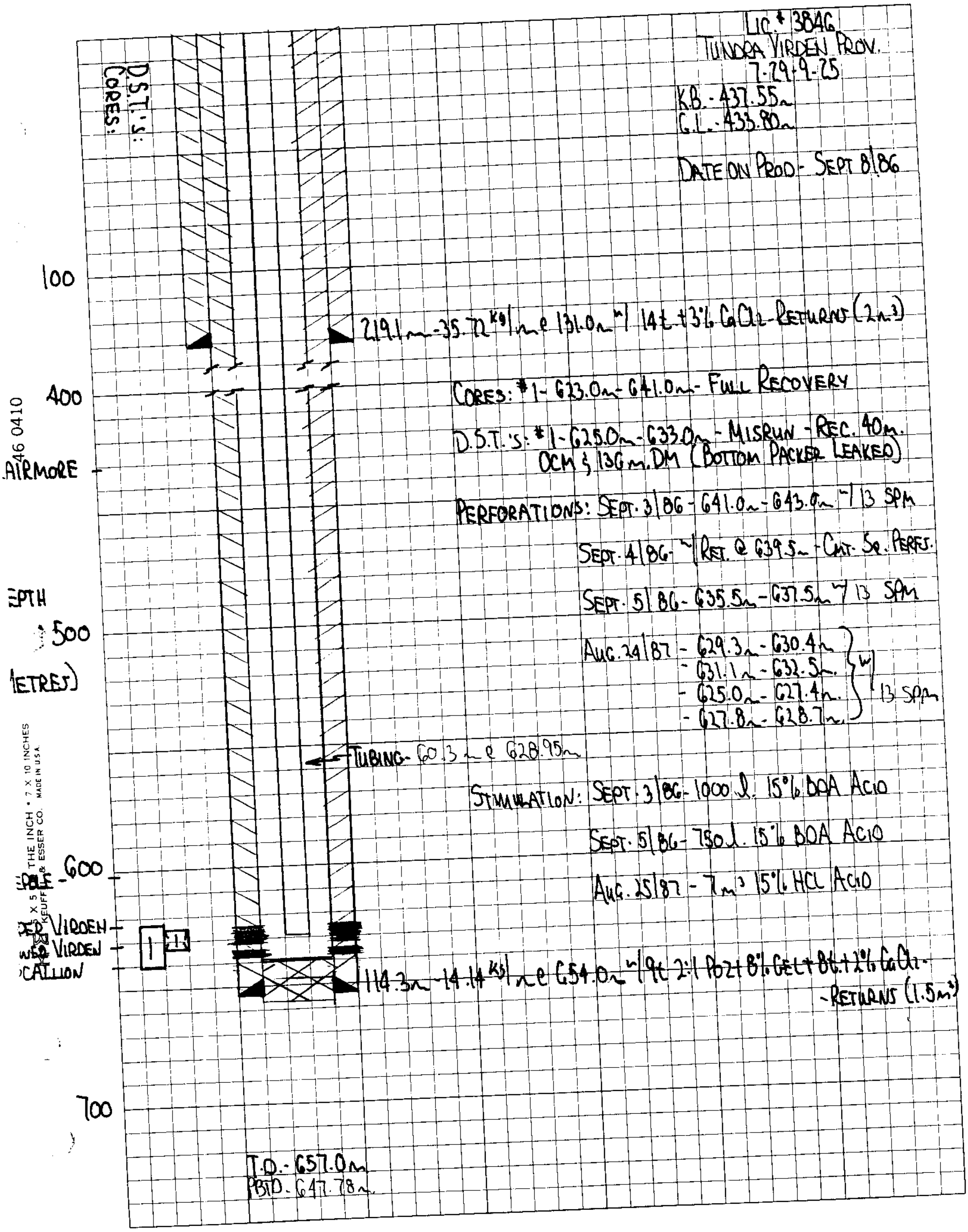
HORIZONTAL PERMEABILITY (KMAX) VS. POROSITY



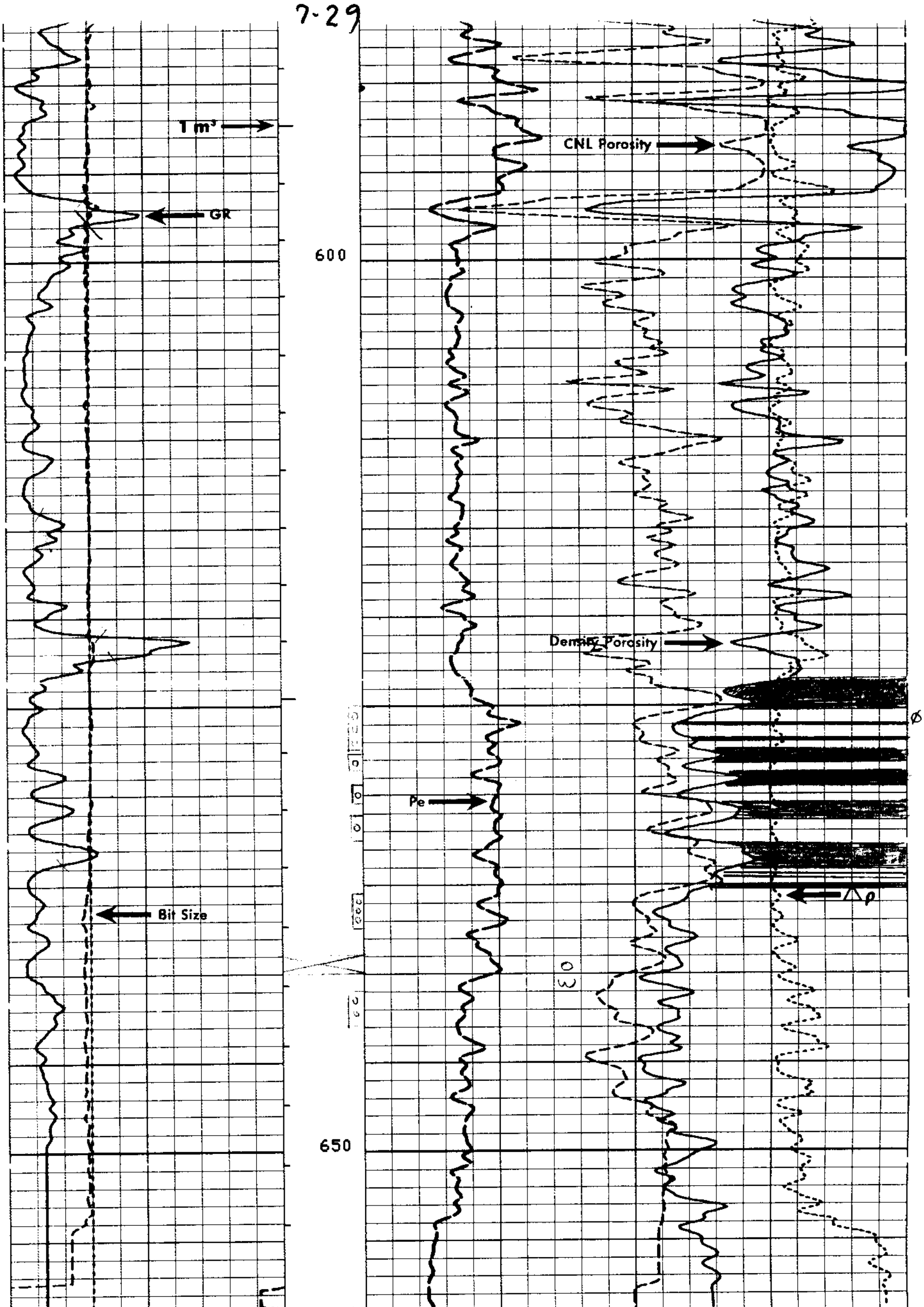
SASKATCHEWAN OIL AND GAS CORPORATION — Job No.: S86-142
Well: SASKOIL VIRDEN PROV. 6-29-9-25 W1 — Fig No.: 3
Formation : LODGEPOLE-VIRDEN — Date : 1986-01-23
Interval : 619.00 - 637.40

HORIZONTAL PERMEABILITY (KMAX) VS. POROSITY





LIC.# 3846
TUNDRA VIRDEN PROV.
7-29-9-25
K.B. - 437.55m
G.L. - 433.80m
DATE ON PROD - SEPT 8/86
D.S.T.'S:
CORES:
100
219.1mm - 35.72 kg/m @ 131.0m w/ 14t + 3% CaCl2 - RETURNS (2m3)
400
CORES: #1 - 623.0m - 641.0m - FULL RECOVERY
D.S.T.'S: #1 - 625.0m - 633.0m - MISRUN - REC. 40m. OCM & 136m. DM (BOTTOM PACKER LEAKED)
AIRMORE
PERFORATIONS: SEPT. 3/86 - 641.0m - 643.0m w/ 13 SPM
SEPT. 4/86 - w/ RET. @ 639.5m - CMT. SQ. PERFS.
SEPT. 5/86 - 635.5m - 637.5m w/ 13 SPM
EPTH
500
ETRES)
AUG. 24/87 - 629.3m - 630.4m
- 631.1m - 632.5m
- 625.0m - 627.4m
- 627.8m - 628.7m
w/ 13 SPM
TUBING - 60.3mm @ 628.95m
STIMULATION: SEPT. 3/86 - 1000 l. 15% BDA ACID
SEPT. 5/86 - 750 l. 15% BDA ACID
AUG. 25/87 - 7m3 15% HCL ACID
600
VIRDEN
VIRDEN
CALLION
114.3mm - 14.14 kg/m @ 654.0m w/ 9t 2:1 Poz + 8% GEL + 8t + 2% CaCl2 - RETURNS (1.5m3)
700
T.D. - 657.0m
PBTD. 647.78m
46 0410
X 5 THE INCH • 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.



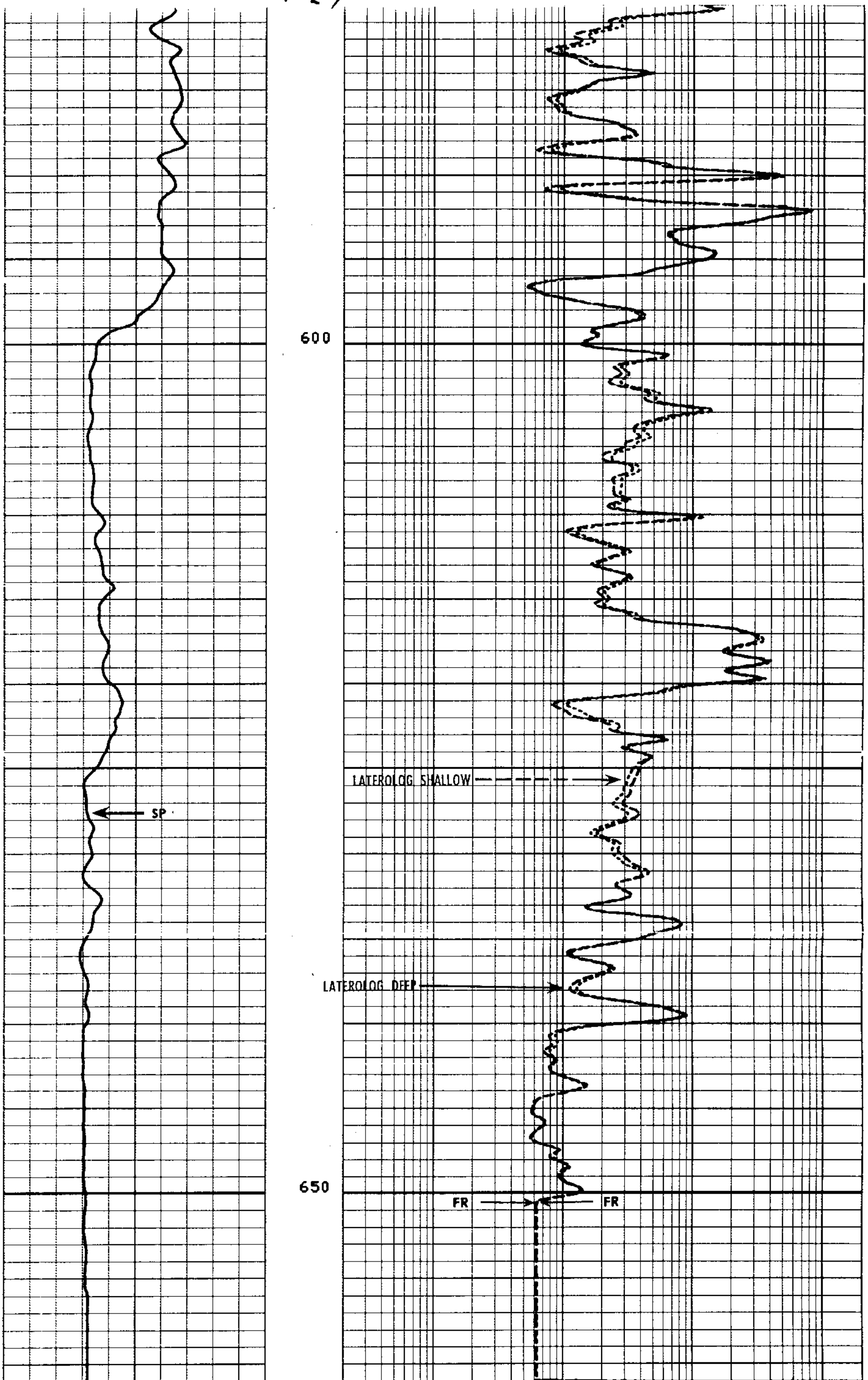
CP 28.0 LIMESTONE FILE 4 26-FEB-86 10:13 LIMESTONE

CALI(MM)		PEF		DRHO(K/M3)	
125.00	375.00	0.0	10.000	-250.0	250.00
GR (GAPI)		DPHI			
0.0	150.00	.45000			-.1500
BS (MM)		NPHI			
125.00	375.00	.45000			-.1500

SENSOR MEASURE POINT TO TOOL ZERO

STSG	-.28 METER	GR	8.94 METER
NCNL	6.35 METER	FCNL	6.35 METER
LITH	.79 METER	SCNL	-.28 METER
LS	.79 METER	LL	.79 METER
SS1	.64 METER	LU	.79 METER
DTCL	.79 METER	SS2	.64 METER
DTPL	.79 METER	DTCS	.64 METER
LLLC	.79 METER	DTPS	.64 METER
LLUC	.79 METER	LULC	.79 METER
SLLC	.64 METER	LUUC	.79 METER
SLUC	.64 METER	SULC	.64 METER
CALI	.81 METER	SUUC	.64 METER
NRAT	6.35 METER	TENS	-.28 METER

7-29



FILE 3 26-FEB-86 08:49

		LLS (OHMM) 2000.0 200000
		LLD (OHMM) 2000.0 200000
		LLS (OHMM) .20000 2000.0
SP (MV) -80.00 20.000		LLD (OHMM) .20000 2000.0

SENSOR MEASURE POINT TO TOOL ZERO

SPAR 9.9 METER SP 9.9 METER

7 21 1 25

FULL DIAMETER ANALYSIS

CORE ADJUSTMENT −0.7 m

Sample Number	Depth Metres (m)	m Rec.	Sample Length	Permeability to Air Millidarcys mD Max.	mD 90 deg.	mD V	Perm. X m	Porosity	Porosity X m	Density (kg/m3) Bulk	Grain	Residual Saturation (Frac of Pore Vol) Oil	Water	VISUAL EXAMINATION
	CORE NO. 1	623.00 m − 641.00 m (core received 18.40 m) (14 Boxes)												
-	623.00-23.96	0.96	-	-	-	-	-	-	-	-	-	-	-	dol anhy
-	623.96-25.89	1.93	-	-	-	-	-	-	-	-	-	-	-	dol anhy ls
P 1	625.89-25.99	0.10	-	1.01	-	-	0.101	0.092	0.009 Øh	-	2710	0.092	0.345	ls i PPV
2	625.99-26.19	0.20	.14	0.65	0.52	0.21	0.130	0.092	0.018	2470	2720	0.251	0.197	ls i PPV
3	626.19-26.36	0.17	.10	4.83	4.16	2.86	0.821	0.130	0.022	2370	2720	0.192	0.421	ls i PPV sv
P 4	626.36-26.44	0.08	- h=0.48	4.31	-	-	0.345	0.118	0.009 .062	-	2710	0.186	0.385	ls i PPV
5	626.44-26.58	0.14	.10	2.73	2.21	2.28	0.382	0.127	0.018	2380	2720	0.141	0.424	ls i PPV sv
P 6	626.58-26.67	0.09	-	3.17	-	-	0.285	0.140	0.013	-	2720	0.134	0.479	ls i PPV mv
7	626.67-26.92	0.25	.10	0.68	0.68	0.47	0.170	0.125	0.031	2380	2720	0.150	0.455	ls i PPV anhy
8	626.92-27.14	0.22	.16	1.05	1.02	0.87	0.231	0.121	0.027 Øh	2400	2730	0.162	0.395	ls i PPV
9	627.14-27.38	0.24	.12 h=0.57	1.60	1.47	1.23	0.384	0.123	0.030	2380	2710	0.180	0.358	ls i PPV
SP 10	627.38-27.49	0.11	-	1.82	-	-	0.200	0.119	0.013 .070	-	2720	0.153	0.500	ls i
11	627.49-27.68	0.19	.09	0.49	0.48	0.43	0.093	0.113	0.021	2430	2740	0.098	0.561	ls i PPV anhy
SP 12	627.68-27.82	0.14	-	1.32	-	-	0.185	0.138	0.019	-	2710	0.188	0.467	ls i
SP 13	627.82-27.95	0.13	- h=0.51	2.01	-	-	0.261	0.114	0.015 .063	-	2700	0.208	0.364	ls i
14	627.95-28.19	0.24	.09	2.47	2.43	2.27	0.593	0.122	0.029	2380	2710	0.244	0.244	ls i PPV
SP 15	628.19-28.30	0.11	-	0.95	-	-	0.105	0.094	0.010	-	2700	0.222	0.353	ls i
-	628.30-28.50	0.20	-	-	-	-	-	-	-	-	-	-	-	ls anhy
16	628.50-28.69	0.19	.10	0.39	0.39	0.22	0.074	0.091	0.017	2480	2720	0.127	0.563	ls i PPV
17	628.69-28.93	0.24	.13	0.88	0.82	0.28	0.211	0.102	0.024	2450	2720	0.165	0.401	ls i PPV
18	628.93-29.15	0.22	.09 h=0.42	4.54	4.46	2.71	0.999	0.136	0.030	2350	2720	0.131	0.370	ls i PPV
SP 19	629.15-29.23	0.08	-	1.11	-	-	0.089	0.121	0.010 .053	-	2720	0.168	0.376	ls i
SP 20	629.23-29.35	0.12	-	1.20	-	-	0.144	0.106	0.013	-	2710	0.151	0.445	ls i

FULL DIAMETER ANALYSIS

Depth Metres (m)	m Rep.	Sample Length	Permeability to Air Millidarcys mD Max.	mD 90 deg.	mD V	Perm. X m	Porosity	Porosity X m	Density kg/m3 Bulk	Grain	Residual Saturation (Frac of Pore Vol) Oil	Water	VISUAL EXAMINATION
CORE NO. 1 CONTINUED													
629.35-29.45	0.10	-	0.16		-	0.016	0.072	0.007	-	2710	0.061	0.562	ls i
629.45-30.21	0.76	-	-		-	-	-	-	-	-	-	-	ls anhy dol
630.21-30.41	0.20	-	0.32	-	-	0.064	0.095	0.019	-	2710	0.076	0.679	ls i
630.41-30.51	0.10	-	0.77	-	-	0.077	0.111	0.011	-	2720	0.130	0.644	ls i
630.51-30.85	0.34	.14	14.7	14.2	13.5	4.998	0.145	0.049	2330	2720	0.168	0.482	ls i ppv
630.85-31.04	0.19	.08	4.99	4.72	4.53	0.948	0.154	0.029	2300	2720	0.192	0.381	ls i ppv
631.04-31.14	0.10	-	1.67	-	-	0.167	0.117	0.012	-	2710	0.145	0.453	ls i
631.14-31.26	0.12	.08	0.09	0.07	0.01	0.011	0.057	0.007	2540	2690	0.114	0.355	ls i ppv
631.26-32.21	0.95	-	-	-	-	-	-	-	-	-	-	-	ls anhy
632.21-32.41	0.20	.15	6.07	4.23	1.14	1.214	0.088	0.018	2470	2700	0.123	0.352	ls i ppv sv
632.41-32.67	0.26	.11	20.0	8.15	6.49	5.201	0.112	0.029	2410	2720	0.133	0.344	ls i ppv sv
632.67-32.77	0.10	-	126.	-	-	12.602	0.145	0.015	-	2720	0.153	0.477	ls i ppv
632.77-32.98	0.21	.12	12.0	10.4	12.3	2.520	0.135	0.028	2350	2710	0.113	0.364	ls i ppv vfrac
632.98-33.08	0.10	-	8.31	-	-	0.831	0.117	0.012	-	2720	0.113	0.501	ls i ppv
633.08-33.19	0.11	-	1.40	-	-	0.154	0.101	0.011	-	2710	0.115	0.457	ls i ppv
633.19-33.33	0.14	.10	1.33	1.27	0.21	0.186	0.091	0.013	2460	2710	0.116	0.415	ls i ppv sv
633.33-34.71	1.38	-	-	-	-	-	-	-	-	-	-	-	ls anhy
634.71-34.87	0.16	.11	0.16	0.09	0.05	0.026	0.047	0.008	2570	2690	0.127	0.189	ls i ppv sv
634.87-35.01	0.14	-	3.30	-	-	0.462	0.079	0.011	-	2700	0.258	0.202	ls i
635.01-35.09	0.08	-	0.93	-	-	0.074	0.070	0.006	-	2700	0.146	0.460	ls i ppv
635.09-35.28	0.19	.08	1.48	1.39	0.94	0.281	0.070	0.013	2510	2690	0.184	0.158	ls i ppv
635.28-35.38	0.10	-	0.46	-	-	0.046	0.056	0.006	-	2700	0.253	0.156	ls i
635.38-35.61	0.23	.12	0.28	0.27	0.19	0.064	0.051	0.012	2560	2690	0.162	0.138	ls i ppv sty
635.61-35.71	0.10	-	2.65	-	-	0.265	0.067	0.007	-	2700	0.229	0.199	ls i ppv
635.71-35.88	0.17	.10	0.48	0.40	0.21	0.082	0.065	0.011	2540	2710	0.141	0.243	ls i ppv sty frac

FULL DIAMETER ANALYSIS

Sample Number	Depth Metres (m)	m Rep.	Sample Length	Permeability to Air Millidarcys mD Max.	mD 90 deg.	mD V	Perm. X m	Porosity	Porosity X m	Density:kg/m3 Bulk	Grain	Residual Saturation (Frac of Pore Vol) Oil	Water	VISUAL EXAMINATION
	CORE NO. 1 CONTINUED													
3	635.88-36.11	0.23	.16	2.33	2.12	1.63	0.536	0.097	0.022	2450	2720	0.297	0.141	ls i ppv sv sty
4	636.11-36.21	0.10	-	11.4	-	-	1.140	0.108	0.011	-	2700	0.311	0.200	ls i ppv
5	636.21-36.33	0.12	.11	h=1.95 10.3	9.91	10.2	1.236	0.120	0.014 φh	2380	2700	0.293	0.102	ls i ppv vfrac
6	636.33-36.46	0.13	-	4.94	-	-	0.642	0.108	0.014 0.238	-	2700	0.190	0.333	ls i ppv
7	636.46-36.95	0.49	.22	2.89	2.71	2.06	1.416	0.120	0.059	2420	2750	0.110	0.497	ls i ppv anhy
8	636.95-37.21	0.26	.18	5.38	4.64	3.04	1.399	0.145	0.038	2360	2760	0.255	0.358	ls i ppv anhy
9	637.21-37.36	0.15	.10	9.48	9.28	5.25	1.422	0.126	0.019	2380	2720	0.274	0.292	ls i ppv anhy
0	637.36-37.52	0.16	-	17.1	-	-	2.736	0.144	0.023	-	2700	0.242	0.370	ls i ppv
1	637.52-37.73	0.21	.09	14.0	12.9	9.14	2.940	0.134	0.028	2360	2720	0.160	0.559	ls i ppv anhy hf
2	637.73-37.83	0.10	-	13.6	-	-	1.360	0.104	0.010	-	2710	0.300	0.150	ls i ppv
-	637.83-37.89	0.06	-	-	-	-	-	-	-	-	-	-	-	ls anhy
3	637.89-38.01	0.12	-	4.56	-	-	0.547	0.105	0.013	-	2710	0.177	0.405	ls i
-	638.01-38.04	0.03	-	-	-	-	-	-	-	-	-	-	-	anhy
4	638.04-38.36	0.32	.15	10.6	10.5	10.3	3.392	0.136	0.044	2340	2710	0.260	0.304	ls i ppv foss
-	638.36-39.07	0.71	-	-	-	-	-	-	-	-	-	-	-	dol anhy lmy
5	639.07-39.22	0.15	-	h=1.46 6.21	-	-	0.932	0.114	0.017	φh=0.173	2710	0.153	0.398	ls i ppv
-	639.22-39.30	0.08	-	-	-	-	-	-	-	-	-	-	-	dol ls anhy
6	639.30-39.37	0.07	-	4.84	-	-	0.339	0.098	0.007	-	2710	0.294	0.214	ls i
-	639.37-39.46	0.09	-	-	-	-	-	-	-	-	-	-	-	ls dol anhy
7	639.46-39.56	0.10	-	11.7	-	-	1.170	0.133	0.013	-	2730	0.273	0.222	ls i
8	639.56-39.79	0.23	.16	11.7	10.0	2.92	2.691	0.117	0.027	2400	2710	0.356	0.116	ls i ppv sty
9	639.79-40.01 c	0.22	.13	24.3	15.9	9.92	5.347	0.115	0.025	2390 c	2690	0.226	0.165	ls i ppv anhy fo
0	640.01-40.19 w	0.18	.13	37.5	37.5	20.1	6.750	0.114	0.021	2390 w	2690	0.330	0.173	ls i ppv hfrac
1	640.19-40.26	0.07	-	12.9	-	-	0.903	0.084	0.006	-	2710	0.188	0.330	ls i ppv
-	640.26-40.29	0.03	-	-	-	-	-	-	-	-	-	-	-	anhy

le er	Depth Metres (m)	m Rec.	Sample Length	Permeability to Air Millidarcys mD Max.	mD 90 deg.	mD V	Perm. X m	Porosity	Porosity X m	Density: kg/m3 Bulk	Grain	Residual Saturation (Frac of Pore Vol) Oil	Water	VISUAL EXAMINATION
	CORE NO. 1 CONTINUED													
2	640.29-40.47	0.18	.08	16.3	16.3	2.62	2.934	0.108	0.019	2410	2700	0.233	0.153	ls i PPV
	640.47-40.49	0.02	-	-	-	-	-	-	-	-	-	-	-	dol anhy
3	640.49-40.67	0.18	.09 h=0.97	22.7	22.7	8.72	4.086	0.118	0.021	2380	2700	0.203	0.150	ls i PPV sty
4	640.67-40.78	0.11	-	132.	-	-	14.522	0.140	0.015	-	2690	0.225	0.178	ls i mv
5	640.78-40.94	0.16	.08	36.1	30.1	16.7	5.775	0.126	0.020	2350	2690	0.256	0.160	ls i PPV
6	640.94-41.04	0.10	-	46.0	-	-	4.600	0.129	0.013	- ϕh=0.129	2690	0.220	0.321	ls i mv
7	641.04-41.12	0.08	-	524.	-	-	41.931	0.171	0.014		2700	0.227	0.188	ls i PPV
	641.12-41.15	0.03	-	-	-	-	-	-	-		-	-	-	ls anhy
8	641.15-41.31	0.16	-	179.	-	-	28.636	0.167	0.027	-	2710	0.226	0.132	ls i PPV
	641.31-41.40	0.09	-	-	-	-	-	-	-	-	-	-	-	ls anhy

POROSITY-METRES OF STORAGE CAPACITY LOST FOR SELECTED POROSITY CUT OFF

POROSITY CUT OFF	METRES LOST	CAPACITY LOST (%)	METRES REMAINING	CAPACITY REMAINING (%)	ARITH MEAN	MEDIAN
0.000	0.0	0.0	11.1	100.0	0.113	0.117
0.020	0.0	0.0	11.1	100.0	0.113	0.117
0.040	0.0	0.0	11.1	100.0	0.113	0.117
0.060	0.6	2.5	10.5	97.5	0.117	0.119
0.080	1.4	6.9	9.7	93.1	0.120	0.121
0.100	2.9	18.1	8.2	81.9	0.125	0.125
0.120	6.0	46.0	5.0	54.0	0.13[illegible]	
0.140	9.6	82.2	1.5	17.8	0.149	
0.160	10.8	96.8	0.2	3.2	0.168	
0.180	11.1	100.0	0.0	0.0		

TOTAL STORAGE CAPACITY IN POROSITY-METRES = 1.251

STATISTICAL DATA FOR POROSITY AND PERMEABILITY HISTOGRAM

PAGE [illegible]
FILE [illegible]

NY: SASKATCHEWAN OIL AND GAS CORPORATION
: VIRDEN

WELL : SASKOIL ET AL VIRDEN PROV. [illegible]
PROVINCE: MANITOBA

MILLIDARCY-METRES OF FLOW CAPACITY LOST FOR SELECTED PERMEABILITY CUT OFF

PERMEABILITY CUT OFF	METRES LOST	CAPACITY LOST (%)	METRES REMAINING	CAPACITY REMAINING (%)	GEOM MEAN	MEDIAN
0.005	0.0	0.0	11.1	100.0	3.72	3.51
0.010	0.0	0.0	11.1	100.0	3.72	3.51
0.020	0.0	0.0	11.1	100.0	3.72	3.51
0.039	0.0	0.0	11.1	100.0	3.72	3.51
0.078	0.0	0.0	11.1	100.0	3.72	3.51
0.156	0.1	0.0	11.0	100.0	3.88	3.59
0.312	0.6	0.1	10.5	99.9	4.45	3.91
0.625	1.5	0.3	9.6	99.7	5.48	4.56
1.250	3.0	1.0	8.1	99.0	7.70	7.42
2.500	4.6	2.7	6.5	97.3	11.16	11.55
5.	6.5	7.0	4.5	93.0	17.81	15.61
10.	7.4	10.3	3.7	89.7	22.45	
20.	9.5	26.2	1.5	73.8	48.10	
40.	10.5	41.7	0.5	58.3	144.29	142.54
80.	10.6	44.3	0.4	55.7	186.03	170.74
160.	10.8	59.8	0.2	40.2	256.08	
320.	11.0	76.1	0.1	23.9	524.10	
640.	11.1	100.0	0.0	0.0		

TOTAL FLOW CAPACITY IN MILLIDARCY-METRES(ARITHMETIC) = 175.46

ELL SASKOIL ET AL VIRDEN PROV. 7-29-9-25 DATE

ELD VIRDEN FORMATION LOWER VIRDEN ELE

ROVINCE MANITOBA DRLG. FLD. WATER BASE MUD CORES

OCATION LSD XX/07-29-009-25 W1M/X

CORRELATION COREGRAPH

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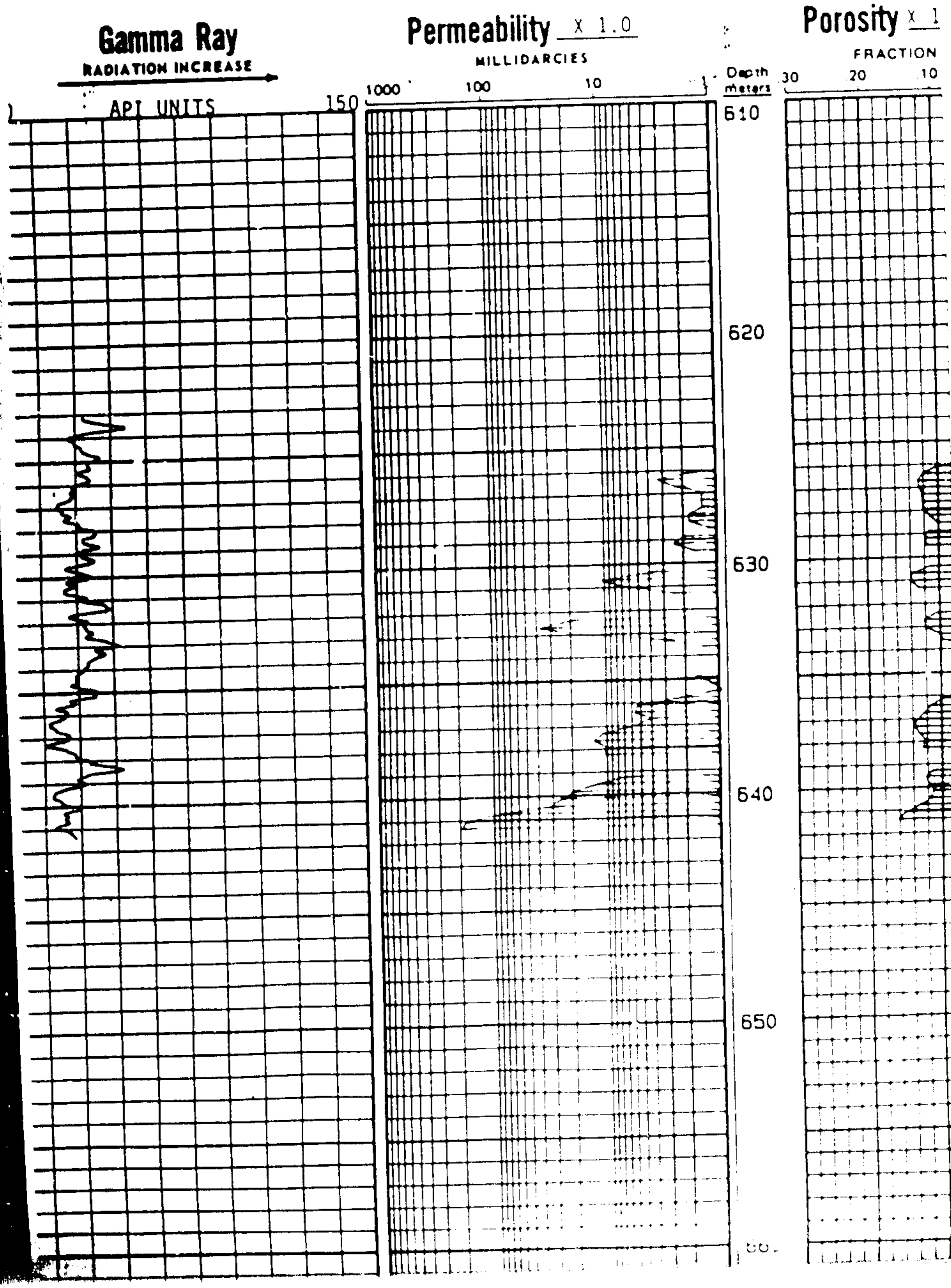
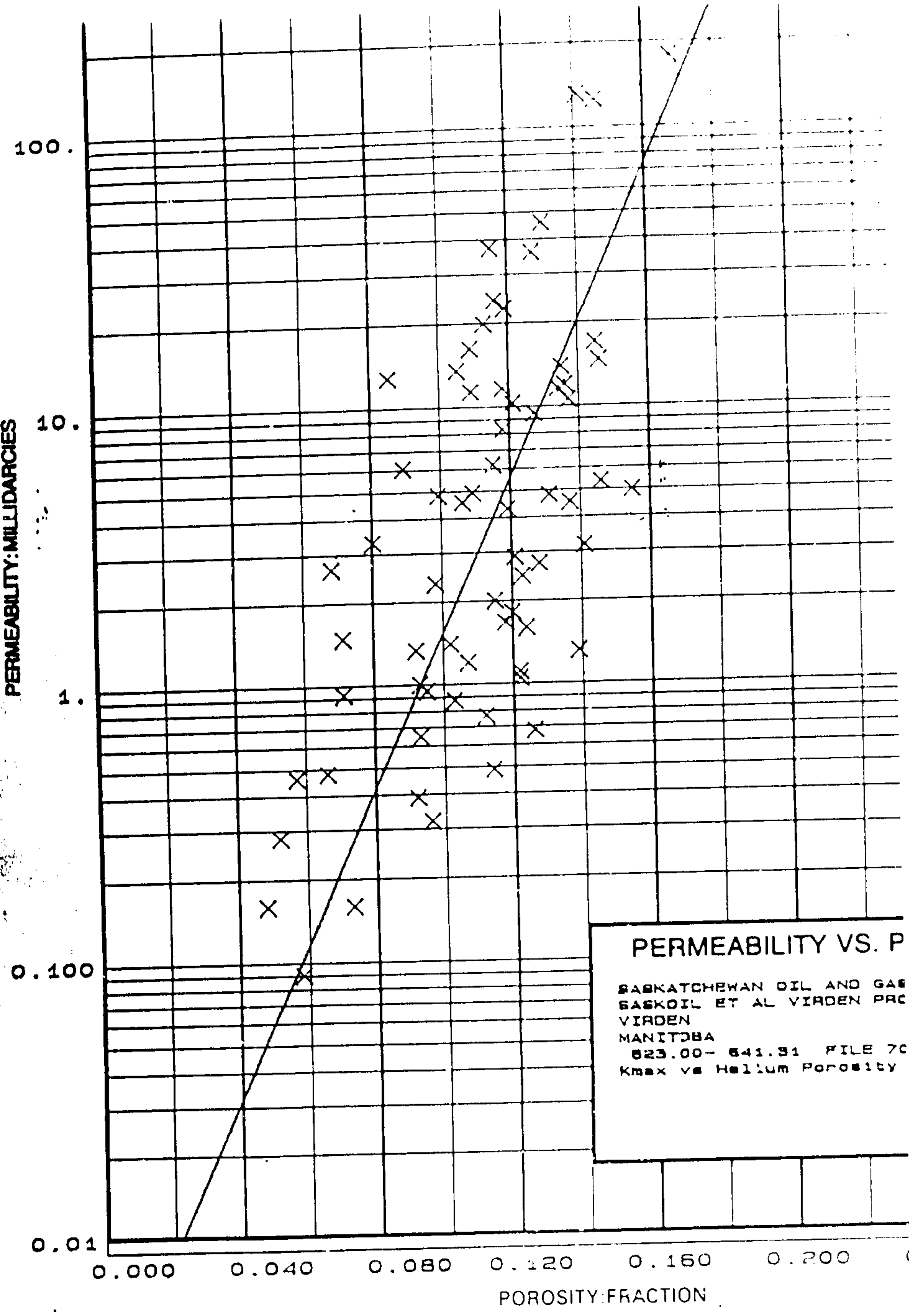
VERTICAL SCALE 10cm = 24m





EQUATION OF REDUCED LINE RELATING PERMEABILITY (K) TO POROSI

LOG (K) = (SLOPE)(POROSITY) + LOG OF INTERCEPT

K = ANTILOG (SLOPE)(POROSITY) + LOG OF INTERCEPT

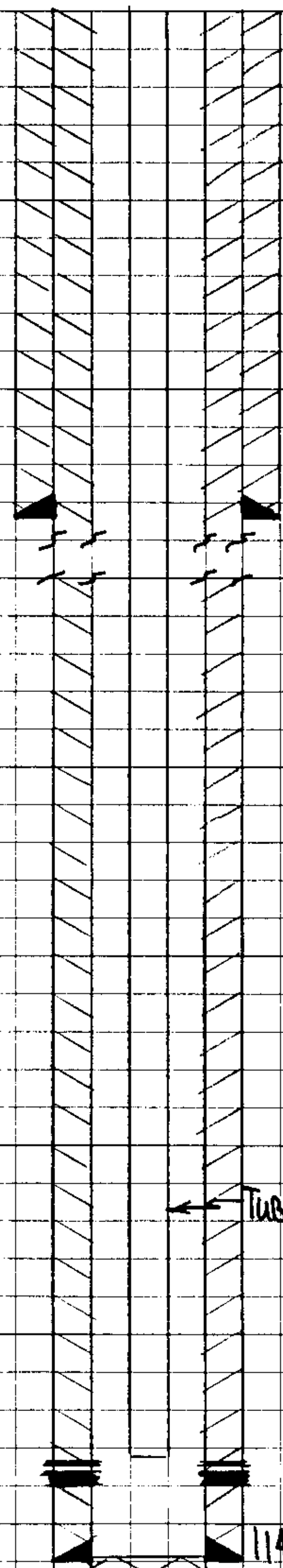
RANGE	SYMBOL	EQUATION OF THE LINE
1	X	PERM=ANTILOG (0.2807) (POROSITY) -2.5938

7004-11

Lic.# 3852
TUNDRA VIRDEN PROV.
10-29-9-25
K.B. - 437.95m
G.L. - 434.20m

DATE ON PROD - MAR 14/86

CORES:



100

219.1mm - 35.72 kg/m @ 134.0m w/ 14t + 3% $CaCl_2$ - RETURNS (2m³)

400

CORES: #1 - 615.0m - 633.0m - FULL RECOVERY

D.S.T.'S: NONE RUN

PERFORATIONS: MAR. 13/86 - 636.8m - 638.6m w/ 13 SPM

JUNE 22/94 - 639.0m - 640.0m
- 634.2m - 635.2m w/ 13 SPM

AIRMORE

DEPTH
500
(METRES)

TUBING - 60.3mm @ 632.56m

STIMULATION: MAR. 14/86 - 700 L 15% BDA & 200 L 28% HCL ACID

JUNE 23/94 - 2000 L 15% HCL ACID

600

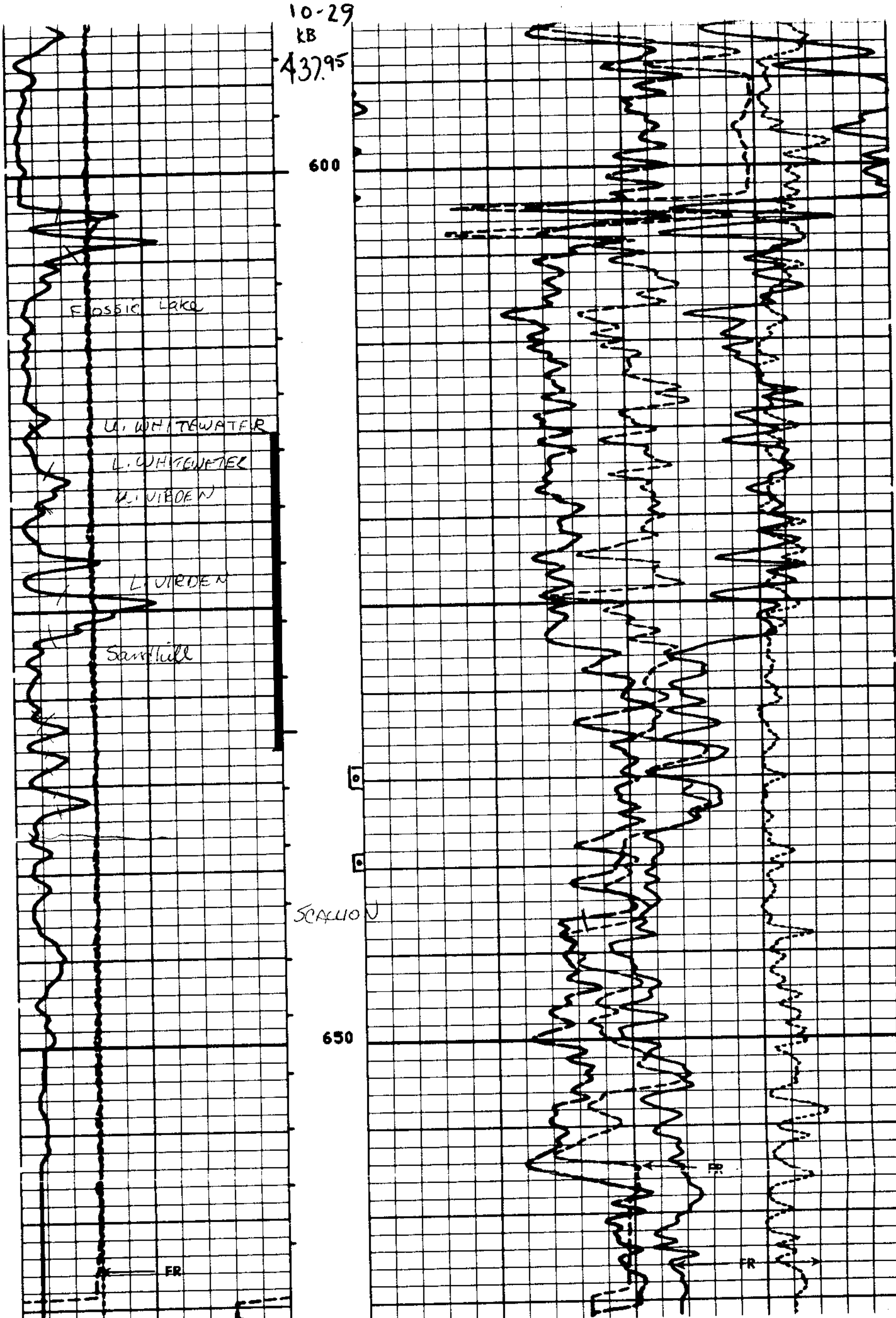
EPOLE
UPPER VIRDEN
LOWER VIRDEN
ALLAN

1

114.3mm - 14.14 kg/m @ 660.0m w/ 15t. 2:1 POZ + 8% GEL + 8t. FILLTROL - RETURNS (2.5m³)

700

T.D. - 663.0m
PBTD - 659.0m



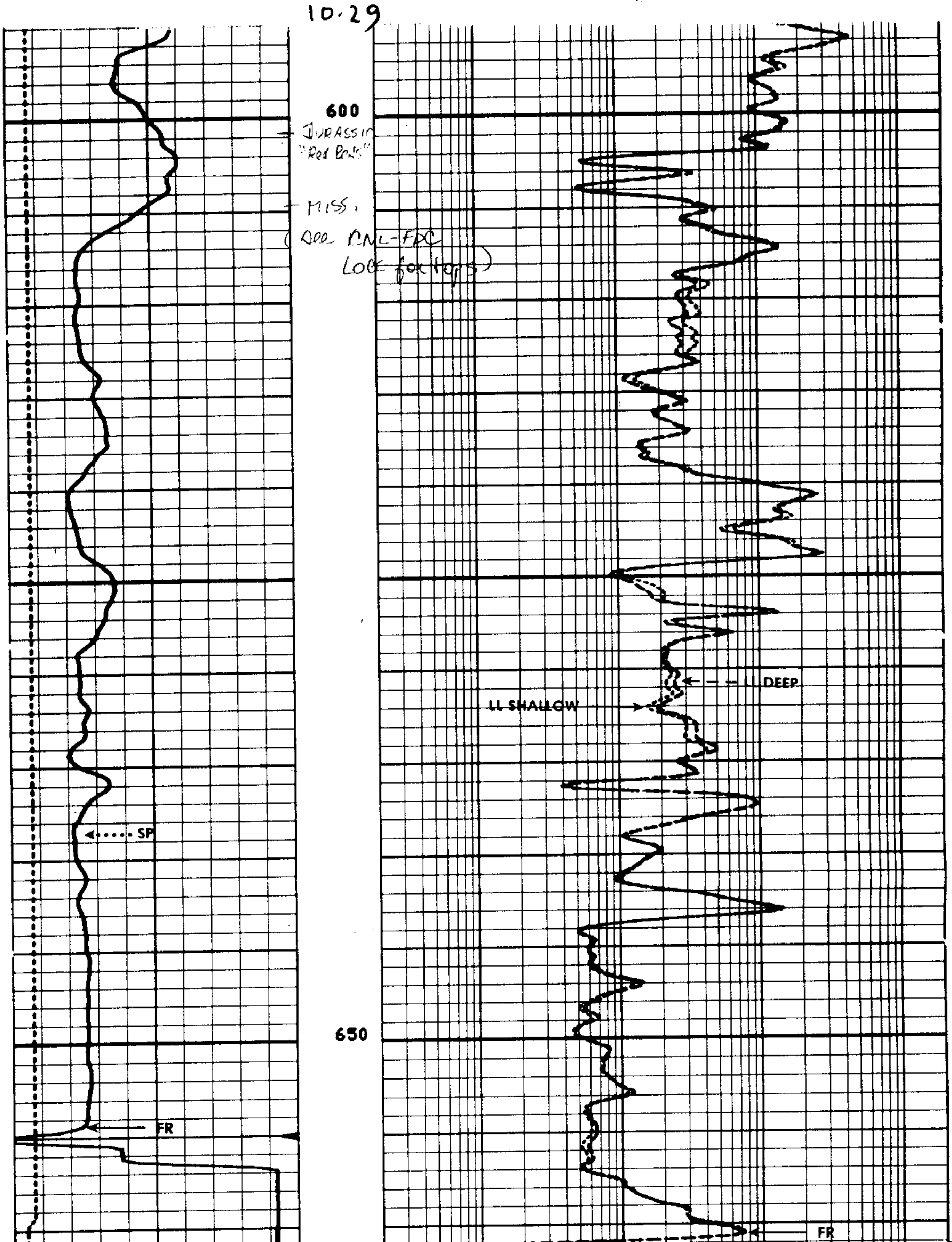
CP 28.2 FILE 3 02-MAR-86 09:21 LIMESTONE

CALI (MM) 125.00 — 375.00	DRHO (K/M3) -250.0 — 250.00
GR (GAPI) 0.0 — 150.00	DPHI .45000 — -.1500
BS (MM) 125.00 — 375.00	NPHI .45000 — -.1500
	PEF 0.0 — 10.000

SENSOR MEASURE POINT TO TOOL ZERO

STSG	-.28 METER	GR	8.94 METER
NCNL	6.35 METER	FCNL	6.35 METER
LITH	.79 METER	SCNL	-.28 METER
LS	.79 METER	LL	.79 METER
SS1	.64 METER	LU	.79 METER
DTCL	.79 METER	SS2	.64 METER
DTPL	.79 METER	DTCS	.64 METER
LLLC	.79 METER	DTPS	.64 METER
		LULC	.79 METER

10.29



CP 28.2 FILE 12 02-MAR-86 12:59

TENS(KG) 0.0 — 10000.	LLS (OHMM) 2000.0 — 200000
SP (MV) -80.00 — 20.000	LLD (OHMM) 2000.0 — 200000
	LLS (OHMM) .20000 — 2000.0
	LLD (OHMM) .20000 — 2000.0

SENSOR MEASURE POINT TO TOOL ZERO

SPAR	9.96	METER	SP	9.96	METER
SIO	4.55	METER	SI90	4.55	METER
SVO	4.55	METER	SV90	4.55	METER
DIO	4.55	METER	DI90	4.55	METER
DVO	4.55	METER	DV90	4.55	METER
LLD	4.55	METER	TENS	4.55	METER
LLS	4.55	METER			

PARAMETERS

NAME	VALUE	UNIT	NAME	VALUE	UNIT
BHS	OPEN		CSIZ	219.000	MM
BS	200.000	MM	RM	.0350000	OHMM

CORE LABORATORIES - CANADA, LTD.

COMPANY SASKATCHEWAN OIL AND GAS CORPORATION
WELL SASKOIL ET AL VIRDEN PROV. 10-29-9-25
FIELD VIRDEN, MANITOBA
LOCATION LSD XX/10-29-009-25 W1M/X

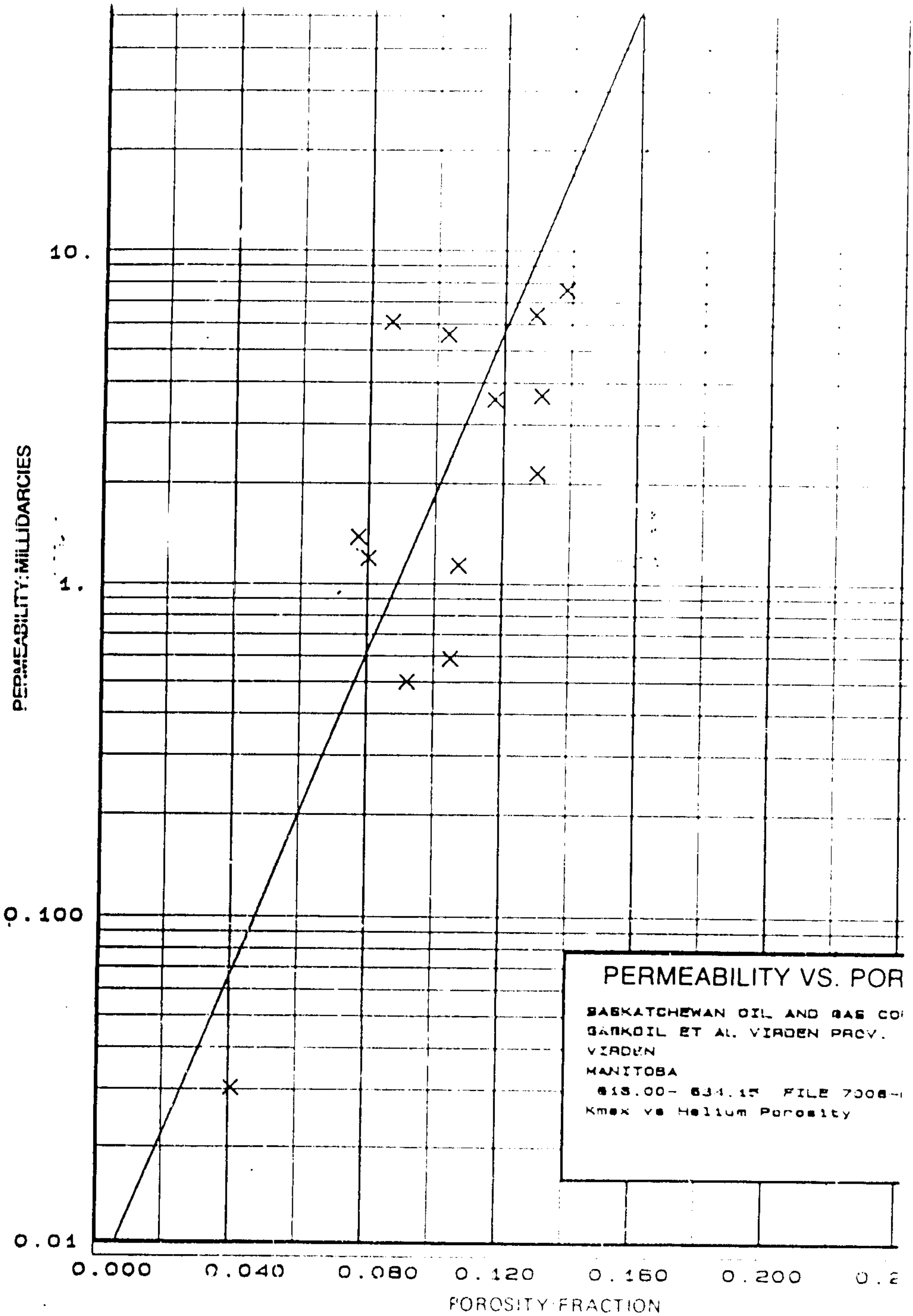
FORMATION LOWER VIRDEN
CORING EQUIPMENT DIAMOND
CORE DIAMETER.(mm) 89
CORING FLUID WATER BASE MUD

PAGE 1
FILE 7008-86-91
DATE 1986 03 02
ANALYSTS BB

FULL DIAMETER ANALYSIS

Core Adjustment + 0.5 m.

Sample Number	Depth Metres (m)	m Rec.	Sample Length	Permeability to Air Millidarcys mD Max.	mD 90 deg.	mD V	Perm. X m	Porosity	Porosity X m	Density kg/m3 Bulk	Grain	Residual Saturation (Frac of Pore Vol) Oil	Water	VISUAL EXAMINAT
	CORE NO. 1	616.00 m - 634.00	(core received 10.15 m) (14 Boxes)											
-	616.00-27.29	11.29	-	-	-	-	-	-	-	-	-	-	-	dol anhy .mg
1	627.29-27.40	0.11	.07	1.20	1.07	0.79	0.132	0.080	0.009	2490	2700	0.071	0.586	ls i ppv
-	627.40-27.47	0.07	-	-	-	-	-	-	-	-	-	-	-	ls
2	627.47-27.82	0.35	.14	6.14	6.14	2.33	2.149	0.086	0.030	2470	2700	0.310	0.163	ls i ppv mv
-	627.82-30.53	2.71	-	-	-	-	-	-	-	-	-	-	-	ls dol anhy
3	630.53-30.66	0.13	.10	1.14	1.05	1.44	0.148	0.107	0.014	2120	2710	0.084	0.509	ls i ppv mv o
4	630.66-30.75	0.09	-	2.16	-	-	0.194	0.130	0.012	-	2730	0.107	0.551	ls i ppv
5	630.75-31.03	0.28	.18	3.59	3.34	3.40	1.005	0.117	0.033	2400	2720	0.120	0.575	ls i ppv mv o
-	631.03-31.93	0.90	-	-	-	-	-	-	-	-	-	-	-	ls dol anhy
6	631.93-32.09	0.16	.11	0.50	0.47	0.27	0.080	0.092	0.015	2470	2720	trace	0.820	ls i ppv ool
7	632.09-32.25	0.16	.12	0.59	0.53	0.47	0.094	0.105	0.017	2430	2710	0.160	0.349	ls i ppv ool
8	632.25-32.43	0.18	.12	7.69	4.86	9.47	1.384	0.138	0.025	2340	2710	0.064	0.723	ls i ppv ool
9	632.43-32.59	0.16	.10	6.44	1.19	1.08	1.030	0.129	0.021	2360	2710	0.090	0.657	ls i ppv ool
10	632.59-32.73	0.14	.09	3.68	3.68	3.33	0.515	0.131	0.018	2360	2720	0.155	0.601	ls i ppv ool
11	632.73-32.86	0.13	.09	0.03	0.01	<0.01	0.004	0.041	0.005	2580	2700	0.081	0.522	ls i ppv
-	632.86-33.77	0.91	-	-	-	-	-	-	-	-	-	-	-	ls anhy
12	633.77-33.87	0.10	.08	1.39	0.98	0.48	0.139	0.077	0.008	2500	2710	0.152	0.375	ls i ppv ool
13	633.87-34.15	0.28	.15	5.62	3.52	2.19	1.574	0.103	0.027	2430	2710	0.124	0.320	ls i ppv ool



EQUATION OF REDUCED LINE RELATING PERMEABILITY (K) TO POROSITY

LOG (K) - (SLOPE)(POROSITY) + LOG OF INTERCEPT

K - ANTILOG (SLOPE)(POROSITY) + LOG OF INTERCEPT

RANGE	SYMBOL	EQUATION OF THE LINE
1	X	PERM=ANTILOG (0.2436) (POROSITY) -2.1

-2.1695

PERMEABILITY VS POROSITY

COMPANY: SASKATCHEWAN OIL AND GAS CORPORATION
WELL : SASKOIL ET AL VIRDEN PROV. 10-29-9-25
FIELD : VIRDEN
PROVINCE: MANITOBA
FORMATION: LOWER VIRDEN

AIR PERMEABILITY : MD - MAXIMUM (UNCORRECTED FOR SLIPPAGE)
POROSITY : FRACTION (HELIUM)

DEPTH INTERVAL	METERS ANALYZED	RANGE & SYMBOL	PERMEABILITY MINIMUM	PERMEABILITY MAXIMUM	POROSITY MIN.	POROSITY MAX.	POROSITY AVERAGE	PERMEABILITY AVERAGES ARITHMETIC	HARMONIC	GEOMETRIC
.00 - 634.15	2.27	1 (X)	0.000	10000.0	0.000	0.460	0.103	3.7	0.41	2.2

61600

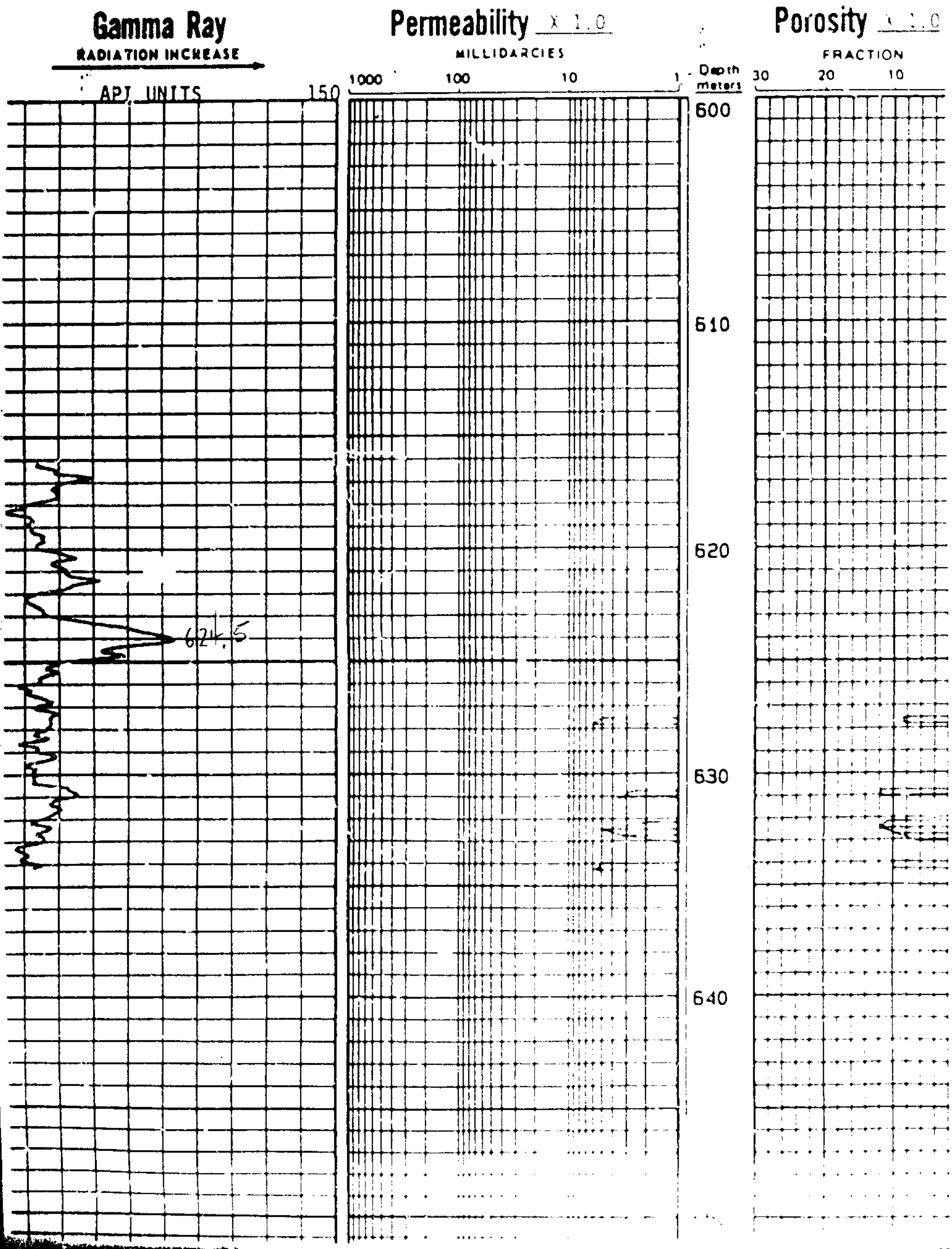
EQUATION OF REDUCED LINE RELATING PERMEABILITY(K) TO POROSITY :
LOG(K) = (SLOPE)(POROSITY) + LOG OF INTERCEPT
K = ANTILOG((SLOPE)(POROSITY) + LOG OF INTERCEPT)

RANGE	EQUATION OF THE LINE
1	PERM = ANTILOG((0.2436)(POROSITY) + -2.1699)

ELD VIRDEN FORMATION
OVINCE MANITOBA DRLG. FLD. WATER BASE MUD CORES
CATION LSD XX/10-29-009-25 W1M/X

CORRELATION COREGRAPH

VERTICAL SCALE 10cm = 24m



- all 29 Agricultural Use

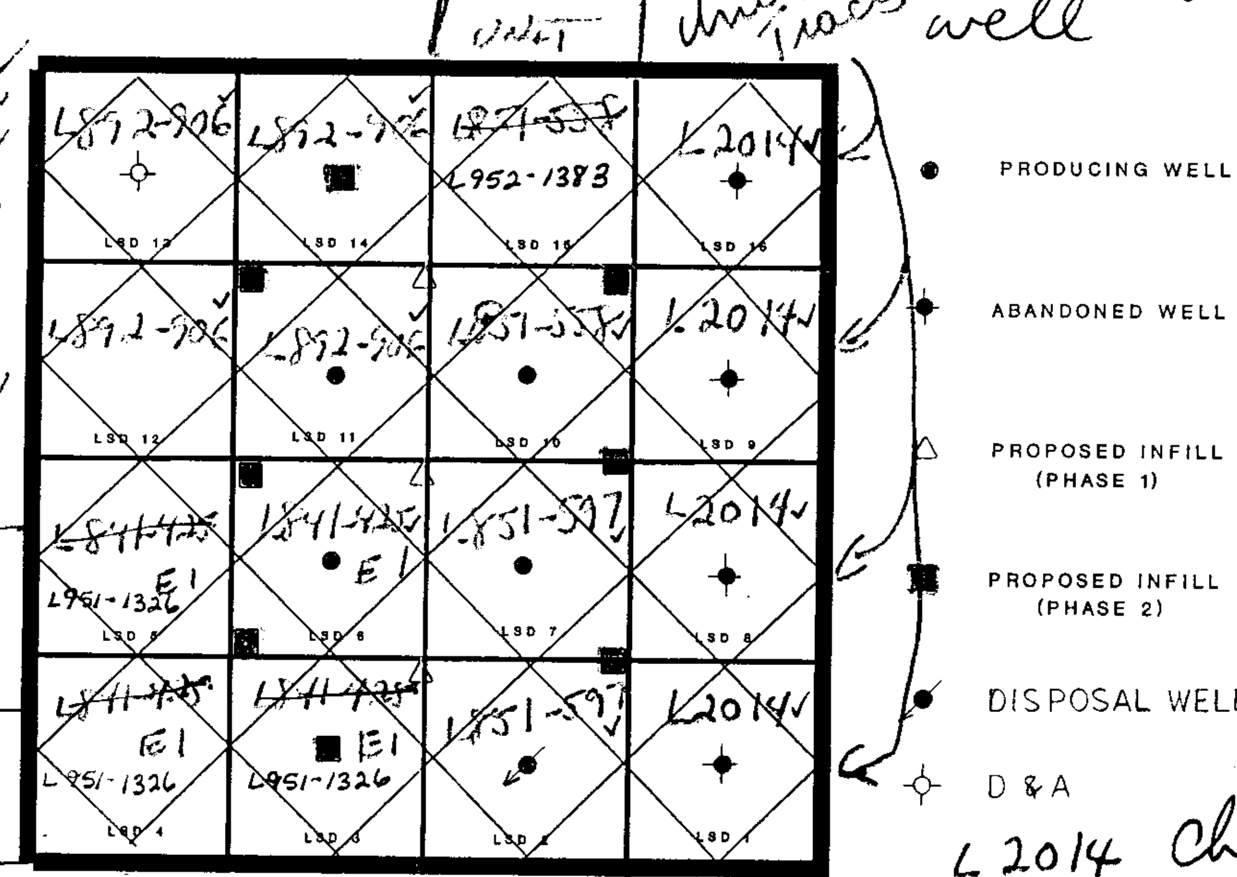
- anything on file at time offered - see land sale file
- see lease file as well

ROUTLEDGE FIELD

INFILL DRILLING PROGRAM

20 ACRE SPACING

SECTION 29-9-25



L851-597 - Tundra ✓

L841-425 E1 - Tundra ✓

L851-558 - Tundra/Cromwell ✓

L892-906 - Tundra ✓

TUNDRA
L84-425 - NOTHING
L851-597 NOTHING
L892-906 NOTHING
L95-1326 YES
L952-1383 YES

TUNDRA / CROMWELL
L85-558 - NOTHING

CHEVRON / MURPHY
L2014 - NOTHING

L2014 Chevron to lease of L.P.

- 1,8,9+16 Routledge Unit #1

Assignment of (√)

☐ Crown Land Permit
☐ Lease

Under The Crown Lands Act

Richland File: 392

Manitoba
Natural Resources
Lands

1495 St. James Street
Winnipeg, Manitoba
R3H 0W9

THIS PAGE TO BE COMPLETED BY EXISTING PERMITTEE/LESSEE

I (WE) Richland Petroleum Corporation (or authorized signing officer of company or organization) of the City (City, Town, Community)

of Calgary (Name of City, Town, etc.) in the Province of ~~Manitoba~~ Alberta, being holder of

(or signatory for the holder of) Lease/Permit No. GP 930003211

expiring December 31, 1994 covering the following land: NE 29-009-25 W1M

Permit Description: Part LS 10 of Section 29

do hereby in consideration of the sum of $ 1.00 (receipt whereof is hereby acknowledged) and other

valuable consideration paid to me by Tundra Oil and Gas Ltd. (Name)

of Winnipeg (City, Town, Community) in the Province of Manitoba, hereinafter called the Purchaser, assign all my right, title and interest in and to the said permit/lease to the Purchaser. I further certify that I have not executed or done or knowingly suffered or been party or privy to any deed or thing by which the term of said permit/lease has been charged, assigned, encumbered, affected or impeached in title, estate or otherwise however. (I haven't sold or mortgaged the buildings to anyone else). I further certify that all appurtenances (buildings, etc.) on the said lands have been granted, transferred, assigned and set over to the said Purchaser.

I further certify that all taxes, rents, and fees are paid in full.

Attachments (attach items checked):

- [x] Assignment Fee
- [ ] Copy of my/our original lease/permit
- [ ] Copy of receipt from local taxing authority
- [ ] Copy of bill of sale for appurtenances on the said land
- [ ] Copy of death certificate
- [ ] Copy of grant of probate /OR/ letters of administration
- [ ] Letter from registered collateral holder regarding status of collateral recording
- [ ] Copy of approval and endorsed change or alteration in membership form under The Business Names Registration Act.

Richland Petroleum Corporation

Dale C.J. Mennis
Vice President, Land

April 1 1994
(Date)

(Signature of Existing Permittee/Lessee)

(Witness)

(Signature of Existing Permittee/Lessee)

OFFICE USE ONLY:

Assignment fee attached: Receipt # ______ Revenue Code ______
M.R.O. ______ Date ______
Cheque/M.O./Cash $ ______ Signature ______

Land Unit # 3-184-000054 Encumbrance Type and No. G.P. 3211

REVERSE SIDE MUST BE COMPLETED BY PROPOSED NEW PERMITTEE/LESSEE

THIS PAGE TO BE COMPLETED BY PROPOSED NEW PERMITTEE/LESSEE

44009

I (WE) Tundra Oil and Gas Ltd. of the City (City, Town, Community)

of Winnipeg (Name of City, Town, Community) in the Province of Manitoba,

having read the terms and conditions of said lease/permit No. GP 930003211 hereby consent and agree with the Province of Manitoba to observe and perform all said terms and conditions, and to the use of the said land for the purpose of maintaining & operating an oil well site and oil pipeline associated with well site and for no other purpose without the express prior written consent of the Minister.

Existing Use: To maintain and/or operate an oil well site and oil pipeline associated with well site

Proposed Use: To maintain and/or operate an oil well site and oil pipeline associated with well site

Buildings: Existing: (Give number of buildings and sizes of each)

Proposed: (Give size, type of construction, and value)

Services:	Access	Hydro	Telephone	Water Supply and Sewage Disposal
Existing				
Required				

I/We request the permit/lease be registered in the following name(s):

Name: Tundra Oil and Gas Ltd.
15A Last First Middle (no initials)

Address: 1111 One Lombard Place
16A Postal Address/Street Address/Section-Township-Range

Address: Winnipeg Manitoba R3B 0X4
15A City Province Postal Code

Occupation: Telephone: Home Work

If Permit or Lease is to issue in more than one name, complete section below:

Name:
15 Last First Middle (no initials)

Occupation/relationship to Applicant:

Address (if different from above):

Specify: ☐ As Joint Tenants ☐ As Tenants in Common ☐ Other (specify)

If Permit or Lease is to issue in Name of Company or Organization, complete section below:

Registered Name: Tundra Oil and Gas Ltd. 15

Authorized Signing Officers: R. G. Puchniak D. H. Taylor

Tundra Oil and Gas Ltd.

April 1, 1994
(Date)

SRClamp
(Witness)

(Signature of Proposed New Permittee/Lessee)

Note: This assignment deals only with the permit. If buildings are involved in this transaction, it is suggested that the purchaser consult his/her solicitor.

Municipal/Community Council Resolution #

☐ This assignment approved as submitted **OR** with the following changes/stipulations:

Registered as No. 203 - Electronic

for the Director, Department of Natural Resources

94/06/21
Date/initials

94/06/21
Date

Manitoba
Natural Resources
Lands Branch

CROWN LAND PERMIT

Lic 385

MAY 1986
SASKATCHEWAN OIL & GAS CORPORATION

EFFECTIVE FROM FEBRUARY 26, 1986 TO DECEMBER 31, 1986

TAXING AUTHORITY SIFTON NR REGION SW

DEPARTMENT OF NATURAL RESOURCES, LANDS BRANCH BOX 2, 1495 ST. JAMES STREET, WINNIPEG, MANITOBA R3H 0W9

43975

SASK OIL & GAS CORPORATION
P.O. BOX 1550
REGINA
SK CD

S4P 3C4

PERMIT NUMBER	
GP	860003211

CASH NUMBER
6635

IS AUTHORIZED UNDER THE CROWN LANDS ACT AND REGULATIONS THEREUNDER, SUBJECT TO CONDITIONS ON REVERSE SIDE, HEREUNDER OR ATTACHED, TO USE THE FOLLOWING DESCRIBED LAND FOR THE PURPOSE STATED BELOW.

LEGAL DESCRIPTION OF LAND: 3-184-0001054	LAND REF. FILE #	AREA:
NE SEC 29 TWP 009 RNG 25 W PERMIT DESCRIPTION: PART LS 10 OF SECTION 29		

AS SHOWN ON SKETCH/PLAN/MAP ON FILE IN THE CROWN LANDS OFFICE.

AUTHORIZED USE: To maintain and/or operate a (n):

OIL WELL SITE

SPECIAL CONDITIONS:

ANY CUTTING OF TREES AND CLEARING REQUIRES A WORK PERMIT FROM THE LOCAL NATURAL RESOURCE OFFICER.

2757

MG 10263 10M-05/85

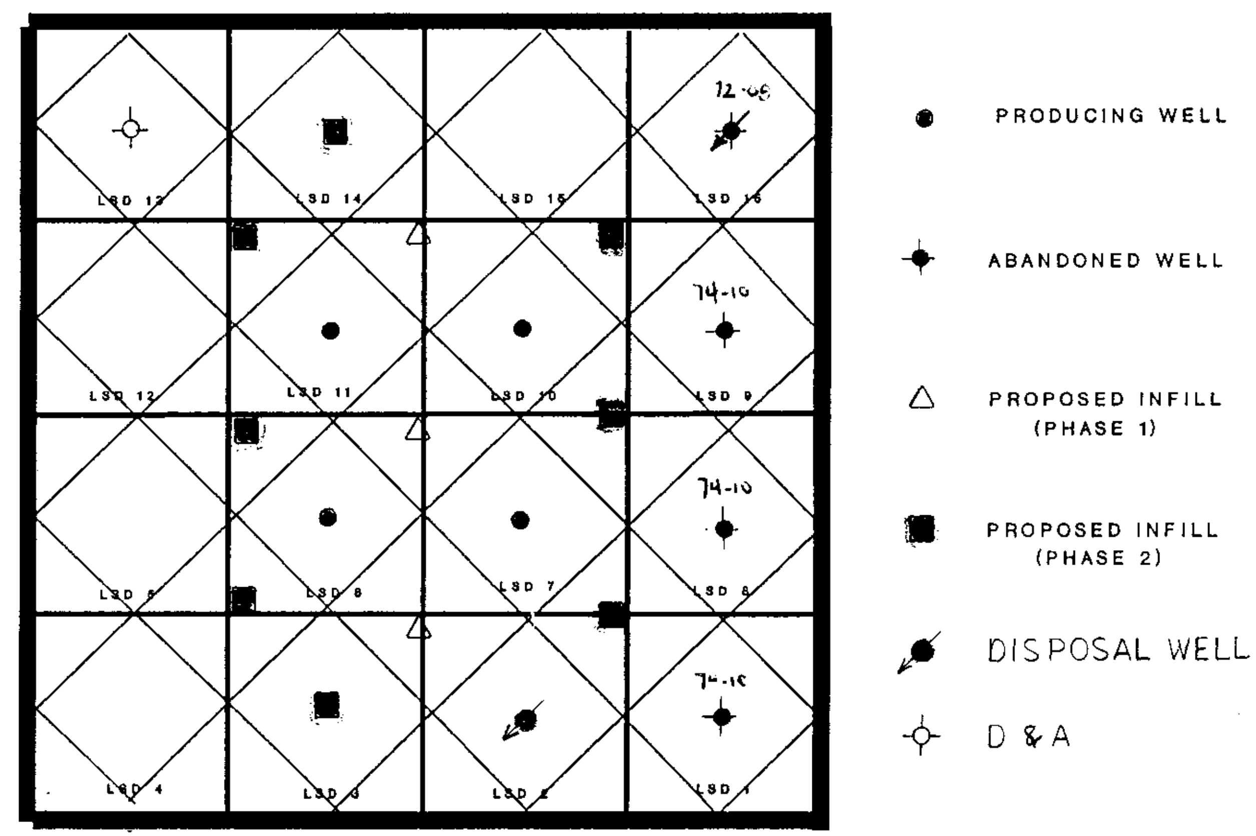
ROUTLEDGE FIELD

INFILL DRILLING PROGRAM

20 ACRE SPACING

SECTION 29-9-25

ABANDONMENT DATE



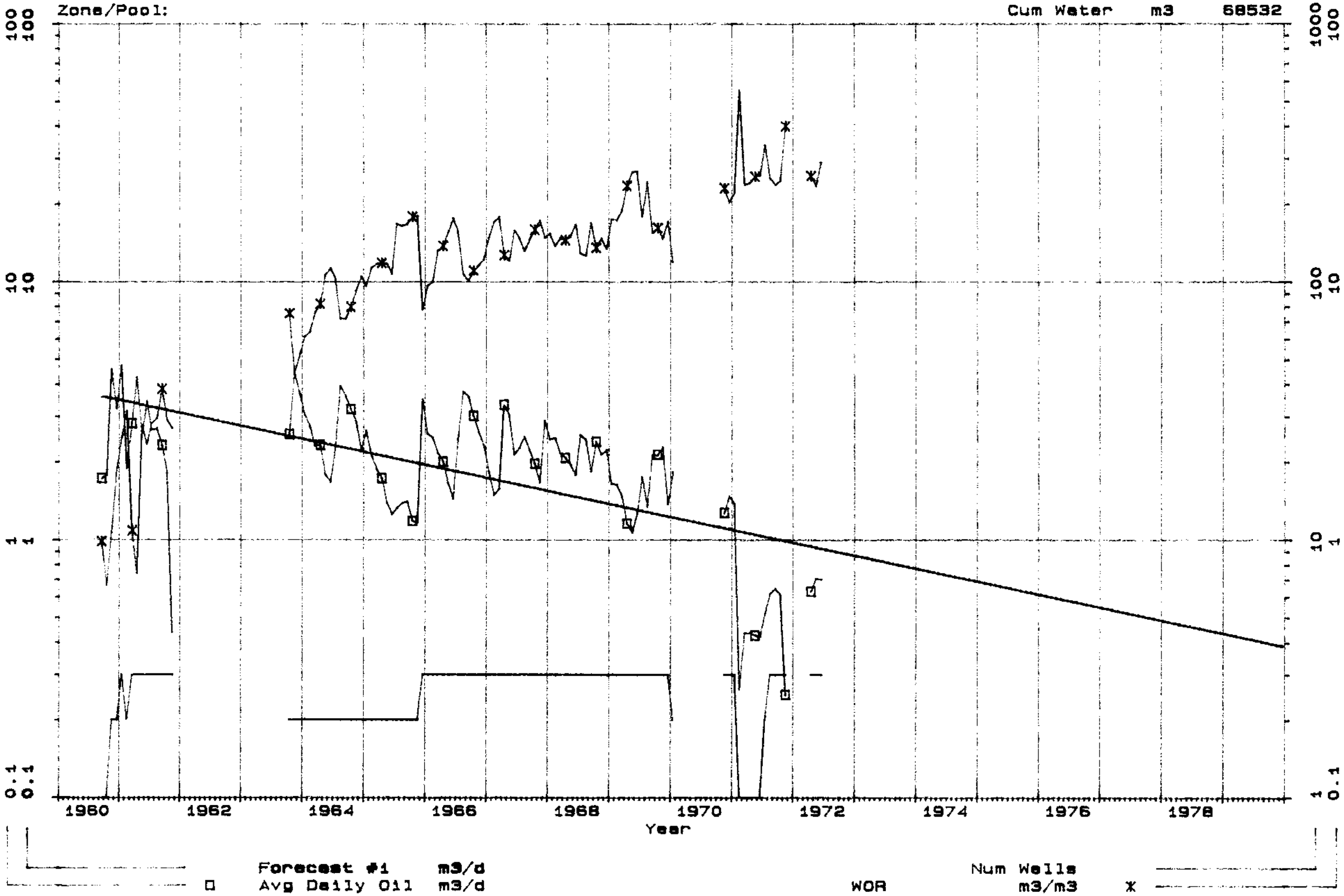
PRODUCTION WELL

02/07/95 15:05

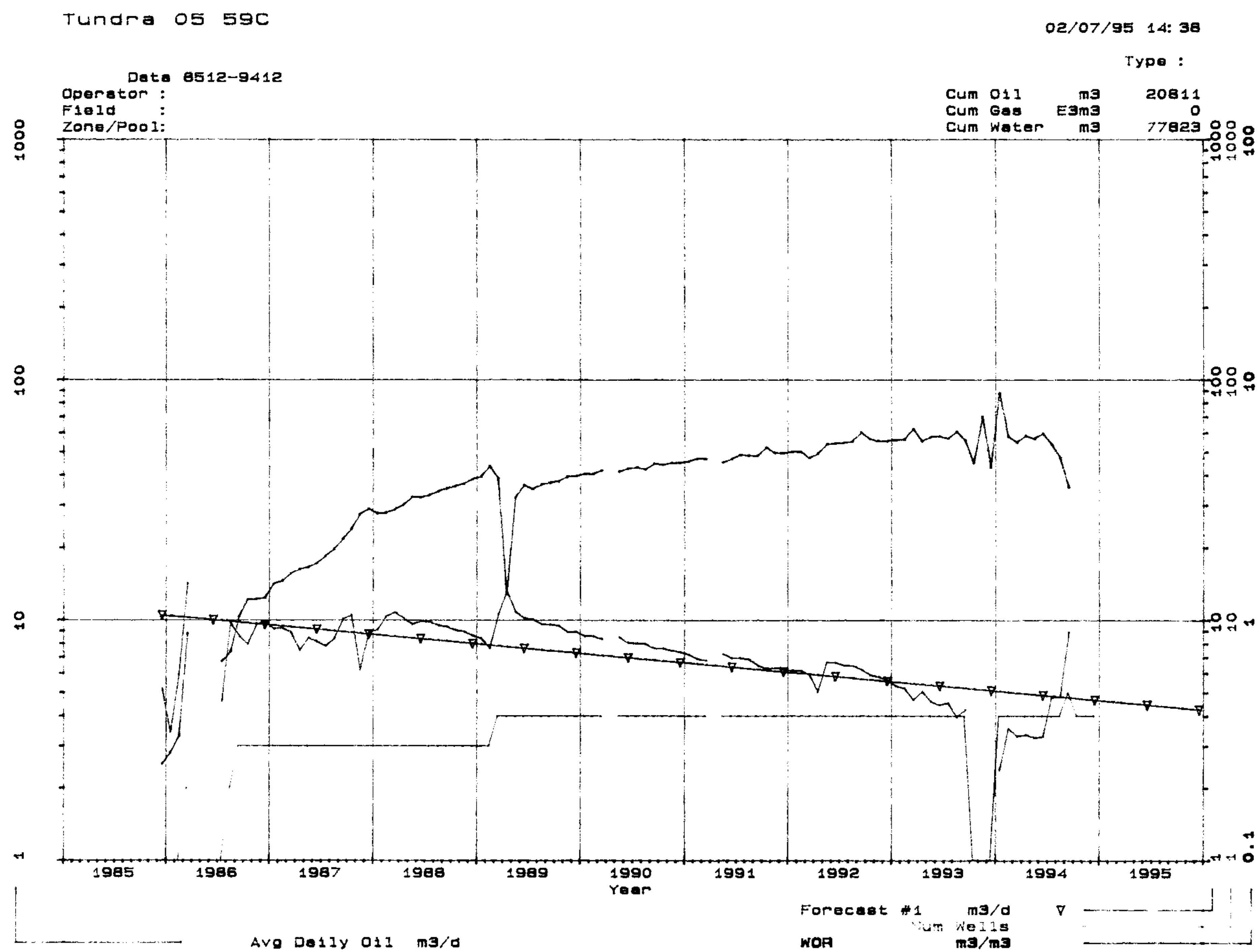
Type :

Data 6009-7206
Operator :
Field :
Zone/Pool:

Cum Oil	m3	6017
Cum Gas	E3m3	0
Cum Water	m3	68532



2.6.7.10+11-29-9-25

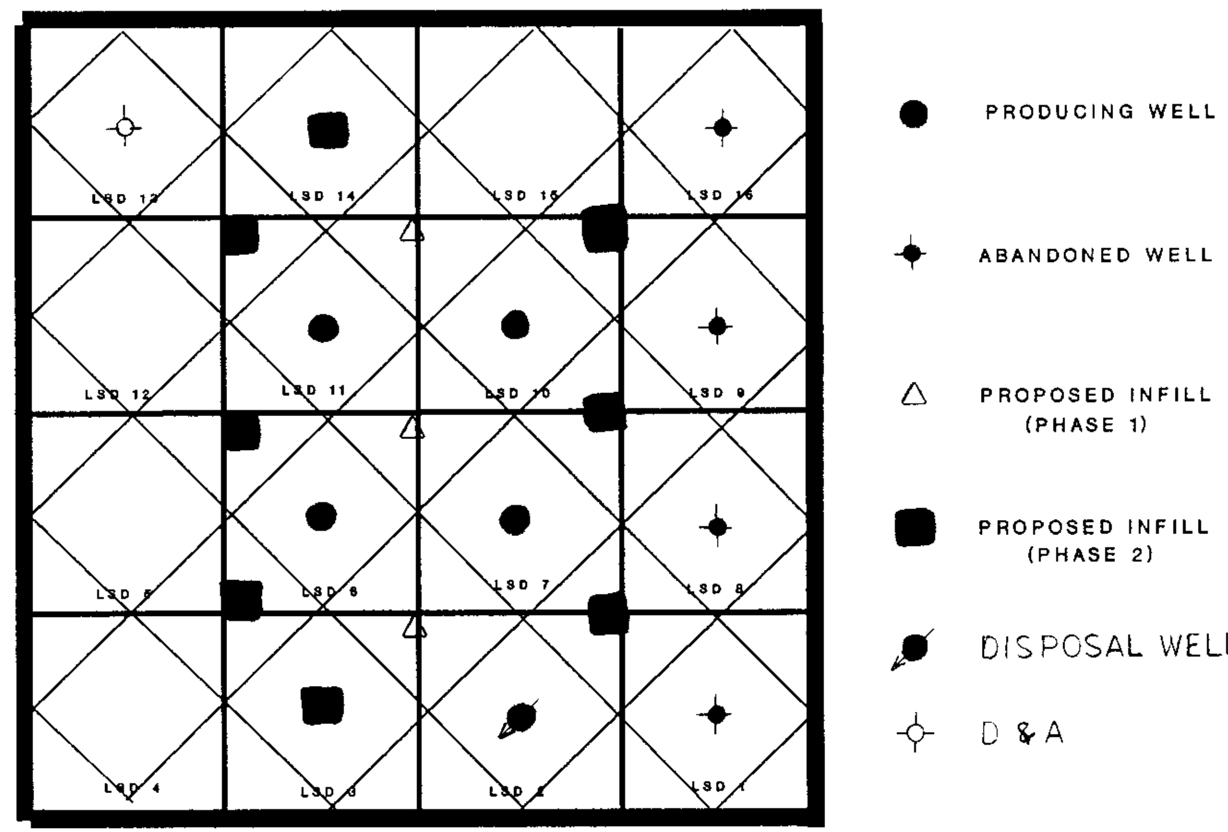


ROUTLEDGE FIELD

INFILL DRILLING PROGRAM

20 ACRE SPACING

SECTION 29-9-25



BATTERY @ 6-29-9-25 (clay barrier underlying tank dyke

INJECTION PUMP @ 2-29-9-25

- EVERYTHING FLOWLINED

- SANDY SOIL THROUGH-OUT

WP issued by DNR for 3 & 11-29 wellsites in JUN/94
Well Site
Access Road : cookbook conditions
F/L

- Tundra required the approval of the occupant SW/4 Sec 29

- Crown Land Permit for the wells ie. 10-29 well are issued annually & require a work permit be obtained before cutting & clearing work

INFILL PROJECT 9 WELLS

7 located in crop land
2 located in bush

bush cleared for wellsite & access road
$2 \times 100\,m \times 100\,m$ (wellsites) $+ 800\,m \times 15\,m$ (access road) $= 2.8$ ha.

cropland affected $7 \times 100 \times 100$ (wellsites) $+ (800\,m + 800) \times 15\,m = 9.4$ ha.

+ flowline RoW follow access roads

- non-built up roads, efforts to ~~protect~~ access roads from erosion.

- flowlines required to follow access roads

- infill wells located on agricultural land where possible

- Tundra required to conduct a survey ~~for~~ of flora & fauna note: the possibility of "spider wort" endangered

- development plan → optimum timing for drilling (?)

- NEED A FLOWLINE ROUTE MAP
- buried hydro preferred ?

- DNR has proposed a WMA in the W/2 of Sec 29 which currently contains 2 oil wells & a licensed location & Tundra tentatively plans 4 additional locations

CURRENT STATUS OF DEVELOPMENT

5 ABD WELLS 1, 8, 9, 13 & 16-29
4 PRODUCERS 6, 7, 10, 11-29
1 LOCATION 3-29
1 SWD 2-29
1 BATTERY 6-29

- CURRENT PRODUCTION (NOV/94) 10 m^3/d (NET VALUE NOV/94 : 40410 m^3)
- CUMUL. PROD. (94-12-01) 26828 m^3
INCLUDES ABD WELLS

REMAINING RECOVERABLE RESERVES : 33692 m^3
OOIP (4 WELLS) - 160,000 m^3 not including 11-29 200000 bbl
Pri. Rec 16 ba = 25% OOP
INCREMENTAL RECOVERY - 10%
INFILL WELL = 35000 - 40000 bbl

CROWN ROYALTIES PAID NOV/94 → $1593
INCLUDING 11-29 (HOV) → $5432

Feb. 13/95

John

RE: TUNDRA'S APPLICATION FOR REDUCED SPACING
– ROUTLEDGE (SEC. 29, T.9, R.25 WPM)

Attached are structure maps on top of the "Sandhill" and Scallion for the proposed infill area (Sec. 29) and surrounding sections, along with a gross isopach of the "oolites" in the Lower Virden and interbedded shaly carbonates.

A prominent structural high runs north-south through LSD's 2, 7 & 8 of Sec. 29 on the Scallion level. This high is reflected as a closure on the "Sandhill" level.

A isopach thick of the "Sandhill" to Scallion interval runs through Sec. 29 and northeast into Secs. 32 & 33.

The proposed infill program is therefore consistent with the mapping of the area.

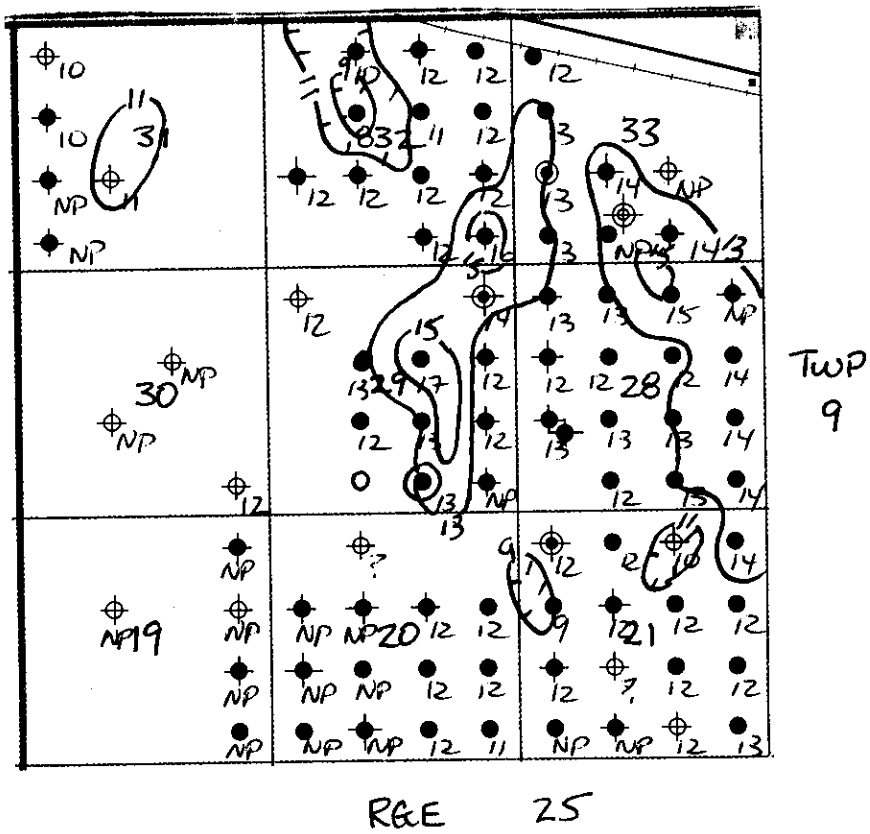
Wells in sec. 29 have been completed as follows:

1-29	OPEN-HOLE
2-29	OOLITES (L. VIRDEN)
6-29	SANDHILL + OOLITES OOLITES } L. VIRDEN
7-29	SANDHILL + OOLITES OOLITES } L. VIRDEN and SCALLION
8-29	OOLITES } L. VIRDEN
9-29	SCALLION
10-29	OOLITES } L. VIRDEN
11-29	OOLITES } L. VIRDEN and SCALLION
16-29	OPEN-HOLE

The majority of completions in Sec. 29 are in the oolites below the "Sandhill" in the Lower Virden.

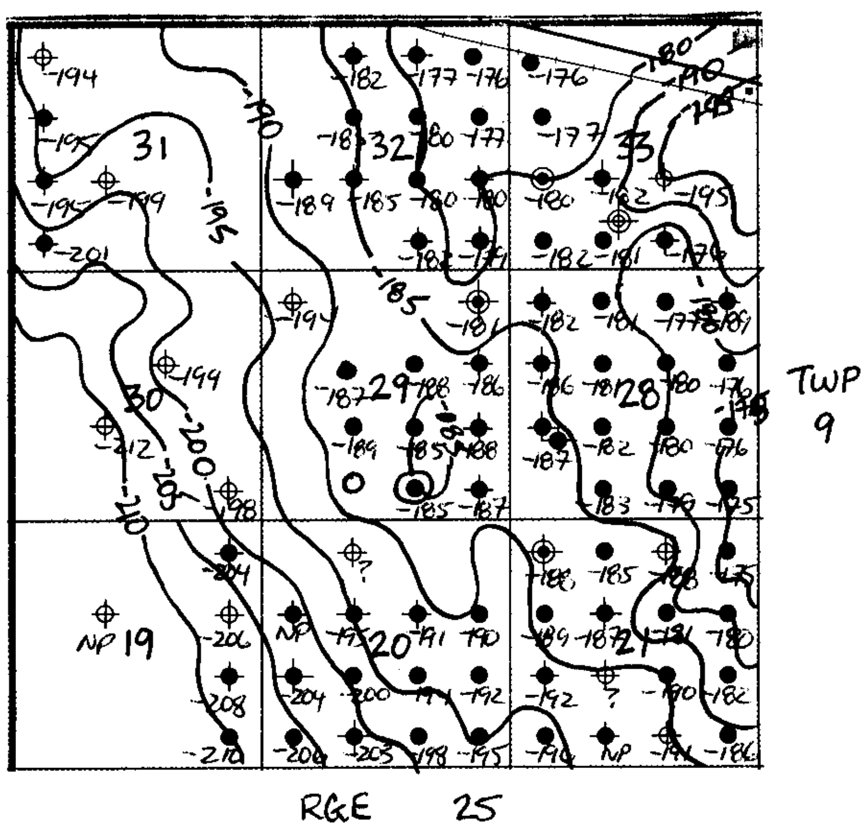
Carol M

ISOPACH MAP – FIRST OOLITE (SANDHILL) TO TOP OF SCALLION



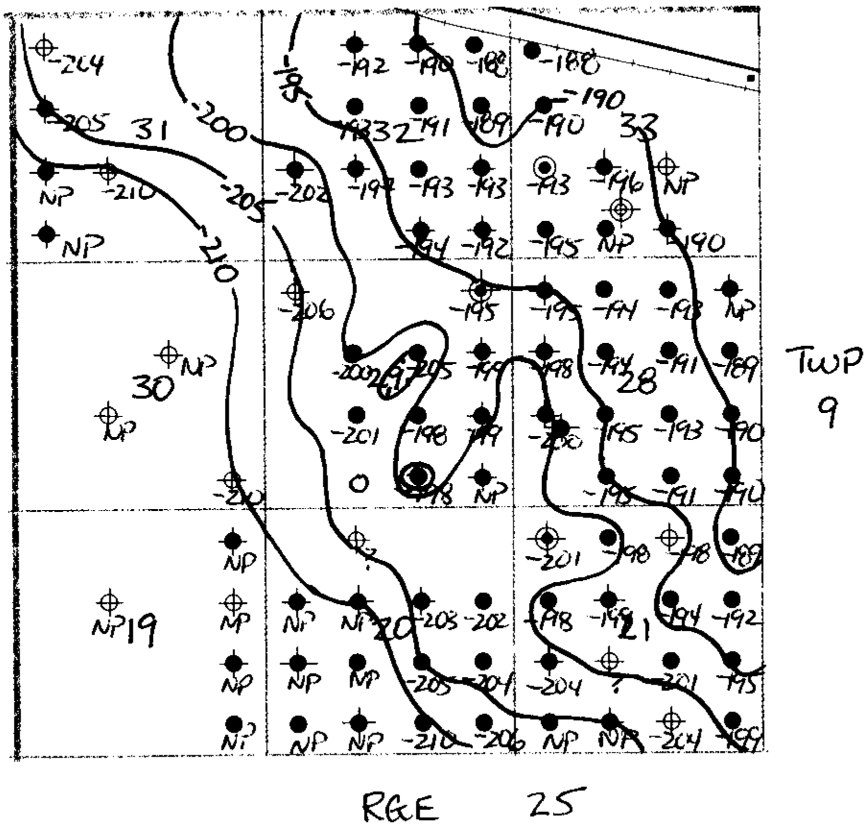
NP – NOT PENETRATED

STRUCTURE MAP ON TOP OF THE FIRST OOLITE (SANDHILL)



NP – NOT PENETRATED

STRUCTURE MAP ON TOP OF THE SCALLION



NP - NOT PENETRATED

Reference: DNR

Fax No: (204) 945-0586

Date: 29-JUL-99

Total No. of Pages: (including this page) 6 + 1

FROM:

John N. Fox, P. Eng.
Petroleum Branch, Energy & Mines
Phone: (204) 945-6574

CONTACT:
JANET MOORE
945-2315
RE: SURVEY REQUIREMENT
FROM: LARRY BIDLAKE

TO:

Name: KIP TYLER

Branch: DNR

Fax No: 945-4552

Comments:

ATTACHED ARE COPIES OF TUNDRA'S APPLICATION FOR INFILL DRILLING IN SEC. 29-9-25 AND A COPY OF OUR CORRESPONDENCE WITH TUNDRA ON THE MATTER. TUNDRA WOULD LIKE TO MEET JOINTLY WITH ~~OF~~ THE DNR & ENERGY + MINES TO DISCUSS THE REQUIREMENTS FOR A FLORA & FAUNA SURVEY & ANY OTHER ASSESSMENT WORK TO BE CARRIED OUT

Originals will be:

Mailed to you ____ Mailed upon request ____ Remain on file ____

Manitoba

Energy and Mines

Petroleum

1395 Ellice Avenue Suite 360
Winnipeg MB R3G 3P2
CANADA

PH: (204) 945-6577
Fax: (204) 945-0586

February 10, 1995

Mr. George Czyzewski, P.Eng.
Senior Reservoir Engineer
Tundra Oil and Gas Ltd.
1111 - One Lombard Place
Winnipeg MB R3B 0X4

Dear Mr. Czyzewski:

Re: Reduced Spacing in the Routledge Field

This letter is to acknowledge receipt of your request for a review of land issues involved with reduced 8 ha spacing in Section 29-9-25 WPM.

Tundra has requested Lsd's 3,4 & 5 be posted for the May 3, 1995 Crown land sale. As part of land sale review, the Department of Natural Resources (DNR) will be asked to comment on conditions for petroleum development. We expect the DNR's comments in early March just before the land sale notice released. The Branch is also working with the DNR to clarify the approval process and conditions for petroleum development where the Crown owns the surface.

Section 29-9-25 WPM has sandy soil, natural areas and is habitat for the endangered Spider Wort plant. It is anticipated a development plan will be required before additional drilling is permitted. The development plan should include plans to minimize the impact of petroleum development on:

- existing land uses
- indigenous flora and fauna
- aesthetic and scenic value of the land
- recreational uses

Based on previous discussions with the DNR on other locations, Tundra can anticipate some or all of the following conditions in a development plan:

a) where possible, locate wells on agricultural lands;

b) conduct a survey of rare and endangered flora and fauna and no surface disturbance will be permitted, where endangered species may be effected;

c) minimize surface disturbance and protect against erosion;

d) there may be times of the year when drilling is restricted; and

e) restoration and rehabilitation guidelines.

After the May 3rd land sale, if Tundra is the successful bidder and still intends to pursue reduced spacing, we can commence formal discussions with the DNR. If you have any questions please don't hesitate to call the undersigned.

Yours truly,

John N. Fox, P.Eng.
Chief Petroleum Engineer

THE CALIFORNIA STANDARD COMPANY

Plan of

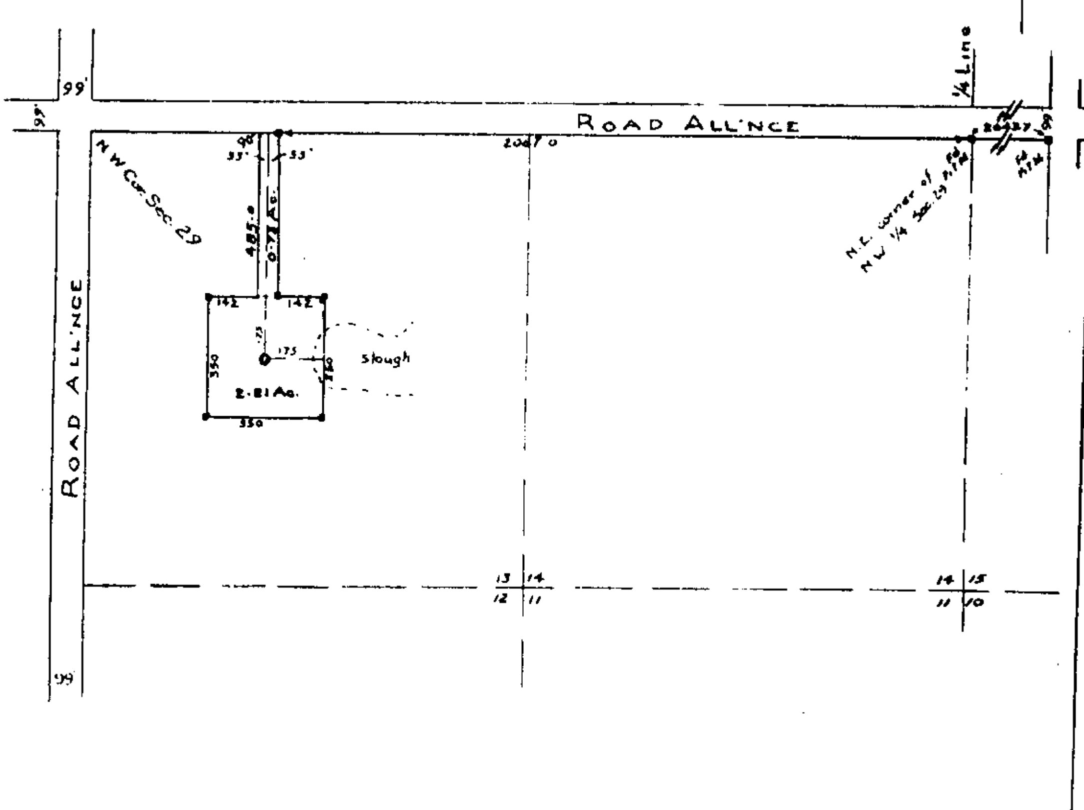
CALSTAN ~ ROUTLEDGE ~ PROV. 13-29

Ls. 13, Sec. 29, Tp. 9, Rg. 25 W.P.M.

MANITOBA.

Scale 400 feet = 1 inch

Area req'd. 3.54 Ac shown outlined in pink.
Coords. of well referred to N.E corner of the N.W. ¼ of Sec 29. South 660, West 2100
Elev of ground at well 1425.
Iron bars ½" diam x30" ■
Well location : o



Survey and plan certified correct

M. A. Fawcett

Manitoba Land Surveyor
Nov. 30, 1953.

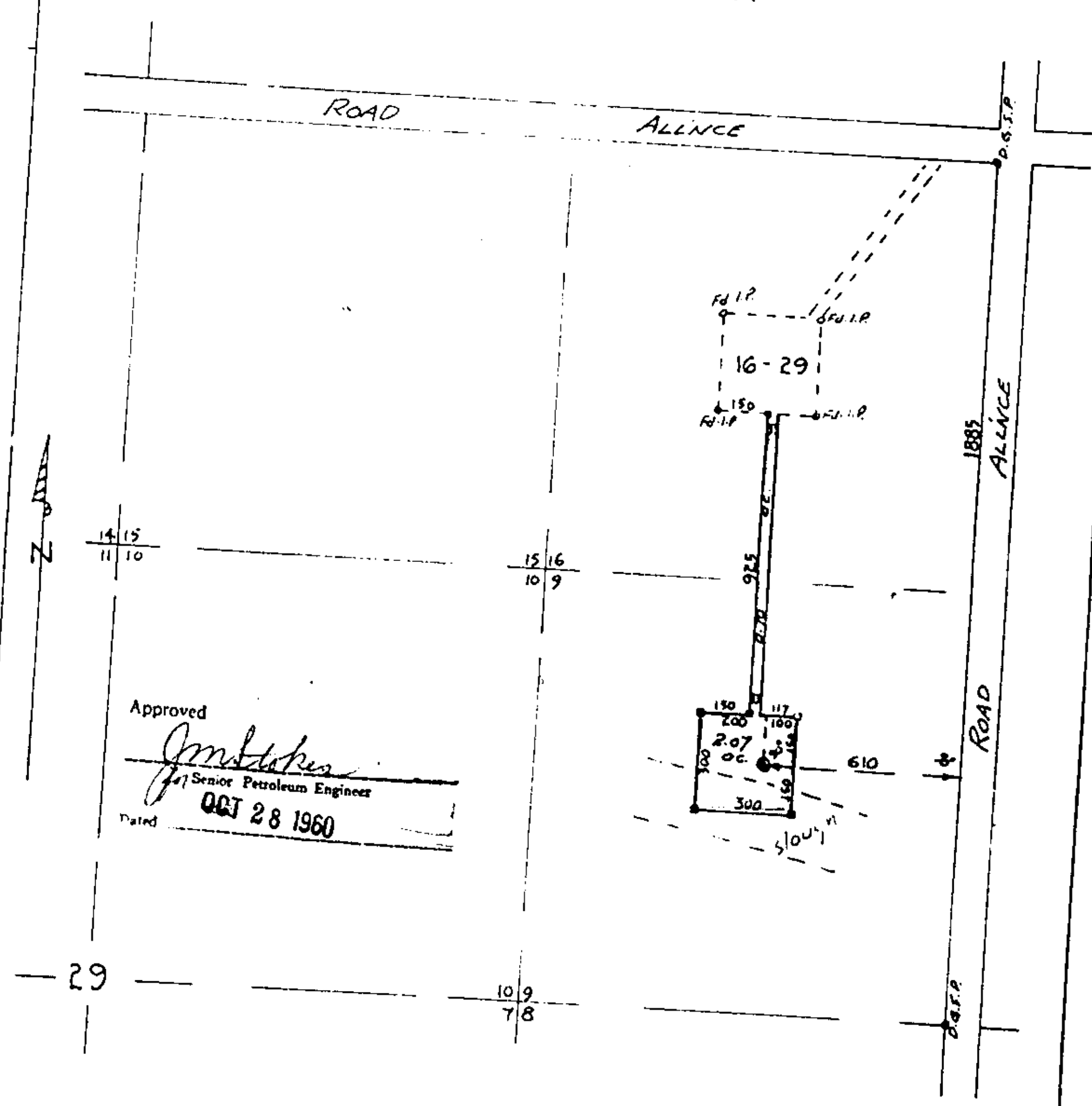
GLACIER PETROLEUMS INC.

Plan of

GLACIER ROUTLEDGE PROV. 9-29-9-25

L.S. 9, Sec. 29, Twp. 9, Rge. 25 W.P.M.

MANITOBA



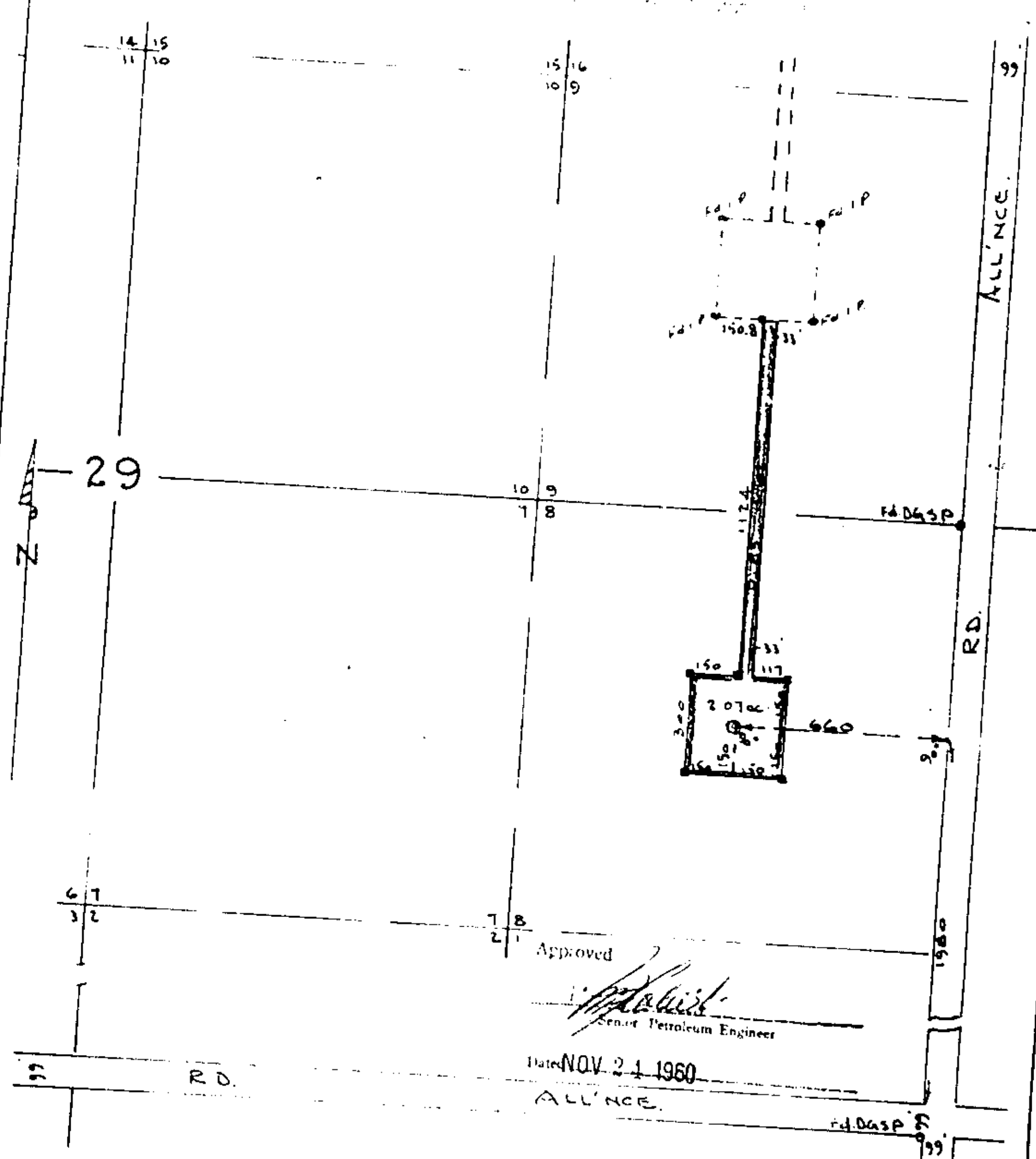
Survey and plan certified correct
Date of survey, Oct. 13, 1960

M.L.S.

Well co-ords
1885 South of North bdy. Sec. 29
610 West of East bdy. Sec. 29
Area reqd. 2.77 ac., bordered red.
Ground elev. at well. 1423.6
Iron bars 5/8" x 24" at: ▪
Well location shown: ◎

V14/143, 144

GLACIER PETROLEUMS INC.
Plan of
GLACIER ROUTLEDGE PROV. 8-29-9-25
L.S. 8, Sec. 29 Twp. 9. Rge. 25 W.P.M.
MANITOBA



Survey and plan certified correct
Date of survey. Nov 8 & 9, 1960

R. [illegible]
M.L.S.

Well co ords
1980 North of South bdy. Sec. 29
660 West of East bdy. Sec 29.
Area reqd 2.92 ac., [illegible] red
Ground elev. at well 1423.4
Iron bars 5/8" x 16" at •
Well location shown ◎

V15/11/12

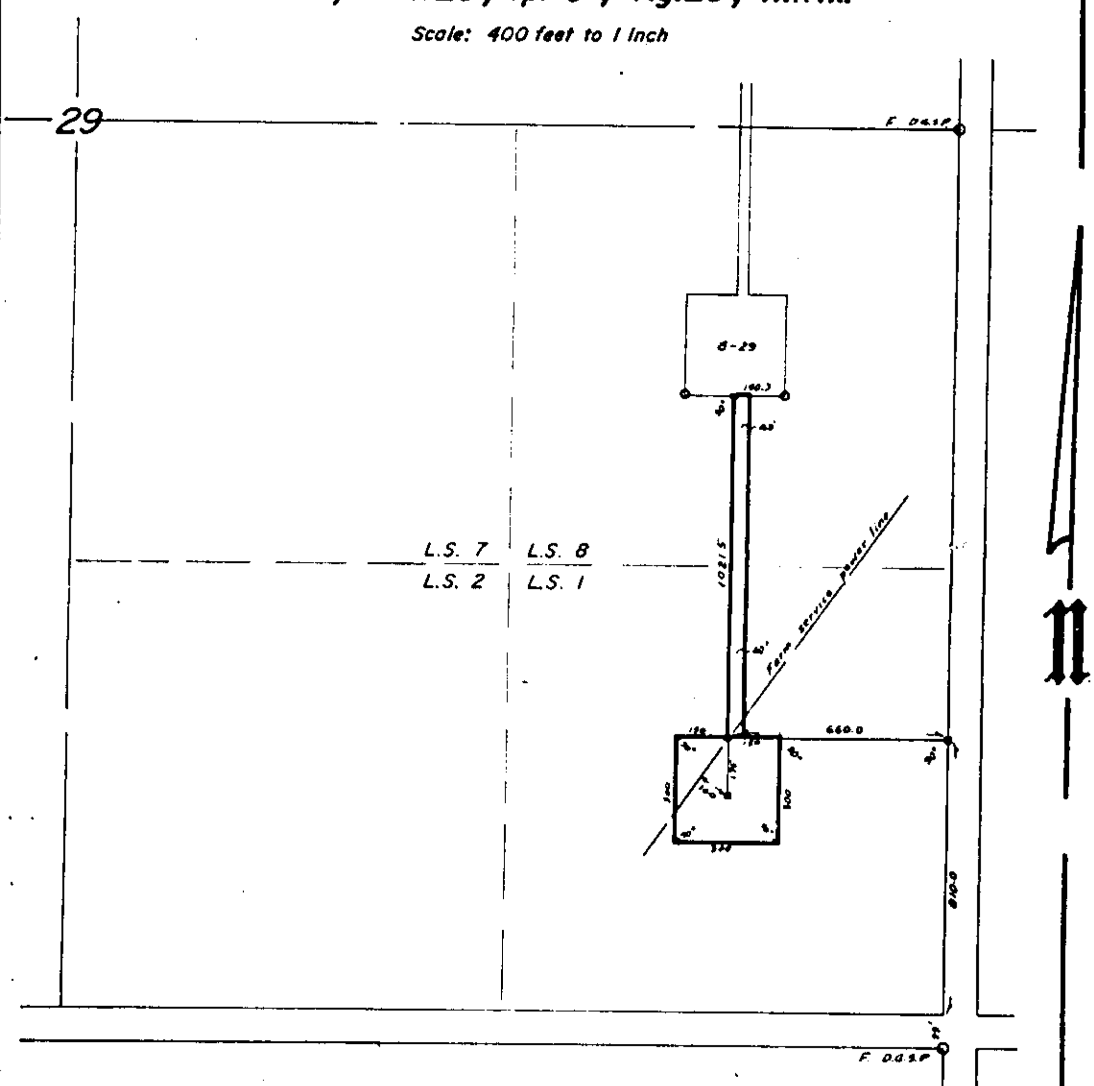
606

RUNDLE ROUTLEDGE PROV. 1-29-9-25

Well Site and Access Road

L.S. 1, Sec. 29, Tp. 9, Rg. 25, W.P.M.

Scale: 400 feet to 1 inch



I certify that the survey represented by this plan is correct and true to the best of my knowledge and was performed on the 1, 2, days of November, A.D. 1965

Manitoba Land Surveyor

B. E. Howey

Witness

MIDWEST SURVEYS (SASK) LIMITED

Operator:

RUNDLE PETROLEUMS LTD.

ELEVATION: 1421 Ground

CO-ORDINATES: N 635 from S. Bdy. 29

W 660 from E. Bdy. 29

AREAS:

Well Site	2.07	ac.
Access Road	0.94	ac.
Total	3.01	ac.

Portions referred to outlined in red ——

Survey monuments found shown thus ○

Iron pins ⅝"x15" planted shown thus •

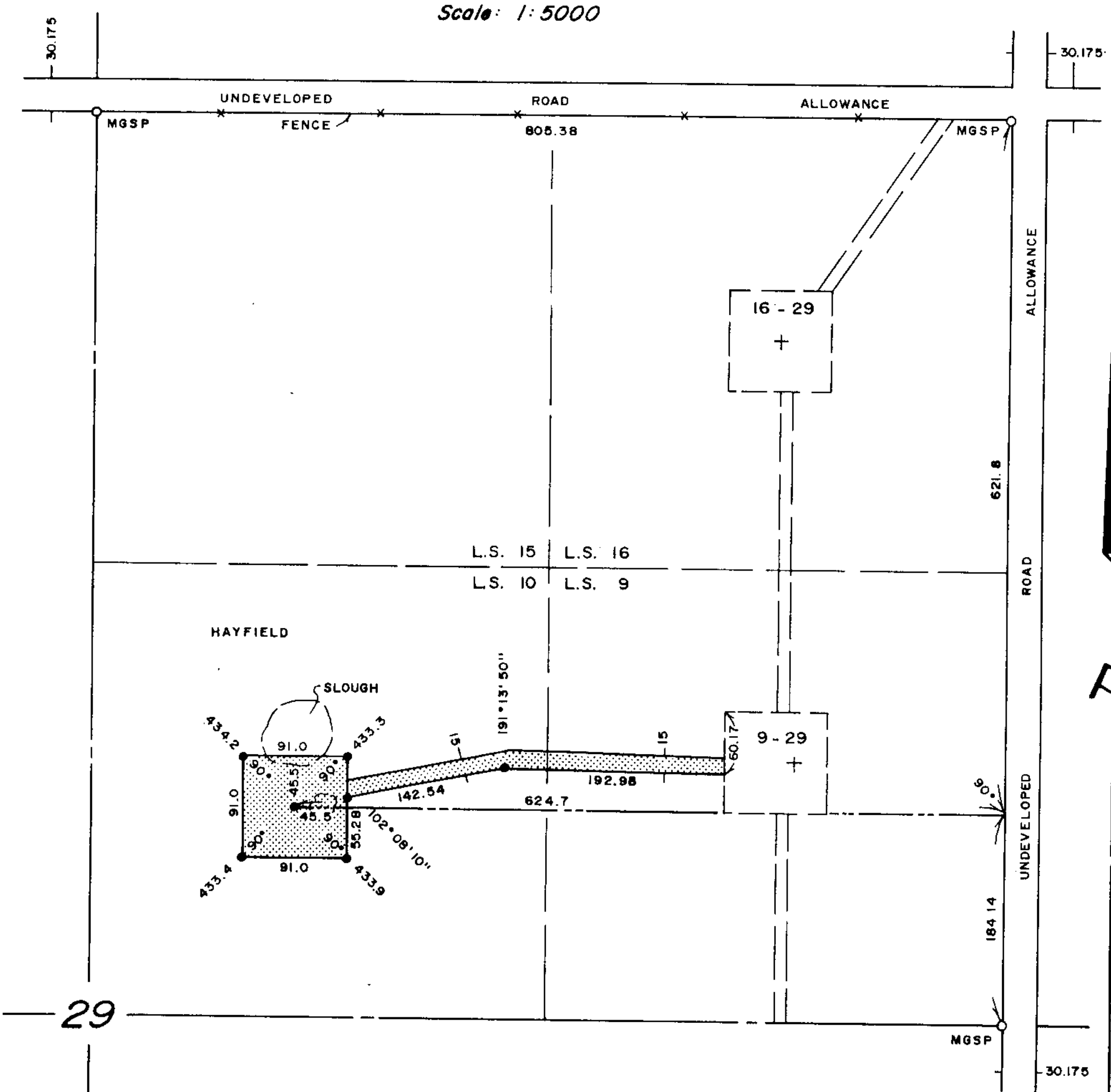
Fir posts 2"x2"x15" planted shown thus ▪

SASKOIL ET AL VIRDEN 10·29·9·25

Well Site and Access Road

L.S. 10, Sec. 29, Tp. 9, Rg. 25, W.P.M.

Scale: 1:5000



I certify that the survey represented by this plan is correct and true to the best of my knowledge and was completed on the 10th day of February, A.D. 1986.

Manitoba Land Surveyor

Witness

Operator: SASKATCHEWAN OIL AND GAS CORPORATION

ELEVATION: 434.2 Ground

CO-ORDINATES: 621.8 S. of N. Bdry. / 624.7 W. of E. Bdry. } Sec. 29

AREAS:

Well Site:	0.83 ha	(2.05 ac.)
Access Road:	0.50 ha	(1.24 ac.)
Total:	1.33 ha	(3.29 ac.)

Portion referred to shown thus
Survey monuments found shown thus ○
Iron pins 1.5 cm x 38.1 cm planted shown thus •
Fir posts 5.0 cm x 5.0 cm x 38.1 cm planted shown thus ■

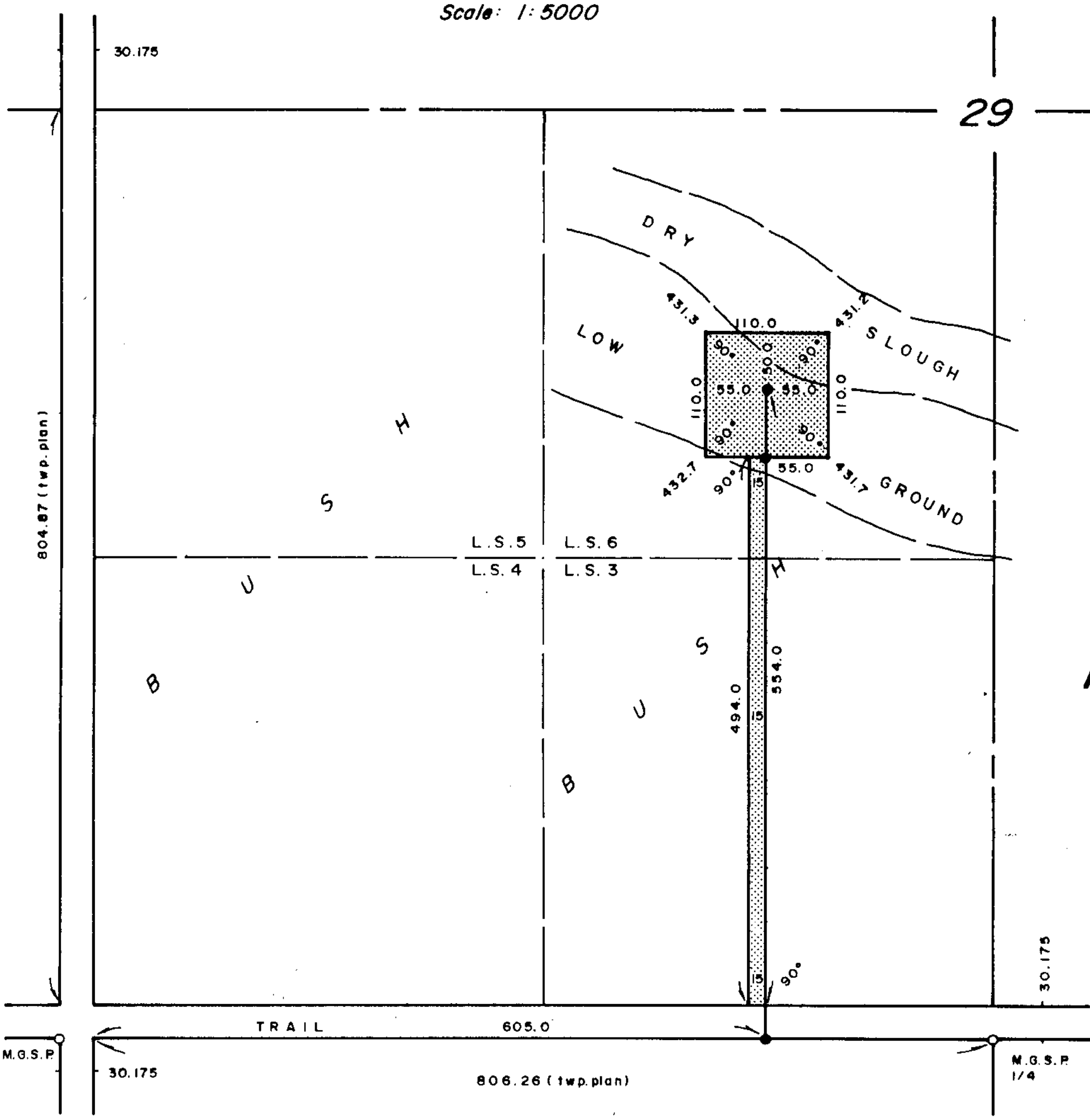
E-5999

SASKOIL VIRDEN 6·29·9·25

Well Site and Access Road

L.S. 6 , Sec. 29, Tp. 9 , Rg. 25, W. PM.

Scale: 1:5000



I certify that the survey represented by this plan is correct and true to the best of my knowledge and was completed on the 4th day of November , A.D. 1985.

Manitoba Land Surveyor

Witness

ELEVATION: 431.1 Ground

CO-ORDINATES: 554.0 N of S Bdry. } Sec. 29
605.0 E of W Bdry.

AREAS:

Well Site: 1.21 ha (2.99 ac.)
Access Road: 0.74 ha (1.83 ac.)
Total: 1.95 ha (4.82 ac.)

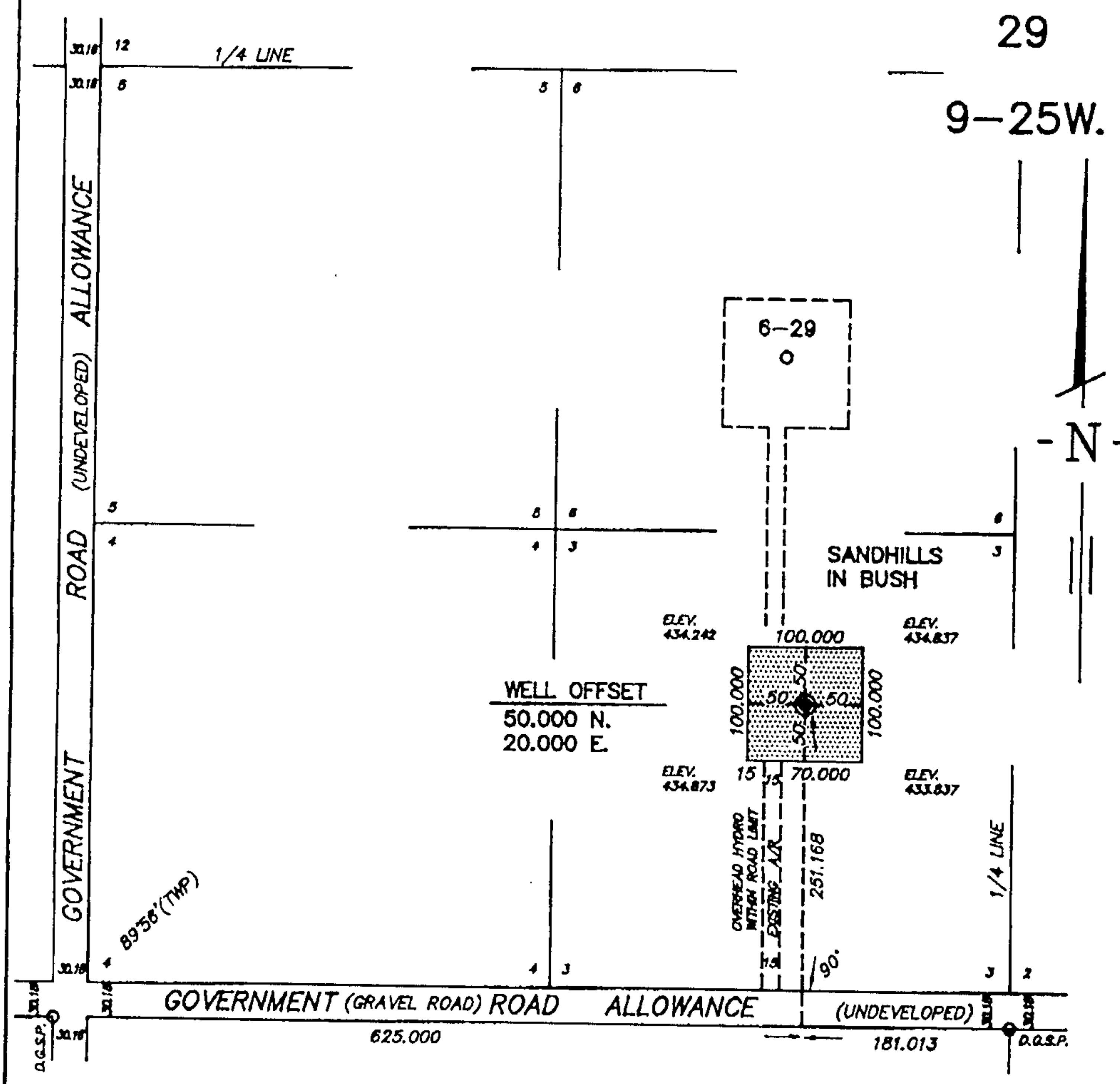
Operator:
SASKATCHEWAN OIL AND GAS CORPORATION

E 5512

Portion referred to shown thus
Survey monuments found shown thus
Iron pins 1.5 cm x 38.1 cm planted shown thus
Fir posts 5.0 cm x 5.0 cm x 38.1 cm planted shown thus

PLAN OF WELL SITE LOCATION
TUNDRA VIRDEN
LSD. 3 ,SEC. 29 ,TP. 9 ,RGE. 25 W.P.M.
MANITOBA

Scale 1: 5000



NOTES

All distances are in metres or decimals of a metre and may be converted to feet by multiplying by 3.28084
Well location is shown thus
Area required is shown outlined thus
Survey monuments found are shown thus
Iron posts 0.025 SQ. planted are shown thus
Iron posts 0.013 Diam. planted are shown thus
Well Coordinates: 625.000 E. OF W. BDRY. SEC.29
251.168 N. OF S. BDRY. SEC.29

Ground elevation at well: 433.776
Areas Well Site 1.000 ha., 2.47 acres
Access Road 0.000 ha., 0.00 acres
Total 1.000 ha., 2.47 acres

TUNDRA OIL AND GAS LTD.

(REVISED June 9th., 1994)
Plan and Survey certified correct this 7th day of June, 1994.

Richard C. Purvis
Manitoba Land Surveyor

Witness

LENNON SURVEYS
1840 Rosser Avenue
Brandon,Manitoba R7A 0M8
(204) 727-0651
FAX (204) 727-5247

FB/PGE 290/59

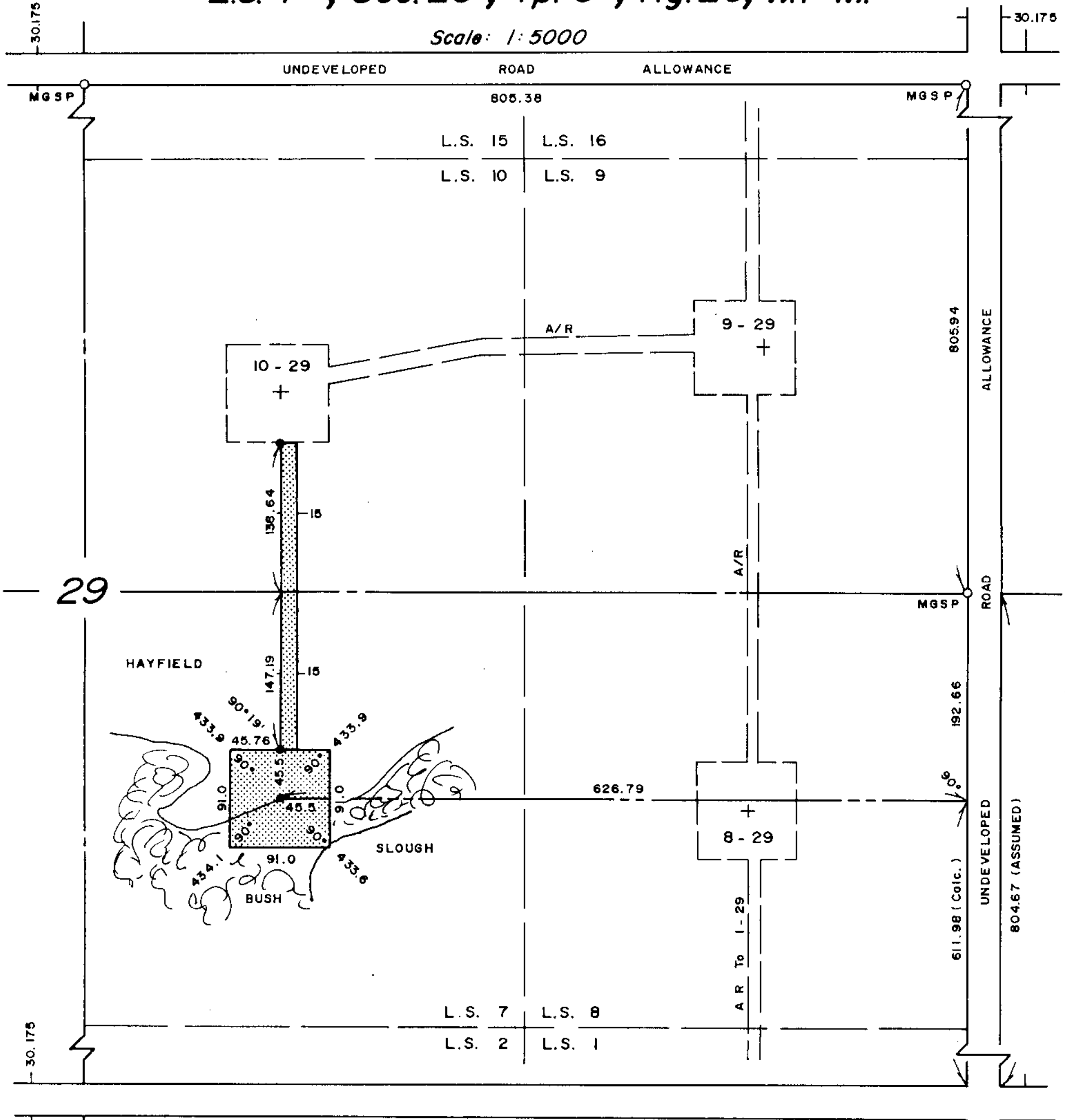
JOB No. 94-126F
REVISED

SASKOIL ET AL VIRDEN 7·29·9·25

Well Site and Access Road

L.S. 7 , Sec. 29 , Tp. 9 , Rg. 25, W.P.M.

Scale: 1:5000



I certify that the survey represented by this plan is correct and true to the best of my knowledge and was completed on the 10th day of February , A.D. 1986.

Manitoba Land Surveyor

M Jordan
Witness

Operator: SASKATCHEWAN OIL AND GAS CORPORATION

ELEVATION: 433.8 Ground

CO-ORDINATES: 611.98 N. of S. Bdry. } Sec. 29
626.79 W of E. Bdry.

AREAS:

S.E. 1/4-29	Well Site:	0.83 ha	(2.05 ac.)
	Access Road:	0.22 ha	(0.55 ac.)
	Total:	1.05 ha	(2.60 ac.)
N.E. 1/4-29	Access Road:	0.21 ha	(0.51 ac.)
	Total:	1.26 ha	(3.11 ac.)

Portion referred to shown thus . . . .

Survey monuments found shown thus . . . . . . ○

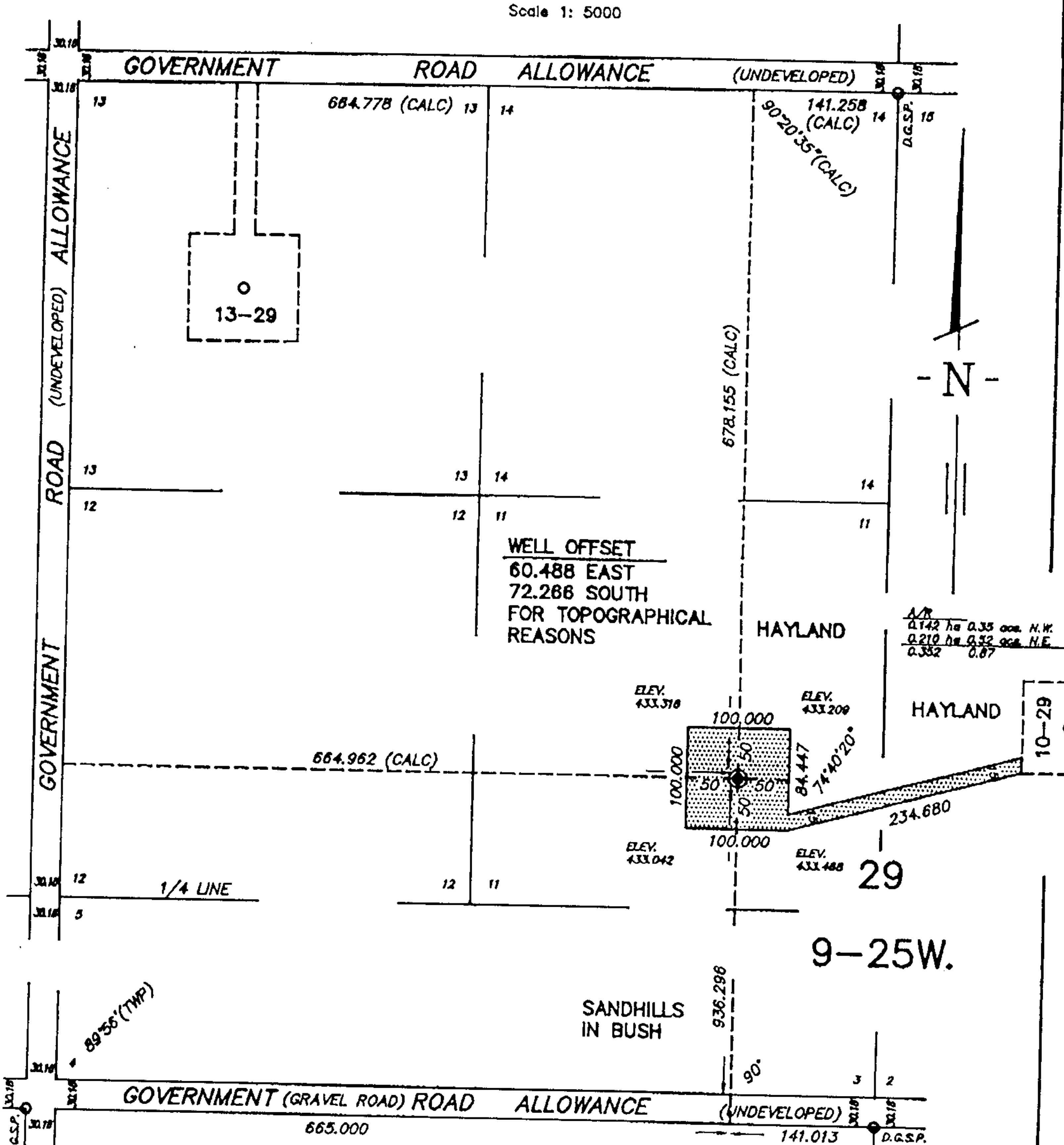
Iron pins 1.5 cm x 38.1 cm planted shown thus . . . ●

Fir posts 5.0 cm x 5.0 cm x 38.1 cm planted shown thus . . ■

E-5998

PLAN OF WELL SITE LOCATION
TUNDRA VIRDEN
LSD. 11 ,SEC. 29 ,TP. 9 ,RGE. 25 W.P.M.
MANITOBA

Scale 1: 5000



NOTES

All distances are in metres or decimals of a metre and may be converted to feet by multiplying by 3.28084
Well location is shown thus
Area required is shown outlined thus
Survey monuments found are shown thus
Iron posts 0.025 SQ. planted are shown thus
Iron posts 0.013 Diam. planted are shown thus
Well Coordinates: 664.962 E. OF W. BDRY. SEC.29
678.155 S. OF N. BDRY. SEC.29

Ground elevation at well: 433.636
Areas Well Site 1.000 ha., 2.47 acres
Access Road 0.352 ha., 0.87 acres
Total 1.352 ha., 3.34 acres

TUNDRA OIL AND GAS LTD.

Plan and Survey certified correct this 9th day of June, 1994.

Richard C. Francis
Manitoba Land Surveyor

Witness

LENNON SURVEYS
1640 Rosser Avenue
Brandon, Manitoba R7A 0M8
(204) 727-0651
FAX (204) 727-5247

FB/PGE 280/62

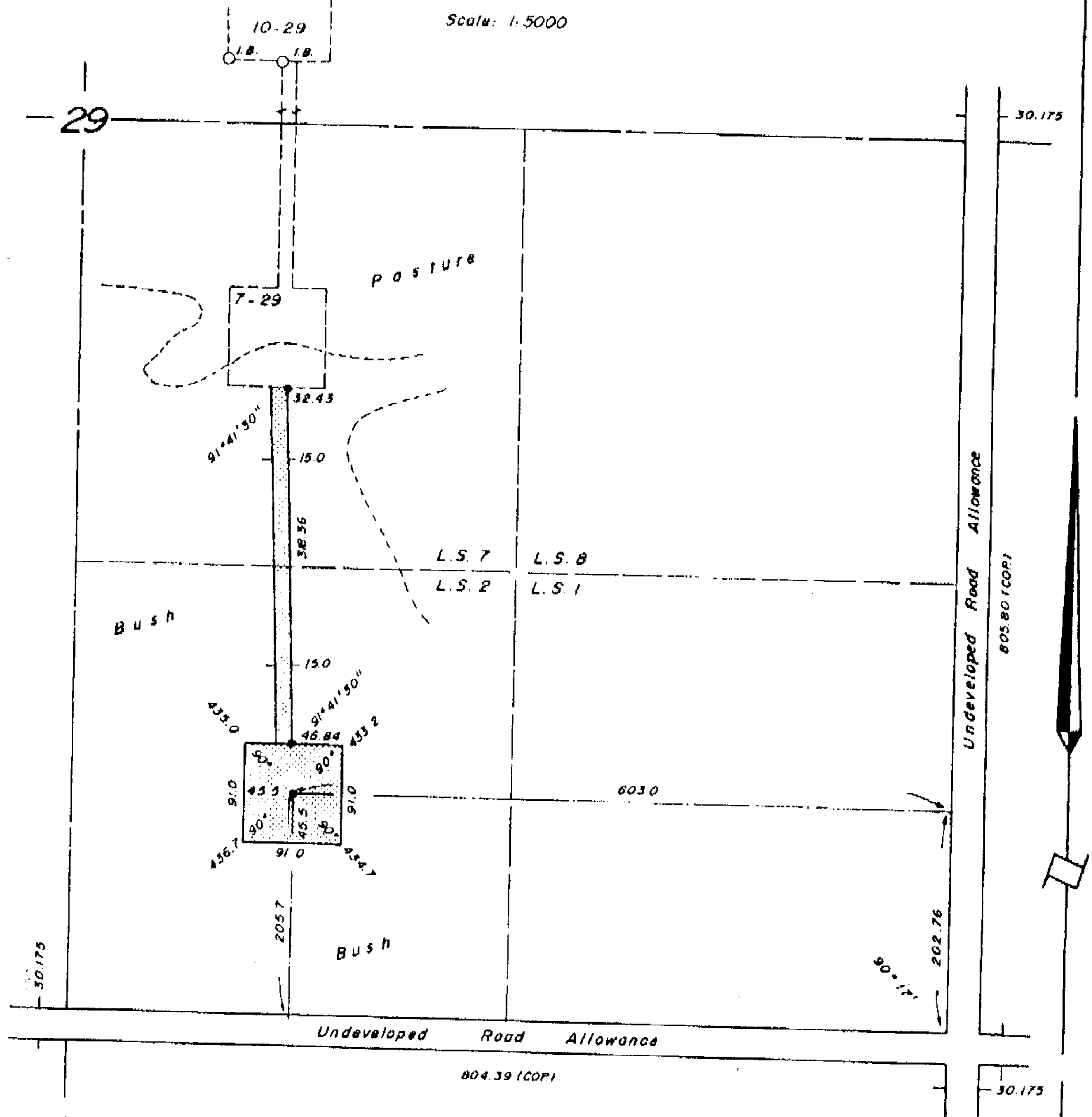
JOB No. 94-126G

SASKOIL ET AL VIRDEN 2·29·9·25

Well Site and Access Road

L.S. 2 , Sec. 29, Tp. 9 , Rg. 25, W.P.M.

Scale: 1:5000



I certify that the survey represented by this plan is correct and true to the best of my knowledge and was completed on the 5th day of December , A.D. 1988.

Saskatchewan Land Surveyor

Witness

E-8704

OPERATOR: SASKATCHEWAN OIL AND GAS CORPORATION

ELEVATION: 434.8 Ground

CO-ORDINATES: 205.7 N. of S. Bdry. } Sec. 29
603.0 W. of E. Bdry.

CARTESIAN CO-ORDINATES: 202.76 N. & 603.0 W. of S.E. Cor. Sec. 29

AREAS: Well Site: 0.83 ha (2.05 ac.)
Access Road: 0.48 ha (1.18 ac.)
Total: 1.31 ha (3.23 ac.)

NOTE:
All underground installations should be located by the respective authorities prior to construction.
There are no surface improvements within 75 m of Well location except as shown
Occupied farmyards are shown thus ▲
Unoccupied farmyards are shown thus △
Portion referred to shown thus
Survey monuments found are shown thus ○
Iron spikes 30cm planted are shown thus •
Firposts 5.0 cm x 5.0 cm x 38.1 cm planted are shown thus ■

REVISIONS:

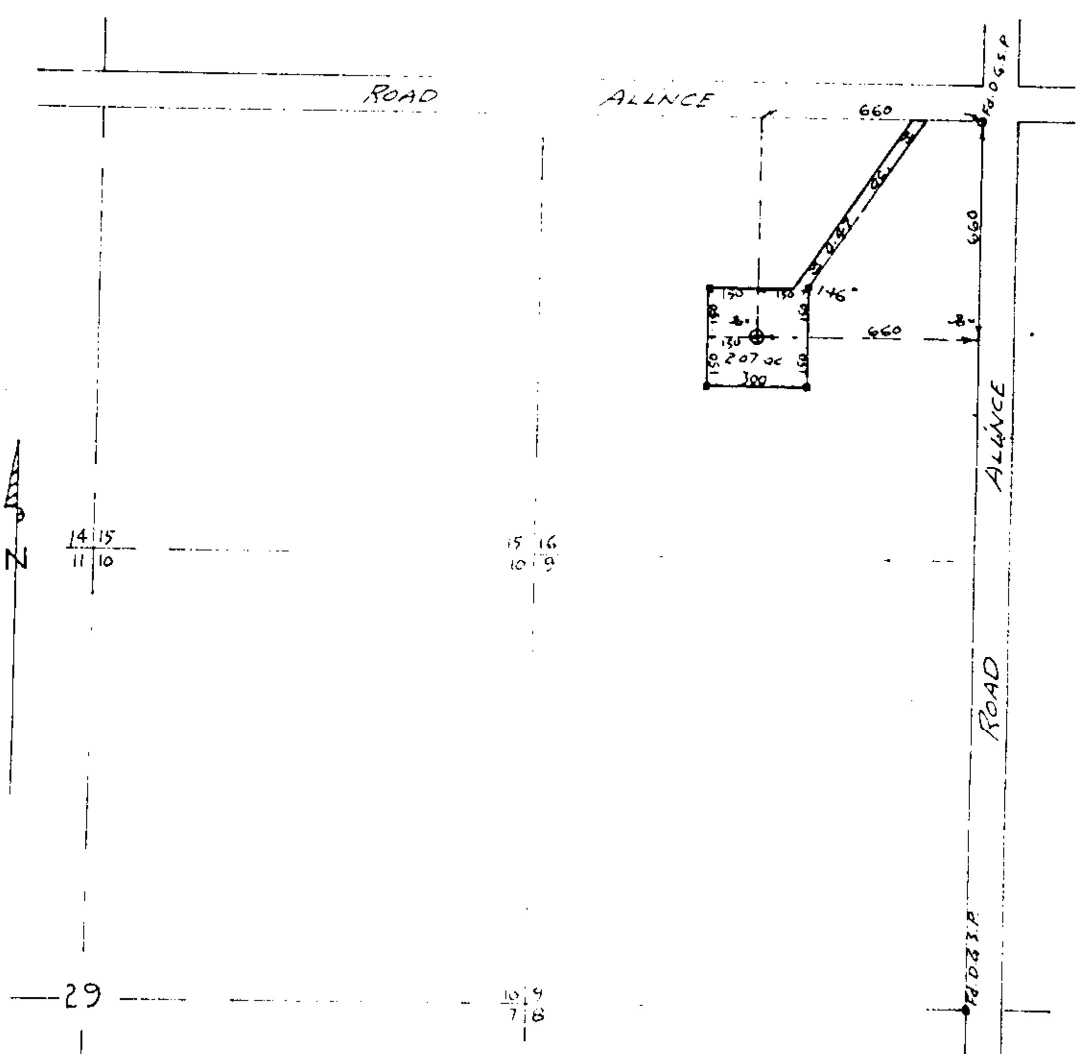
GLACIER PETROLEUMS INC.

Plan of

GLACIER ROUTLEDGE PROV. 16-29-9-25

L.S. 16, Sec. 29, Twp. 9, Rge. 25 W.P.M.

MANITOBA



Approved
M. J. GUBERI Per [signature]
Senior Petroleum Engineer

Dated JUL 4 1960

Survey and plan certified correct
Date of survey, June 17, 1960.

[signature]
M.L.S.

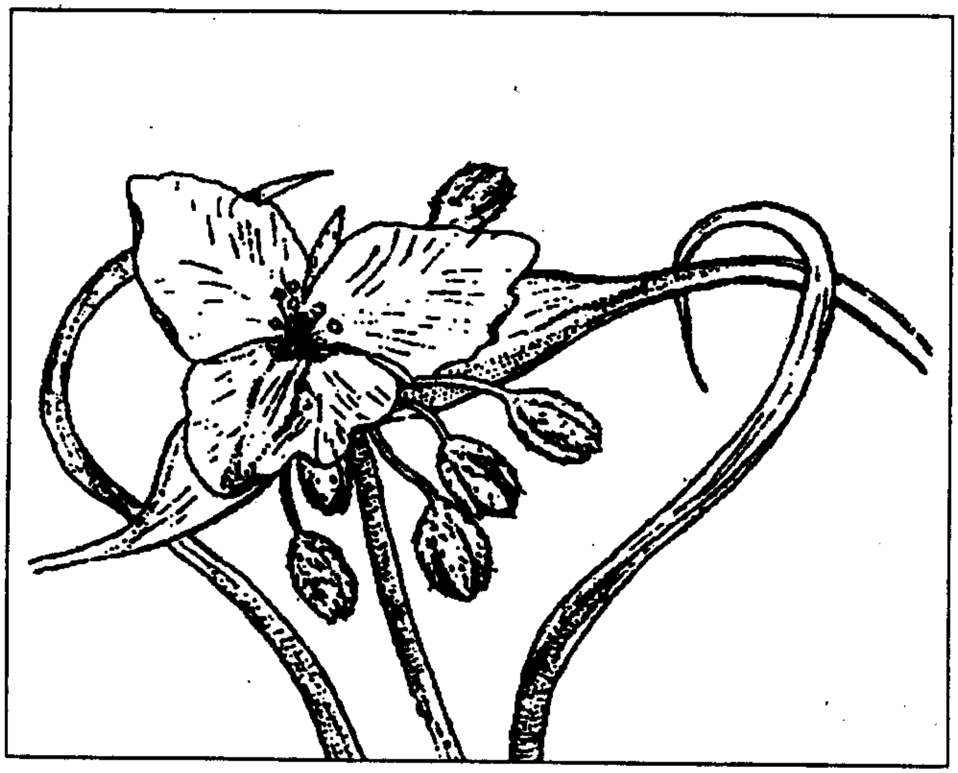
Well co ords
660 South of North bdy Sec. 29
660 West of East bdy. Sec. 29
Area reqd. 2.54 ac. bordered red
Ground elev. at well 1423.1
Iron bars 3/8" x 24" at •
Well location ⊙

v14/39,40

71
Green

STATUS REPORT ON ENDANGERED WILDLIFE IN CANADA

Western Spiderwort



COMMITTEE ON THE STATUS
OF ENDANGERED WILDLIFE
IN CANADA

COSEWIC

Status Report

on

Western Spiderwort

(*Tradescantia occidentalis* (Britt.) Smyth)

Prepared by:

Bonnie Smith and Cheryl Bradley
459 - 30th Avenue N.W.
Calgary, AB
T2M 2N5

Submitted to:

Committee on the Status of Endangered Wildlife in Canada

October 1990

STATUS RECOMMENDED BY THE PLANTS SUBCOMMITTEE: ENDANGERED (OCT. 1991)

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I. Species Information

1. Classification and Nomenclature

The scientific name for prairie or western spiderwort is *Tradescantia occidentalis* (Britt.) Smyth. It is a member of the family Commelinaceae in the order Commelinales. The name Commelinaceae comes from Johannes Commelin (1629-1692), who was appointed to establish a botanic garden in Amsterdam in 1682 (Radford 1986; Bainhart 1965). The Commelinaceae is a medium-sized tropical, subtropical, and warm temperature group preferring damp habitats (Johnson 1985) It contains some 700 species worldwide (Jones & Luchsinger 1986). The name *Tradescantia* comes from John, the elder Tradescant (about 1580-1638), who was chief gardener to Charles the First of England and one of the most remarkable horticulturalists of the seventeenth century. He established collections of living plants, natural history specimens, artifacts and curiosities at South Lambeth near London (Everett 1981). He presumably had something to do with domesticating or developing cultivated strains of the spiderworts (Johnson 1985). His son, also John Tradescant (1608-1662), was chief gardener at Lambeth to Charles II of England (Bainhart 1965). Father and son travelled widely, the son to Virginia. The English private garden, the Tradescants at Lambeth, had early Virginian introductions (1620-1687). Their collections became the basis of the Ashmolean Museum at Oxford (Everett 1981).

The genus *Tradescantia* has 60 species worldwide, all confined to the Americas (Jones & Luchsinger 1986), with 20-22 species occurring in the United States (Lawrence 1951). The genus *Tradescantia* was monographed in 1881 by the British botanist C.B. Clarke (1832-1906) (DC. Monogr. Phaner. 3) (Bailey 1930; Stafleu and Cowan 1981). *Tradescantia* is sometimes called spiderwort because of the soft, stringy, mucilaginous material which can be pulled from the broken ends of the stem. This material will harden into a cobweb-like thread after exposure to the air (Jones & Luchsinger 1986). Of the genera of Commelinaceae, only *Tradescantia* extends indigenously into Canada (Lawrence 1951).

The species was first described by Smyth in 1899 in the Transactions of the Kansas Academy of Science 16:163 (Gray Herbarium Index 1968) Bernard Bryan Smyth (1843-1913) was an Irish born American botanist, geologist and professor of botany at

2. Description

Tradescantia occidentalis is a perennial plant with thickened roots. The stem is erect, almost succulent, often branching, smooth, glaucous, 10-50 cm tall, with 2-5 nodes. The leaves are alternate, linear-lanceolate, often folded lengthwise, 10-30 cm long, 4-12 mm wide, the sheaths are inflated at the nodes to 2-4 times the width of the blade and have prominent purplish parallel veins. (Figures 2E, 5D)

The inflorescence is an umbellate cyme, few-many flowered, solitary and terminal or with 1-2 peduncles arising from upper nodes (see Figures 2F, 2G, 5E, 5F). Each inflorescence has two elongate and divergent leaf-like bracts. The pedicels are 1-2 cm long and glandular-hairy. The flowers have elliptical sepals that are 6-12 mm long, glandular-hairy, acute to acuminate, and the margins are often purplish. The three rose to blue petals, occasionally white, are broadly ovate and 7-15 mm long. (Figures 2B, 5F) Just one flower in each cluster opens each day and lasts only a few hours (ephemeral). (Figure 2B) There are six stamens with bearded filaments, and the stigma is capitate, atop a very thin style. The fruit is an oblong three-locular capsule, each locule producing 1-2 oblong seeds that are 2-4 mm long, ridged and pitted, and grey in colour. (Johnson 1985; Hrapko 1989) In Canada, flowering of populations occurs mostly in late June and early July.

There are no other indigenous species of plants with which to confuse *Tradescantia occidentalis* in its natural habitats in southeastern Alberta and southwestern Manitoba. As a garden or cultivated species the genus *Zebrina,* separable by its tubular perianth among other things, has sometimes been confused with *Tradescantia* by gardeners (Bailey 1930). In gardens, as well as *Zebrina pendula,* some kinds of *Commelina, Callisia, Cuthbertia, Dichorisandra, Gibasis, Hadrodemas,* and *Setcreasea* are frequently mistakenly named *Tradescantia* (Everett 1981).

The only other *Tradescantia* native to Canada is *Tradescantia ohiensis* Raf. which is restricted to southwestern Ontario. *T. occidentalis* may be differentiated from *T. ohiensis* by its glandular-pubescent sepals. The sepals of *T. ohiensis* are glabrous or merely bearded at the tips. *Tradescantia ohiensis* Raf, itself, is rare in Ontario and Canada. The ranges of *Tradescantia occidentalis*

occidentalis and *Opuntia polyacantha* exhibited delayed development (phenological index). Overall the shortgrass plains vegetation appears to be one of the most resistant community types studied to date.

4. Distribution

The genus *Tradescantia* is confined in the wild to the Americas (Everett 1981). *Tradescantia occidentalis* , a temperate western American species is common on the Great Plains of the United States, from Montana to Utah eastward to western Wisconsin, and southward as far as Mexico. Specifically, *T. occidentalis* occurs in the following states: Montana, North Dakota, South Dakota, Minnesota, Wisconsin, Nebraska, Wyoming, Utah, Colorado, Kansas, Arizona, New Mexico, Texas, Wisconsin, Oklahoma, Arkansas, and Louisiana. (Map 1) In Canada, *T. occidentalis* occurs in southeastern Alberta and southwestern Manitoba. Populations from southeastern Alberta were first reported in 1986. The Alberta populations are disjunct, 400 km from the closest populations in Montana. (Fernald 1950; Anderson & Woodson 1935; White & Johnson 1980; Anderson & Sax 1936; Anderson & Hubricht 1938; Ramaley 1939) Fernald (1950) includes Manitoba in the range, but the first report with citation of specimens for Canadian populations was given by Scoggan (1957) in the Flora of Manitoba.

Precise locality data and land ownership, if known, is on file with COSEWIC and the appropriate provincial/territorial jurisdictions. This information is generally available unless the localities are considered to be publicity-sensitive.

4.1 Alberta

The 1986 discovery site for *T. occidentalis* in Alberta, the first report of the species in Alberta, is the Pakowki Lake Sand Hills, a dune area north to northeast of Pakowki Lake and about 13 km west of Manyberries. Since then two other colonies have been found nearby in the Pakowki dunes (1988) (Hrapko 1989). Detailed field investigation of all sand plains and sand hill habitats (34 sites in total) in southern Alberta in 1987 found *T. occidentalis* only in the Pakowki Lake sand hills (Wallis and Wershler 1988)

There is another questionable location at Whiskey Gap (1987) but Dr. W. J. Cody stated that the specimen, collected on May 30, was too immature for positive identification (letter Ap. 20, 1989 from W.J. Cody). Further visits to the site by Dr. George Scotter have not been successful in relocating the species.

4.2 Manitoba

The only other known Canadian records for the prairie spiderwort are in two sand dune areas in southwestern Manitoba (Hrapko 1989). Prior to the mid-1950's, *T. occidentalis* had only been collected four times in Manitoba, 3 times from near Routledge and once from about 24 km northeast of Melita. Both sites were rediscovered in 1990 (Smith and Lewis 1990).

During the summer of 1990, many other potential sites in the Lauder, Routledge, and Oak Lake Sand Hills were explored for spiderwort specimens. No other sites were located at this time. (Smith and Lewis 1990)

4.3 Historical Populations of Unknown Status

Tradescantia virginiana L. cited from Winnipeg by Bourgeau (in Palliser 1863), is referable to *Tradescantia occidentalis* as is also the citation of *Tradescantia bracteata* Small from sandhills near Routledge and Virden in an undated supplement to Lowe's 1943 checklist. (Scoggan 1957)

5. General Environment and Habitat Characteristics

Tradescantia occidentalis populations occur in the mixed grassland (prairie) natural region in Alberta and Manitoba. Western populations are found in dry habitats, particularly in dune and sand hill areas. The species appears to be best adapted to partially stabilized sand in dune slack areas although it is also found growing in active sand (Wallis and Wershler 1988, Smith and Lewis 1990)

5.1 Climate

The Prairies Climatic Region, encompassing both the Alberta and Manitoba populations, are characterized by low winter precipitation. Soil moisture is not always restored to capacity in an average year and water surplus averages only 7 mm. The southeastern Alberta deltas has permitted modification of the surface by wind to form parabolic dunes. These are characteristic of semiarid climates where a partial cover of vegetation is present during dune formation. Since the effective wind direction in southwestern Saskatchewan is from the northwest, most of the present dunes tend to be oriented in a northwest to southeast direction. Rates of movement of partially denuded dunes reported in other areas vary from 2 to 22 ft. (0.6 to 6.6 m) per year. (Hulett *et al.* 1966)

5.3 Dependence on Dynamic Factors

Tradescantia occidentalis is restricted to sand dune areas. It appears to require some element of active (drifting) sand. Wallis and Wershler (1988) suggest it requires active blowouts based on Alberta locations, however, the Lauder Sand Hill site in Manitoba was stable.

Annual water deficiency and wind erosion cause considerable soil drifting in sand dunes. Populations of *Tradescantia occidentalis* are dependent, as are numerous rare, threatened, and endangered species of plants and animals, on major active sandy areas which now have been almost completely cultivated. However, Wallis and Wershler in their study of sand dune areas in southern Alberta note sand dunes are stabilizing and attribute it to lack of fire. Large areas of once active sand have become stabilized over the last forty years. (Wallis 1988)

5.4 Biological Characteristics

Alberta and Manitoba sites are located in the Western Grassland vegetation region in Canada, specifically, the mixed grassland natural region. Plants are perennials on prairies being composed mostly of grasses associated with sedges, forbs, and a few dwarf shrubs. Before European settlement, this vegetation occupied valleys of southern interior British Columbia and much of southern Manitoba, Saskatchewan and Alberta. The nature of grassland vegetation depends on climate and soil. (Bird 1988)

Sand dunes exhibit a range of habitats from active dunes to stabilized sites with spear grass (*Stipa comata*) and sand grass (*Calamovilfa longifolia*); a variety of low shrubs, primarily buckbrush (*Symphoricarpos occidentalis*) and rose (*Rosa acicularis* which are replaced by prairie. Both tall-grass and mixed-grass species were extensive before settlement. Elm, ash, and Manitoba Maple grow along stream courses, and oak grows on dry sites. (Weir 1988)

The sandy hills of the Manitoba sites immediately south of Routledge are of low relief and covered with *Populus tremuloides* and *Acer negundo* around the wet areas. Level areas have been cultivated and cropped. The Oak Lake area itself is a broad lake plain with bur oak woodland at its northeast end. This area is adjacent to a provincial park and cottage developments. The sand hills of higher relief (3-5 m) three miles south of the lake are probably beach ridges. The sandy areas are mostly well forested and stable. The only bare sand seen was in areas disturbed by road and pipeline construction operations (pers. comm., Johnson, June 28, 1989).

Tradescantia occidentalis was discovered on a short, steep, stabilized, southwestern running dune ridge, in the southwestern Lauder Sand Hills, northeast of Melita (Figures 3A-3C). The dune ridge flattens and disappears after approximately 1.5 miles. The dune slopes and flats were partly open and very stabilized with shrubs, from 1-3 feet in height, scattered throughout. Shrubs were mostly represented by *Rhus radicans, Prunus virginiana,* and *Rosa* sp. Ridge crests were characterized by scattered lone *Ulmus americana* (Figure 3D). Other major species were noted as follows: *Stipa comata, Calamovilfa longifolia, Artemisia frigida* and *Artemisia ludoviciana. Mamillaria vivipara* was very noticeable along the ridge slopes. The primary upper slope association was *Calamovilfa longifolia/Prunus virginiana/Rhus radicans.* Lower rolling dune flats were characterized by massive *Juniperus horizontalis* beds associated with *Campanula rotundifolia* (Figure 3E). *Tradescantia occidentalis* did not occur on these lower slopes but was restricted to upper dune slopes and dune crests. The valleys between the rolling dune edges were filled with *Euphorbia esula.* In some areas along the dune crests *Euphorbia esula* was actually growing amongst the spiderwort plants. *Tradescantia occidentalis* was restricted to the southwest-facing slopes as the opposite dune slopes were heavily forested. (Smith and Lewis 1990; Figure 3F)

A second location in southwestern Manitoba, the Routledge Sand Hills, was also rediscovered in 1990. This dune system was much more extensive than the one found at the Lauder Sand Hills. The Routledge Sand Hills dune ridge runs north-south for half its length,

Figure 1. Habitat, Pakowki Lake, southeastern Alberta.

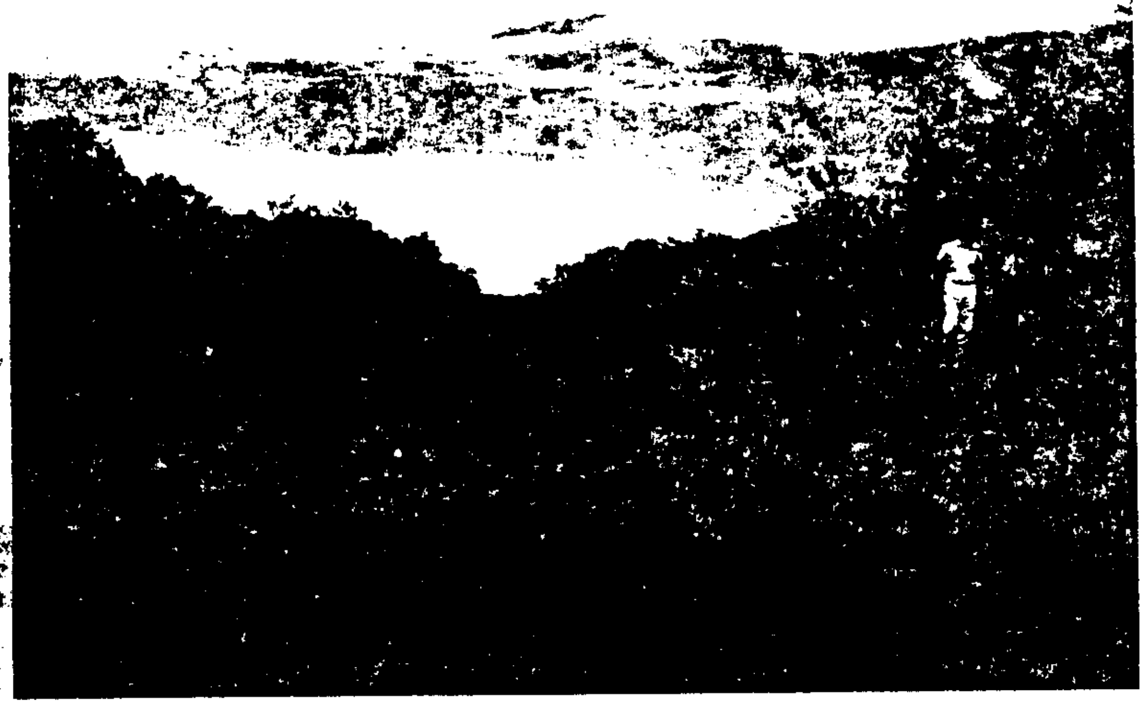


Figure 1A. Loose sand, sage-grass association.

Figure 1B. Stabilized dunes, sagebrush-grass association.

Figure 2. Pakowki Lake Sand Hills, southeastern Alberta.

Figure 2C. Habitat of Tradescantia, leeward slope of partly stabilized dune.

Figure 2D. Habitat of Tradescantia, partly stabilized dune slope and plain.

Figure 2. Pakowki Lake Sand Hills, southeastern Alberta.

Figure 2F. Inflorescence, Tradescantia occidentalis.

Figure 2G. Inflorescence, Tradescantia occidentalis.

Figure 3. Lauder Sand Hills, southwestern Manitoba.

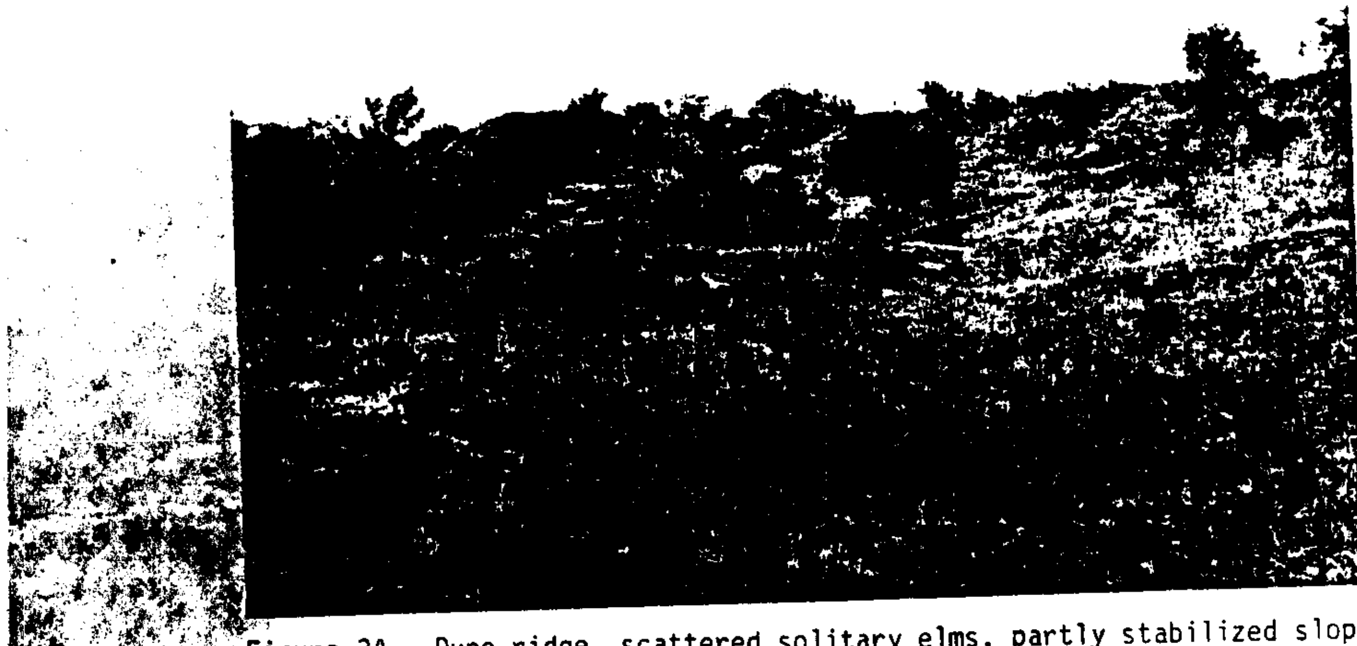


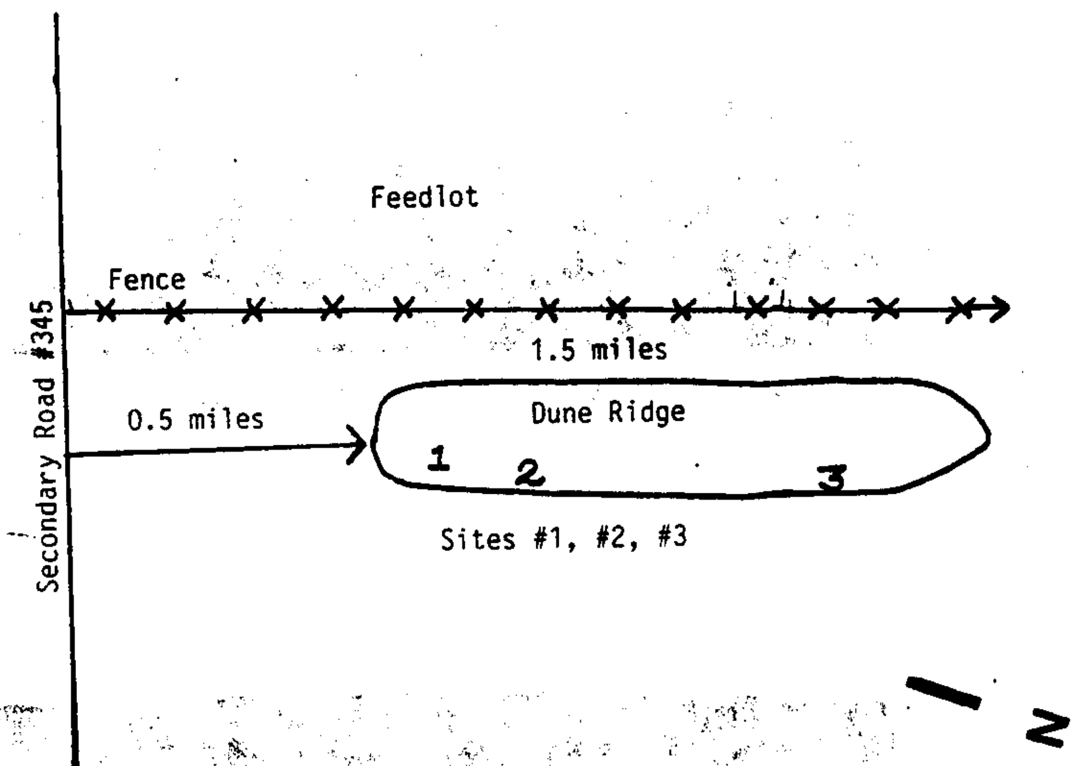
Figure 3A. Dune ridge, scattered solitary elms, partly stabilized slopes.

Figure 3B. Dune ridge, scattered areas of open sand.

Figure 4

Lauder Sand Hills, southwestern Manitoba

<u>Population Distribution</u>



the Kansas Medical College 1890-1895 and curator of the Kansas State Museum Herbarium in 1895 (Stafleu and Cowan 1981). *Occidentalis* is latin for west or western, a reference to its distribution in western North America (Stearn 1966). Britton had previously recognized the plant as *Tradescantia virginiana* var. *occidentalis* Britton (Gray Herbarium Index 1968). Nathaniel Lord Britton (1859-1934) was an American botanist, founder and first director of the New York Botanical Garden (Stafleu and Cowan 1981). A variety *scopulorum* was described by Anderson & Woodson in 1935 in Contributions to the Arnold Arboretum 9:106. This variety had prior recognition as *Tradescantia scopulorum* Rose. A variety *typica* was also described by Anderson & Woodson in 1935 in the same journal 9:101. There have been no taxonomic revisions of this species documented since the 1930's. (Gray Herbarium Index 1968)

Anderson & Woodson (1935) recognize two varieties of *Tradescantia occidentalis;* namely, var. *typica* and var. *scopulorum,* in their studies on hybridization in the United States. The two varieties differ on the following points. The sepals and pedicels of var. *scopulorum* (Rose) Anderson & Woodson (formerly *T. scopulorum* Rose) are more or less glabrous whereas they are glandular-pubescent in var. *typica.* The type of *T. scopulorum* was collected in the Santa Catalina Mountains, Pima County, Arizona by Pringle in 1884. The var. *scopulorum* is about as frequent and as widely distributed in Arizona as typical var. *typica.* (Kearney & Peebles 1969)

T. occidentalis is known to hybridize with *T. canaliculata* , a southern United States species (Anderson & Hubricht 1938). Hybrids formed with *T. ohiensis* have also been noted in the eastern United States (Legeay 1968). In the genus *Tradescantia* one of the chief barriers between closely related species is differences in habitat preference. These barriers have often been broken down as a result of human activity such as construction of roads, railways, and ditches. The more that natural ecological conditions have been upset the greater would be the opportunity for introgressive hybridization (Anderson & Hubricht 1938). However, hybridization in nature is highly unlikely in Canada due to the large geographic separation of the two species *T. occidentalis* and *T. ohiensis.*

Plants on Sites 1 and 2 are restricted to dune ridge crests and upper slopes. Plants on Site 3 extended from the ridge crest to the lower ridge slopes. (Smith and Lewis 1990; Figure 4)

E. Routledge Sand Hills, southwestern Manitoba (Figure 5, 6)

Tradescantia occidentalis plants on this site were generally very tall, bearing many flowers per inflorescence. Stem number per plant ranged from 1 to 6 with an average of 2 stems per plant. In total 1578 plants were counted. It was estimated that at least 100 additional plants likely existed giving a projected total of 1650-1700 plants for this site. This location contains by far the most well established population of this species in Canada. Indeed, the population may exceed 2000 plants if a more detailed count was conducted on all of the surrounding dune areas. Of this number only 8 dark pink and 1 light pink flowered plants were discovered (Figure 5F). By far, the dominant flower colour was blue. (Smith and Lewis 1990)

Plants were scattered over a 1.5-2.0 mile stretch along a major dune ridge (Figure 5A). There were scattered plants on flatter areas and on dune crests as well. Generally, the dune slopes were the preferred habitat. Some plants were found growing on open active sand in the scattered blowouts. These specimens were actively colonizing the blowouts (Figures 5C, 5D). As well, patches of spiderwort were found growing near heavily forested areas amongst tall grasses. Plants found in this habitat had deep blue petals (Figure 5E). A few plants (21 in total) were found on flat areas surrounding the dunes.

A more detailed breakdown of the specimen count for the sand dune system is presented in Figure 6.

Dr. H.J. Scoggan, author of both the Flora of Manitoba and the Flora of Canada, the standard botanical reference works on Manitoba's and Canada's flora, writes in the Flora of Canada as follows: "At Routledge an extensive colony of both purplish-flowered and roseate-flowered individuals were observed by the writer in 1953." (Johnson 1985).

and *Tradescantia ohiensis* are widely separate in Canada, the latter being a predominantly eastern North American species. (Argus and White 1977; Keddy 1987). *Tradescantia virginiana* L. and *Commelina communis* L. may occur sporadically as garden escapes in Ontario and Quebec. This is the entire representation of the family Commelinaceae in Canada. (Scoggan 1978).

3. Biological and Economic Significance

The family Commelinaceae is of little importance economically except for several ornamentals (Jones & Luchsinger 1986). A few members of 11-12 genera are grown to a limited extent as garden ornamentals. *Tradescantia* is among these genera (Lawrence 1951). Native species of spiderwort are appropriate for informal or semi-formal native plant gardens. Generally the hybrids are the most desirable hardy sorts. Nonhardy *Tradescantias* are highly regarded as easy-to-grow greenhouse and window plants, the trailers suitable for hanging baskets as well as pots. (Everett 1981)

Although no data is available on the horticultural use of *T. occidentalis,* specifically, several members of the genus *Tradescantia* are the common house and garden plants known as 'Wandering Jews' or 'Spiderworts'. One of them, the Common Spiderwort (*T. virginica*) is a native species occasionally seen in flower beds in Winnipeg yards although its natural range is considerably to the south and east (Johnson 1985). The long hairs of *T. virginica* are favorite objects for demonstrating protoplasmic currents in the cells (Rendle 1963).

None of the Spiderwort Family are poisonous and most members have been used as pot-herbs by various peoples at one time or another (Johnson 1985). All the native *Tradescantias* have succulent stems and leaves which can be used as salads or pot-herbs and are "rich flavoured", especially the Common Spiderwort (*T. virginica*) (Fernald *et al.* 1950)

Stamen hairs in some strains of *Tradescantia ohiensis* (and hybrids between *Tradescantia ohiensis x Tradescantia occidentalis*) mutate from pink to blue if exposed to nuclear radiation, and have been planted around a reactor site in Japan to monitor low-level radiation (Smith & Smith 1980). Radiation damage research performed using shortgrass plains vegetation in Colorado found that *Tradescantia*

Figure 5. Routledge Sand Hills, southwestern Manitoba.

Figure 5C. Active blowout.

Figure 5D. Tradescantia occidentalis colonizing active blowout.

MAP 1 - Distribution of Tradescantia occidentalis (Britt.) Smyth

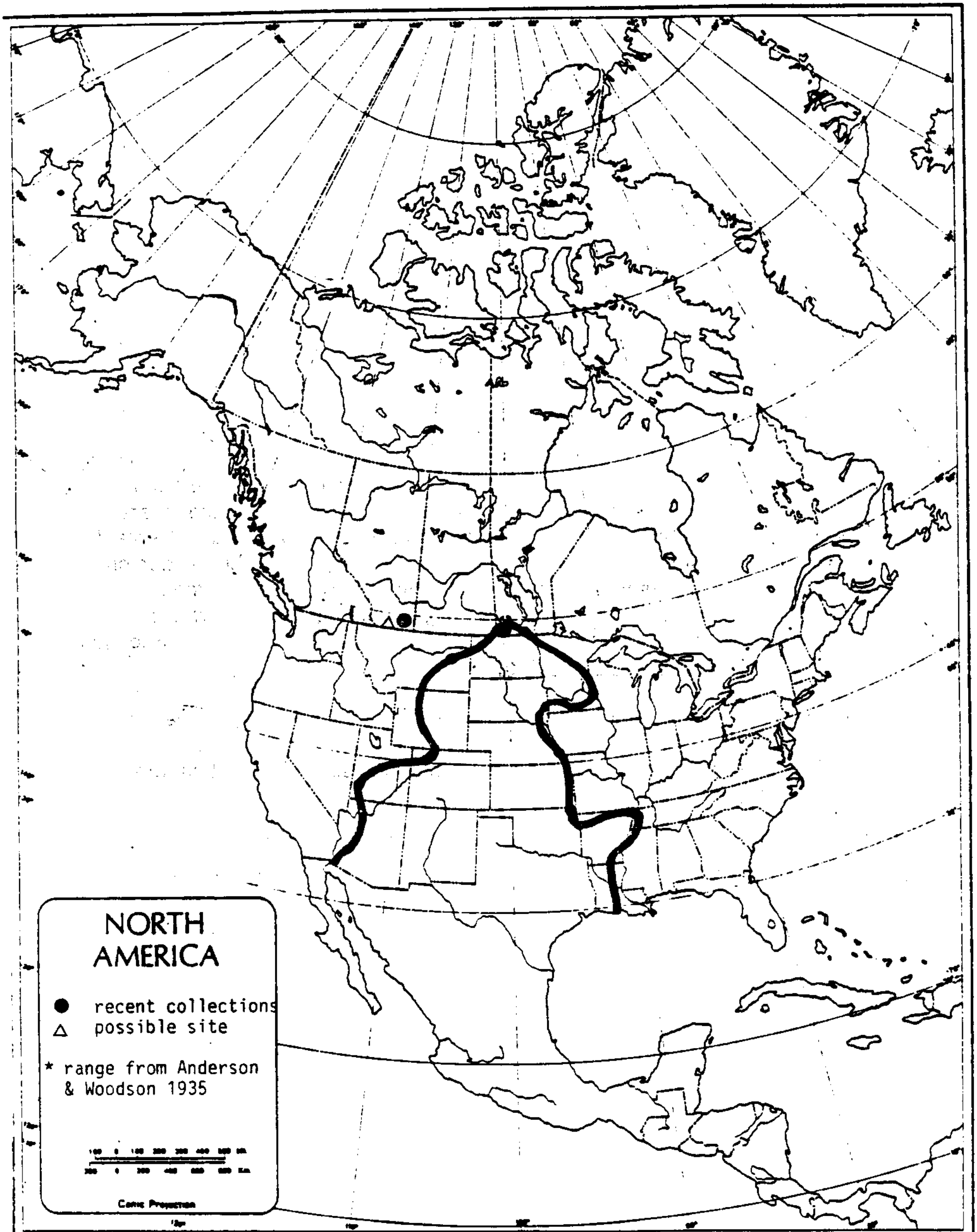


Figure 5. Routledge Sand Hills, southwestern Manitoba

Figure 5G. Areas near fencelines, disturbed by grazing, partly denuded of vegetation.

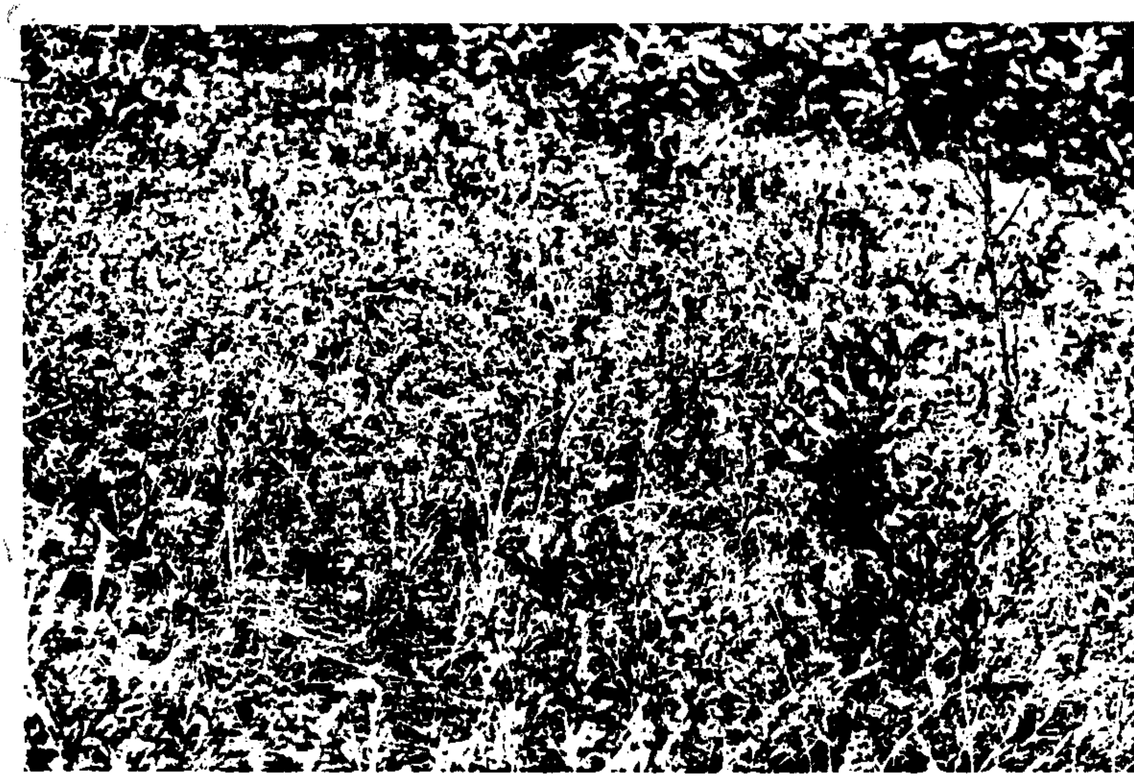


Figure 5H. Euphorbia esula (yellow flowered) invading Tradescantia occidentalis habitat.

area has a greater average annual water deficiency than the southwestern Manitoba area. (Sanderson 1988)

The climate of the mixed grassland natural region is continental, characterized by extremes in temperatures with warm summers and cold winters. The mean annual temperature ranges from 6 C in the hotter parts to 0 C in the cooler areas. The growing season is relatively short, with an average of 105 to 130 frost-free days. There is comparatively low annual precipitation, ranging from about thirty centimetres in extreme south-eastern Alberta and south-western Saskatchewan to forty centimetres along the western and northern fringes. Dry summers and winters are typical. Spring is the wettest season with about two-thirds of the annual precipitation falling as rain, the peak occurring in June. Because of the warm temperatures and high average wind speed, the rate of evaporation is high through the summer months. (Wallis 1982)

Alberta is in the northern cool-temperate zone characterized by low annual precipitation, high evaporation rates and fast runoff. These factors lead to chronic water deficits in southern Alberta with severe shortages in the short-grass prairie area. In southern Alberta the mean temperature is -8 C in January and 20 C in July. (Stamp 1988)

Nearly two thirds of the precipitation falling on the Manitoba sites occurs during the six summer months, the remainder appearing mostly as snow. The southwestern area of Manitoba has an average 100-day frost-free period. (Weir 1988)

5.2 Physiography, Hydrology, and Edaphic Factors

The Alberta and Manitoba populations occur in sand dune areas of the Interior Plains physiographic region. (Brookes 1988) The sand dune areas occurring in southern Saskatchewan are aeolian deposits derived from glacial alluvial and lacustrine sediments. Glacial ice retreated from the region 10,000 to 13,000 B.P. Since the general inclination of the land surface was to the north and east and the ice obstructed water flow to the northeast, the melt water moved southeastward along the ice front until it was impounded in one of several glacial lakes. When it flowed into a lake the load capacity of the water decreased. The larger particles (sand) were deposited first in deltas, the finer materials being carried farther to be deposited lakeward. Subsequent exposure of the sand in extensive

6.1 Reproductive Ecology

Tradescantia occidentalis is a perennial species. Sullivan and Daley (1981) report that each section of the stem can develop roots and make a new plant and they probably reproduce by this means as well as by seeds.

All six stamens are fertile in *Tradescantia*. The style is terminal, the stigma is generally capitate. The flowers are entomophilous. Self-pollination may occur by the approximation of style and stamens in withering. (Rendle 1963)

6.2 Population Ecology

No information on *Tradescantia occidentalis* population ecology was found.

7. Land Ownership and Management Responsibility

A. Alberta

The Pakowki Lake site is on crown land which is leased for grazing. Land ownership of the potential site at Whiskey Gap is unknown. Although the site occurs on a ranch, it is not known if the area is part of a grazing lease (crown land) or is under private ownership.

B. Manitoba

The Lauder Sand Hills site in southwestern Manitoba lies within land purchased for Wildlife Habitat under the Manitoba Habitat Heritage Corporation Wildlife Project (N.W. 17-5-25W) in co-operation with the Manitoba Wildlife Branch, Manitoba Natural Resources. (Smith and Lewis 1990)

The Routledge Sand Hills site in southwestern Manitoba is mostly under private land ownership. W.A. (Vanny) Hellman Ent. Ltd. is the landowner of the majority of the southern areas of the ridge system. The remainder of the northern areas of the dune ~~system is owned~~ by the provincial government and presently leased by a Mr. Cox. (Smith and Lewis 1990)

); tall shrubs, mainly chokecherry (*Prunus virginiana*), silverberry (*Elaeagnus commutata*), and water birch (*Betula occidentalis*) and trees, including clones of aspen (*Populus tremuloides*) and scattered cottonwoods (*Populus deltoides*). These dune areas support some of the largest upland bird and ungulate populations in the mixed grasslands, as well as some rare small mammals and birds, for example, Ord's Kangaroo Rat (*Dipodomys ordii*) and Grasshopper Sparrow (*Ammodramus savannarum*). (Wallis 1982)

The Pakowki Lake Sand Hills area, in southeastern Alberta, contains many active blowouts but most of the area is at least partly stabilized by vegetation (mixed grassland) (Figures 1A, 2A, 2C). The land has been used for grazing. (Hrapko 1989) The original colony (Alberta) occurred in a sparsely vegetated and somewhat depressed site among dunes. Slip faces of dunes immediately to the south and north of the site and another dune with chokecherry thickets to the west, provided some shelter but sand was actively being deposited on the site during the very windy day of Hrapko's visit (Hrapko 1989)

The southeastern Alberta population occurs in the mixed grassland natural region populated by relatively drought resistant grasses such as blue grama and spear grass (Bird 1988). The dominant associated plants on the Pakowki Lake site were as follows: *Koeleria macrantha, Rosa arkansana, Selaginella densa* and *Artemisia ludoviciana* (Hrapko 1989; Figures 1A, 1B) Wallis and Wershler (1988) states that the western spiderwort occurs where there is 70% or more bare sand in an *Oryzopsis hymenoides* and *Calamovilfa longifolia* community associated with species such as *Artemisia campestris, Rosa* sp., *Helianthus* sp., *Corispermum* sp., *Franseria acanthicarpa* and *Heterotheca villosa.* Also present were *Stipa comata, Mamillaria vivipara, Opuntia fragilis, Thermopsis rhombifolia* and scattered *Prunus virginiana* (growing to 15 feet in height). Plants were scattered over the leeward area of the partly stabilized dune and on the flat sand plain at the base of the dune ridge. (Smith and Lewis 1990; Figures 2C-2E).

One questionable discovery at Whiskey Gap was in a rough fescue grassland habitat (J.D. Johnson, letter to W.J. Cody, 1989).

The prairies of southern Manitoba are true prairies with bluestems and porcupine grass forming the dominant species (Bird 1988). Southern Manitoba's natural vegetation is open grassland and aspen. In the south, high evaporation rates discourage the growth of trees

8.2 Cultivation

All *Tradescantia* are free growers, propagating with ease from cuttings of the growing shoot (Bailey 1930). Division is the most common means of multiplying hardy spiderworts. Keep the soil moderately moist, somewhat drier for those with very thick stems and foliage and for those that are decidedly hairy. Also, do not splash water on the foliage of such kinds and keep the atmosphere somewhat drier than for non-succulent hairless sorts. (Everett 1981)

Tradescantia occidentalis may be propagated by seed with no seed treatment required (Texas, New Mexico, North Dakota data). As well, it may be propagated by root cuttings (North Dakota data) or stem cuttings (Texas data). (Sullivan & Daley 1981) *Tradescantia ohiensis* is easily propagated from seeds or divisions. Moist stratification is required. (Smith & Smith 1980)

The hybrids of *Tradescantia* succeed with little attention in ordinary soil, in light shade or sun, and seem to give the best results if the ground is on the dry side, rather than as moist as their parent species favour in the wild. The hybrids are the most desirable hardy sorts for native plant gardens. (Everett 1981)

8.3 Current Management Policies

The Pakowki Lake site (Alberta) is on crown land and is presently under a grazing lease.

The Lauder Sand Hills site (Manitoba) is presently designated as Wildlife Habitat by the provincial government. The site is afforded a measure of protection. A feedlot (heavily eroded to bare sand) borders this site. The feedlot landowner stated that he had requested the Manitoba government's permission to graze cattle on the Wildlife Habitat land but was denied access. It would seem that this site is protected to a certain extent although the full nature of this protection is not fully understood at present. (Smith and Lewis 1990)

The majority of the Routledge Sand Hills site (Manitoba) is presently under private ownership. The landowner stated that he had particularly purchased this dune system as a means of preserving it then east-west for most of the rest of its length before turning north-south again at its termination (Figure 5A). The main ridge is steep and partly to mostly stabilized although there are areas of active blow-outs along its length (Figure 5C). West-facing and north-facing slopes are mostly open although studded with *Ulmus americana* and *Quercus macrocarpa* along its length (Figures 5A, 5B). The other side of the ridge system is covered in a mixed deciduous forest composed of *Quercus macrocarpa, Prunus virginiana, Acer negundo, Populus balsamifera,* as well as scattered birch and alder. Areas to the west and south have been lightly grazed (Figures 5B, 5G). The dominant shrub association along the partly stabilized dune crests and ridges is *Rhus radicans/Prunus virginiana/Rosa* sp. Herb associations on dune crests and slopes consist of *Stipa comata/Calamovilfa longifolia/Koeleria cristata/Lygodesmia juncea.* Patches of *Juniperus horizontalis, Arctostaphylos uva-ursi* and *Campanula rotundifolia* dominate areas along the dune slopes were spiderwort does not occur. *Euphorbia esula* is rather common especially on ridge crests of blowouts associated with elm and oak trees. (Smith and Lewis 1990; Figure 5H)

6. Population Biology and Ecology

A. Phenology

Flowering occurs mostly in early July. On June 11, 1986, the spiderwort plants were mostly in bud on the Alberta site, with only a few of the flowers opening. On return to this site on July 19, 1986, all the plants had mature fruits with good seed production. Wallis and Wershler found the plants in full flower on July 5, 1987. (*) Smith and Lewis (1990) found the plants on the Alberta site in flower on June 21, 1990. Flowering had already finished on several stems. The spring and summer of 1990 were much wetter than is usually experienced in the area. Plants at the Lauder Sand Hills site, northeast of Melita, in southwestern Manitoba were just coming into flower on June 26, 1990. Most of the plants were in bud at this time. A number of specimens had not produced any flowers. Plants at the Routledge Sand Hills site, southwest of Routledge, in southwestern Manitoba were about 25% in flower on July 1, 1990. Most plants were well along in the budding stage by this time. (Smith and Lewis 1990)

The main limiting factors affecting *Tradescantia occidentalis* are its natural narrow preference for unstabilized sites within dune fields and loss of natural habitat through management intervention as a result of grazing and fire control. It would appear unstabilized sites within sand hills depend on a continued regimen of grazing and fire working cooperatively. A management dilemma presents itself as the increasing pressure of grazing by livestock is causing a deterioration in the Mixed Prairie Grassland surrounding azonal areas such as sand hills.

9.1 Conversion to Tame Pasture and Cropland

More than two-thirds of the Mixed Prairie Grassland region has been destroyed by cultivation. Some clearing continues but it is not as pervasive a problem as in the Parkiand Region. (Wallis 1987)

The proportion of farmland occupied by rangeland declined from 53% to 41% between 1956 and 1981 in Alberta (Mixed Prairie Census Districts). About one-third of the disappearing rangeland has been converted to seeded pasture in the Mixed Prairie Region of Alberta. The area of uncultivated grassland in Saskatchewan and Alberta is declining at a rapid rate. The surviving untilled area contains a smaller proportion of typical grassland and a large proportion of azonal types (saline flats, sloughs, sandhills, badland) as time goes by, because the typical upland situations are being converted to cropland. (Coupland 1987) Based on the experience in the United States with sand hill areas, the potential for cultivation exists but has not been developed to a significant degree in Alberta (Wallis 1987).

9.2. Dune Stabilization

Rare, threatened and endangered plants were studied to map distribution and assess the degree to which dune stabilization was occurring and how this was affecting native plants. While the exact mechanisms are unclear, it appears that large areas of once active sand have become stabilized over the last forty years. If the current trends continue, rare native plants which now have dangerously low populations could be eliminated entirely. The active sand surface of some dunes in the Pakowki Lake area has been reduced by 50 to 75%. (Wallis 1988) Continued stabilization of the dunes at Pakowki Lake would likely be detrimental to the long-term survival of *Tradescantia occidentalis* (Wallis and Wershler 1988)

Figure 2. Pakowki Lake Sand Hills, southeastern Alberta.

Figure 2A. Active leading dune overlooking Tradescantia habitat.

Figure 2B. Tradescantia occidentalis flower, 3 blue petals.

was not listed as occurring in loose sand and blow-out communities. This early data would apparently contradict to some degree the present preference for recently destabilized sites within sand dune communities.

Post-glacial History of Dune Stabilization in Southern Manitoba

David (1971) dated periods of dune activity in southern Manitoba by radiocarbon dating buried soil profiles. He found six periods of major dune activity which were associated with major droughts. The earliest recorded active phase ended prior to 4000 B.P. with vegetation stabilizing the dune surface after the end of the Atlantic dry period. Another active phase occurred between 3700-2500 B.P. It ended when the regional climate became more humid. Four active periods followed, ca. 2100, 1500, 900 and 400 B.P. The earliest occurred during a period of generally sub-humid regional climate and likely was the result of a local drought. The rest occurred during major changes of regional climate. (David 1971; Bryson *et. al.;* from Epp 1980)

There have been periods of dune stabilization in southern Manitoba prior to 4000 years ago but none of the soil profiles which would have been formed have been found. Either such stabilizations have not occurred or subsequent sand movement has destroyed the evidence of them. (David 1971 from Epp 1980)

In addition to dune activity, dune size also is an important factor in the response to climatic change. Dunes less than 6 metres high become active only during major periods of drought while larger ones are affected by droughts of both minor and major intensities. (David 1971 for Epp 1980) Extensive dune activity occurs only during major droughts except in areas which contain very large dunes. (Epp 1980)

9.3 Grazing and Fire Control.

The large tracts of uncultivated grassland east of the mountains, mostly community pasture or crown land leased by ranchers, are grazed by domesticated livestock (Bird 1988) While the dynamics of dune destabilization are poorly understood, a consensus is emerging that it is a combination of fire and grazing during appropriate seasons that keeps blowouts active. Dunes have been stabilizing in the Middle Sand Hills where there have been repeated fires but little

Figure 2. Pakowki Lake Sand Hills, southeastern Alberta.

Figure 2E. Tradescantia occidentalis , partly stabilized dune plain.

In places it extends over the dune crests into western spiderwort habitat. In one spot, leafy spurge actually grows intermixed with spiderwort plants. So far, *Tradescantia occidentalis* appears to be unaffected by the spurge. There may be a potential loss of habitat should the leafy spurge overtake any substantial part of the open dune ridges. (Smith and Lewis 1990)

9.5 Petroleum Exploration and Extraction

The Routledge Sand Hills site (Manitoba) lies within a petroleum field which is presently being developed. Many active wells were noted in the northern areas of the sand hills. Development of access roads to potential wells, exploration by seismic crews, development of well sites, and potential revegetation with non-native species could all become issues should petroleum development extend into the southern regions of the dune ridge system. Any negative effects of such procedures would be greatly elevated since the Routledge Sand Hills site contains by far the best population of *Tradescantia occidentalis* in Canada. There are only 276 specimens at all other known Canadian sites compared to 1700+ specimens at the Routledge site. The present landowner of the southern dune ridge system has expressed concern and an unwillingness to have his land subjected to petroleum exploration and development. Affects of such practices on both the crown land to the north and this southern area should be given grave consideration given the importance of this site as rare plant habitat. (Smith and Lewis 1990)

10. Present Legal or Other Formal Status

No specific legal status is accorded *Tradescantia occidentalis* in any part of Canada. Alberta has no legislation which covers plants or endangered species.

In Canada, *Tradescantia occidentalis* naturally occurs only in the extreme southeastern corner of Alberta and southwestern corner of Manitoba (Map 1) so it is considered rare from a national perspective. White and Johnson (1980) identified *Tradescantia occidentalis* as rare in Manitoba and Hrapko *et. al.* (1986) and Wallis and Wershler (1988) identified it as a potentially endangered species in Alberta. While it is widespread in the United States (Map 1) it is represented by only two populations in Manitoba and is somewhat disjunct at its Alberta location.

B. Pakowki Lake Sand Hills, southeastern Alberta (Figures 1, 2)

Tradescantia occidentalis is restricted, in Alberta, to the Pakowki Lake area (111 longitude, 49 approx. 10' to 49 approx. 20' latitude). The Pakowki Lake Sand Hills cover a surface area of 49 sq. km. or 19 sq. miles in the mixed grassland area of southeastern Alberta (David 1977 from Hrapko 1989).

At the Pakowki Lake site, about 50 individuals were seen in 1986 but only 15 individuals were found in 1987, a much drier year (Hrapko 1989). Population sizes were 2, 1 and 12 at three sites situated close to one another. Only 15 had been found in 1987 despite intensive searching through all active dune areas and many stabilized dune areas at Pakowki Lake. (Wallis and Wershler 1988) In 1990, a much wetter year, 210 individual plants bearing 1-6 stems per plant (2 stems on average) were counted. All flowers were blue. Each inflorescence contained many flowers (Figure 2E-2G). The plants were found in an area covering approximately 100 m x 150 m on the leeward side of a partly stabilized dune and on the sand plain at the base of this dune. (Smith and Lewis 1990; Figures 2C, 2D)

C. Whiskey Gap, southcentral Alberta

One population may have been discovered at Whiskey Gap (49 01', 113 ;-01') but, as a result of its immature stage, identification may be questionable (W.J. Cody, letter, April 20, 1989).

D. Lauder Sand Hills, southwestern Manitoba (Figure 3, 4)

Plants were found scattered on mostly stabilized steep dune upper slopes and crests in three sites along a distance covering approximately one mile. (Figure 4) The population was distributed as follows: Site 1 - 21 plants (1-3 stems per plant), 3/21 had deep pink rather than the typical blue petals. Site 2 - 22 plants (1-3 stems per plant), 2/22 had deep pink petals, 1/22 had light pink petals. Site 3 - 23 plants (1-4 stems per plant), all had the typical blue petal colour. Total: 66 plants (1-4 stems per plant) - 5/66 had deep pink petals, 1/66 had light pink petals, 60/66 had blue petals. (Smith and Lewis 1990)

II. Assessment of Status

11. General Assessment

The following criteria have been used to assess the status of *Tradescantia occidentalis* in Canada:

taxonomy (*Tradescantia occidentalis* is the only representative of the family Commelinaceae and genus *Tradescantia* in Alberta and Manitoba. As well, there is only one other species (*Tradescantia ohiensis)* , itself rare in southern Ontario, of the genus found in Canada.)

abundance (Alberta population is estimated at less than 210 individuals. One site in Manitoba contains less than 70 individuals while the population of the second site is estimated at approximately 1700 individuals.)

distribution (restricted in Canada to southeastern Alberta and southwestern Manitoba; known to occur in only one active dune in the Pakowki Lake dune complex and two sand hill areas in Manitoba, namely, the Lauder and Routledge Sand Hills.)

habitat distribution (restricted in Canada, Alberta and Manitoba)

habitat stability (unstable, ongoing loss of sites and habitat through grazing and fire control)

population trend (only recently discovered in Alberta, appears stable or increasing but too early to recognize trends. Rediscovered in Manitoba in 1990 after nearly forty years, too early to recognize trends.)

reproductive potential (moderate, given habitat restructuring)

international standing (unique in North America, not internationally)

protective status (low, no formal designation, uncertainty about future landowners and management of grazing leases)

Figure 3. Lauder Sand Hills, southwestern Manitoba.

Figure 3C. Northwest-running dune ridge.

Figure 3D. Elm, left background, poison ivy-grass habitat, dune slope.

Map 2A. Critical Habitat of Tradescantia occidentalis (Britt.) Smyth

Pakowki Lake Sand Dunes, southeastern Alberta

Scale: 1:250,000

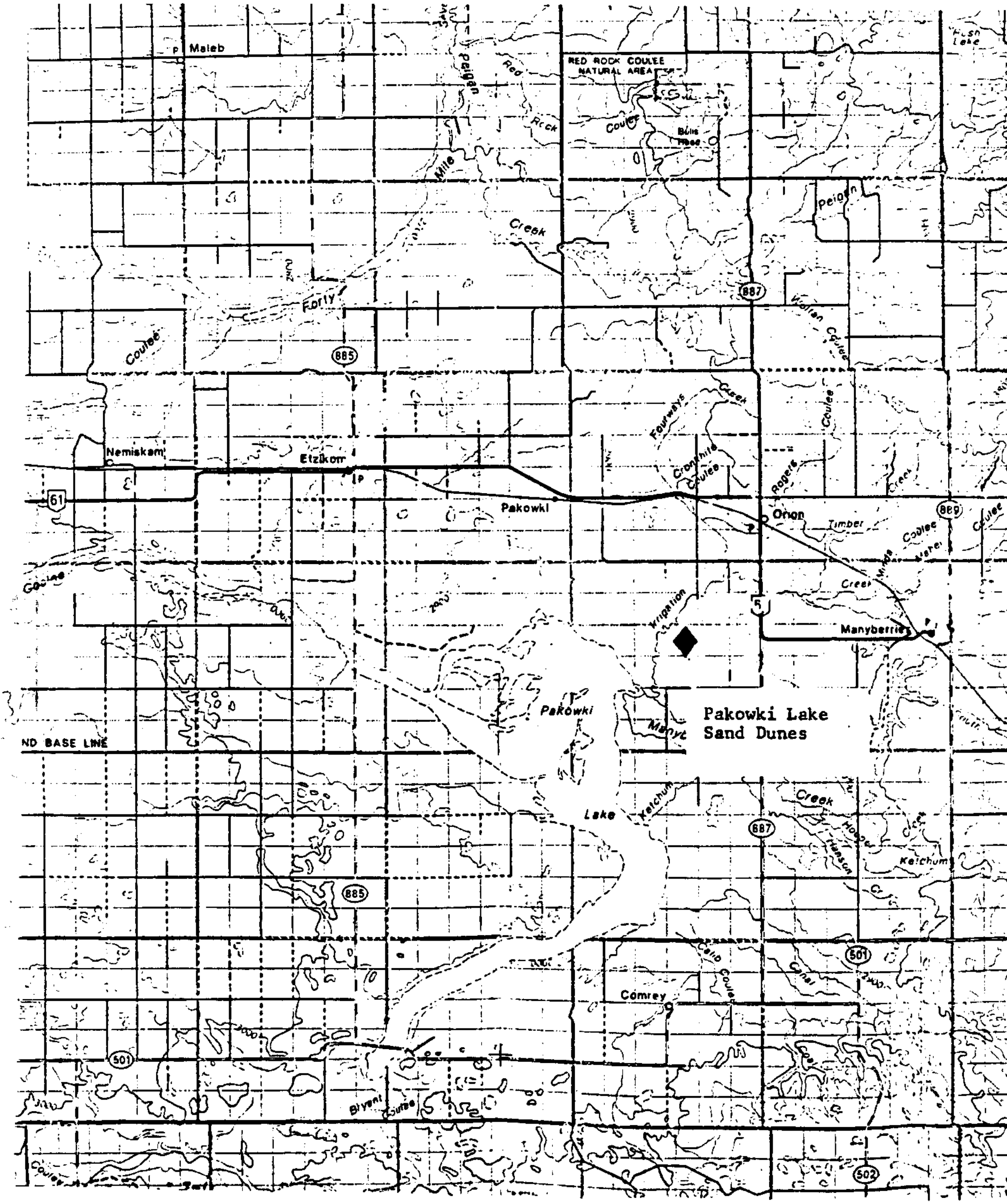


Figure 3. Lauder Sand Hills, southwestern Manitoba.

Figure 3E. Surrounding lower dune plains, Juniperus horizontalis (darker green) beds.

Figure 3F. Surrounding forests, opposite dune slopes.

Map 3A. Critical Habitat of *Tradescantia occidentalis* (Britton) Smyth

Oak Lake Regional Sand Hills, southwestern Manitoba

Scale: 1:250,000

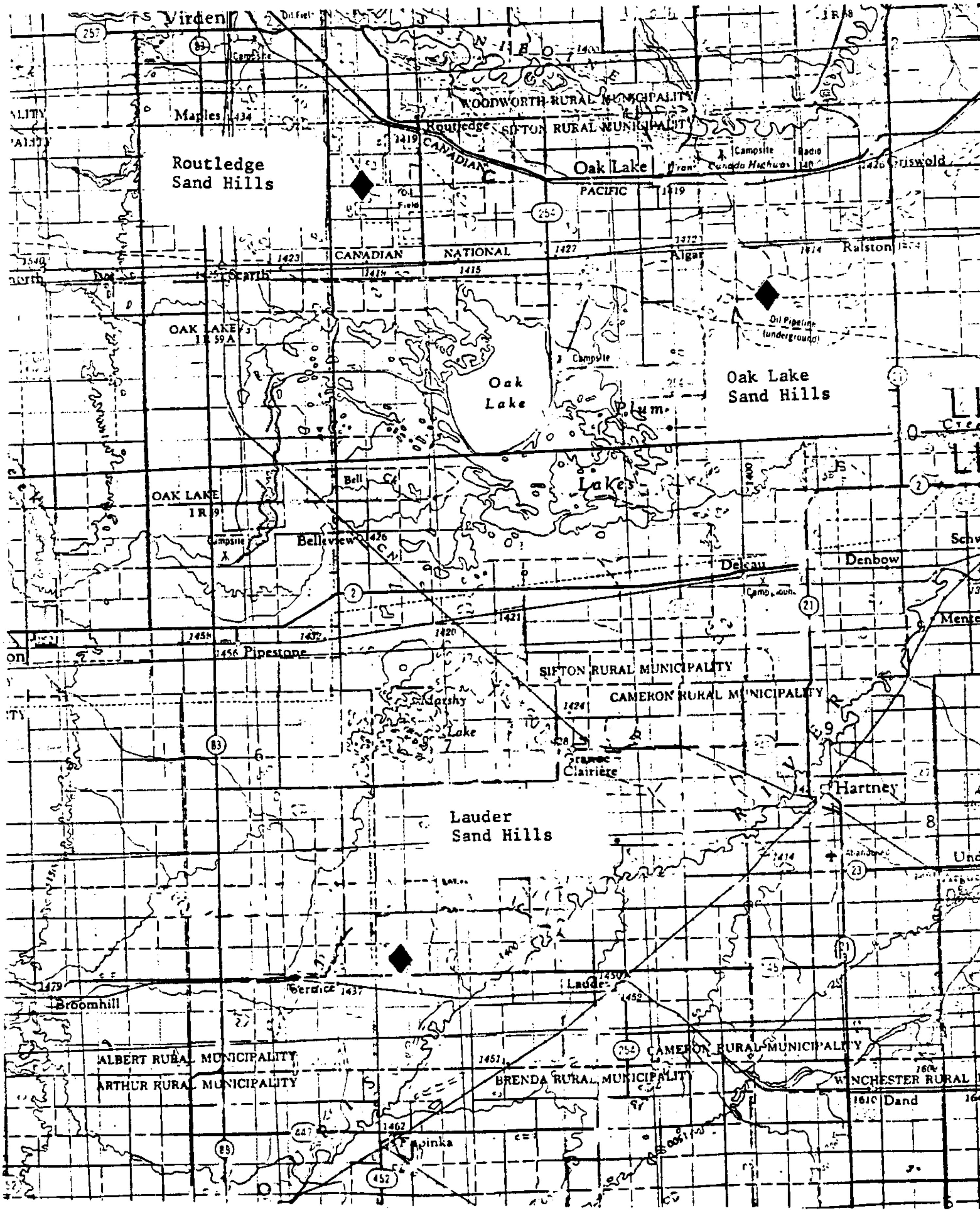


Figure 5. Routledge Sand Hills, southwestern Manitoba.

Figure 5A. Extensive north-running dune ridge system.

Figure 5B. Fence and lower slopes of dune ridges.

Map 3C. Critical Habitat of Tradescantia occidentalis (Britt.) Smyth

Routledge Sand Hills, southwestern Manitoba

Scale: 1:50,000

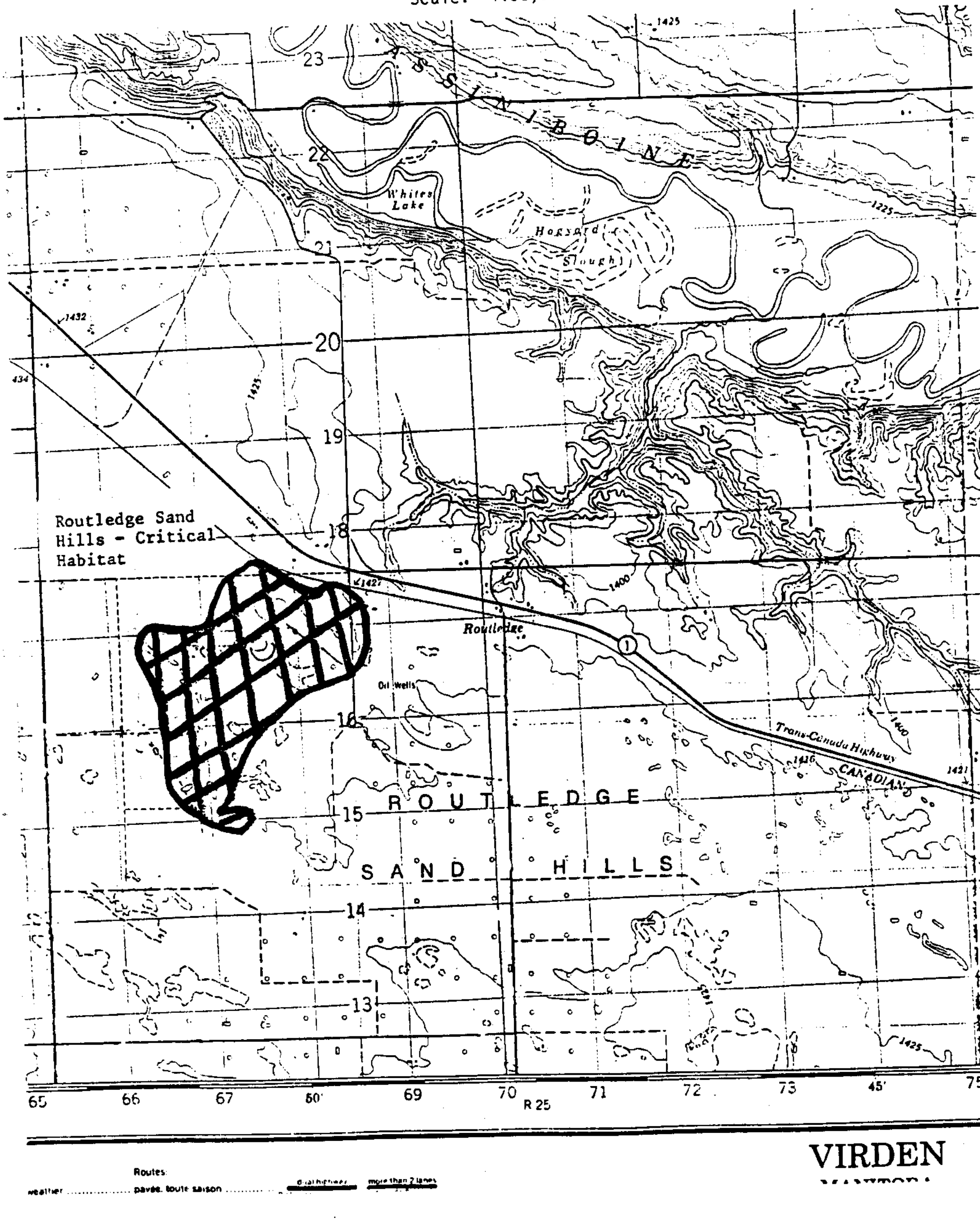


Figure 5. Routledge Sand Hills, southwestern Manitoba.

Figure 5E. *Tradescantia occidentalis* inflorescences, pink-flowered type.

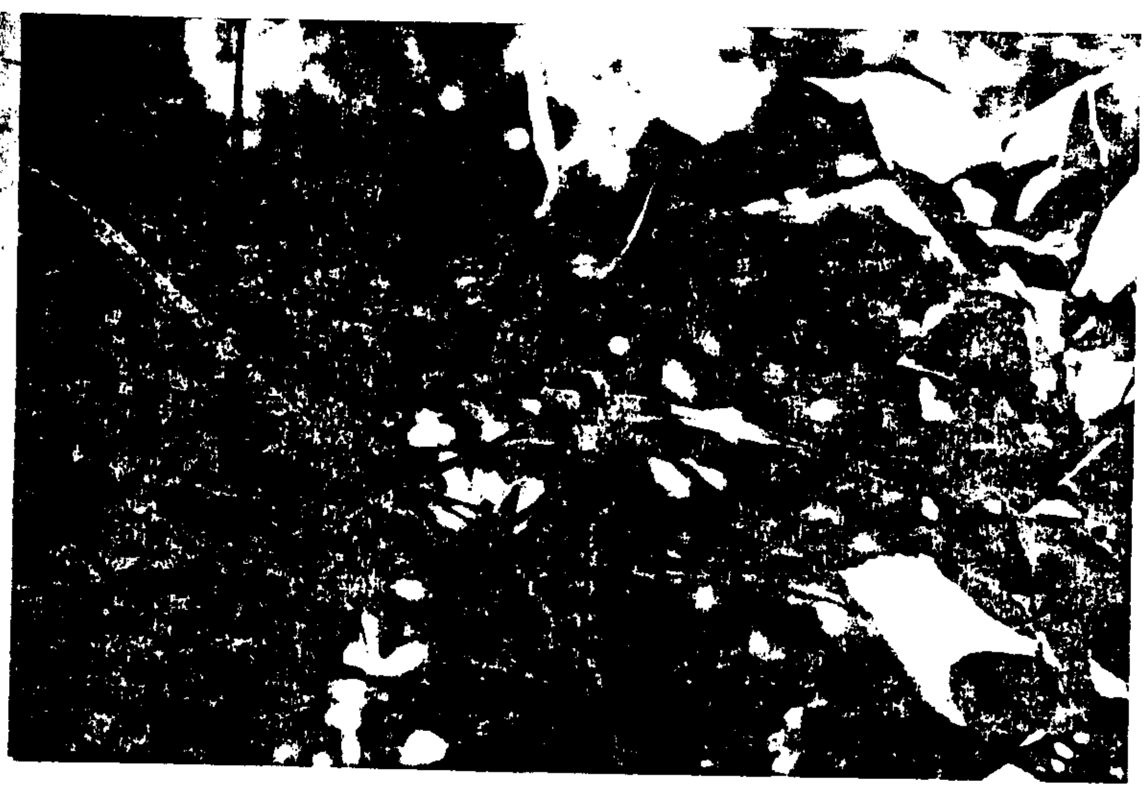


Figure 5F. *Tradescantia occidentalis* inflorescence, dark blue flowered type near forest edge.

Hill complexes should be protected as potential habitat (Maps 3A, 4) (Smith and Lewis 1990)

14. Conservation Recommendations

Detailed recovery and monitoring plans should be prepared for *Tradescantia occidentalis* in an attempt to reverse the trend towards loss of habitat. There must be a clear recognition of the value of actively eroding sands for rare plants and animals. Changes in grazing patterns and attitudes to the use of fire for grassland management are essential if the full range of environmental diversity in Alberta's sandhills and sand plains is to be protected. (Wallis 1988)

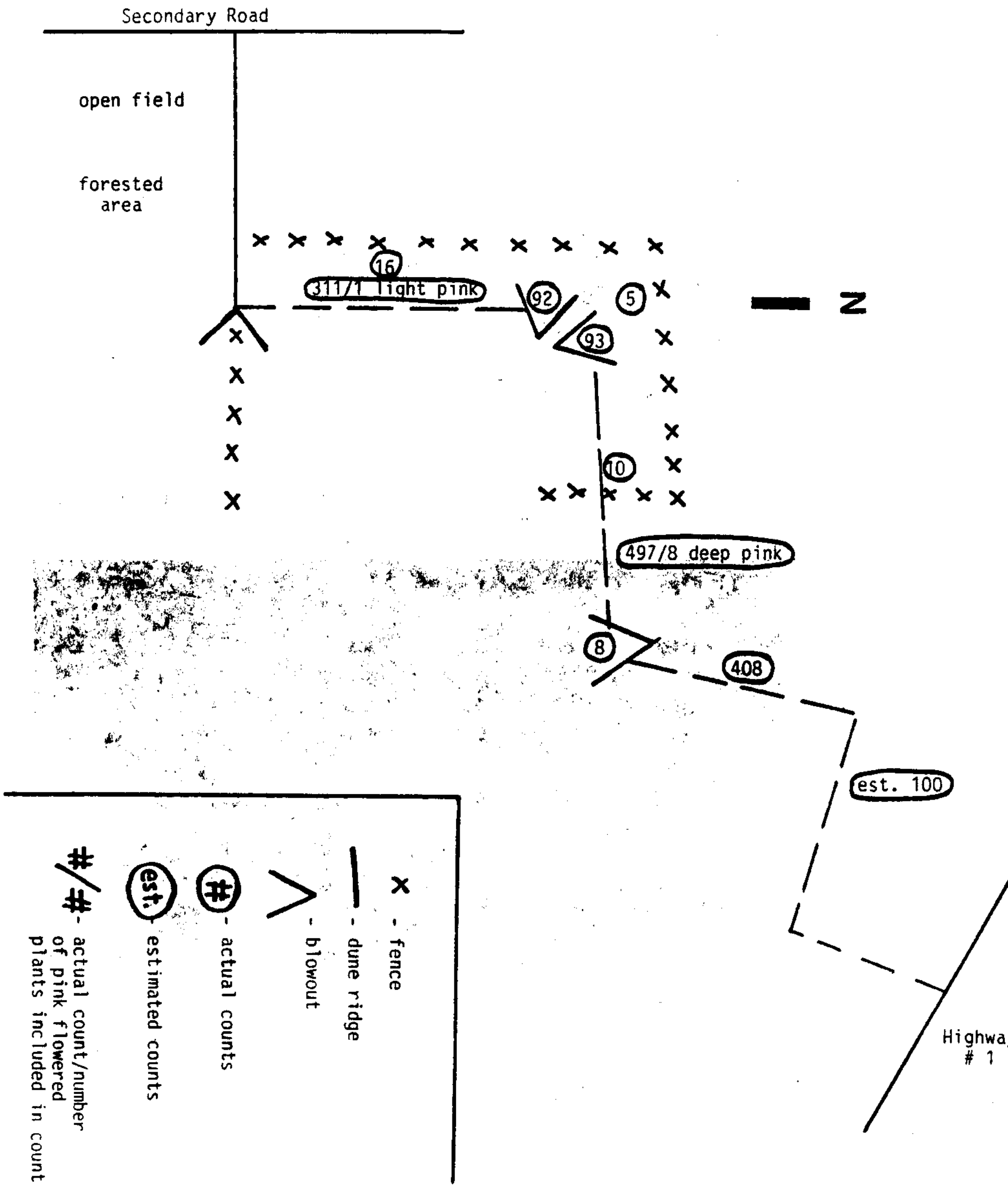
Selective destabilization of parts of some dunes may be beneficial to this species over the long-term (Wallis and Wershler 1988). Collection of seed and research into the biology of this species could be useful in attempts to establish other populations in the Pakowki Lake North dunes (Wallis and Wershler 1988).

The necessity for a control plan for *Euphorbia esula* for the Manitoba sites should be studied. As well, grazing practices in the Lauder and Routledge Sand Hills should be monitored. The protective status accorded the Routledge Sand Hills site regarding the possibility of petroleum exploration and extraction should be clarified.

Figure 6

Routledge Sand Hills, southwestern Manitoba

Population Distribution



Bryson, R. A., D. A. Baerreis and W. M. Wendland. 1970. "The character of late glacial and post-glacial climatic changes" in Pleistocene and recent environment of the Great Plains, W. Dort, Jr. and J. K. Jones, Jr. (editors). Department of Geology, University of Kansas, Special Publication 3, Wichita, Kansas.

Coupland, Robert T. 1950. Ecology of mixed prairie in Canada. Ecological Monographs 20:271-315.

Coupland, Robert T. 1987. "Endangered prairie habitats: the mixed prairie", pp. 35-41 in "Proceedings of the workshop on endangered species in the prairie provinces" ed. by Geoffrey L. Holroyd *et al.* Provincial Museum of Alberta Natural History Occasional Paper No. 9, Edmonton, Alberta.

David, P. P. 1971. The Brookdale road section and its significance in the chronological studies of dune activities in the Brandon Sand Hills of Manitoba. The Geological Association of Canada, Special Paper No. 9,

David, P. P. 1977. Sand dunes occurrences of Canada. Prepared under contract for Parks Canada, Department of Indian and Northern Affairs, Ottawa, Ontario.

Epp, H. T., C. I. G. Adam and L. Townley-Smith. 1982. The Harris Sand Hills: A Saskatchewan natural area. Saskatchewan Natural Areas Report No. 6. Saskatchewan Environment, Regina.

Epp, H. T. and L. Townley-Smith, eds. 1980. The Great Sand Hills of Saskatchewan. Policy, Planning and Research Branch, Saskatchewan Department of the Environment, Regina.

Everett, Thomas H. 1981. "Tradescantia" in The New York Botanical Garden illustrated encyclopedia of horticulture. Vol. 3. Garland Publishing Inc., New York.

Fernald, M. L. 1950. Gray's Manual of Botany, Eighth Edition - A Handbook of the flowering plants and ferns of the central and northeastern United States and adjacent Canada. American Book Company, New York, New York.

_____. 1968. Gray Herbarium Index. Vol. 10. Harvard University, Boston.

8. Management Practices and Experience

Mixed prairie is so named because it includes both mid and short grasses. This the most extensive grassland region found in North America. The area of uncultivated mixed prairie is declining rapidly. Some 23% of the rangeland still existing in 1956 had been plowed by 1981. Much of the remaining rangeland exists in areas unsuitable for cultivation. At the same time, greatly increased grazing pressure on the remaining rangeland has changed the plant composition in all types of habitats. About 24% of the original mixed prairie remains in its native state. One national park, Grasslands National Park in southwestern Saskatchewan, several provincial parks and natural areas exist within the mixed prairie zone, but further protection is necessary. (World Wildlife Fund 1988)

Native grasslands continue to be broken and seeded to tame pasture and crops. The majority of short-grass and mixed-grass prairie has been lost or converted in Alberta. Within the grasslands natural area several major sand dunes have also been mostly lost through cultivation. A southern Alberta study of rare wildlife and plants in sandhill and sand plain habitats indicates that these areas contain a concentration of significant features, including numerous rare, threatened, and endangered species of plants and animals. (Wallis and Wershler 1988) Loss of primary habitat as well as destruction of specific habitats via stabilization of active sand has contributed to a weaker position for the rare entities within these areas.

8.1 Habitat Management

The grasslands natural region in Alberta is considered to be among the most threatened of Alberta's natural regions. They are being lost or converted at an extremely rapid rate. (Wallis 1987) Several major sand plains have been almost completely cultivated and a major threat to the remaining habitats exists. Alberta is not alone in the problem of loss of active sand habitats. Nebraska sandhill plants have been placed on the United States endangered species' list. Ironically, stabilization of the active sand was seen as good conservation practice. Land managers went to great lengths to stabilize active blowouts, extinguishing fires, modifying their grazing patterns and even placing old tires in the blowouts. (Wallis 1988) This needs to be studied.

Legeay, G. *et al.* 1968. Biophysical aspects of radiation quality. International Atomic Energy Agency, Vienna, Austria. (Distributed in the United States by Unipub, Inc., New York)

Pylydec, Bohdan. 1989. A Floristic inventory of a sand hills area near Saskatoon, Saskatchewan. Blue Jay 47(2):74-83.

-----. 1988. Prairie conservation action plan 1989-1994. World Wildlife Fund Canada.

Radford, Albert E. 1986. Fundamentals of Plant Systematics. Harper and Row, New York.

Ramaley, F. 1939. Sand-hill vegetation of northeastern Colorado. Ecological Monograph 9:1-51.

Rendle, Alfred Barton. 1963. The Classification of Flowering Plants. Vol. 1: Gymnosperms and Monocotyledons. 2d ed. Cambridge University Press, Cambridge.

Sanderson, Marie. 1988. "Climatic Regions" in The Canadian Encyclopedia. Vol. 1. 2d ed. Hurtig Publishers, Edmonton, Alberta.

Scoggan, H. J. 1957. Flora of Manitoba. National Museums of Canada Bulletin 140. National Museums of Canada, Ottawa.

Scoggan, H. J. 1978. Flora of Canada. Part 2. Publications in Botany, No. 7. National Museum of Natural Sciences. National Museums of Canada, Ottawa.

Smith, Bonnie and Glennis Lewis. 1990. Field observations, late June - early July.

Smith, Robert J. with Beatrice S. Smith. 1980. The Prairie garden: 70 native plants you can grow in town or country. University of Wisconsin Press,

Stafleu, Frans A. and Richard S. Cowan. 1981. Taxonomic literature. 2d ed. Bohn, Scheltema & Holkema, Utrecht.

Stamp, Robert M. 1988. "Alberta" in The Canadian Encyclopedia. Vol. 1. 2d ed. Hurtig Publishers, Edmonton, Alberta.

in its original state. The landowner had contacted the Nature Conservancy regarding solidification of conservation status for his property in perpetuity and was informed that he was already conserving the area in the best manner possible. Management policies for this property appear to consist of a hands-off approach with some possible light grazing and use of the area for hiking in summer and cross-country skiing in winter. A desire to control potential development of the land for petroleum extraction was a primary concern expressed by the landowner.

Management policies for the northern portion of the dune system (owned by the Manitoba government), presently under lease, are unknown. There has been active exploration and development of petroleum extraction in this area.

9. Evidence of Threats to Survival

The Grasslands Natural Region is one of the most threatened natural regions in Alberta. Over two-thirds of the Mixed Grassland has been lost to cultivation or other development. (Wallis 1987) Many major sand plains (critical habitat for *Tradescantia occidentalis*) have been lost and many others are threatened (Wallis 1988). Critical habitat is defined by Wallis (1987) as "most crucial to the survival of population, species, races or form. When these critical habitats are disturbed there will be major effects on the plants and animals that depend upon them." Over half of the birds and mammals now listed by COSEWIC are found in the three prairie provinces as a result of habitat loss in Western Canada (Hummell 1987). The government of Alberta has priorized the threatened grassland region for representation and protection in the form of ecological reserves but overall representation of ecological reserves in this region of Alberta is very poor to date.

In Alberta, about 20% of the rare plants in the grassland and parkland regions are found in sandy soils, principally in sand hill areas. Sand hill areas are locally distributed, and diverse sand hill areas are rare. Principal threats to these habitats relate to cattle grazing and invasion of non-native species as a result of vegetation reclamation along oil and gas access roads and well-sites. (Wallis 1987)

Stearn, William T. 1966. Botanical Latin. Hafner Publishing Company, New York.

Sullivan, Gene A. and Richard H. Daley. 1981. Resources of wildflower propagation. Missouri Botanical Garden, St. Louis.

Wallis, Clifford A. 1982. An Overview of the mixed grasslands of North America. Proceedings of Grassland Ecology and Classification Symposium, Kamloops, B.C. Publication No. R28-82060. Information Services Branch, B.C. Ministry of Forests, Victoria.

Wallis, Clifford A. 1987. Critical, threatened and endangered habitats in Alberta, pp. 49-63, in "Proceedings of the workshop on endangered species in the prairie provinces" by Geoffrey L. Holroyd *et al.* Provincial Museum of Alberta Natural History Occasional Paper No. 9, Edmonton, Alberta.

Wallis, Clifford A. 1988. The Unsung benefits of wind erosion - stabilizing sand dunes spell trouble for rare plants. Iris Newsletter 3:1-2.

Wallis, Clifford A. and Cleve Wershler. 1988. Rare wildlife and plant conservation habitats of southern Alberta. Alberta Forestry, Lands and Wildlife; Alberta Recreation and Parks; World Wildlife Fund Canada, Edmonton, Alberta.

Weir, T. R. 1988. "Manitoba" in The Canadian Encyclopedia. Vol . 2. 2d ed. Hurtig Publishers, Edmonton, Albeta.

White, David and Karen Johnson. 1980. The Rare vascular plants of Manitoba. National Museum of Natural Sciences Syllogeus 27. National Museums of Canada, Ottawa.

Particular data showing the trend towards dune stabilization is presented. From 1950 to 1987, there has been a 30 to 40% reduction in active sand at Dune Point with invasion by Russian thistle into the gravelly sands. A series of active dunes stretched virtually unbroken for 2 km along the South Saskatchewan River in 1950 - today all these dunes are stabilized and there are only minor active blowouts. All 16 sand blowouts at Remount Community Pasture, which were active in 1950, are now stabilized. Of 51 blowouts active in 1950 in the Middle Sand Hills, only 20 are still active and, of these, 10 are partly stabilized and 7 are mostly stabilized (90% of the sand which was active in 1950 is now stabilized). (Wallis 1988)

Other examples of the trend towards dune stabilization on the prairies are presented. The Dundurn Sand Hills near Saskatoon, Saskatchewan have mostly been stabilized by vegetation. Small areas still exist where wind erosion and deposition are altering landforms particularly under disturbed conditions such as those incurred under heavy grazing in times of drought. Earlier aerial photographs reveal areas of active dune complexes more extensive in the past (1944). (Pylypec 1989)

The Harris Sand Hills, 80 km southwest of Saskatoon, are surrounded by cultivated land mostly in cereal grains. There are only three small-active areas remaining in the southwest part of the dune surrounded by a larger aspen forest. The vast majority of the dunes are stabilized. The Harris Sand Hills area an oasis for native flora and fauna which inhabit both the grasslands and parklands of central Saskatchewan. (Epp 1982)

The Great Sand Hills of Saskatchewan are located west of Regina near the Manitoba border and northeast of Cypress Hills. High stabilized dunes cover the largest area - 50% of the dune field - and are the most sensitive to disturbance. Active complexes are the least extensive (0.4%). The Great Sand Hills form a varied natural ecosystem that is sensitive to disturbance and is a genetic reservoir for rare and common species. (Epp 1980)

It is interesting to note that Ramaley (1939), while studying sand-hill vegetation in northeastern Colorado, found *Tradescantia occidentalis* was an important species of the sand-hills mixed community and frequent on sand prairies. *Tradescantia occidentalis*

16. Collections Consulted

The following botanical collections have been consulted:

University of Calgary, Calgary, AB

University of Brandon, Brandon, MAN

University of Winnipeg, Winnipeg, MAN

National Museum of Canada, Ottawa, ON

Department of Agriculture, Ottawa, ON

17. Fieldwork

The discovery site at the Pakowki Lake Sand Hills was found by Julie O. Hrapko in 1986. Since then Wallis and Wershler found two additional colonies nearby in the Pakowki dunes in 1987. The Pakowki Lake Sand Hills site was revisited in 1990 by Bonnie Smith and Glennis Lewis. One specimen was collected in 1987 by J. D. Johnson at Whiskey Gap, Alberta. The immature specimen was tentatively identified by W.J. Cody as *Tradescantia occidentalis*. The site has not been revisited to date.

Various sites south and southeast of Oak Lake were checked in 1989 but no specimens were found at that time. (Johnson 1989, pers. comm.) Smith and Lewis rediscovered the 1920-1950's sites in Manitoba at the Lauder and Routledge Sand Hills in the summer of 1990.

18. Knowledgeable Individuals

1. Cheryl Bradley, 158 Westover Dr., Calgary, AB T3C 2S6. Phone: (403) 246-9127

- has prepared background material on *Tradescantia occidentalis*.

2. Dr. W. J. Cody, Research Associate, Biosystematics Research Centre, William Saunders Building, Ottawa, ON K1A 0C6

grazing; and in other areas where there has been grazing but few fires. (Wallis 1988) The Pakowki Lake site is leased for grazing (Wallis and Wershler 1988) On the other hand, the condition of surviving Mixed Grassland in Alberta is deteriorating because of increased grazing (Coupland 1987). This presents a management dilemma.

The positive or negative impacts of grazing at various seasons are unknown (Wallis and Wershler 1988). A current theory is that late summer or fall fires formerly created lush green areas the following spring. These green patches attracted large herds of grazing animals like bison and resulted in reactivation of the sand dunes. The sandhills were also apparently used as sheltering areas by bison during the winter and this could have been significant in keeping dunes active. Fire control and changes in grazing patterns have completely changed the factors which shape sand dune environments. (Wallis 1988)

Both Manitoba sites (Lauder and Routledge Sand Hills) are potentially threatened by grazing practices. The Lauder Sand Hills site is protected from grazing under the Manitoba government's Wildlife Habitat Management Program. There is a heavily eroded feedlot next to the site. An electric fence separates this property from the protected land. The Routledge site is lightly grazed from time to time by the private landowner. No noticeable damage to the dune system was noted except along some fencelines (Figure 5G). The more northern areas of the dune ridge are under lease by the Manitoba government. Grazing practices in this area are unknown. (Smith and Lewis 1990)

9.4 Invasive Weeds

Habitat of the two Manitoba sites (Lauder and Routledge Sand Hills) is threatened by the leafy spurge, *Euphorbia esula*. The valleys between the dune ridges at the Lauder Sand Hills site are filled with leafy spurge (Figure 3C). At the most northern site on the dune ridge *Euphorbia esula* grows mixed in with the spiderwort plants growing on the upper slopes. The leafy spurge could potentially invade and overtake the habitat of the western spiderwort at this location. (Smith and Lewis 1990)

Euphorbia esula is particularly common on the opposite forested sides of the dune ridge at the Routledge Sand Hills site (Figure 5H).

- tentatively identified immature specimen from Whiskey Gap, Alberta as *Tradescantia occidentalis* .

3. Julie O. Hrapko, Provincial Museum of Alberta, 12-845-102nd Avenue, AB T5N 0M6. Phone: (403) 427-1730.

- original discovery with others from the Provincial Museum of the Pakowki Lake site in southeastern Alberta. Also, wrote 19 article on *Tradescantia occidentalis* for .

4. Karen Johnson, Curator of Botany, Natural History Division, Manitoba Museum of Man and Nature, 190 Rupert Avenue, MN R3B 0N2. Phone: (204) 956-2830.

- co-author of the Rare Vascular Plants of Manitoba and checked sites south and southeast of Oak Lake, Manitoba for specimens of *Tradescantia occidentalis*. Also, wrote 1985 article on *Tradescantia occidentalis* for Manitoba Naturalist.

5. Glennis Lewis, 2511-17th Street N.W., Calgary, AB T3A 2E6. Phone: (403) 284-5714.

- visited Pakowki Lake and rediscovered the Manitoba sites, summer 1990, with Bonnie Smith. Photographed Pakowki Lake, Lauder Sand Hills and Routledge Sand Hills sites and specimens, summer 1990.

6. Bonnie Smith, 459-30th Avenue N.W., Calgary, AB T2M 2N5. Phone: (403) 276-9197.

- principal author of COSEWIC report on *Tradescantia occidentalis.* Visited the Pakowki Lake Sand Hills site in 1990 and conducted further population studies. Rediscovered the mid-1950's Manitoba sites, with Glennis Lewis, in the summer of 1990 at the Lauder and Routledge Sand Hills.

7. Cliff Wallis, Cottonwood Consultants Ltd., 615 Deer Croft Way SE, Calgary, AB T2J 5V4. Phone: (403) 271-1408.

- has conducted detailed initial population surveys of the Pakowki Lake sand dune site, southeastern Alberta. Also, prepared management status recommendation reports on *Tradescantia*

The Nature Conservancy rank is Global G?, Canada N1, Alberta P1, Manitoba P1. The United States rank in not known but Ayensu and DeFilipps (1978) did not list it as endangered or threatened on any of their state listings.

All the lists of rare species for the prairie provinces are relatively long. The most recent Alberta list (Packer and Bradley 1984) contains 360 species, representing 24% of the native flora. The Manitoba (White and Johnson 1980) list contains 300 taxa. (Kershaw 1987)

Kershaw (1987) acknowledges three major groups of distribution patterns of rare species in prairie provinces. Over 80% of the "rare" species in the prairie provinces appear to belong to a group composed of species extending into the provinces from nearby (non-disjunct) widespread populations. Such populations add considerably to the species diversity of the provinces, probably accounting for more than 20% of the total floras. The Manitoba populations of *Tradescantia occidentalis* probably fall into this category. The Alberta population may belong to a second group composed of species extending into the province as small disjunct populations. This group is composed of less than 10% of the number of total rare species in the prairie provinces. A third group composed of endemic species is limited to a local area and is restricted geographically. (Kershaw 1987)

Johnson, Karen L. 1985. Another rare prairie plant: the western spiderwort (*Tradescantia occidentalis* (Britt.) Smyth.) Rare Plant Alert, Manitoba Naturalist Society Bulletin 8(3).

_____. Land Ownership, Range and Township Map, Oak Lake (Routledge, Melita area), southwestern Manitoba.

_____. 1988. Prairie conservation action plan 1989-1994. World Wildlife Fund Canada.

Pylydec, Bohdan. 1989. A Floristic inventory of a sand hills area near Saskatoon, Saskatchewan. Blue Jay 47(2):74-83.

Ramaley, F. 1939. Sand-hill vegetation of northeastern Colorado. Ecological Monograph 9:1-51.

Smith, Bonnie and Glennis Lewis. 1990. Field notes, trips to Pakowki Lake Sand Hills, AB and southwestern Manitoba's Lauder, Oak Lake, and Routledge Sand Hills.

_____. Travel Manitoba Map. Manitoba Highways and Transportation.

Wallis, Clifford A. 1982. An Overview of the mixed grasslands of North America. Proceedings of Grassland Ecology and Classification Symposium, Kamloops, B.C. Publication No. R28-82060. Information Services Branch, B.C. Ministry of Forests, Victoria.

Wallis, Clifford A. 1988. The Unsung benefits of wind erosion - stabilizing sand dunes spell trouble for rare plants. Iris Newsletter 3:1-2.

Wallis, Clifford A. and Cleve Wershler. 1988. Rare wildlife and plant conservation habitats of southern Alberta. Alberta Forestry, Lands and Wildlife; Alberta Recreation and Parks; World Wildlife Fund Canada, Edmonton, Alberta.

All preceding criteria are items of concern in assessing the status of this species. In Canada, *Tradescantia occidentalis* has experienced declines in populations and ongoing habitat destruction and changes in land use and grazing patterns in the the remaining known and potential habitat placing the future survival of the species in question. The lack of formal protection for most sites with a viable management plan is a critical problem for the species' survival in Canada. Many sites in this habitat type have been lost through catastrophic destruction by cultivation as well as gradual attrition due to changes in grazing and fire regimes.

12. Status Recommendation

The western spiderwort (*Tradescantia occidentalis)* is proposed for listing as an endangered species in Canada.

13. Recommended Critical Habitat

Several major sand plains have been almost completely cultivated (Wallis and Wershler 1988). Designation and appropriate management of the Pakowki Lake North Dune G would help protect the only known population of *Tradescantia occidentalis* in Alberta and Canada. (Wallis and Wershler 1988) (Maps 2A, 2B) As well, an area of critical habitat may be proposed at Whiskey Gap should the presence of *Tradescantia occidentalis* be verified at this location. (Map 1) A major threat to remaining sand plain habitats exists in Alberta.

Other key sandy habitats in Alberta which have highly significant resources or concentrations of features and are worthy of legislated formal protection include Dune Point (west of Bindloss), Empress Dunes, Lost River, Lower Bow Dunes, Bindloss Depression Springs, Middle Sand Hills, Turin dunes and Wolf Island Dunes. (Wallis 1988)

Designation of critical habitat in Manitoba should include the southwestern section of the Lauder Sand Hills (Maps 3A, 3B) and the extensive ridge complex southwest of Routledge in the Routledge Sand Hills (Maps 3A, 3C) These populations have survived undisturbed since their last citation in the mid-1950's. The Lauder Sand Hills, Oak Lake Sand Hills, and Routledge Sand Hills all require more extensive exploration. Until this is completed all three Sand *occidentalis*. Located additional sites at Pakowki Lake dunes with Cleve Wershler, 1987.

19. Summary of Materials On File

Christiansen, E. A. 1979. The Wisconsin deglaciation of southern Saskatchewan and adjacent area. Can. J. Earth Sci. Vol. 16:913-938.

Coupland, Robert T. 1950. Ecology of mixed prairie in Canada. Ecological Monographs 20:271-315.

Epp, H.T. and L. Townley-Smith, eds. 1980. The Great Sand Hills of Saskatchewan. Policy, Planning and Research Branch, Saskatchewan Department of the Environment, Regina.

Epp, H.T., C.I.G. Adam and L. Townley-Smith. 1982. The Harris Sand Hills: A Saskatchewan natural area. Saskatchewan Natural Areas Report No. 6. Saskatchewan Environment, Regina.

Epp, Henry T. 1983. "Prehistoric settlement in two sand hills area on the Saskatchewan plains: archaeological design in action" (Chapter 13) in Tracking ancient hunters: prehistoric archaeology in Saskatchewan, ed. by H. T. Epp and I. Dyck. Saskatchewan Archaeological Society, Regina.

Epp, Henry T. 1986. Prehistoric settlement response to the Harris Sand Hills, Saskatchewan, Canada. Plains Anthropologist 31 (111):51-63.

Epp, Henry T. 1988. Way of the migrant herds; dual dispersion strategy among bison. Plains Anthropologist 33(121):309-320.

Hrapko, Julie O. 1989. Prairie spiderwort (*Tradescantia occidentalis)* in Alberta. Iris Newsletter, Winter Issue.

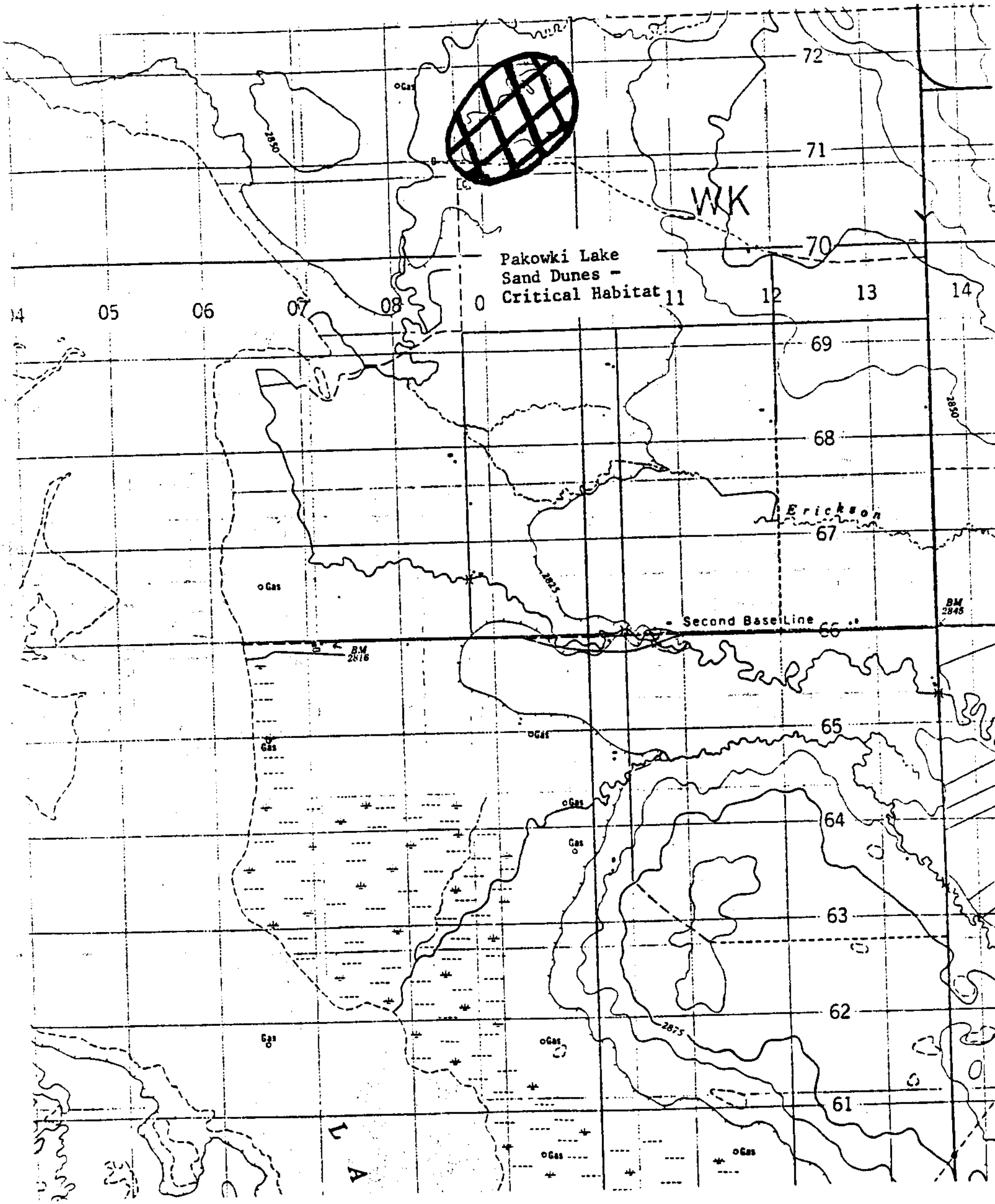
Hulett, G., R.T. Coupland and R.L. Dix. 1966. The Vegetation of dune sand areas within the grassland region of Saskatchewan. Can. J. Bot. 44:1307-1331.

Johnson, J.D. 1989. Letter to Dr. W.J. Cody, April 20, 1989.

Map 2B. Critical Habitat of Tradescantia occidentalis (Britt.) Smyth

Pakowki Lake Sand Dunes, southeastern Alberta

Scale: 1:50,000



IV. Authorship

20. Initial Authorship of Status Report

The initial authors of this report were:

Bonnie Smith, 459-30th Avenue N.W., Calgary, AB T2M 2N5. Phone: (403) 276-9197.

Cheryl Bradley, 158 Westover Dr., Calgary, AB T3C 2S6. Phone: (403) 246-9127

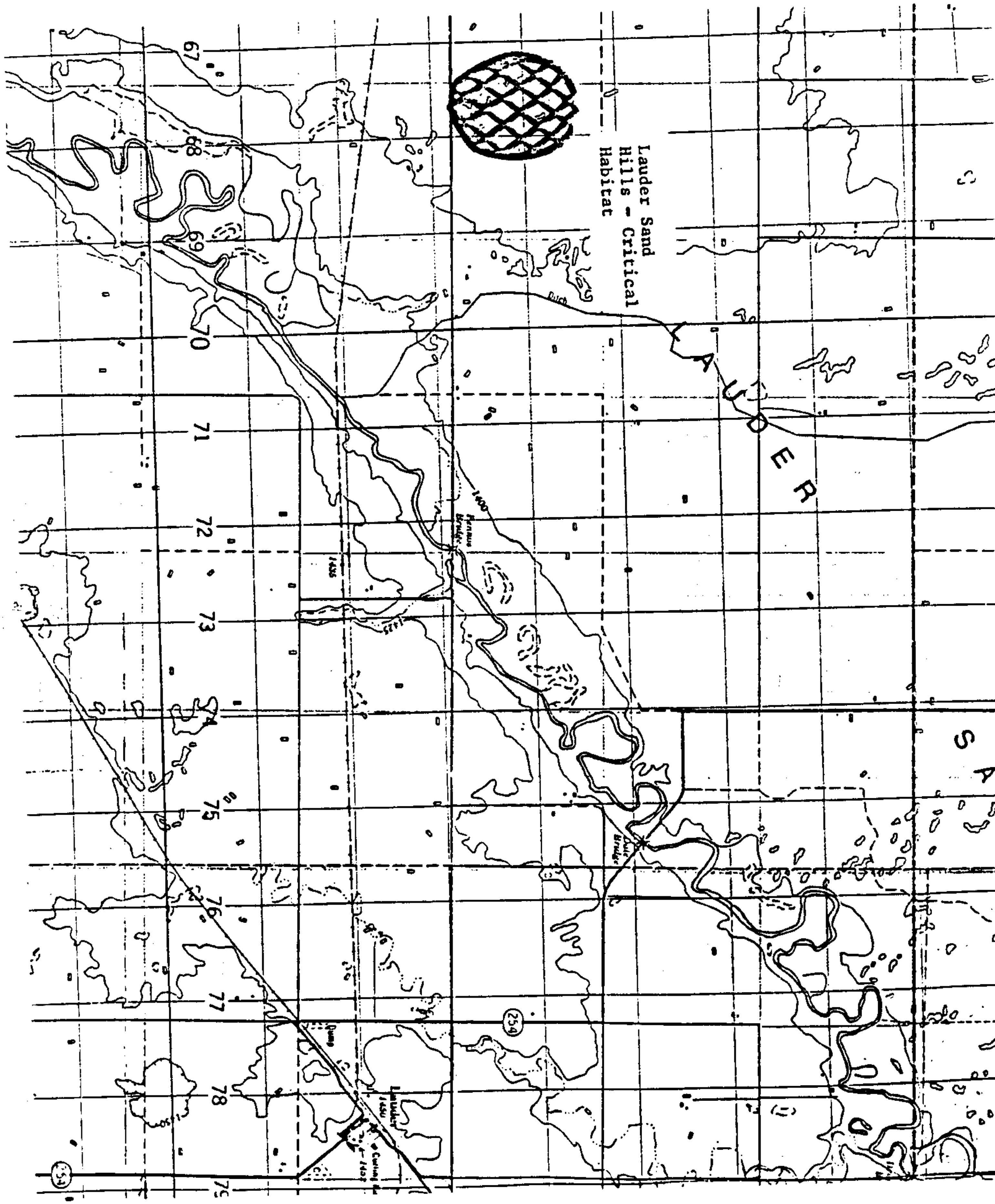
21. Maintenance of Status Report

Bonnie Smith, 459-30th Avenue N.W., Calgary, AB T2M 2N5, phone (403) 276-9197, will be responsible for receiving new information and making revisions and corrections to this status report and passing information on to COSEWIC.

Map 3B. Critical Habitat of Tradescantia occidentalis (Britt.) Smyth

Lauder Sand Hills, southwestern Manitoba

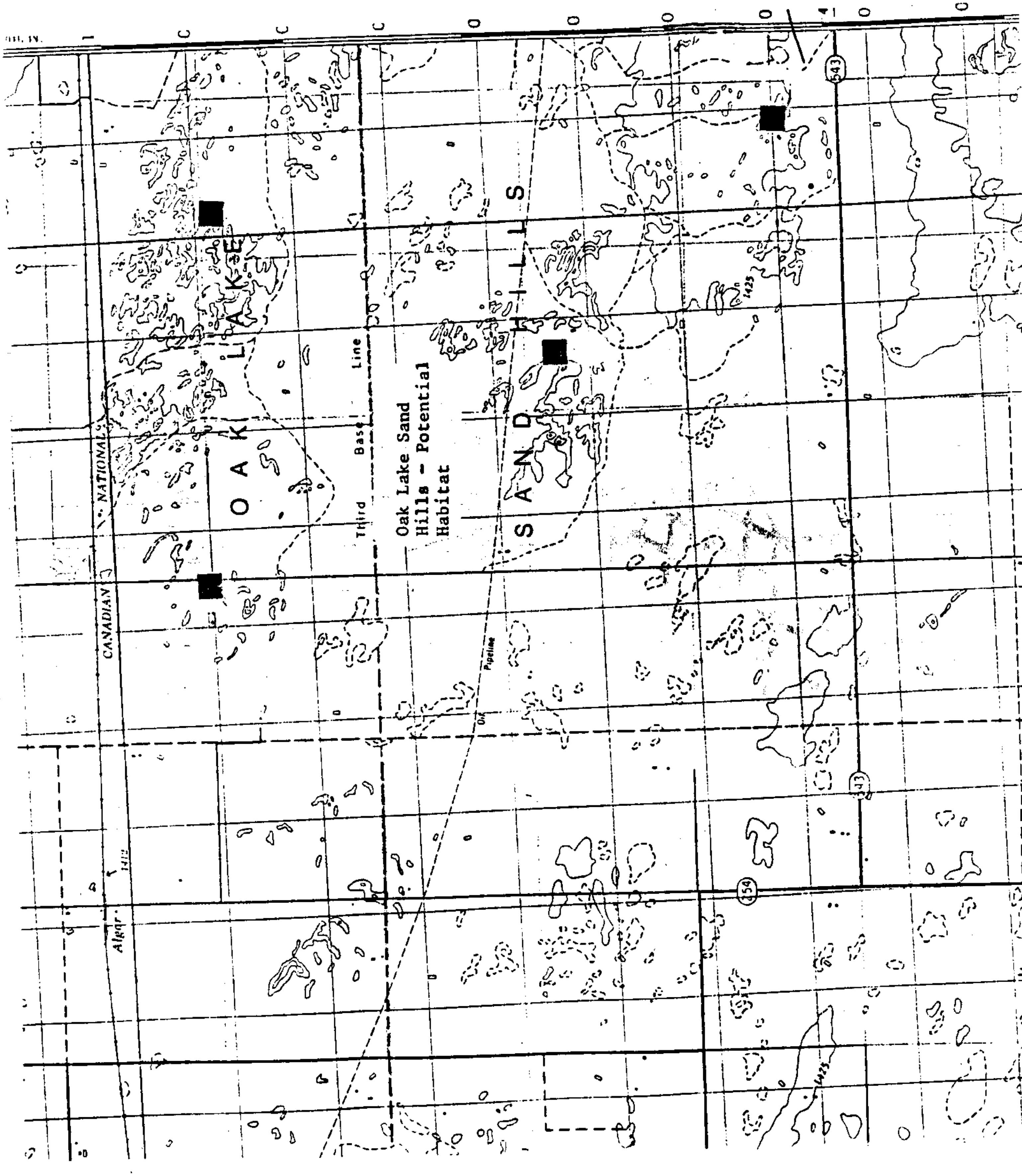
Scale: 1:50,000



Map 4. Critical Habitat of <u>Tradescantia</u> <u>occidentalis</u> (Britt.) Smyth

Potential Habitat - Oak Lake Sand Hills, southwestern Manitoba

Scale: 1:50,000



STATUS REPORT ON ENDANGERED WILDLIFE IN CANADA

ADDENDUM TO:

Western Spiderwort
(*Tradescantia occidentalis*)

[The enclosed document provides information on the first record of this species for Saskatchewan. This brings the total to four sites in three prairie provinces.]

COMMITTEE ON THE STATUS OF ENDANGERED WILDLIFE IN CANADA

COSEWIC

III. Information Sources

15. References Cited in Report

Anderson, Edgar and Leslie Hubricht. 1938. Hybridization in *Tradescantia* III. The evidence for introgressive hybridization. Amer. Jour. Bot. 25(6):396-402.

Anderson, Edgar and Karl Sax. 1936. A Cytological monograph of the American species of *Tradescantia*. Bot. Gaz.. 97(3):433-476.

Anderson, Edgar and Woodson. 1935. Contributions from the Arnold Arboretum 9:101-106.

Argus, George W. and David J. White. 1977. The Rare vascular plants of Ontario. National Museum of Natural Sciences, Syllogeus Series No. 14. National Museums of Canada, Ottawa.

Ayensu, Edward S. and Robert A. DeFilipps. 1978. Endangered and threatened plants of the United States. Smithsonian Institution and the World Wildlife Fund, Washington.

Ayers, H. D. 1988. "Drainage basins" in The Canadian Encyclopedia. Vol. 1. 2d ed. Hurtig Publishers, Edmonton.

Bailey, L. H. 1930. "Tradescantia", by F. Tracy Hubbard in The Standard cyclopedia of horticulture. Vol. III. the MacMillan Company, New York.

Bailey, L. H. 1951. Manual of cultivated plants. The MacMillan Company, New York.

Bainhart, John Hendley, comp. 1965. The New York garden biographical notes upon botanists. G.K. Hall & Co., Boston.

Bird, C. J. 1988. "Vegetation regions" in The Canadian Encyclopedia. Vol. 4. 2d ed. Hurtig Publishers, Edmonton.

Brookes, I. A. 1988. "Physiographic regions" in The Canadian Encyclopedia. Vol. 3. 2d ed. Hurtig Publishers, Edmonton.

the area. The location where the Western Spiderwort is found lies just west of the extensive leafy spurge invasion.

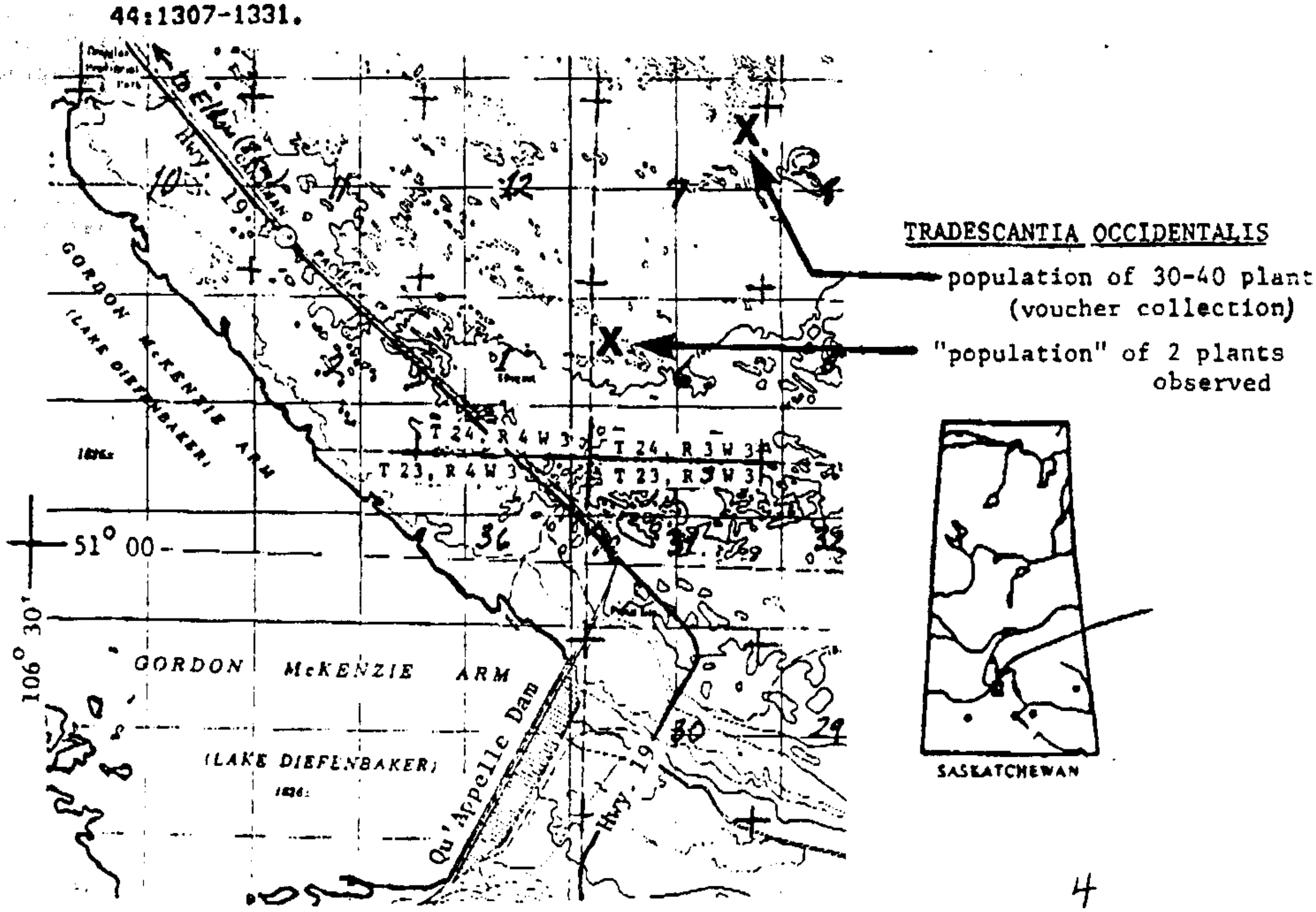
To the west of the site with Western Spiderwort a highway and railline run through the Provincial Park. This has provided a location for Smooth Brome (Bromus inermis) to become established and has resulted in some invasion of smooth brome into the adjacent undisturbed sand hill habitat. To the east of the Western Spiderwort site, several pipelines have caused a comparable amount of disturbance, providing additional possible sites for establishment of invasive exotics. A natural gas pipeline built nearby during 1991 is the closest major human disturbance site to this Spiderwort colony. It passes within approximately one km of the main population and could prove to be a major site for invasion of invasive exotic plants. Belcher and Wilson (1989) found that 95% of leafy spurge infestations were associated with anthropogenic disturbances.

Anderson H.G. and A.W. Bailey. 1980. Effects of annual burning on grassland in the aspen parkland of east-central Alberta. Can. J. Bot. 58:985-996.

Belcher, J.W. and S.C. Wilson. 1989. Leafy spurge and the species composition of a mixed-grass prairie. J. of R. Mgmt. 42:172-175.

Epp, H.T., and L. Townley-Smith eds. 1980. The Great Sand Hills of Saskatchewan. Policy, Planning and Research Branch, Saskatchewan Department of the Environment, Regina.

Hulett, G.K., R.T. Coupland, and R.L. Dix. 1966. The Vegetation of dune sand areas within the grassland region of Saskatchewan. Can. J. Bot. 44:1307-1331.



Hrapko, Julie O. 1989. "Prairie spiderwort (*Tradescantia occidentalis)* in Alberta. Iris Newsletter, Winter Issue.

Hummel, Monte. 1987. Prairie conversation, pp. 21-26 in "Proceedings of the workshop on endangered species in the prairie provinces" by Geoffrey L. Holroyd *et al.* Provincial Museum of Alberta Natural History Occasional Paper No. 9, Edmonton, Alberta.

Hulett, G., R.T. Coupland and R.L. Dix. 1966. The Vegetation of dune sand areas within the grassland region of Saskatchewan. Can. J. Bot. 44:1307-1331.

Johnson, J. D. 1989. letter to Dr. W. J. Cody, April 20, 1989.

Johnson, Karen L. 1985. Another rare prairie plant: the western spiderwort (*Tradescantia occidentalis* (Britt.) Smyth), Rare Plant Alert, Manitoba Naturalist Society Bulletin 8(3).

Johnson, Karen. 1989. Personal communication: telephone, June 28, 1989.

Jones, Jr., Samuel B. and Arlene E. Luchsinger. 1979. Plant Systematics. 2d ed. McGraw-Hill Inc., New York.

Kearney, Thomas H. and Robert H. Peebles. 1960. Arizona Flora. University of California Press, Los Angeles, California.

Keddy, C. J. 1987. Atlas of the rare vascular plants of Ontario, ed. by Kathleen M. Pryer and George W. Argus. National Museum of Natural Sciences, Ottawa.

Kershaw, Linda. 1987. Rare plants in the prairie provinces: a discussion of terms and distribution characteristics, pp. 103-107, in "Proceedings of the workshop on endangered species in the prairie provinces" by Geoffrey L. Holroyd *et al.* Provincial Museum of Alberta Natural History Occasional Paper No. 9, Edmonton, Alberta.

Lawrence, George H. M. 1951. Taxonomy of Vascular Plants. MacMillan Publishing Company, New York.

1992

WESTERN SPIDERWORT SURVEY

by

SHERRY HOHN & ROBERT PARSONS

CRITICAL WILDLIFE HABITAT PROGRAM
PARTNERS

WILDLIFE HABITAT CANADA
MANITOBA HABITAT HERITAGE CORPORATION
WORLD WILDLIFE FUND
MANITOBA NATURALISTS SOCIETY
MANITOBA OF NATURAL RESOURCES

INTRODUCTION

Western spiderwort (*Tradescantia occidentalis*) was designated as "threatened" by COSEWIC in 1992. Currently, the species is being considered for inclusion under the Endangered Species Act.

COSEWIC designated the species in Canada based on a status report prepared by Smith and Bradley (1990). In the 1990 report, two extant sites and one extirpated site were identified in Manitoba. These sites all occurred in the Lauder, Routledge and Oak Lake sandhill complexes. The major portion of the existing population was found on private land just south of Routledge, owned by V.A. Hellman. A secondary site was found on Manitoba Habitat Heritage Corportation (MHHC) land near Bernice (Figure 1). No plants were found at Oak Lake in 1990.

The private land is under voluntary designation as an Ecologically Significant Area. This status recognizes the uniqueness of the area but provides no legal protection. This land was purchased specifically to preserve the character of the area and the landowner is very protective of his property and the species that occur on it.

The MHHC land has no official protection beyond the requirement that permission must be obtained in order to enter upon the land. This is very difficult to enforce because the MHHC is an absentee landowner.

Monitoring activities on the species commenced in 1992 in response to the COSEWIC listing and concern for prairie habitats in the province. Little is known of the spiderwort's ecology and habitat requirements.

Objectives of the study were:

1. to monitor the health and distribution of the western spiderwort population in Manitoba;

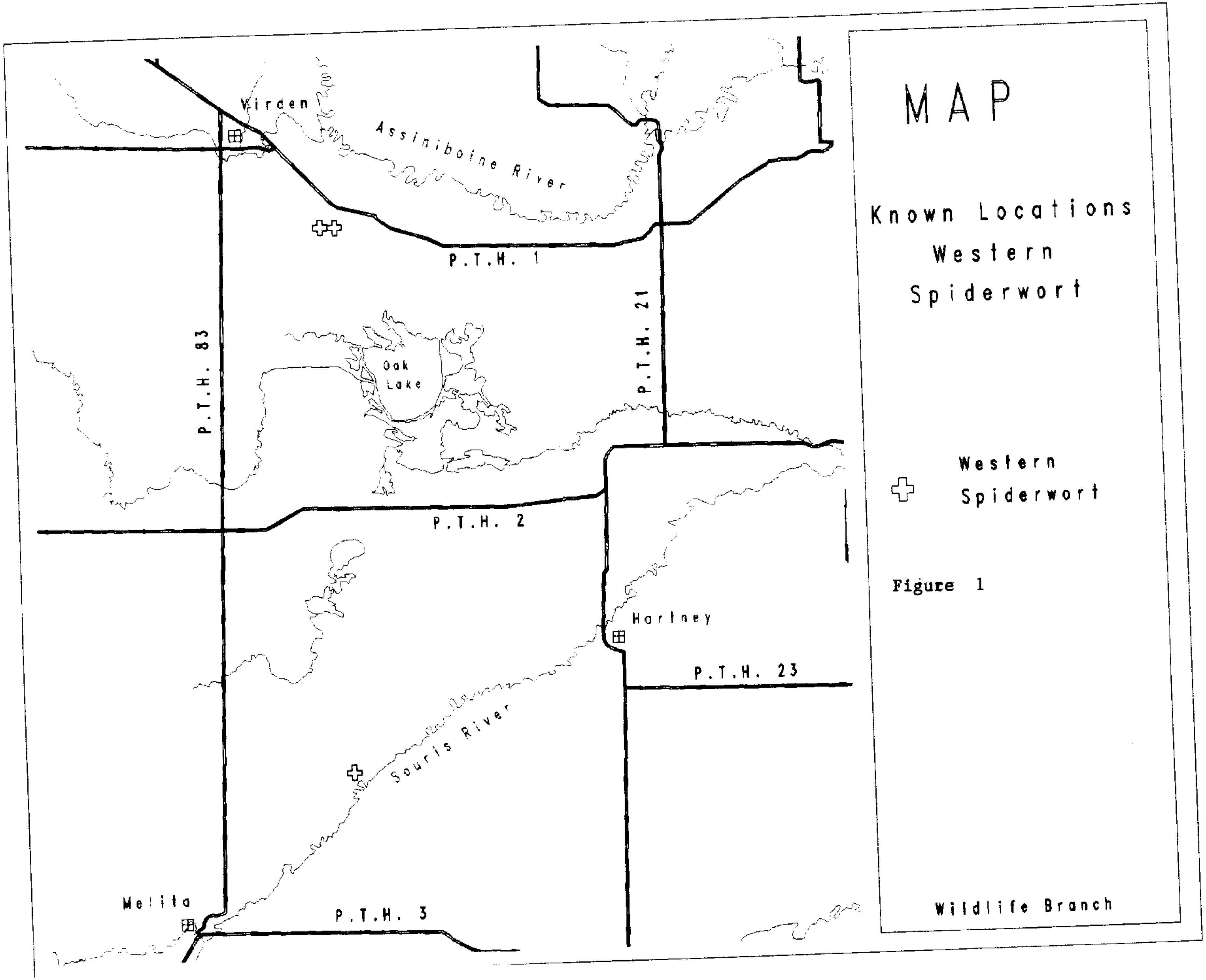

MAP
Known Locations
Western
Spiderwort
Western
Spiderwort
Virden
Assiniboine River
P.T.H. 1
P.T.H. 83
P.T.H. 21
Oak
Lake
P.T.H. 2
Hartney
P.T.H. 23
Souris River
Melita
P.T.H. 3
Wildlife Branch

Figure 1

2. to discover any additional populations if they occurred; and
3. to begin quantifying habitat characteristics and species associations.

These data will be used to develop recovery guidelines and management plans for the species and for those lands on which the species occurs or could potentially occur.

METHODS

In the summer of 1992, sites identified in the draft COSEWIC status report (Smith and Bradley 1990) were monitored for species occurrence, number of plants and flowering data. Occurrence of the species in any additional sites was also recorded. On the MHHC property, sampling was undertaken to determine the associated species in this sanddune community.

On all sites, the number of plants, stems/plant, flowers/stem and percentage of pink and purple flowers were recorded. On the MHHC land nine 10x10m plots were sampled. Within these plots, 51-1m^2 randomly selected quadrats were sampled for ground cover, species, number of stems and estimated cover. Cover estimates were categorized according to the following scale, the mid-point of each category was used for calculations.

1. 0% - 10%
2. 10% - 25%
3. 26% - 50%
4. 51% - 75%
5. 76% - 100%

Stems were not counted for species with dense distributions (grasses) due to time constraints. The objective was to provide an inventory of the species rather than in-depth productivity information. Resulting Importance Values for these species will therefore be higher than indicated in the results. Calculations were carried out for density, frequency, and dominance (formulas in Appendix III). Subsequently, relative densities, frequencies, dominance and Importance Values were calculated. Shrubs were sampled in two 1m wide swaths across the centre of the plot (total area sampled $20m^2$). Species and number of stems were recorded and density and frequency were calculated. All trees occurring within the $100m^2$ plot were sampled. The species and DBH category were recorded. Density, frequency and basal area were calculated.

Any other pertinent observations (grazed, diseased etc.) were also recorded.

RESULTS

Hellman Property

The Hellman family property consisted of a lightly grazed pasture (20 cattle, 3 horses), a long (approximately 3km) series of sand dunes (three chains[1]) that was fenced to protect it from grazing and a large area of aspen (*Populus tremuloides*) forest with small clearings. The aspen grove contained wild rose (*Rosa arkansana*), western red lily (*Lilium philadelphicum*), harebell (*Campanula rotundifolia*), bur oak (*Quercus macrocarpa*), common and creeping juniper (*Juniperus communis*, *J. horizontalis*), bearberry (*Arctostaphylos uva-ursi*), and northern bedstraw (*Galium boreale*). Leafy spurge (*Euphorbia esula*) was present on the property.

---

[1] While one chain of hills in the grazed pasture was checked and counted, there was, apparently, another chain of hills with additional spiderwort that we were unaware of. The Hellman's estimated its population to be about 100 plants.

There was a total of 7848 spiderwort plants counted. The average number of stems/plant was 2.16. There were 47 pink flowered plants comprising 0.6% of the total population. Approximately 1% of the plants counted (87) were grazed by cattle or deer. Plants were found on south-facing slopes, from crest to the base. There were, in general, two categories of slopes:

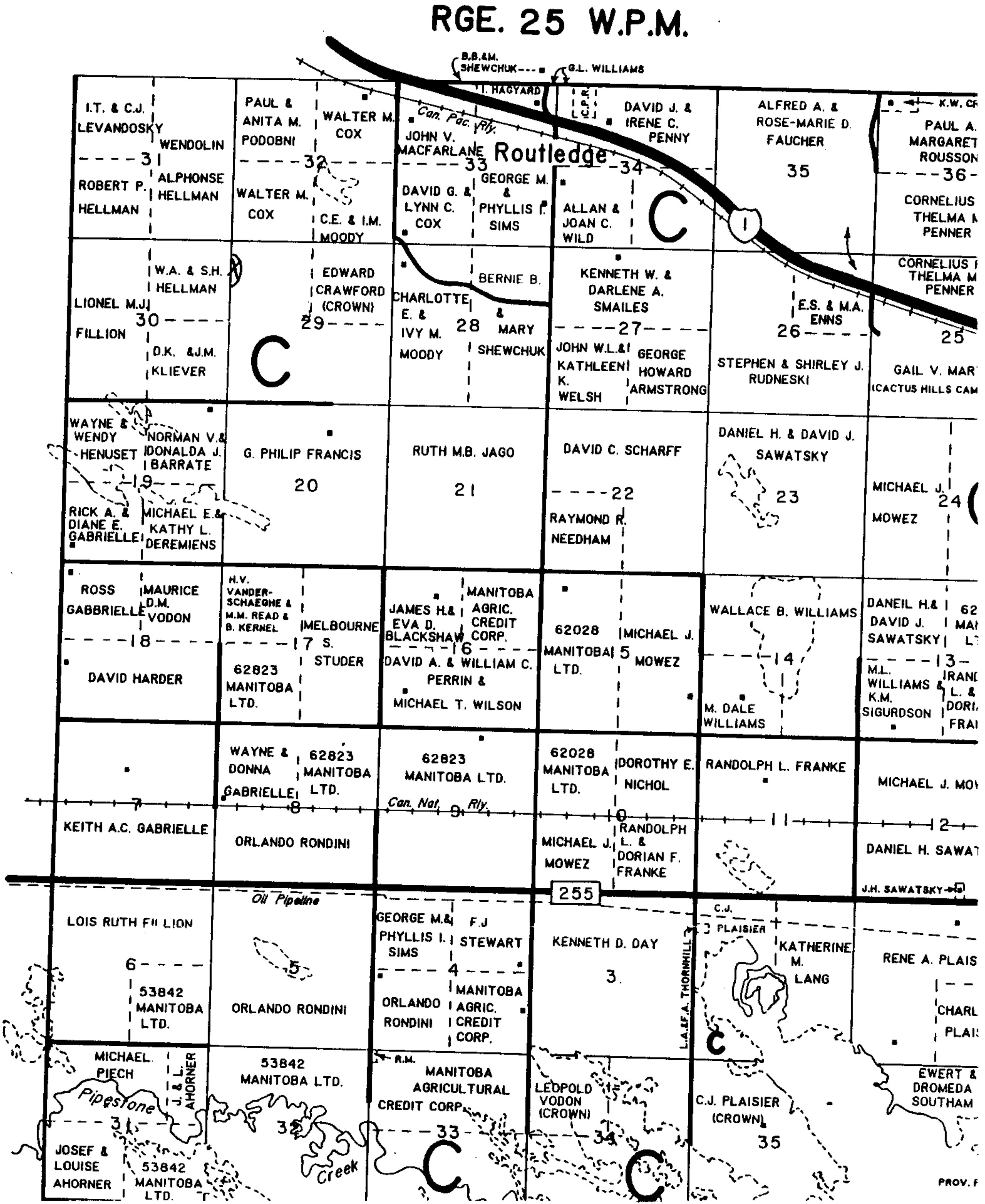
1) Partially destabilized slopes with many bare spots. Surrounding vegetation included: pincushion cactus (*Coryphantha vivipara*); creeping juniper; sand grass (*Calamovilfa longifolia*); chokecherry (*Prunus virginiana*); snowberry (*Symphoricarpus occidentalis*); pasture sage (*Artemisia frigida)*; star-flowered false Solomon's seal (*Smilacina stellata*); wild rose.
2) Heavily vegetated slopes, usually succeeding to aspen forest. Associated vegetation included: chokecherry; snowberry; poison ivy (*Rhus radicans*); star-flowered false Solomon's-seal; red-osier dogwood (*Cornus stolonifera*); river birch (*Betula occidentalis*); bur oak; white birch (*Betula papyrifera*); common juniper; June grass (*Koeleria cristata*).

Crown Land (29-9-25W)

Crown land east of Hellmans' was examined and found to have spiderwort growing in an isolated clump (Figure 2) immediately adjacent to the ridge that serves as the cattle pasture.

An estimated 700 plants were identified in this area, mainly blue-purple, but a handful were of the pink variety. Grazing on the plants was not apparent and the only large mammal tracks in the area were of deer (*Odocoileus* sp.).

Figure 2: Location of spiderwort population on 29-9-25W.



A large aspen and Manitoba maple forest surrounded this area and probably serves as a natural barrier to grazing and other disturbances around the spiderwort site.

MHHC Property (17-5-25W)

This parcel is bordered by pasture on all sides. The area of prime interest and concern (the spiderwort sites) is along a ridge of high sandhills located in the northeast corner of the quarter section. It is bordered by aspen forest to the west, a thin strip of aspen and poison ivy to the north, a pasture to the east and low sandhills to the south.

Western spiderwort began flowering on the MHHC property the week of June 21, 1992. A total of 380 plants were counted with an average of 2.8 stems/plant and 13.2 flowers/stem. Fifteen per cent were pink flowering plants.

Three separate sites on the sand ridge were sampled (Figure 3). Site No. 1, was reported as two separate sub-populations in the status report (Smith and Bradley 1990) but appeared to have grown together to form one larger stand. The crest of the hill was separated from the remainder of the slope by a small gully. Forty-five plants occurred on the crest, 6 of which were pink. Associated vegetation included poison ivy, wild rose and creeping juniper. The second site was located on the southwestern crest and slope of a partially destabilized sand hill. The most common vegetation in the stand of spiderworts was sand grass. Associated vegetation consisted of leafy spurge and bearberry. The crest and north slope were covered mainly by chokecherry, poison ivy, aspen and some elm (*Ulmus americana*). The third site was located northwest of site 2. It occurred in a shaded area (forested ravine to the south, north and east) and the slope was heavily covered by chokecherry, snowberry, wild rose, Virginia creeper (*Parthenocissus inserta*), leafy spurge and sand grass.

A summary of the 20 most important associated plant species is presented in Table 1. A complete listing of sampling results is presented in Appendix I and II. Leafy spurge was the most important component of the sandhill community, the remainder of the top 20 were a mixture of prairie and aspen forest species. Chokecherry was the only shrub found in the sampling plots at a low density (.01 stems/m^2). Trees were also uncommon with American elm occurring at a density of 0.01 stems/m2 and covering an area of 1.8cm^2/m^2.

DISCUSSION

Increased precipitation since 1990 was probably partly responsible for the increase in the number of plants found in 1992. Sixty-six plants were found on MHHC land in 1990 compared to 380 in 1992. Approximately 1700 were found on the Hellman property in 1990 compared to 8000 in 1992.

Leafy spurge, recognized as a problem in 1990, persisted in 1992. Successful management of western spiderwort may depend upon effective leafy spurge control. It would be beneficial to the spiderwort and other native species to have spurge beetles released on both properties.

Western spiderwort habitat requirements need to be determined before the species can be effectively managed. Monitoring activities indicated that western spiderwort required a fairly open de-stabilized dune environment to flourish. The species does not appear to respond well to grazing or shading. The presence of western spiderwort on Hellmans' property appears to be partly the result of restricted grazing for the past fifty or more years.

Table 1: The twenty most important species associated with western spiderwort on MHHC property.

Species	Density Stems/m^2	Dominance % Cover	Frequency	Rel. Density	Rel. Dominance	Rel. Frequency	IV
Euphorbia esula	9.73	6.93	.30	19.50	9.02	5.02	33.55
Ambrosia psilostachya	10.41	3.95	.35	20.86	5.13	5.93	31.92
Calamovilfa longifolia	0.00	12.51	.81	0.00	16.26	13.70	29.96
Artemisia ludoviciana	9.00	4.30	.24	18.04	5.58	4.11	27.73
Juniperus horizontalis	0.00	13.92	.49	0.00	18.08	8.22	26.30
Carex spp.	0.11	8.43	.49	0.22	10.96	8.22	19.39
Rhus radicans	4.62	2.19	.24	9.26	2.84	4.11	16.22
Rosa arkansana	2.84	2.68	.41	5.69	3.48	6.85	16.01
Prunus virginianus	1.41	5.16	.32	2.82	6.71	5.48	15.00
Lepidium densiflorum	2.19	1.81	.30	4.39	2.35	5.02	11.76
Artemisia frigida	2.32	1.35	.27	4.66	1.76	4.57	10.98
Erigeron canadensis	2.14	0.73	.08	4.28	0.96	1.37	6.60
Arctostaphylos uva-ursi	0.00	3.76	.08	0.00	4.88	1.37	6.25
Stipa comata	0.00	1.41	.22	0.00	1.83	3.65	5.48
Arabis spp.	0.51	0.95	.19	1.03	1.23	3.20	5.45
Linum rigidum	0.49	0.81	.16	0.98	1.05	2.74	4.77
Polanisia dodecandra	0.62	0.68	.14	1.25	0.88	2.28	4.41
Coryphantha vivipara	0.30	0.54	.11	0.60	0.70	1.83	3.12
Festuca rubra	0.00	1.30	.08	0.00	1.69	1.37	3.06
Galium boreale	0.97	0.14	.03	1.95	0.18	0.46	2.58

It is recommended that studies on spiderwort ecology, and management of sandhill habitats continue. Rehabilitation of adjacent sandhill areas (Lauder WMA) could facilitate the species' recovery. Surrounding private grazed pastures should be further investigated to see whether some of these sites may also be suitable if grazing pressures were restricted or eliminated. Where feasible such lands should be leased or acquired through the Critical Wildlife Habitat Program.

LITERATURE CITED

Scoggan, H.J. 1978. The Flora of Canada. National Museum of Natural Sciences Publications in Botany, No. 7(1).

Smith, B. and C. Bradley. 1990. Status report on Western Spiderwort (*Tradescantia occidentalis* (Britt.) Smyth). COSEWIC.

APPENDIX I

All plant names are according to Scoggan (1978).

Equisetaceae

Equisetum hyemale L. var. *affine* (Engelm.) A. A. Eat.	common scouring-rush

Pinaceae

Juniperus communis L.	common juniper
J.horizontalis Moench	creeping juniper

Gramineae

Agropyron cristatum (L.) Gaertn.	crested wheat grass
A. intermedium (Host) Beauv.	wheat grass
Calamovilfa longifolia (Hook.) Scribn.	sand grass
Festuca rubra L.	creeping red fescue
Koeleria cristata (L.) Pers.	June grass
Poa pratensis L.	Kentucky bluegrass
Stipa comata Trin. & Rupr.	spear grass

Cyperaceae

Carex spp.	sedge

Commelinaceae

Tradescantia occidentalis (Britt.) Smyth	western spiderwort

Liliaceae

Lilium philadelphicum L.	prairie lily
Smilacina stellata (L.) Desf.	false Solomon's seal

Salicacea

Populus tremuloides Michx.	trembling aspen

Betulaceae	
Betula papyrifera Marsh.	white birch
B. occidentalis Hook.	river birch
Fagaceae	
Quercus macrocarpa Michx.	bur oak
Ulmaceae	
Ulmus americana L.	American elm
Chenopodiaceae	
Chenopodium spp.	goose foot
Ranunculaceae	
Anemone patens L. var. *wolfgangiana* (Bess.) Koch	prairie crocus
Capparidaceae	
Polanisia dodecandra (L.) DC. var. *dodecandra*	clammyweed
Cruciferae	
Arabis spp.	rock cress
Lepidium densiflorum Schrad.	pepper grass
Sisymbrium altissimum L.	tumble mustard
Rosaceae	
Prunus virginiana L.	chokecherry
Rosa arkansana Porter	prairie rose
Leguminosae	
Petalostemum villosum Nutt.	prairie clover
Linaceae	
Linum rigidum Pursh	yellow flax

Euphorbiaceae	
Euphorbia esula L.	leafy spurge
Anacardiaceae	
Rhus radicans L. var. *rydbergii* (Small) Rehd.	poison ivy
Aceraceae	
Acer negundo L.	Manitoba maple
Vitaceae	
Parthenocissus inserta (Kerner) Fritsch	Virginia creeper
Violaceae	
Viola spp.	violets
Cactaceae	
Coryphantha vivipara (Nutt.) Britt. & Brown	pincushion cactus
Cornaceae	
Cornus stolonifera Michx.	red-osier dogwood
Ericaceae	
Arctostaphylos uva-ursi (L.) Spreng.	bearberry
Boranginaceae	
Lithospermum incisum Lehm.	narrow-leaved puccoon
Solanaceae	
Physalis virginiana Mill.	ground cherry

Rubiaceae	
Galium boreale L. var. *boreale*	northern bedstraw
Caprifoliaceae	
Symphoricarpus occidentalis Hook.	snowberry
Campanulaceae	
Campanula rotundifolia L.	harebell
Compositae	
Liatris ligulistylis (Nels.) K. Schum.	blazing star
Erigeron canadensis L.	horse weed
Artemisia frigida Willd.	pasture sage
A. ludoviciana	white sage

APPENDIX II

MHHC PROPERTY SAMPLING DATA RESULTS

Table A: Sampling data results.

Species	Density Stems/m^2	Dominance % Cover	Frequency	Rel. Density	Rel. Dominance	Rel. Frequency	IV
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Coryphantha vivipara	0.30	0.54	.11	0.60	0.70	1.83	3.12
Festuca rubra	0.00	1.30	.08	0.00	1.69	1.37	3.06
Galium boreale	0.97	0.14	.03	1.95	0.18	0.46	2.58
Liatris ligulistylis	0.62	0.27	.05	1.25	0.35	0.91	2.51
Equisetum hyemale	0.22	0.41	0.08	0.43	0.53	1.37	2.33

Equisetum hyemale	0.22	0.41	0.08	0.43	0.53	1.37	2.33
Symphoricarpos occidentalis	0.27	0.27	0.05	0.54	0.35	0.91	1.81
Lithospermum incisum	0.22	0.27	0.05	0.43	0.35	0.91	1.70
Smilacina stellata	0.16	0.27	0.05	0.33	0.35	0.91	1.59
Chenopodium spp.	0.08	0.27	0.05	0.16	0.35	0.91	1.43
Petalostemum villosum	0.27	0.14	0.03	0.54	0.18	0.46	1.17
Agropyron cristatum	0.00	0.46	0.03	0.00	0.60	0.46	1.05
Physalis virginiana	0.14	0.14	0.03	0.27	0.18	0.46	0.90
Viola spp.	0.14	0.14	0.03	0.27	0.18	0.46	0.90
Tradescantia occidentalis	0.05	0.14	0.03	0.11	0.18	0.46	0.74
Anemone patens	0.05	0.14	0.03	0.11	0.18	0.46	0.74
Sisymbrium altissimum	0.03	0.14	0.03	0.05	0.18	0.46	0.69
Poa pratensis	0.00	0.14	0.03	0.00	0.18	0.46	0.63
Koeleria cristata	0.00	0.14	0.03	0.00	0.18	0.46	0.63
Agropyron intermedium	0.00	0.14	0.03	0.00	0.18	0.46	0.63

APPENDIX III

CALCULATIONS

$$\text{DENSITY} = \frac{\text{\# STEMS}}{\text{AREA SAMPLED}}$$

$$\text{FREQUENCY} = \frac{\text{\# SAMPLING UNITS SPECIES OCCURS IN}}{\text{TOTAL \# UNITS SAMPLED}}$$

$$\text{DOMINANCE} = \frac{\text{ESTIMATED AREA COVERED BY THE SPECIES}}{\text{TOTAL AREA SAMPLED}}$$

$$\text{RELATIVE DENSITY} = \frac{\text{DENSITY OF EACH SPECIES}}{\text{TOTAL DENSITY FOR ALL SPECIES}}$$

$$\text{RELATIVE FREQUENCY} = \frac{\text{FREQUENCY FOR EACH SPECIES}}{\text{TOTAL FREQUENCY FOR ALL SPECIES}}$$

$$\text{RELATIVE DOMINANCE} = \frac{\text{DOMINANCE FOR EACH SPECIES}}{\text{TOTAL DOMINANCE FOR ALL SPECIES}}$$

$$\text{IMPORTANCE VALUE} = (\text{RELATIVE DENSITY} + \text{RELATIVE DOMINANCE} + \text{RELATIVE FREQUENCY}) * 100$$

HABITAT REQUIREMENTS
AND
MANAGEMENT IMPLICATIONS
FOR
WESTERN SPIDERWORT
(Tradescantia occidentalis)

by

Sherry L. Hohn

CRITICAL WILDLIFE HABITAT PROGRAM
PARTNERS

WILDLIFE HABITAT CANADA

MANITOBA HABITAT HERITAGE CORPORATION

WORLD WILDLIFE FUND

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Approved by:

Section Chief/Director

Habitat Requirements and Management Implications for Western Spiderwort.

Hohn, Sherry L.

Manitoba
Department of Natural Resources
Wildlife Branch
Endangered Species and Nongame
1993 Progress Report

ABSTRACT

The major portion of western spiderwort (*Tradescantia occidentalis*) populations in Canada is found on two sandhill sites in southwestern Manitoba. In 1993, a study was initiated to assess the environmental parameters of spiderwort habitat. Approximately 9,000 spiderwort plants were found on the dune slack areas of the Routledge and Lauder sandhill sites. Permanent plots, exhibiting various potential limiting factors, were established for monitoring spiderwort growth and phenology under natural and manipulated conditions. Black dot spurge beetles (*Aphthona nigriscutis*) were introduced at four sites in an attempt to control the encroachment of leafy spurge. Over the next two years of the project, additional potential sites will be surveyed, propagation methodology will be investigated and several management systems will be assessed for spiderwort habitat and population enhancement.

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ACKNOWLEDGEMENTS

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I would like to thank Cathy Johnson (Chief of Endangered Species and Nongame) for initiating, laying the groundwork for the project and editing the manuscript. I am grateful to Richard Stardom for supervisory support and in putting the report together. I also thank Janet Moore and Randy Bean for inspirational editing and technical assistance in preparing the final report. I am especially grateful to the Hellman family of Virden for their enthusiasm, assistance and hospitality.

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INTRODUCTION

Based on a status report by Smith and Bradley (1990), western spiderwort (*Tradescantia occidentalis*) was designated as "threatened" by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 1992. This species is known to exist in only four sites in Canada; one in Alberta, one in Saskatchewan and two in Manitoba. Not only are there few sites but each is limited in size and exemplifies a very specific habitat type. It must be recognized that if species requirements are not identified and adequate management strategies are not implemented, natural succession and encroachment by invasive plants could move spiderwort towards the endangered category in Canada.

A three year project was initiated in 1993 with the goal of improving the status of the western spiderwort in Manitoba.

Objectives of the study are:

1. Identify the environmental parameters of western spiderwort habitat.
2. Identify potential re-introduction sites and examine possible transfer processes.
3. Determine most appropriate habitat enhancement processes by on site investigation of burning, removal of invasive plant species and release of spurge beetles (*Aphthona nigriscutis*).
4. Development of the most feasible management plan for retention of western spiderwort.

The first year of the project commenced with collating a detailed profile of western spiderwort through additional literature search and soliciting available information from other jurisdictions within the species current range. Field investigation of known and potential sites assisted in defining some of the physical and biological parameters within which western spiderwort populations function. Experimental plots were established to monitor the effects of a number of environmental influences on the species (Appendix III).

SPECIES OVERVIEW

Distribution

The western spiderwort is found throughout much of mid-western North America (Figure 1). It is fairly common throughout the central United States, particularly in the southern regions. In Canada, the species is rare, known to be found only in four areas: the Pakowki Lake Sandhills (Alberta), the Elbow Sand Dunes (Saskatchewan), the Routledge Sandhills (Manitoba) and the Lauder Sandhills (Manitoba).

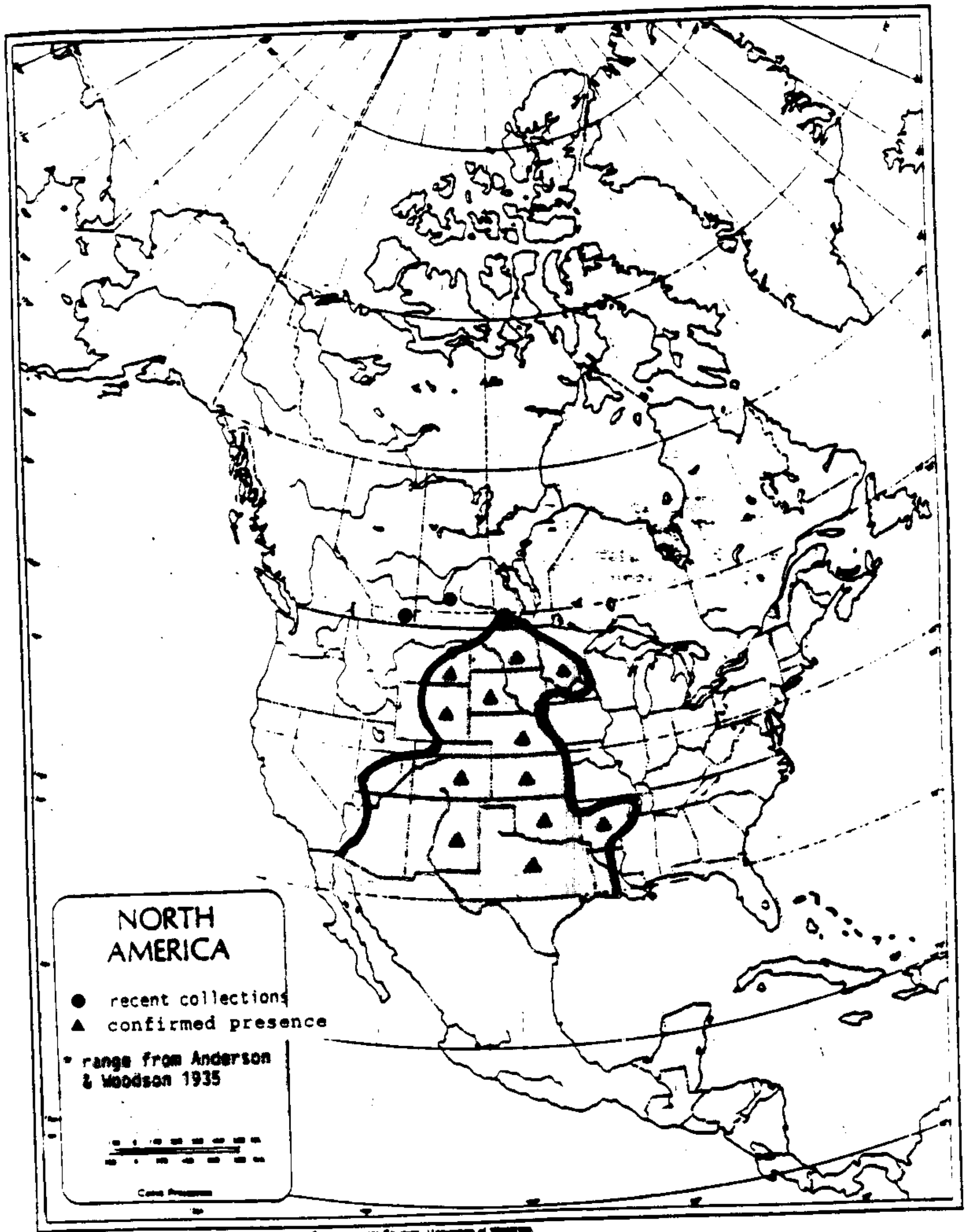
Protection

The spiderwort is not currently under any legal protection in Manitoba. The Endangered Species Advisory Board (ESAB) has recommended that the species be designated as "threatened" in the province and regulations are now being prepared for protection of the species under the Manitoba Endangered Species Act. The Manitoba sites have limited access but any restrictions are not strictly enforced or easily enforceable.

Population Size and Trend

The Manitoba spiderwort population increased greatly between 1990 and 1992 (Smith and Bradley, 1990; Hohn and Parsons, 1992) possibly as a result of increased

Figure 1: Distribution of Western Spiderwort (*Tradescantia occidentalis*) in North America.



precipitation levels. The number of plants in confirmed sites has remained relatively constant for the past year. The Routledge Sandhills, including the Hellman property (a pastured quarter, NE 30-9-25W; and the Ecologically Significant Area, S 31-9-25W) and the adjacent Crown land (29-9-25W) has the largest population (Figure 2). The Hellman property has approximately 8000 plants, while the adjacent Crown property has approximately 700 plants. The Lauder Sandhills population, found on Manitoba Habitat Heritage Corporation (MHHC) property (NW 17-5-25W) has just under 300 plants (Figure 2). A more detailed breakdown of these areas can be found in Appendix I.

Biology

The western spiderwort is an erect perennial with slender stems. The leaves are linear, with conspicuously ribbed, curved sheaths, swollen at the juncture with the node. The roots are stout and fleshy with slender fibrous rootlets. The flowers are in terminal cymes. Pedicels and sepals are glandular pubescent. Petals are 10-15mm long, rose to dark blue in colour, arranged in threes, slightly pointed at the tips. There are six stamens, hairy, with bright yellow anthers. Capsules are obovoid or oblong in shape, puberulent at the apex, 5-10mm long, each containing 2-6 pitted compressed seeds (Figure 3). Spiderwort normally flowers from May to July (shorter and later in northern climates). Each flower lasts only one day. The plant reproduces through seeds and by vegetative propagation.

Figure 2: Location of Western Spiderwort sites in Manitoba.

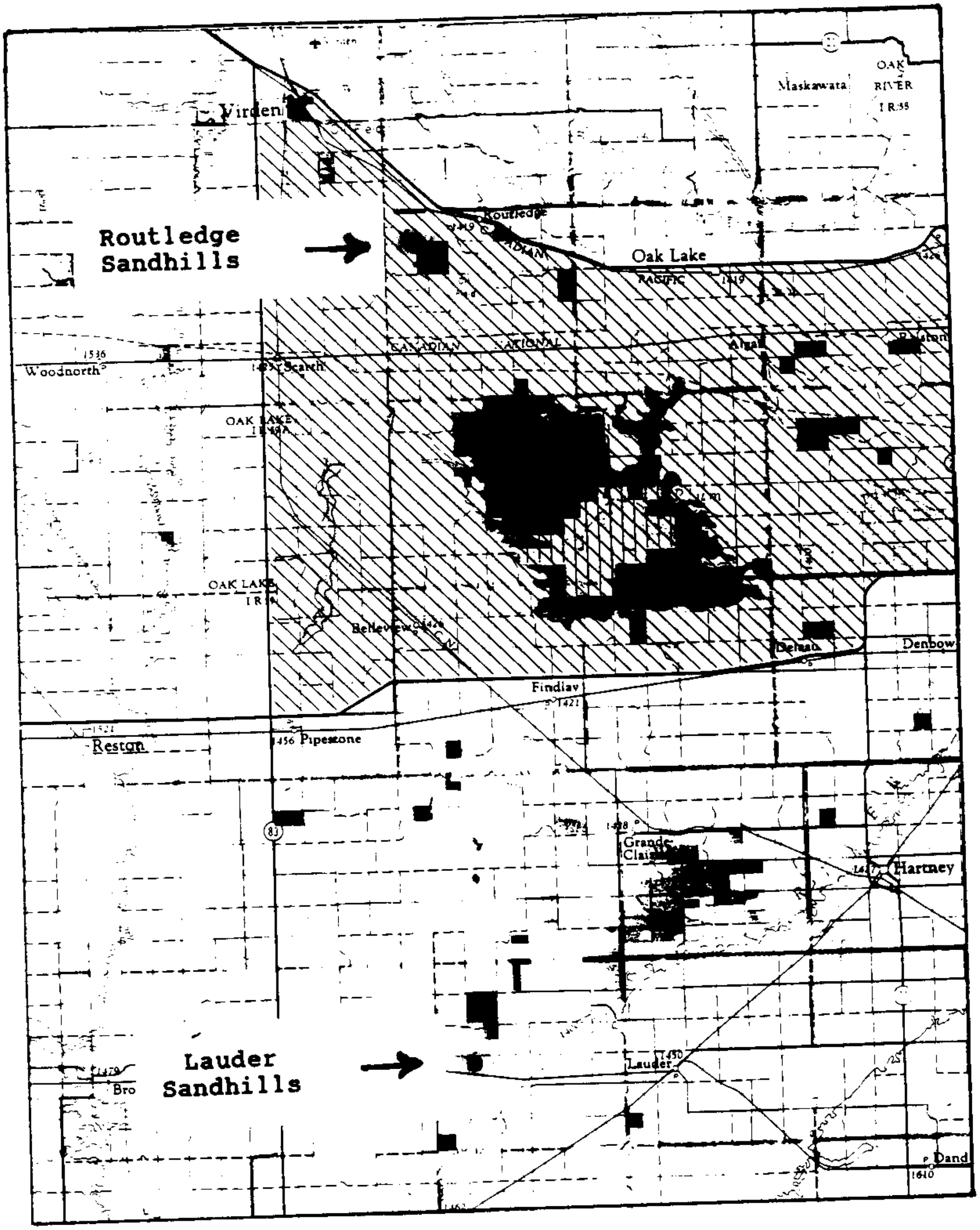
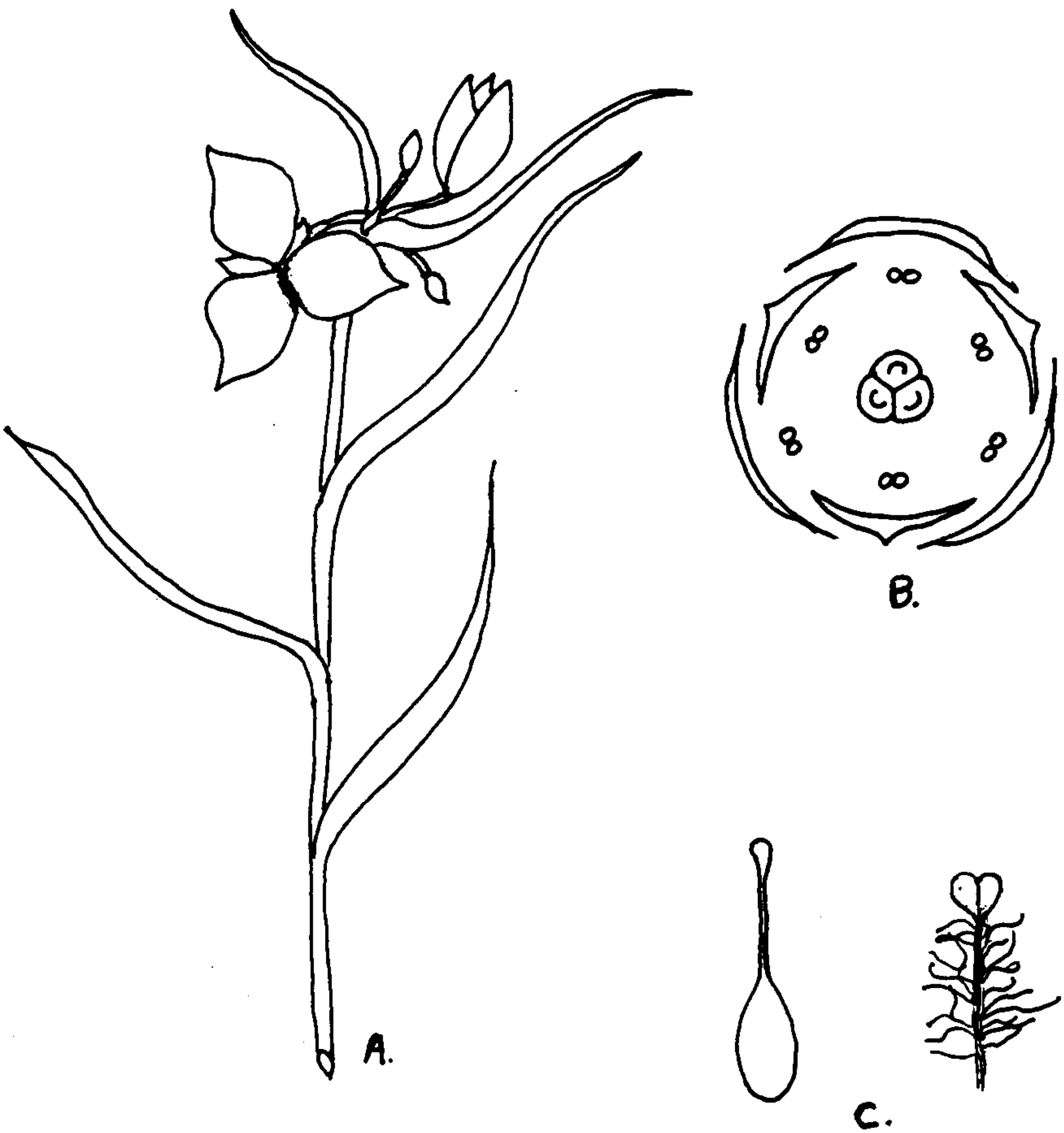


Figure 3: ***Tradescantia occidentalis***
A. Above ground portions of the plant
B. Arrangement of pistil and stamens
C. Enlarged diagram of pistil and stamen



Growth conditions

The soil in the region of spiderwort range in southwestern Manitoba is sand or sand/silt, classified as lacustrine sediments over Palaeozoic rock of Ordovician, Silurian and Devonian age (Atlas of Canada 1981).

Southwestern Manitoba generally receives 400-800mm of precipitation annually (Atlas of Canada 1981). Spiderwort appears to thrive on additional moisture, as more robust plants of larger size are present in portions of the study sites where the soil is more moist. At the same time, drainage of the soil is essential.

Annual temperatures in this region range between January averages of -15°C to -20°C to July averages of 15°C to 20°C (Atlas of Canada 1981). Summer temperatures have been below normal for the past two years with greater than normal rainfall and these conditions may have contributed to the unusually long flowering period of the spiderwort in 1993 (June 15 to August 20).

While spiderwort do not thrive in continuously shaded areas, shading by small shrubs such as chokecherry (*Prunus virginiana*) and wild rose (*Rosa* spp.) does not appear to have a significant impact on the general health of the plants. Spiderwort are often found concentrated on the crests and upper slopes of sandhills, where shrub populations are high. The shrubs may provide the spiderwort with some protection against intense grazing or disturbance by grazers.

Examination of the spiderwort communities suggest that the plants do not experience heavy grazing pressure from native species such as white-tailed deer (*Odocoileus virginianus*) and elk (*Cervus elaphus*), but cattle will graze on the plants if they are easily accessible. Plants growing on the crests and upper slopes do not appear to be greatly affected.

Spiderwort are extremely sensitive to disturbance, such as trampling by cattle, motor vehicles or people. The stems are brittle and break with little impact.

This species does not appear to be very competitive. There also may be another factor affecting spiderwort growing in close proximity to leafy spurge (*Euphorbia esula*). They are generally smaller and have shorter flowering periods than spiderwort growing in more open areas. Areas with low accumulation of litter and having sparse vegetation are best suited for spiderwort.

HABITAT

General Requirements

Spiderwort are generally found on partially destabilized sandhills with south or west facing slopes. The hills generally have a slope angle of 30°-50°, and a vertical rise of about 10m. Soil ranges from pure sand to sand/silt mixture.

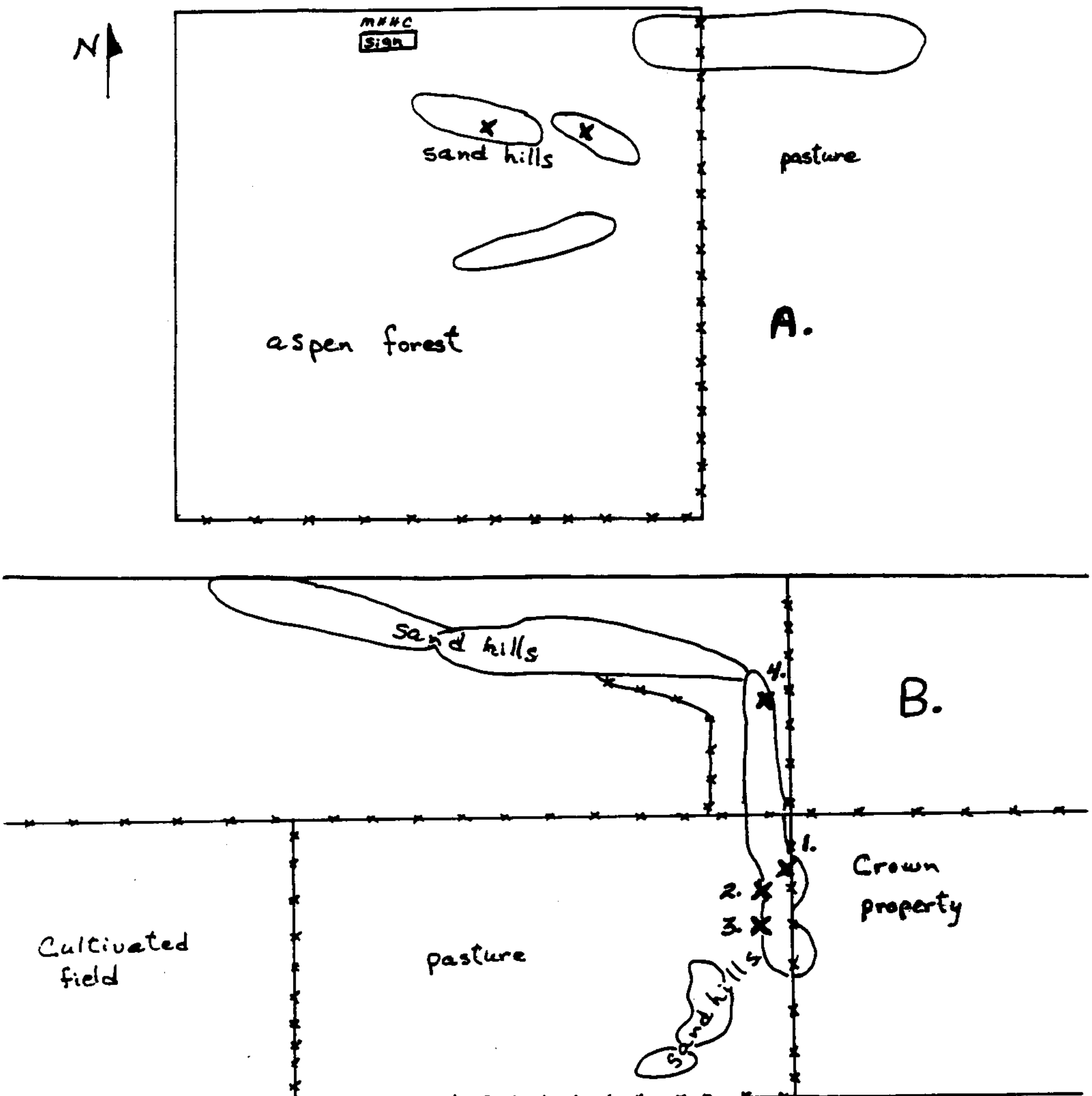
Hellman property (NE30-9-25W, S31-9-25W)

The habitat at this site (Figure 4) consists of a series of four sandhill chains spread over three quarter sections. The plants are restricted, with few exceptions, to south or southwest facing slopes and crests of the sandhills. The soil is partially stabilized by the sparse growth of grasses. Shading and competition are limited except at the lower edges of the slopes where aspen/shrub invasion occurs.

Crown Land (29-9-25W)

The hills on this property are a southeastward extension of the chains running through the Hellman property. Spiderwort are found on two sites, separated and bordered by aspen forest.

Figure 4: Spiderwort sites.
A. Manitoba Habitat Heritage Corporation property
B. Hellman and Crown properties
(X) Leafy Spurge Beetle release sites.



MHHC Property (NW17-5-25W)

There are two chains of sandhills located on this quarter, but spiderwort are only found on the northern chain. There are two separate spiderwort sites, one covering the southwest slope of a partially stabilized sandhill, the second site covering the lower slope and basin of another hill on the same ridge system. The soil is sand, mixed with silt, held by grasses and native sandhill plants. Shading is limited, but competition for resources is slightly greater at this site.

MANAGEMENT CONSIDERATIONS

Hellman Property

The Hellman family owns 25 head of cattle which are confined to NE 30-9-25W and the forested portion of SW 31-9-25W. The pastured quarter is under light grazing pressure, and the cattle do not appear to favour spiderwort. All three quarters show some signs of grazing or browsing by deer or elk, but very few spiderwort plants are affected. The Hellmans have received requests in the past to rent their land for pasture, an action the entire family opposes.

Aspen (*Populus tremuloides*) and chokecherry shrub encroachment is not an immediate threat to the sandhills, but could become one if their growth is left unchecked.

The pastured quarter has several large sites of leafy spurge. The Ecologically Significant Area contains two hills that are almost completely covered by spurge. Black dot leafy spurge flea beetles (*Aphthona nigriscutis*) obtained from the Department of Agriculture were released in four locations in 1993 (Figures 5-11). Details on the four sites can be found in Appendix II.

Figure 5: Site #1 Border of Crown and Hellman properties

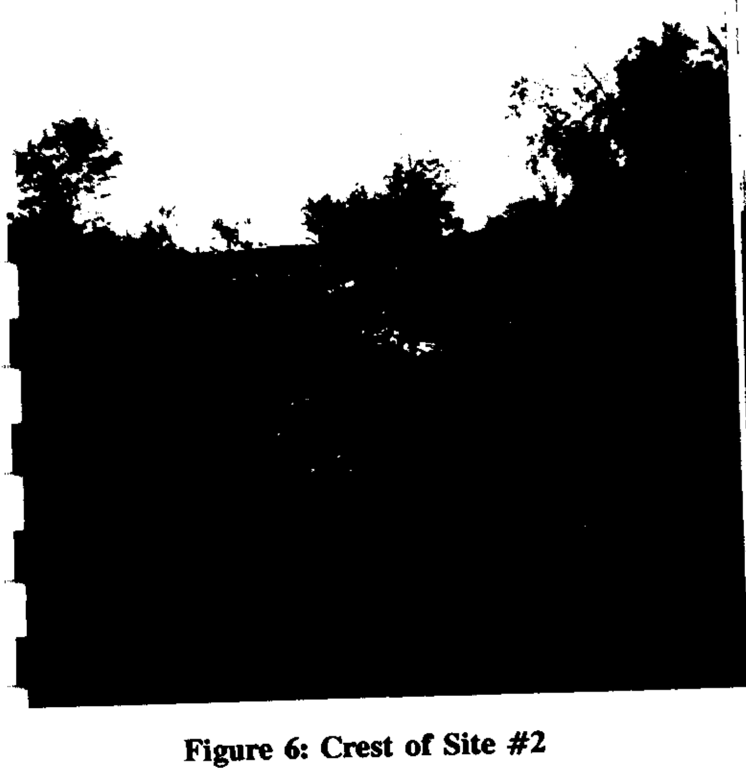


Figure 6: Crest of Site #2

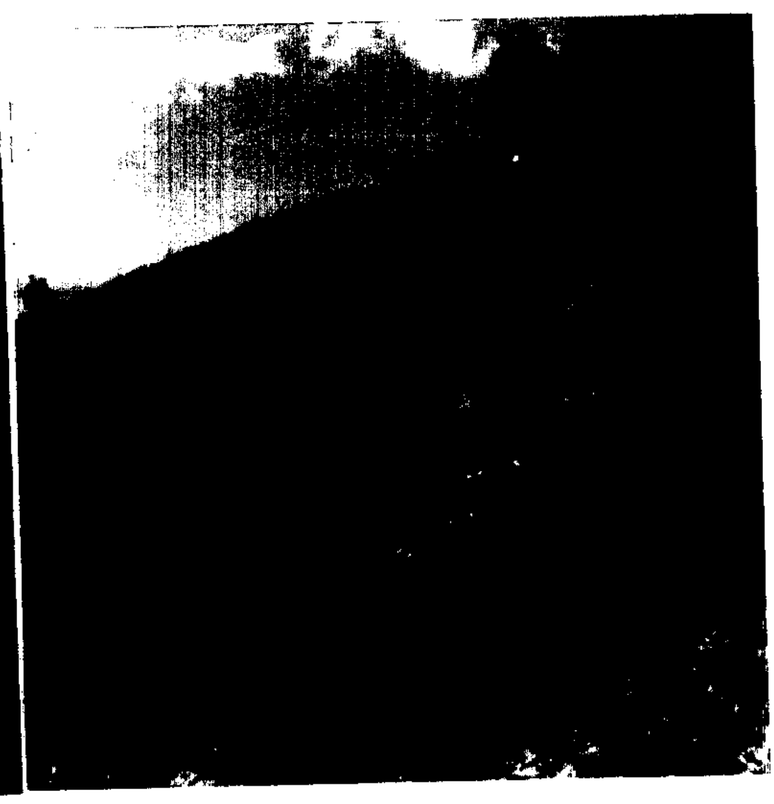


Figure 7: Upper slope of Site #2

Figure 8: Slope of Site #3

Figure 9: Slope of Site #3

Figure 10: Crest of Site #4

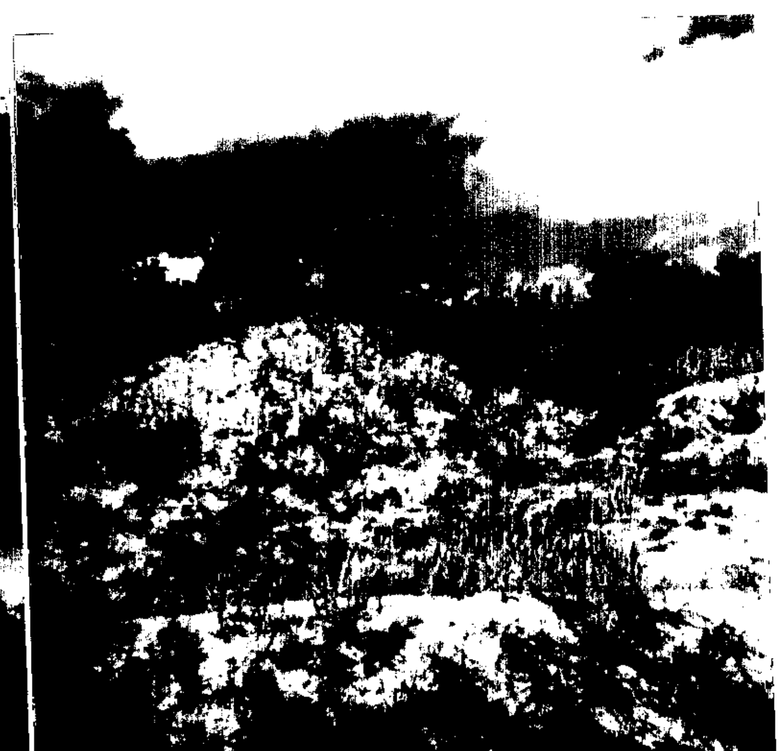


Figure 11: Slopes of Site #4

The pastured quarter contains areas of active sand as a result of the movement of cattle. These areas are usually restricted to the bases of the sandhills. There are two "trails" worn by deer and other animals on the hills of the remaining two quarters. To a limited extent, destabilization and erosion have occurred along these paths. However, the area affected by this is extremely small.

There is extensive petroleum exploration in this area, and the Hellmans have been approached by one of the companies to allow drilling on their property. To date, none have been allowed and when the spiderwort becomes protected under the Endangered Species Act, there may be additional deterrents to development.

Crown Land

This quarter section is leased as pasture, but a dense aspen forest surrounding the two spiderwort sites serves as a natural barrier to the cattle and horses. There is no evidence of any impact by domestic animals at either spiderwort site.

The hills supporting spiderwort are not particularly steep or sandy in many areas of this location. Snowberry (*Symphoricarpos occidentalis*) and chokecherry shrubs appear to be successfully colonizing the slopes and could be removed manually.

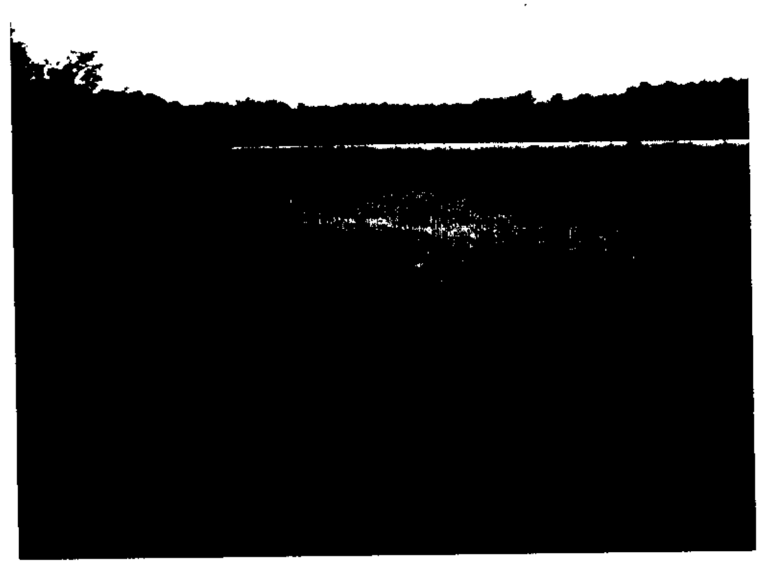
MHHC Property

Shrub encroachment of the dunes is occurring from the crest down (by chokecherry and wild rose) and across the base by the aspen forest surrounding the hills. The encroachment is limited, and is not currently threatening the dune slopes to any great extent. The sandhills are heavily infested with leafy spurge, and the spiderwort sites are under immediate threat.

This MHHC property is being subjected to destabilization and erosion through the use of four-wheel drives and other all-terrain vehicles throughout the hills (Figures 12-13). The vehicles gain entrance to the property off P.R. 345 and there is easy access to the hills at the point where the MHHC sign is located.

Figure 12: Erosion damage caused by off-road vehicles of a sandhill on the MHHC.

Figure 13: Vehicle tracks leading from Provincial Road 345 onto the MHHC property and the sandhills.



ALTERNATIVE LOCATIONS

Although there are no other confirmed extant sites of western spiderwort in Manitoba, sandhills do occur in several locations in the southwestern portion of the province. Several of these could provide suitable habitat for this species if these sites possess the environmental characteristics that spiderwort requires.

Whether the current spiderwort sites are small remnants of a much broader post-glacial distribution or indicative of a rare northern distribution of a southern species is unknown. From a Manitoba and Canadian perspective the species is being treated as a threatened species. Therefore it is important to retain the spiderwort as a component of prairie diversity in the province. Additional sites could serve as a safety net in the event of a catastrophic disappearance of significant portions of the current population.

Introduction of spiderwort to alternate locations would require investigation as to site suitability and into propagation and transplanting techniques. There are sufficient numbers of plants at current sites to serve as a limited transplant source.

Creation of new spiderwort sites would likely be a two year process. Cuttings (stem or root) taken in spring from plants at the established sites could be raised in a greenhouse or other suitable environment. The young plants could then be transplanted to suitable locations. An alternative would be to collect the mature seeds in the late summer and either plant them directly at a chosen site, or raise them in a greenhouse for transplanting the following spring.

Site preparation, should any be needed, would include removal of non-native species (ie. leafy spurge), thinning of shrub cover and partial destabilization of the sand soil.

Oak Lake

Historically, the sandhills around Oak Lake supported a spiderwort population. These sandhills fall into one of two categories. The first is completely stabilized hills, while the second is destabilized pasture. The area judged to be most suitable for spiderwort transplant is a quarter section 3.5km south on Hesselwood Road from the southwestern corner of the Upper Assiniboine Wildlife Management Area (Runnymede Unit). The hills in this quarter fit the habitat profile, but might require some mechanical destabilization before any transplanting occurred.

Lauder Sandhills Wildlife Management Area

There are two chains of hills running through this region, with the larger one having several hills suitable for spiderwort (Figure 14). These hills would require very little site preparation if spiderwort were to be transplanted to these sites.

There are two disadvantages to this area. The first of these is the presence of leafy spurge throughout the Wildlife Management Area. If spiderwort were to be moved into this area, measures to control spurge would have to be implemented. The second factor is the high public use of the hills. Care would have to be taken to select sites that are removed from the main roads and show little sign of off-road vehicle use. There are several hills in this chain that meet these requirements.

Carberry Sandhills

The sandhills south of Carberry cover an extensive region and range from the active dunes of the Spirit Sands trail to the completely stabilized pastures found north of Spruce Woods Provincial Park. There are many locations within this region that would be suitable, or that could be made suitable, for spiderwort habitat. The presence of a provincial park adds an element of protection to much of the region. An inventory of

Spruce Woods undertaken during the summer of 1993 may provide more detailed information.

Portage Sandhills

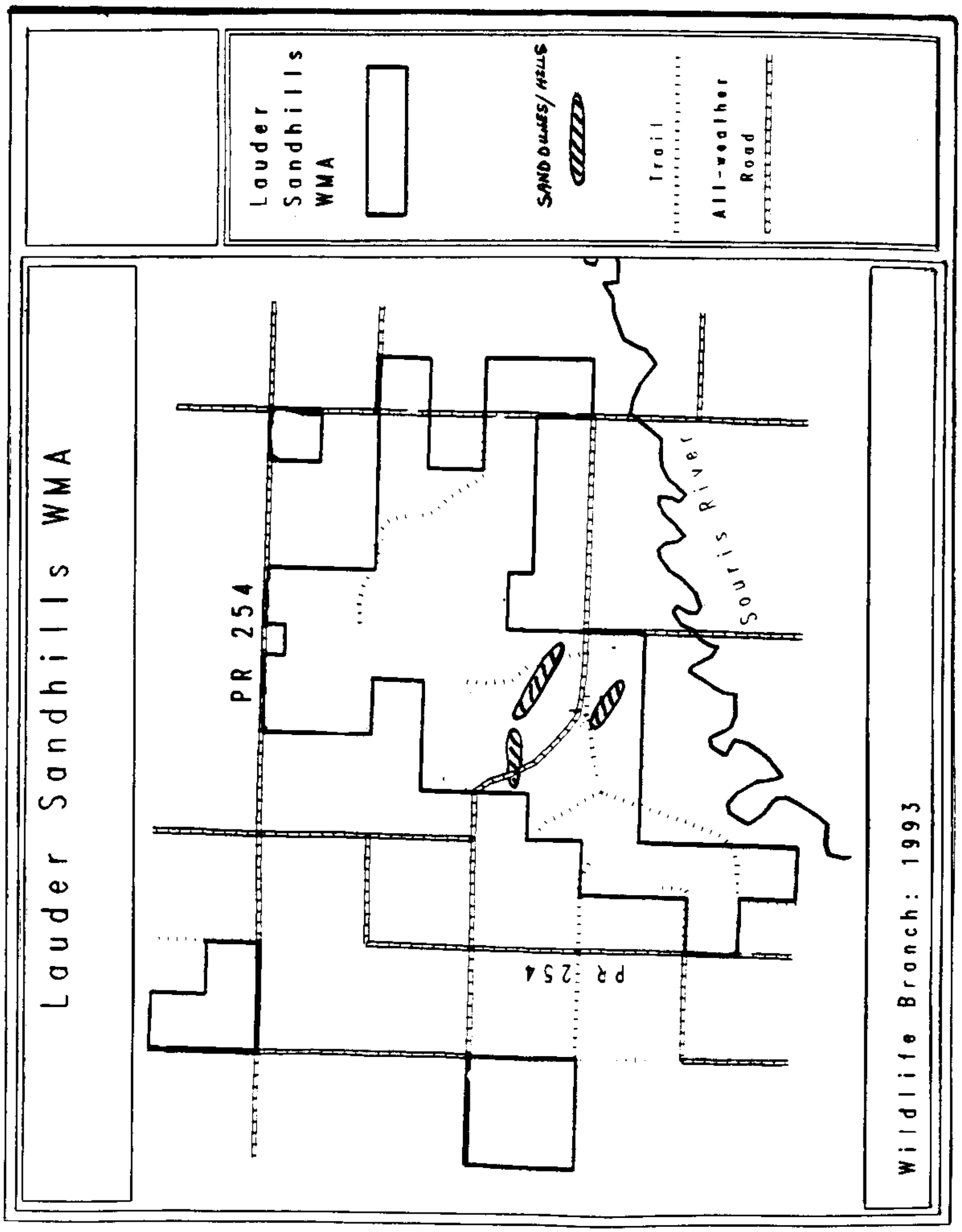
The sandhills in this region are similar to those of the southwest but they tend to be smaller, with most under 8m in height. However, all the sandhills are easily accessible to off-road vehicles. These vehicles seriously threaten the future of the sandhills flora and this problem needs to be addressed before any action can be taken on transplanting spiderwort to the area. The sandhill community is also at risk of being overgrown by woody vegetation. This problem could be corrected with controlled burns and brush-cutting around the hills and should not act as a deterrent to spiderwort transplanting. On the positive side, there is no leafy spurge population on these sandhills.

FUTURE GOALS

The goals for the future are twofold. The first is to preserve and, if feasible, enhance the existing sites; the second is to expand the population through the creation of new sites.

Leafy spurge control is critical to the preservation of the spiderwort sites, especially on the MHHC property. Release of leafy spurge flea beetles will not have a significant effect soon enough, or on a large enough area. Mowing and burning have been generally ineffective for reducing leafy spurge (Jonker 1992). This leaves few other alternatives. The first is to spray the affected areas with herbicide. This could be done at relatively low cost but would be extremely damaging to the native flora and fauna and may cause other environmental problems.

Figure 14: Lauder Sandhills Wildlife Management Area



A second alternative is to remove the leafy spurge manually. Given the extent and area of the coverage, this proposal could be extremely labour intensive on an annual basis. It could also cause excessive destabilization and erosion of the slopes. A third possibility is the introduction of a sheep or goat grazing system. While this appears to have some potential from trials in Saskatchewan, it must be closely controlled and continued annually. A final choice is to do nothing, in which case the spiderwort sites on this property may cease to exist within the next few years.

Shrub encroachment is another problem that must be addressed. While it is not yet a serious threat to any of the sites, preventative action would keep it from becoming one. Use of a brush-cutter along the crests and forest edges would remove much of the young tree and shrub growth in the area. Such action would have to be repeated for several years to be effective. The use of controlled burning at the sites may not be feasible.

Limiting or controlling access to the MHHC property should be considered. Currently there are not any restrictions against motorized vehicles on the property. There is also no restriction on the removal of sand from the property, as seen by the damage to the hill at the northeast corner of the quarter section. Any restrictions should be accompanied by education and promotion of public awareness of endangered species and habitats. Cooperation from the area residents would greatly aid in the protection of the site.

The Hellmans have expressed interest in the possible (re)introduction of other species unique to sandhill habitats, further enhancing the area's ecosystem. This activity will have to be examined carefully and assessed with regard to the implementation of the Biodiversity Convention in Manitoba.

Spiderwort sites in Canada are few, and are under threat of one variety of or another. The small size and relative isolation of the two sites in Alberta and Saskatchewan puts them especially at risk, as well as placing a greater importance on the two known Manitoba sites. If spiderwort is to continue to flourish in Canada, the population must be protected and increased.

REFERENCES

Personal Communications

Ken Brunson	Dept. of Wildlife and Parks, Kansas
Bill Carr	Parks and Wildlife Dept., Texas
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Robert B. Kaul, Professor	University of Nebraska
George F. Ledingham, Curator	University of Regina
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Maureen Romine, Professor	New Mexico Highlands University
Allyn J. Sapa	Fish and Wildlife Service, North Dakota
Robert Sivinski	Natural Resources Dept., New Mexico

Literature*

Atlas of the Flora of the Great Plains. p.427

Britton, N. and A. Brown. An illustrated Flora of the Northern United States and Canada. Dover Publications. New York, NY. p.460

Budd, A.C., J. Looman and K.F. Best. 1987. Budd's Flora of the Canadian Prairie Provinces. Research Branch Agriculture Canada. Hull, PQ. p.246.

Farrar, J. 1990. Field Guide to Wildflowers of Nebraska and the Great Plains. Nebraskaland Magazine. Lincoln, Nebraska. p.150

Flora of the Great Plains. p.1049

Hershey, J. 1960. The Woman's Day Book of Wildflowers. Simon and Shuster. New York, NY. p.16

Jonkers, P. (ed.) 1992 Proceedings of a Canadian Conference on Vegetation Management in Parks and Protected Areas. Ext. Div., University of Saskatchewan, Saskatoon.

Kannowski, P.B. 1988. Wildflowers of North Dakota. University of North Dakota Press. Grand Forks, ND. p.98

Manual of the Vascular Plants of Texas. p.364

Marsh, J. 1985. The Canadian Encyclopedia. Hurtig Publishers Ltd. Edmonton, Alberta.

Martin and Hutchins. A flora of New Mexico. p.383

Porter, C.L. Taxonomy of Flowering Plants. W.H. Freeman and Company. San Francisco, California. p.161

Reader's Digest. 1981. Atlas of Canada. The Reader's Digest Association. Toronto, Ontario.

Smith, B. and C. Bradley. 1990. Status Report on Endangered Wildlife in Canada -- Western Spiderwort. COSEWIC. Calgary, Alberta.

Stevens, O.A. 1963. Handbook of North Dakota Plants. North Dakota Institute for Regional Studies. Fargo, North Dakota. p.89

Strickler, D. Prairie Wildflowers. p.23

Welsh *et al.* Great Basin Naturalist Memoirs.

* Since much of this information was in the form of photocopies of the pertinent sections of the books sent through the mail, the complete details of author, date of publishing, name of publisher, and publication location are not complete.

APPENDICES

APPENDIX I: Western Spiderwort Population Survey

1. MHHC Property

Site #1

total # of plants = 200
avg. # stems/plant = 4.1
total # plants in bud or flower = 126
% of stems in bud or flower = 37%
comments: 1 plant browsed, 28 pink-flowered plants

Site #2

total # of plants = 85
avg. # stems/plant = 2.9
total # plants in bud or flower = 80
% of stems in bud or flower = 67%
comments:

Site #3

total # of plants = 0
comments: This site appears to have been completely choked out by leafy spurge. No sign of spiderwort could be found in the entire area.

2. Crown Land

Site #4

total # of plants = 370
avg. # stems/plant = 2.0
total # plants in bud or flower = 366
% of stems in bud or flower = 82%
comments: 17 plants browsed, 1 pink-flowered plant

Site #5

total # of plants = 335
avg. # stems/plant = 2.1
total # plants in bud or flower = 330
% of stems in bud or flower = 76%
comments: 15 plants browsed, 2 pink-flowered plants

3. Hellman's

Site #6 (pastured quarter)

total # of plants = 236
avg. # stems/plant = 2.0
total # plants in bud or flower = 234
% of stems in bud or flower = 72%
comments: 19 plants browsed, 6 pink-flowered plants

Site #7 (Ecologically Significant Area)

total # of plants >7000
(Note: plants were not counted in 1993 but distribution and numbers appeared similar to the 1992 count)

APPENDIX II: Leafy Spurge Control

On 28 July 1993, *Aphthona nigriscutis* obtained from the Department of Agriculture were released on four separate sites on the Hellman Property in an effort to control the spread of leafy spurge into sensitive spiderwort habitat.

Site #1

- area size is approximately 25m x 10m
- lower NE slope of the hill is immediately adjacent to spiderwort Site #5 on the Crown land
- movement of cattle on three sides, and the birch and aspen cover on the fourth side may prevent spurge spread
- leafy spurge coverage about 85%

Site #2

- hill crest and SW slope of entire hill
- area size is approximately 35m x 50m
- separated from beetle release Site #3 by thin band of shrubs
- leafy spurge coverage 100%

Site #3

- crest and slopes of two entire hills
- area size is approximately 45m x 25m
- leafy spurge coverage 90%

Site #4

- located in the Ecologically Significant Area
- crest and upper slope of three hills, separated by fence and small gully
- area size is approximately 15m x 85m
- leafy spurge coverage 95%

APPENDIX III: Experimental Plots

In order to obtain some information on growth requirements and habitat conditions of the western spiderwort, several 5m x 5m plots were established. Different conditions were examined, and the plants within the plots were monitored on a weekly basis.

H1. Control (Hellman property)

-located on a lower SW facing slope
-receives partial shading in the early morning
-partially destabilized sand/moss soil
-associated plants: goldenrod, pasture sage, white sweet clover, sand grass, wild rose, June grass, star-flowered false Solomon's-seal, creeping juniper, snowberry

H2. Competition (leafy spurge)

-located on an upper south-facing slope
-experiences no shading
-destabilized (not active) open sand soil
-associated plants: leafy spurge, hairy golden-aster, mustard spp.

H3. Irrigation

-located on a lower SSW facing slope
-no shading
-partially destabilized sand/moss soil
-associated plants: sand grass, pincushion cactus, chokecherry
-plot received 1L of water per week (equivalent to 2mm rainfall) regardless of rainfall amount

H4. Shading

-located on the uppermost slope of west-facing slope
-shaded early mornings and late afternoons, 25% of plot shaded all the time
-partially destabilized, open sand soil
-associated plants: aspen, chokecherry, skeletonweed, sand grass, hairy golden-aster, goldenrod, wild rose, poison-ivy, Manitoba maple

H5. Disturbance

-located on lower west-facing slope in pastured quarter
-destabilized, open sand soil
-partially shaded in early morning
-associated plants: chokecherry, wild rose, star-flowered false Solomon's-seal

M1. Control (MHHC)

-located midway on a SSE facing slope
-stabilized sand/silt soil
-partial shading from small shrubs
-associated plants: chokecherry, poison-ivy, wild rose, pasture sage, creeping juniper

M2. Grazing

-located on an upper SSW facing slope
-open sandy/silt soil
-no shading
-associated plants: poison-ivy, creeping juniper, pasture sage, wild rose
-plants were allowed to grow normally for most of June, and then cut to simulate grazing/browsing

APPENDIX IV: Monitoring data on western spiderwort growth and phenology on the experimental plots (Appendix III).

Table 1. Spiderwort Growth and Phenology on Study Plot H1 (Appendix III).

Date	Avg. Height (cm)	Avg. Stems Per Plant	% Flowering Stems	% Flowering Plants	# Plants Counted	Comments
June 1		6.3	0	0	6	2 plants showing some discoloration.
June 9	27	5.1	0	0	7	5 plants with dead or dying leaf tips.
June 15	33	4.4	0	37.5	8	3 plants in bud, 3 with dead leaf tips.
June 22	34.3	5.3	28.1	100	6	6 plants in bud or flower.
June 28	37.3	4.1	55.2	100	7	7 plants in flower.
July 6	37.5	3.9	61.3	100	8	8 plants in flower.
July 13	43.1	4.0	55.6	100	9	9 plants in flower, 1 robust size.
July 20	43.6	4.1	58.6	85.7	7	6 plants flowering, 1 finished flowering, 1 robust.
July 26	44.3	4.7	24.2	71.4	7	5 plants flowering, 2 finished (turning purple).
Aug. 5	37.1	4.9	17.6	57.1	7	3 plants finished flowering, 1 plant with new shoots, 1 plant dying.
Aug. 10	38.1	4.5	30.6	62.5	8	3 plants finished flowering, 2 plants with new shoots, 3 plants with seed pods.
Aug. 17	31.7	6.6	5.0	16.7	6	5 plants finished flowering, 3 plants with new stems, 4 plants with seed pods.

Table 2. **Spiderwort Growth and Phenology on Study Plot H2 (Appendix III).**

Date	Avg. Height (cm)	Avg. Stems Per Plant	% Flowering Stems	% Flowering Plants	# Plants Counted	Comments
June 1		2.9	0	0	7	All plants in good health.
June 9	25.4	3.2	0	0	9	8 plants in bud.
June 15	32.1	3.7	3.0	11.1	9	9 plants in bud (1 flowering).
June 22	37.7	3.7	51.3	100	10	1 plant ill.
June 28	36.6	3.0	69.7	100	11	1 plant ill, 2 plants robust size.
July 6	36.2	3.3	69.4	100	11	2 plants ill.
July 13	35.1	5.0	57.1	85.7	7	2 plants ill, 1 finished flowering.
July 20	36.1	2.8	66.7	91.7	12	3 plants ill, 1 finished flowering.
July 26	35.9	3.1	32.3	45.5	11	5 plants finished flowering, 1 plant ill.
Aug. 5	33.1	3.2	11.4	27.3	11	8 plants finished flowering, 4 plants with new shoots.
Aug. 10	34.1	3.6	0	0	8	3 plants with new stems, 5 plants with seed pods.
Aug. 17	30.0	3.3	0	0	7	4 plants with new stems, 6 plants with seeds.

Table 3. Spiderwort Growth and Phenology on Study Plot H3 (Appendix III).

Date	Avg. Height (cm)	Avg. Stems Per Plant	% Flowering Stems	% Flowering Plants	# Plants Counted	Comments
June 1		2.0	0	0	7	
June 9	29.8	2.0	0	0	7	4 plants in bud.
June 15	36.6	2.1	33.3	42.9	7	4 plants in bud (3 flowering).
June 22	41.9	1.9	93.3	100	8	6 plants robust size.
June 28	41.2	1.6	93.8	100	10	3 plants robust size.
July 6	41.6	1.5	94.1	100	11	3 plants robust size, 1 new plant, 1 ill.
July 13	39.8	1.5	100	100	12	3 plants robust size, 1 plant ill.
July 20	39.3	1.4	72.2	76.9	13	3 plants finished flowering, 1 plant ill, 1 robust.
July 26	41.9	1.5	68.8	81.8	11	2 plants finished flowering, 2 robust size.
Aug. 5	36.3	1.5	33.3	50.0	12	6 plants finished flowering, 3 robust size, 2 plants with new stems, 1 plant browsed.
Aug. 10	37.0	1.3	21.4	18.2	11	9 plants finished flowering, 2 robust size, 9 plants with seed pods.
Aug. 17	38.4	1.9	15.4	28.6	7	5 plants finished flowering, 2 plants with new stems, 1 plant browsed, 6 plants with seeds.

Table 4. Spiderwort Growth and Phenology on Study Plot H4 (Appendix III).

Date	Avg. Height (cm)	Avg. Stems Per Plant	% Flowering Stems	% Flowering Plants	# Plants Counted	Comments
June 1		3.4	0	0	14	
June 8	29.5	3.2	0	0	17	7 plants in bud, 1 plant browsed, 2 ill.
June 15	36.7	3.7	5.5	20	15	11 plants in bud.
June 22	37.6	2.4	45.9	64.7	17	3 plants robust size, 8 plants in heavy shade (3 flowering).
June 28	42.3	2.0	70.5	90.9	22	7 plants in heavy shade (5 flowering).
July 6	44.3	2.0	62.2	90.9	22	7 plants in heavy shade (5 flowering).
July 13	41.8	2.2	45.1	65.2	23	3 plants finished flowering, 2 plants browsed, 9 plants in heavy shade (4 flowering).
July 20	45.6	2.0	48.8	80.9	21	3 plants finished flowering, 6 plants in heavy shade (4 flowering).
July 26	44.8	2.2	24.3	35.3	17	10 plants finished flowering, 3 in heavy shade.
Aug. 5	40.4	3.1	22.4	43.8	16	1 plant browsed, 8 plants finished flowering, 5 plants in heavy shade (4 flowering).
Aug. 10	38.3	2.6	22.2	35.7	14	8 plants finished flowering, 2 plants with new shoots, 6 in heavy shade (4 flowering) 4 plants with seed pods.
Aug. 17	42.3	2.1	5.9	12.5	8	6 plants finished flowering, 2 plants with new stems, 4 plants in heavy shade (1 flowering) 6 plants with seed pods.

Table 5. Spiderwort Growth and Phenology on Study Plot H5 (Appendix III).

Date	Avg. Height (cm)	Avg. Stems Per Plant	% Flowering Stems	% Flowering Plants	# Plants Counted	Comments
June 1		3.0	0	0	10	Area undisturbed.
June 9	27.5	2.2	0	0	6	1 plant browsed, 1 in bud, 1 plant ill.
June 15	17.5	3.0	16.7	50	2	1 plant browsed, area trampled.
June 22	22	1.8	14.3	25	4	2 plants browsed.
June 28	23	2.7	37.5	100	3	1 plant browsed.
July 6	18	1.7	20	33.3	3	3 plants browsed.
July 13	6	2.0	0	0	1	1 plant browsed, area disturbed.
July 20	12	4.0	100	100	1	1 plant browsed.
July 26	10	1.0	0	0	1	1 plant browsed.
Aug. 5	38	1.0	0	0	1	Plant in heavy shade.
Aug. 10	-	-	0	0	-	No plants found.
Aug. 17	-	-	0	0	-	No plants found.

Table 6. **Spiderwort Growth and Phenology on Study Plot M1 (Appendix III).**

Date	Avg. Height (cm)	Avg. Stems Per Plant	% Flowering Stems	% Flowering Plants	# Plants Counted	Comments
June 2	20.2	3.2	0	0	20	3 plants with dead leaf tips.
June 10	21.8	3.3	0	0	20	3 plants browsed, 4 plants with dead leaf tips, 3 plants in bud, 1 plant ill.
June 17	25.6	2.7	14.3	38.1	21	1 plant with dead leaf tips, 2 plants browsed, 6 plants in bud, 3 plants in heavy shade.
June 22	29.4	2.8	57.4	94.1	17	7 plants with pink flowers, 1 plant browsed.
July 1	29.5	3.1	59.1	92.9	14	2 plants with pink flowers.
July 7	32.5	2.7	62.5	100	18	8 plants with pink flowers, 1 in heavy shade.
July 14	30.3	2.6	25.4	34.8	23	8 plants finished flowering, 1 plant browsed, 5 plants with pink flowers, 5 in heavy shade.
July 23	28.5	2.5	40.0	59.1	22	6 plants finished flowering, 1 plant browsed, 8 plants with pink flowers.
July 29	29.9	2.8	15.9	31.3	16	9 plants finished flowering, 1 plant browsed, 1 plant ill, 3 plants with pink flowers.
Aug. 5	29.9	3.1	4.1	12.5	16	12 plants finished flowering, 1 plant browsed, 3 plants with pink flowers, 1 in heavy shade, 5 plants with new stems.
Aug. 12	29.7	2.2	8.3	18.2	11	1 plant browsed, 7 plants finished flowering, 4 plants with new stems, 3 plants in heavy shade, 6 plants with seed pods.
Aug. 19	26.7	3.0	0	0	7	6 plants finished flowering, all with seed pods.

Table 7. Spiderwort Growth and Phenology on Study Plot M2 (Appendix III).

Date	Avg. Height (cm)	Avg. Stems Per Plant	% Flowering Stems	% Flowering Plants	# Plants Counted	Comments
June 2	22.3	5.4	0	0	8	4 plants with dead leaf tips.
June 10	26.0	5.5	0	0	8	3 plants in bud, 2 plants with dead tips.
June 17	28.9	5.9	17.1	57.1	7	2 plants in bud.
June 22	16.0	4.3	5.9	25.0	4	4 plants cut.
July 1	13.5	3.3	23.1	50.0	4	4 plants browsed.
July 7	18.6	3.0	6.7	20.0	5	3 plants browsed.
July 14	18.4	4.0	15.0	60.0	5	4 plants browsed.
July 23	18.7	5.4	15.8	57.1	7	1 plant finished flowering, 4 plants browsed, 1 new plant.
July 29	21.5	5.5	12.1	50.0	6	3 plants browsed, 1 plant finished flowering, 2 new plants.
Aug. 5	21.7	5.5	6.1	16.7	6	2 plants browsed, 6 plants with new stems, 2 plants finished flowering.
Aug. 10	22.3	3.7	13.6	33.3	6	2 plants browsed, 1 plant with seed pods.
Aug. 19	22.0	4.3	0	0	4	1 plant with seed pods.