-DALY (01)
- DALY GAS STORAGE ~~AUGUST 1982~~
- REPORTS
- DALY GAS STORAGE COMPREHENSIVE REPORT - JULY, 1982

DALY GAS STORAGE LTD.

COMPREHENSIVE REPORT

JULY, 1982

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COMPREHENSIVE REPORT

JULY, 1982

Daly Gas Storage Ltd. is a company incorporated in the Province of Manitoba, formed for the express purpose of determining the feasibility of developing and operating a gas storage reservoir in the area of Virden, Manitoba. Daly Gas Storage Ltd. is a wholly owned subsidiary of Northern and Central Gas Corporation Limited, an Ontario public utility, and is an associated company of Greater Winnipeg Gas Company.

On December 30, 1975, Greater Winnipeg Gas Company entered into an agreement with Daly Gas Storage Ltd. (Daly) to provide for the financing of a preliminary study, to be carried out by Daly to ascertain the feasibility of developing a gas storage reservoir. This agreement was subsequently approved by the Manitoba Public Utilities Board.

Daly has carried out its efforts under Exploration Permit No. 1 and subsequent renewal, issued pursuant to The Gas Storage and Allocation Act. Copies of the above noted documents are found in Appendix 'A'.

The purpose of this submission is to satisfy condition five (5) of the Renewal Permit, that being a report on the operations carried out within the designated area declared under Manitoba Regulation 253/75, during the initial term and renewal period of Exploration Permit No. 1.

I OBJECTIVE

Daly's efforts were concentrated on the objectives of exploring for a reservoir suitable for gas storage in the Virden, Manitoba area, and if feasible, to develop and operate said gas storage facility.

II METHODOLOGY

In support of the objectives Daly undertook to:

(i) carry out detailed engineering and geological analyses of the designated area as indicated in Table 1 to determine the presence of a reservoir suitable for gas storage in the formations of the Devonian age; and

(ii) subsequently carry out economic and financial analysis to determine the feasibility of developing the gas storage facility.

In Daly's view, should the efforts undertaken above have positive results, then Daly would proceed to the development and operation of the facility. Should the results not be positive, then Daly would examine other courses of action of potential benefit.

III GEOLOGICAL AND ENGINEERING ACTIVITIES

During the terms of the initial Exploration Permit No. 1 and subsequent renewal, the following activities occurred:

(i) Drilling of four wells as noted:

Name	Location	Year Drilled
Daly Gas #1	7-18-10-27-W1M	1976
Daly Gas #2	11-19-10-27-W1M	1976
Daly Gas #3	10A-12-10-28-W1M	1977
Daly Gas #4	10-07-10-27-W1M	1977

These wells were completed in the Souris River Formation of the Upper Devonian.

(ii) In the spring of 1978 an existing suspended well, Apache Darling Daly 15A-18-10-27-WiM was recompleted in the Souris River Formation.

(iii) Intercomp Resource Development and Engineering Ltd. were retained to undertake a geological and petrophysical analysis. The revised report was completed in November 1977 and discussed with representatives of the Manitoba Oil and Natural Gas Conservation Board in December 1977.

(iv) Flow tests were conducted on four wells (7-18, 11-19, 10A-12 and 15A-18) from June to November 1978 with draw-down and build-up pressures being monitored. The 10-7 well was utilized as an observation well. These tests were conducted after discussions with the Clean Environment Commission.

(v) A gas mixing study was undertaken by Intercomp using compositional models, to evaluate the extent of mixing that may be experienced between the native nitrogen and injected natural gas. This report was completed in March 1980.

(vi) Field wide bottom hole pressure survey tests were undertaken in April 1980 to further evaluate the potential in the penetrated intervals.

Geological Assessment

The Intercomp report number CGS 19-77-483 provides a detailed analysis of the geological results of the exploration activities. Copies of this report were resubmitted to the Conservation Board in December 1977. Appendix 'B' provides a comprehensive review of the findings.

With the exploration program providing substantial evidence of the existence of a suitable reservoir, engineering assessment was required to further delineate the reservoir capacity and characteristics.

Engineering Assessment

The reservoir as defined in the Intercomp report has some 100 feet plus of enclosure containing, by estimate, 32 to 34 BCF of nitrogen within three discrete porosity units, or zones separated by thin beds of anhydrite. Reservoir content separation was postulated from observation of differing nitrogen/water contacts in at least two of the zones.

In 1978 four wells were flow-tested (7-18, 11-19, 10A-12 and 15A-18) from June to November with the remaining well being used for observation purposes. The purpose of the tests was to gain a better understanding of the true reservoir capacity, zone separation actuality and long-term acquifer influence. Throughout the withdrawal period, reservoir response was monitored through measurement, both surface and subsurface, of the volume/pressure/acquifer relationship changes.

These tests were conducted after discussions with the Clean Environment Commission. Total cumulative gas production during the tests was 2.113 BCF. The results of the tests were analyzed by an independent consulting firm and their material balance calculations from the tests indicated reasonable agreement with the gas in place calculations made by Intercomp. Unfortunately, these tests did not provide all of the data which was required. The primary problem was a consequence of the well completion strategy (multiple zones open in a common wellbore during some phases of the tests). On some zones, the volume of gas produced was too low and there was uncertainty as to what volumes of gas were produced from each zone. Additionally there were considerable concerns as to the quality of the test and post test analysis. Thus the flow tests, while providing some further information, did not present adequate information for incorporation into major studies to predict project feasibility.

In April 1980, field wide bottom hole pressure recovery tests were conducted which confirmed the inconclusiveness of the results of the 1978 tests. The 1980 tests indicated there was communication between Zones 1 and 2. The completion in the 7-18 well may have contributed to the communication problem but this can only be investigated through further tests. The tests supported the material balance work for Zone 3 but it was not possible to assess the water influx. The 1980 tests then raised several questions which could only be answered through extensive tests on the reservoir. These tests, it is felt, would be conducted in the event the project is deemed feasible from a economic viewpoint.

One of the critical factors in the development of the gas storage reservoir was the effects of nitrogen as a cushion gas. In 1979 a gas mixing study was commenced by Intercomp using their compositional models to evaluate the extent of mixing that may be experienced between the native nitrogen and injected natural gas. This study took into account the concerns regarding the 1978 flow tests. Appendix 'C' summarizes the study methodology, results, conclusions and recommendations.

All results obtained in the study indicated that the mixing of the gas would be important to the success of the scheme. The degree to which the lower BTU content can be tolerated will dictate the need to consider and optimize the blowdown level of the native gas. Associated with this is the increased costs to replace the native gas with cushion gas to ensure the scheme can be operated at a reasonable pressure level.

Assessment of Activities

The geological and engineering activities then have determined that there is a reservoir suitable for gas storage in the Souris River formation. At this point further pursuit of the design of a gas storage facility requires additional information in three areas:

1) the tolerance of the producing stream to nitrogen content;
2) the caprock integrity;
3) the reservoir definition.

In reviewing the efforts to this point the decision was made that the work necessary to gain this information should only be under-

undertaken if the economic and financial aspects of the project were feasible. Economic and financial analysis was undertaken in this light.

IV. ECONOMIC AND FINANCIAL ANALYSIS

Background

The intent in creating Daly Gas Storage Ltd. was to provide a gas storage and pre-delivery service, first to the Manitoba gas utilities and if spare capacity were available, to such interested parties as TransCanada PipeLines or other utilities. Originally with Manitoba utilities operating under a fairly low load factor, as compared to gas utilities in Ontario and Quebec, it was felt that underground storage would provide an economic method of load levelling. Pipeline gas could be placed into storage during the summer months and withdrawn to augment direct supplies during the winter.

In the 1974-75 period when the Daly project was initially considered, it was anticipated that demand for natural gas would continue to be strong in both domestic and export markets, thus creating a positive climate for the development of a gas storage reservoir. In actual fact demand requirements have not conformed to expectations. Take or pay provisions in contracts were first incurred in 1976-77 and have continued to the present time. The availability of supply was able to meet the peak period requirements of the Manitoba utilities. The initial gas bubble has evolved into a long term situation.

Economic Analysis

Analysis was undertaken as to the feasibility of the project. Initial analysis considered the utilization of Daly solely by Greater Winnipeg Gas Company. This determined that cycling rates exceeding Greater Winnipeg Gas' peak winter requirements were required.

Given the analysis that the project would only be feasible at higher volumes than required by Greater Winnipeg Gas, contact was made with TransCanada PipeLines and Northern Plains Natural Gas Co. of Omaha (a major shipper on the Northern Border system) to determine their interest in the project. Northern Plains, while interested, was unable to pursue the matter at this time.

TransCanada PipeLines expressed considerable interest and meetings were held to pursue the matter. TransCanada did not see a problem in delivering mixed gas to their system as the scheme would be injecting 50 to 100 MMCFD of mixed gas into their line containing 4 BCFD of natural gas. Trans-Canada, after considering their economics on the project, determined the project was not feasible at this time. The potential cost savings which would be the result of developing Daly, (savings on upstream loop and compressors), is more than offset by Daly's actual development costs as well as fuel and storage costs.

In summary then, the economic assessment has determined that in all possible cases the undertaking of the gas storage project is not feasible at this time.

V. ADDITIONAL ACTIVITY

Once it was realized that it was not currently feasible to develop the storage facility, possible uses for the nitrogen contained in the reservoir were explored. Contact was made with two companies, Canadian Liquid Air and Liquid Carbonic Canada. Both companies, after considering the matter, determined that at the present time there are insufficient economic markets to create a demand for nitrogen.

VI. FINANCIAL EXPENDITURES

Appendix 'D' indicates the financial expenditures incurred from 1976 to 1981 including a breakdown of costs for each well. Total expenditures for the five wells were $934,403. Consultant studies totalled $42,710. Total costs for the project amounted to $1,069,219.

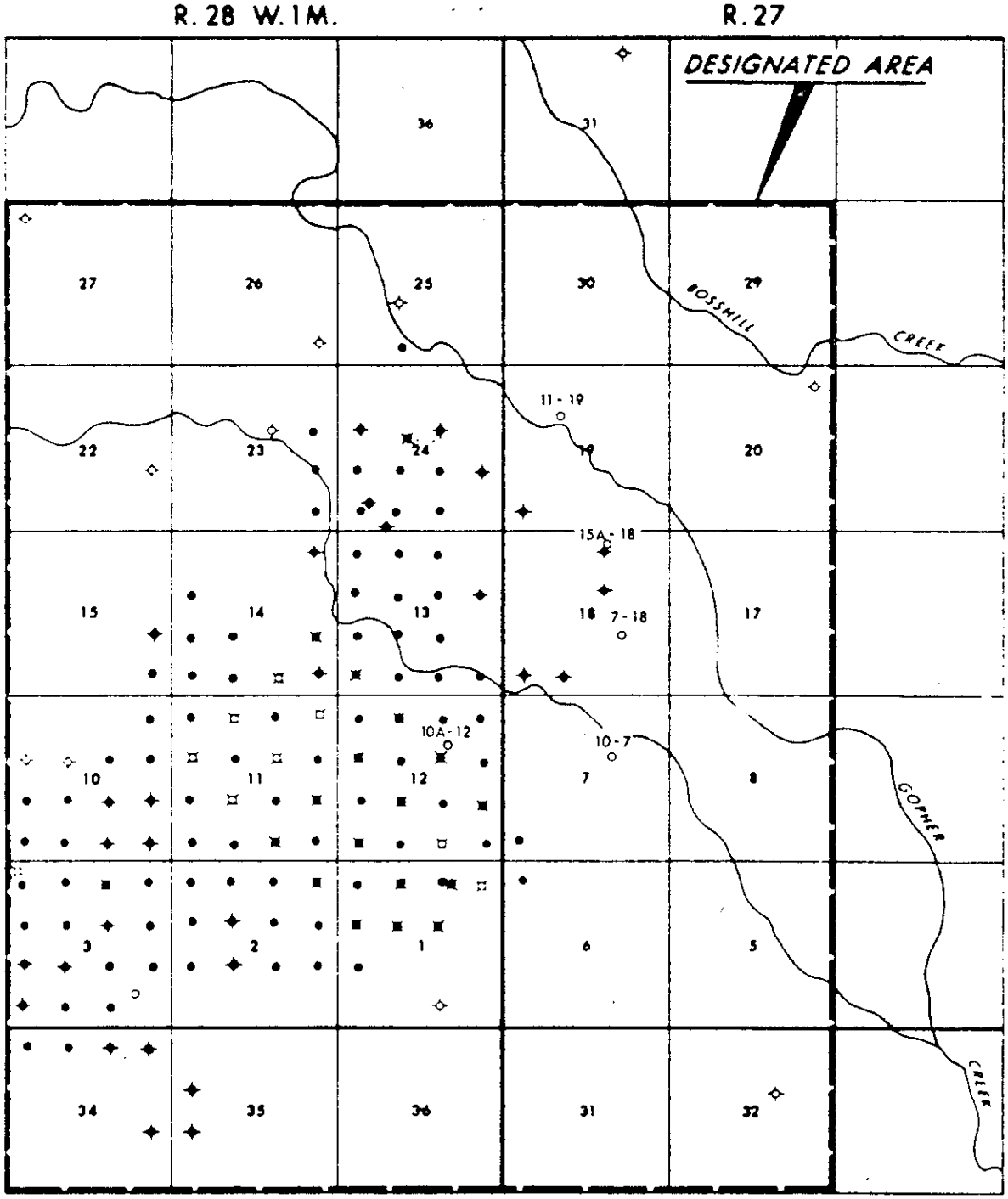
VII. SUMMARY

The work undertaken by Daly Gas Storage Ltd. has determined the presence of a reservoir suitable for the storage of natural gas. Preliminary studies of the reservoir characteristics have arrived at a basic assessment of the reservoir capacity and have presented recommendations as to future studies to investigate the caprock integrity and reservoir limits. These studies should, in Daly's view, be undertaken if the project appears feasible and analysis has determined that the project is not economically feasible at this time. All possible avenues have been considered, with the same results.

VIII. CONCLUSION

Daly Gas Storage Ltd. has investigated the feasibility of developing a gas storage facility in the Virden, Manitoba area. At a point in the future, should economic analysis indicate that the project could be feasible, Daly would be interested in giving the project further consideration. Daly is familiar with the concept and is aware of what is required to develop this gas storage facility.

While it is difficult to predict when the project may become viable, the efforts undertaken to this point have demonstrated the interest on the part of Daly Gas Storage in developing a gas storage facility. Further applications to the Province of Manitoba are anticipated when the project becomes feasible.



DALY GAS STORAGE LTD.

DALY AREA

LANDS REQUESTED AS DESIGNATED AREA

FIG. 2

Scale: 1" = 1 Mile	Contour Interval:
Date: July 1978 Revised:	Drawn by:
Map of	File number: 82-005

APPENDIX A

APPENDIX 'A'

MANITOBA

DEPARTMENT OF MINES, RESOURCES
& ENVIRONMENTAL MANAGEMENT
THE OIL AND NATURAL GAS CONSERVATION BOARD
993 Century Street,
Winnipeg, Manitoba.
R3H 0W4

Jas. T. Cawley 946-7438
CHAIRMAN
J. S. ROPER 946-7859
DEPUTY CHAIRMAN
Dr. I. Haugh 786-7931
MEMBER

The Gas Storage and Allocation Act

Exploration Permit No. 1

This Exploration Permit is issued pursuant to The Gas Storage and Allocation Act, Cap. G52 of the Continuing Consolidation of the Statutes of Manitoba to:

Daly Gas Storage Ltd.,
265 Notre Dame Avenue,
Winnipeg, Manitoba.
R3B 1N9

(hereinafter called "Daly"),

to engage in explorations for the purpose of determining the existence and location of subsurface geological formation(s) suitable for use as a gas storage reservoir within the designated area (which area is described in Appendix 'A') upon the following terms and conditions.

1. Definitions: for the purposes of this Exploration Permit

"cash deposit" in addition to its usual meaning, includes a certificate of deposit or irrevocable letter of credit issued by any chartered bank in Canada and securities issued by the Government of Canada, the Province of Manitoba, the government of any other province in Canada the payment of which is guaranteed by the aforementioned issuers;

. . .2.

"Acts" includes but is not limited to The Mines Act, The Pipelines Act, The Gas Storage and Allocation Act and The Clean Environment Act;

"Regulations" includes but is not limited to Regulations in force from time to time whether made before or after the date of this permit under The Mines Act, The Pipelines Act, The Gas Storage and Allocation Act and The Clean Environment Act;

"Board" means the Oil and Natural Gas Conservation Board.

2. The term of this Exploration Permit shall be for three years from February 1st, 1976 and upon written application by Daly prior to January 1st, 1979 may be renewed for an additional term of up to three years. There shall be no further renewal of this permit.

3. In accordance with the Board's letter dated 76 02 09 (copy attached), Daly shall make a cash deposit in favour of the Board at the Petroleum Branch, Department of Mines, Resources and Environmental Management, 993 Century Street, Winnipeg R3H OW4 in the amount of $50,000. The cash deposit is refundable in whole or in part, at the expiration or termination of the Exploration Permit, subject to the satisfactory completion of all requirements of the Acts, regulations and this permit including performance requirements. Non-compliance with any or all requirements shall enable the Board to take possession of the cash deposit and to expend all or part of the money for the correction of any deficiency or delinquency.

. . .3.

4. In accordance with the Board's letter dated 76 02 09 Daly shall make a submission to the Board at the Department of Mines, Resources and Environmental Management, 993 Century Street, Winnipeg R3H 0W4 setting forth the proposed work program together with cost estimates for the term of the permit or renewal thereof. Such program may be varied depending upon the results of work performed or deviations from the original porposed work program in which case amendments to the proposed work program and cost estimates shall be submitted at least annually on the anniversary date of the permit.

5. Daly shall expend not less than $100,000 annually for geophysical, geological, drilling, environmental, reservoir studies or other work of a similar nature within the designated area during the term of the Exploration Permit or the renewal thereof.

In the event that Daly determines that an expenditure of $100,000 is not justified in any year of the permit or renewal thereof due to technical reasons it may apply to have expenditures within the designated area made by Daly since the commencement of the permit averaged to fulfill the annual $100,000 expenditure requirement. However, in no event may the approved expenditures average less than $100,000 per year for each year that the permit is in good standing.

6. Prior to the entry of, evacuation of, drilling of, abandonment or utilization of any existing well or future well within the designated area Daly shall produce evidence of the consent of the surface owner of the land as well as the consent of the owner and lessee of the mineral rights.

. . .4.

7. When making application to drill a well, under Manitoba Regulation M160-R1P, to the Mississippian or lower strata Daly shall provide amongst other things evidence of the concurrence of the mineral right holder regarding the operational procedures to be followed when the drill is entering, passing through and being removed from producing or potential production strata. In the event that such concurrence is unreasonably withheld Daly may apply to the Board for written permission to drill without such concurrence.

8. At least one of the four wells proposed to be drilled as per Section 9 of the application (copy attached) entitled "Preliminary Estimate of Costs" shall be drilled to the base of the Devonian formation. Selection of the well and the drilling shall be as prescribed by the Petroleum Branch of the Department of Mines, Resources and Environmental Management.

9. Daly shall during each year of this permit or any renewal thereof furnish to the Department of Mines, Resources and Environmental Management all technical data relevant to the purpose of this permit acquired during working within the designated area.

10. Daly, its employees, agents and contractors shall carry on operations hereunder in a competent, sound and workmanlike manner in compliance with the prevailing standards of the petroleum industry in Canada and in compliance with the laws of Manitoba and shall take all reasonable and necessary steps to prevent avoidable injury and damage to life and property.

. . .5.

11. Upon application by Daly at any time prior to the expiration of 6 months next following the expiration of this permit or renewal thereof a hearing shall be convened by the Board to hear an application by Daly for a storage permit with respect to any reservoir that may be located in the course of carrying out explorations under this Exploration Permit.

12. This Exploration Permit may be terminated by Daly upon application in writing to the Board giving reasons provided that all requirements of the permit have been met and approval of the termination in writing has been received from the Board.

Jas. T. Cawley, P. Eng.,
Chairman.

Dated at Winnipeg, Manitoba
this 19th day of February 1976.

Manitoba Regulation 253/75

Being a Regulation Under The Gas Storage and Allocation Act

(Filed December 5, 1975)

1. Pursuant to subsection 3(1) of The Gas Storage and Allocation Act, the area in Manito described below is declared a designated area:

    1. All of Sections 31 and 32 in Township Nine, Range Twenty-seven, West of the Prime Meridian in Manitoba.
    2. All of Sections 34, 35 and 36, in Township Nine, Range Twenty-eight, West of th Prime Meridian in Manitoba.
    3. All of Sections 5, 6, 7, 8, 17, 18, 19, 20, 29 and 30, in Township Ten, Range Twenty-seven, West of the Prime Meridian in Manitoba.
    4. All of Sections 1, 2, 3, 10, 11, 12, 13, 14, 15, 22, 23, 24, 25, 26 and 27 in Township Ten, Range Twenty-eight, West of the Prime Meridian in Manitoba.

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THE PUBLIC UTILITIES BOARD OF MANITOBA
379 BROADWAY AVENUE
WINNIPEG, MANITOBA
R3C 0T9

M A N I T O B A) Order No. 69/76
)
THE PUBLIC UTILITIES BOARD ACT) April 13, 1976

BEFORE: L. S. M. Partridge, Chairman
O. Tonn, Member
R. Schilling, Member

GREATER WINNIPEG GAS COMPANY - APPLICATION FOR APPROVAL OF AN AGREEMENT ENTERED INTO WITH DALY GAS STORAGE LTD. CONCERNING THE FEASIBILITY OF STORING NATURAL GAS UNDERGROUND IN THE VIRDEN AREA OF MANITOBA.

A public hearing was held in Building No. 2, Fort Osborne Barracks, in the City of Winnipeg on Tuesday, March 23, 1976.

APPEARANCES:

Mr. W. C. Gardner, Q. C., and
Mr. D. D. Jessiman - Counsel for the Board
Mr. A. Lorne Campbell, Q.C.- Counsel for the Applicant

The application was not opposed.

On December 30, 1975, Greater Winnipeg Gas Company entered into an agreement with Daly Gas Storage Ltd. to provide for the financing of a preliminary study, to be carried out by the latter Company, to ascertain the feasibility of creating a gas storage reservoir in the area of Virden, Manitoba. The two companies in question are associated companies. Consequently any such agreement falls under the provisions of Section 82(1)(i) of The Public Utilities Board Act. The letter of application from Mr. A. P. Rathke, President of Greater Winnipeg Gas Company, who is also Vice-President of Daly Gas Storage Ltd., was filed as Exhibit No. 1.

Mr. Rathke and Mr. P. O. Petursson, who is Vice-President, Operations, of both companies involved, described the nature of the proposal at some length, and their testimony was supported by that of Mr. B. M. D. Cochrane, a petroleum engineer with Norcen Energy Resources Limited. Because of the unprecedented nature of the proposal put forward, it will be useful to summarize the evidence provided by these three witnesses, both in their evidence in chief and under cross-examination by Board Counsel and by the Chairman and Members of the Board.

Greater Winnipeg Gas Company has been able to maintain a historical load factor for pipeline gas of only about 67 percent, as compared with 90 percent and more for eastern utilities. If underground storage could be made available, this would provide a highly desirable and economical method of load levelling. It would also provide increased security of supply, and reduce the cost of peak shaving in terms of both capital requirement and operating cost.

Greater Winnipeg Gas Company, as a subsidiary of Northern and Central Gas Corporation Limited, cannot form its own subsidiary, nor can

it carry out direct financing. Daly Gas Storage Ltd. is therefore a subsidiary of the parent company. However, in the absence of such an agreement as is being proposed for approval, costs of exploration would have to be borne by customers of the Ontario Utility, and it seems certain that this would not be acceptable to the Ontario Energy Board. The Applicant thus seeks to ensure that costs will be allocated to those ultimate consumers who would have received the benefit of the storage, had the project been successful.

Correspondence from TransCanada PipeLines, presented as Exhibit No. 9, indicated an interest in acquiring gas storage privileges in the Province of Manitoba, and stated that the Company is prepared to enter into a transportation contract. A letter to The Public Utilities Board from Plains-Western Gas (Manitoba) Ltd. (Exhibit No. 4) also stated that it would be interested in storing gas within Manitoba, if storage were available at a comparative cost.

Much discussion centered upon the matter of the feasibility of employing nitrogen, water, or cushion gas in the recovery phase of the storage operation, and on the relative costs of these various methods. Other discussion, and questioning by Board Members, had to do with the future potentiality of gas supplies from new sources, such as the Mackenzie Valley or Arctic Gas. Mr. Rathke emphasized that the prime purpose of the development of the Daly Storage would continue to be largely related to the improvement of the load factor of Greater Winnipeg Gas Company, and to the provision of lower cost peak-shaving gas.

In summation the Board makes the following observations:

The application before the Board contains elements of uniqueness in its experience. In the normal course of its regulatory activity,

it is of course not unusual to have filed, for its information, agreements between utility companies under its jurisdiction and associated companies; such filings are in fact required under the provisions of Section 81(1)(i) of The Public Utilities Board Act, and they enable the Board to provide close and proper surveillance of such non-arms-length relationships in the protection of the public interest. The significant departure in the present instance lies in the fact that the Board is being asked to approve, in advance of the culmination of the activity contemplated by the agreement in question, the recovery of the outlay being committed by Greater Winnipeg Gas Company through its future operating revenues, in the event of a negative outcome to the feasibility study proposed. The total sum involved is not inconsiderable, being the lesser of $700,000 or the actual outlay experienced. While it becomes relatively less formidable when placed beside the gross operating revenues of the Company, it is nonetheless important to the Board that any expenditures which it be asked to approve be evaluated with respect to their prudence, and to their benefit for Manitoba consumers of natural gas. In that context it is to be noted that should a positive outcome to the feasibility study result, no recovery will be required from Greater Winnipeg Gas Company. It is presumed that Daly Gas Storage Ltd. will at that point be a viable project, that it will then be in a position to undertake its own financing, and that it will recover this outlay in the process.

The Board would stress the fact that this sum of $700,000 or less represents the extent of its concern in this application. It was essential, in exploring the potentialities of the proposal, to review the ultimate capital projections related to the possible future exploitation of this gas reservoir, but the many millions of dollars of investment foreseen in the event of a favorable outcome to the proposed study have limited relevance to the decision which will flow from this application.

Should Daly Gas Storage Ltd. succeed in this project, and hence become a Manitoba public utility, the situation will of course be different.

Of no small importance to the Board is the fact, adduced in evidence, that Daly Gas Storage Ltd. has already made an application to the Oil and Natural Gas Conservation Board for a permit pursuant to the Gas Storage and Allocation Act of Manitoba and has been granted an exploration permit, dated the 19th of February, 1976. The Board would also note that Counsel for Greater Winnipeg Gas Company has provided assurance, during this hearing, that an environmental impact study has been provided for in the estimates, and has stated that the Company will be required to go before the Clean Environment Commission prior to proceeding with other aspects of the physical exploration.

The Board has reviewed the evidence before it. It admits that it is faced with a somewhat unusual situation in the case of this application. It accepts the position taken by the Gas Company that it would consider itself remiss, as a public utility, if it had not attempted to proceed with a program which would have a reasonable chance of ultimately benefitting its consumers. It will therefore grant the application. The Board notes that the Applicant will amortize the costs involved over a ten-year period, without carrying charges.

IT IS THEREFORE ORDERED:

1. THAT the agreement entered into between Greater Winnipeg Gas Company and Daly Gas Storage Ltd., an associated company, on December 30, 1975, be approved;

2. THAT the purpose of this agreement is to provide for the financing of a preliminary study to be undertaken by Daly Storage Ltd. to ascertain whether or not there is the potential of creating a gas storage reservoir in the area of Virden, Manitoba;

3. THAT the maximum recoverable cost to Greater Winnipeg Gas Company resulting from this Order shall be the lesser of the sum of $700,000 or the actual cost of the program, and will be subject to the final review of The Public Utilities Board concerning the actual disbursements;

4. THAT the costs to be incurred by Greater Winnipeg Gas Company will be recovered only if the reservoir exploration program is unsuccessful.

5. THAT Greater Winnipeg Gas Company will report periodically to The Public Utilities Board on the progress of the project.

THE PUBLIC UTILITIES BOARD

"L. S. M. PARTRIDGE"
Chairman

"D. BORODITSKY"
Secretary

Certified a true copy of Order No. 69/76 issued by The Public Utilities Board

D Boroditsky
Secretary

DALY GAS.
EX IV

THIS AGREEMENT made this 30th day of December, A. D. 1975.

BETWEEN:

GREATER WINNIPEG GAS COMPANY
(hereinafter called "GW Gas")

OF THE ONE PART

-and-

DALY GAS STORAGE LTD.
(hereinafter called "Daly")

OF THE OTHER PART.

WHEREAS in view of the present gas supply situation, the load factor of GW Gas and restrictions of customer acquisition, it is essential that all efforts be made to ascertain whether or not there is a gas storage reservoir in the Daly area (the "Area") so that gas may be stored in the summer and used in the winter for the benefit of GW Gas customers and others;

AND WHEREAS a gas storage reservoir may be possible in the "Area" and Daly has access to the expertise and organization necessary to explore for, locate and evaluate a gas storage reservoir to meet such requirements;

AND WHEREAS Daly has agreed to perform the exploration program and other work set forth herein provided that if Daly's exploration program is unsuccessful in locating a gas storage reservoir GW Gas will purchase Daly's exploration program including the detailed evaluation report and book debts and other assets for the sum of the total expenditures made by Daly subject to the approval of the Manitoba Public Utilities Board.

NOW THEREFORE this agreement witnesseth that in consideration of the mutual covenants and agreements set forth herein and the sum of One Dollar ($1.00) paid by each of the parties hereto to the other, the receipt and sufficiency of all of which consideration is hereby by each of the parties acknowledged, the parties hereto covenant and agree as follows:

1. Daly agrees and undertakes that it will carry out an exploration program in the Area and will acquire the necessary surface and sub-surface rights in the Area and will drill and test up to four (4) wells for the purpose of discovering a suitable reservoir for the storage of natural gas. As well, Daly will prepare an environmental impact study and perform diffusion and reservoir model studies in order to demonstrate to GW Gas or any other interested person or authority the suitability of the proposed reservoir in the Area.

2. Daly estimates that the acquisition of surface and subsurface rights, drilling rights, drilling and studies mentioned in paragraph 1 hereof will require capital funds of approximately Seven Hundred Thousand Dollars ($700,000 (the "Capital Sum"), based on the following estimated capital budget;

Acquisition of surface and mineral rights (including 15A-18 Well)	$ 125,000
Drilling and testing four wells	450,000
Environment Impact Study	5,000
Diffusion and Reservoir Model Studies	30,000
Contingencies	90,000
	$ 700,000

Such expenditures are subject to the continual ongoing evaluation of information acquired from time to time so that Daly at all times retains the right to halt its exploration program as described if Daly deems it prudent and necessary.

3. Daly shall before embarking upon the works, make the necessary applications under The Gas Storage and Allocation Act (Manitoba) (hereinafter called the "Act") for:

(a) a declaration that the Area is a "designated Area" under the said Act; and

(b) an "exploration permit: to allow Daly to carry out the works it has agreed herein to carry out.

4. Should Daly be unable to obtain the declaration of the "designated Area" and "exploration permit" mentioned in paragraph 3 hereof then this agreement and the undertakings hereunder shall be of no further force or effect.

5. Upon completion of the works to be carried out by Daly pursuant to clauses 1 and 2 hereof, Daly will report to GW Gas and will supply GW Gas with a detailed report as to the viability or otherwise of the Area for the purpose of the establishment of a reservoir for natural gas storage.

6. Should the report by Daly delivered to GW Gas pursuant to paragraph 5 hereof conclude that the Area is suitable for a gas storage reservoir for natural gas, Daly agrees and covenants to enter into an agreement with GW Gas for the use of the gas storage as may be required for the needs of GW Gas at rates to be established by the Public Utilities Board of the Province of Manitoba.

7. Should the report by Daly delivered to GW Gas pursuant to paragraph 5 hereof conclude that the Area is not suitable for the establishment of a reservoir for natural gas storage then the parties shall proceed as follows:

(i) Daly shall forthwith dispose of all its assets except as set out in clause (ii) hereof;

(ii) the report delivered by Daly to GW Gas pursuant to paragraph 5 hereof shall become the sole property of GW Gas in consideration of the net unreimbursed portions of the Capital Sum after the deduction of sale of assets in (i) above, if any;

(iii) GW Gas shall purchase Daly's exploration program in accordance with the estimated costs set out in paragraph 2 hereof and Daly covenants to provide GW Gas with all title documents, releases, etc. as GW Gas's solicitors in their sole discretion deem satisfactory;

(iv) Daly will indemnify and save harmless GW Gas from and against all losses, suits, claims, damages and expenses, arising out of, due to or by any reason or manner of action, liability, cause or thing (contingent or otherwise) GW Gas's purchase of Daly's expenditures for carrying out the exploration program as set forth in paragraph 2 hereof.

8. This agreement shall not be construed so as to constitute the parties partners, joint venturers or principal and agent.

9. Any notices or other documents required to be given under this Agreement shall be delivered by hand or mailed by registered mail to the parties at such of their respective addresses and addressed as the parties may from time to time notify each other.

10. Daly will apply for a storage permit under the Act pursuant to clause 6 if such a positive report is delivered to GW Gas.

11. Each and every term, condition and provision of this agreement is and shall be severable one from the other and in the event that any term, condition or provisions hereof is at any time declared by a Court of competent jurisdiction to be void, invalid or unenforceable, the same shall be stricken from this agreement and shall not extend to, invalidate, make void or make unenforceable any other term, condition or provision of this agreement.

12. No waiver of any provision of this agreement shall be of any force or effect whatsoever unless same is in writing signed by the party who waives and said provision and such waiver shall not be deemed to be a continuing waiver but shall extend to and include only the breach or non-observance so waived and not any other or future breach or non-observance.

13. Time shall be of the essence of this Agreement which shall be binding upon the parties hereto and upon their respective successors and assigns.

IN WITNESS WHEREOF the parties hereto have hereunto affixed their corporate seals attested by the hands of their

respective proper officers in that behalf on the day and year first above written.

G. W. G. CO.
SEAL
NO. 1266

GREATER WINNIPEG GAS COMPANY

Per: A. P. Rathke
President

Per:
Vice-President-Operations

D.G.S. LTD.
SEAL
NO. 2

DALY GAS STORAGE LTD.

Per: A. P. Rathke
Vice-President

Per: Ronald Campbell
ASST. SECRETARY

PROVINCE OF MANITOBA

Department of Mines, Natural Resources and Environment

THE OIL AND NATURAL GAS CONSERVATION BOARD
989 Century Street
Winnipeg, Manitoba
R3H OW4

THE GAS STORAGE AND ALLOCATION ACT

Renewal - Exploration Permit No. 1

This renewal of Exploration Permit No. 1 is issued to:

Daly Gas Storage Ltd.,
265 Notre Dame Avenue,
Winnipeg, Manitoba.
R3B 1N9

(hereinafter called "Daly");

in accordance with Condition No. 2 of Exploration Permit No. 1 dated the 19th day of February, 1976 issued pursuant to The Gas Storage and Allocation Act, Cap. G52 of The Continuing Consolidation of the Statutes of Manitoba subject to the same terms and conditions as those contained in Exploration Permit No. 1, including the following:

1. The term of this Renewal shall be for three years commencing February 1, 1979 and shall expire on February 1, 1982, without right of further renewal.

2. Daly commits to carry out those operations contained in its letter of December 27, 1978 and further described in the proposed work program to be submitted prior to March 1st, 1979.

3. Daly shall continue to maintain during the renewal period a cash deposit in the amount of $50,000 in favour of The Oil and Natural Gas Conservation Board subject to the provisions of Condition No. 3 of Exploration

4. Prior to th
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5

APPENDIX B

APPENDIX 'B'

NORCEN GAS STORAGE FEASIBILITY STUDY

DALY AREA - MANITOBA

GEOLOGICAL AND PETROPHYSICAL REPORT

November, 1977

(Revision)

Prepared for

NORCEN ENERGY RESOURCES LIMITED

Prepared by

INTERCOMP RESOURCE DEVELOPMENT AND ENGINEERING LTD.

Report No. CGS-19-77-483

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INTRODUCTION

In the second quarter of 1976, INTERCOMP undertook to commence studies on the proposed Norcen Gas Storage Project. The studies as per proposal were to progress in three stages:

I. Feasibility Studies

II. Development

III. Operations

This report, which represents part of Phase I, provides the results of the Petrophysical and Geological analysis based on the well control to date. Prior to the commencement of the evaluation program, the Duperow and Souris River nitrogen bearing reservoir units were considered to be prospective gas storage zones. Subsequent to the drilling of the first two evaluation wells, the Souris River Porosity zone was found to have all the favourable attributes from a gas storage standpoint within the proposed operational scheme. Additional feasibility studies on the Duperow were hence curtailed and advanced geological and petrophysical studies continued on the Souris River Porosity unit.

Although 3 to 5 delineation wells will ultimately be required to refine trap capacity estimates, data from four recently drilled delineation wells along with other offset well control has provided sufficient data to qualify the Souris

River Porosity as a potential storage horizon. Furthermore, the results of study to date indicate that further work under Phase II - Development is merited.

CONCLUSIONS

1. Caprock integrity has been confirmed at the top of the Souris River Porosity zone. Well control has indicated that anhydrites effectively seal this interval from overlying Souris River and Duperow porous developments.

2. A closure of roughly 100 feet has been proven to occur in the structure as outlined by the nitrogen gas accumulation in this reservoir unit.

3. At least two and possibly three individual separate reservoir elements are present in the Souris River Porosity unit. These reservoir units are separated by thin but laterally correlatable anhydrite beds and this separation is manifested by the presence of different nitrogen-water contacts in at least two of the three porous units.

4. Based on well control to date, the minimum trap capacity in terms of nitrogen gas is 32.4 Bcf GIP based on proven gas-down-to levels. This estimate is slightly conservative since no water level has been established in Zone 1 and defined within a 5 and 7 foot interval in Zones 2 and 3, respectively. Assuming a water-up-to level for Zones 2 and 3 and a gas-down-to for Zone 1, the trap capacity is calculated to be 34.4 Bcf.

5. Recognizing the uniformity of bedding in the Souris River Porosity unit, the proven differing water levels indicate that the nitrogen volumes contained are probably not spill-point controlled in all three zones. Hence, additional trap capacity may be available before spill would be effected through the structural saddle located at the southwest end of the Daly structure.

RECOMMENDATIONS

1. One additional well in the northeast sector of the structure would be valuable in refining structural regimen in this area.

2. Evaluation programs on any additional delineation wells need not necessarily include core. However, should core be cut, full diameter core analysis should be run. Full porosity log coverage in terms of FDC-CNL and Sonic are recommended in order to fully evaluate critical reservoir parameters throughout the Daly structure.

PETROPHYSICS

The evaluation of all special core data pertinent to the Souris River formation is now complete. Results are herein presented for the following petrophysical control parameters.

1. Porosity-Permeability
2. Formation Water Resistivity
3. Lithological-Saturation Indices

POROSITY-PERMEABILITY

Porosity

As outlined in the preliminary INTERCOMP report dated November 31, 1976 porosity control was previously derived from atmospheric core analysis data augmented where necessary by a full suite of open hole logging devices - namely the CNL-FDC and Borehole Compensated Sonic logs. The recently completed Special Core Analyses studies conducted at Shell Canada Resources Production Laboratory have confirmed an anticipated porosity reduction under simulated overburden conditions. Figure 2 illustrates the comparison of routine atmospheric to overburden measured porosities. Analysis of this plot indicates that a reduction of 1 porosity unit at 25% porosity can be expected. At lower porosities, in the order of 5-10%, the reduction is less severe, being only 0.5 porosity units. This reduction, however, is in the order of 5 percent of total pore volume at high porosities increasing to 10 percent of total pore volume at intermediate to low

porosities. Table 1 is presented to show the heterogeneity of the Souris River formation. Small plugs were cut from intervals previously analyzed by the whole core analysis method. The whole core method generally produced higher porosities but the trend was not totally consistent. Individual data points varied by as much as 6.6 percent but were generally within 1 to 2 percent of each other. Any future core analysis work in this formation should definitely be full diameter in nature.

Permeability

Differing porosity-permeability relationships are indicated for Zones 1 and 2 versus Zone 3. Figure 3 illustrates the pre-dominantly intercrystalline pore network present in Zones 1 and 2, while Zone 3 (Figure 4), which possesses significantly more secondary porosity, displays wide variations in permeability for any given porosity range. Figure 5 illustrates the effects of overburden pressure on permeability to water under overburden conditions.

The high fraction of secondary porosity present in Zone 3 has produced another predictable situation -- high gas trapping tendencies. Figure 6, presents initial-residual non wetting phase saturation relationships, clearly depicting this situation. At 80% initial gas saturation (a figure representative of average reservoir conditions) residual gas saturations are 40% for Zones 1 and 2 and 50% for Zone 3.

FORMATION WATER RESISTIVITY

Laboratory analyses of recovered waters from drillstem test #2 in Daly Gas #1 indicate a saturated salt water condition is present in the aquifer. Total solids were measured as high as 280,170 mg/litre. This is equivalent to a water resistivity at reservoir temperature of 0.033 ohm-meters. This value was used in all calculations of water saturation in Daly Gas #1 and 2.

LITHOLOGICAL-SATURATION INDICES

The formation resistivity factor (FRF) is a measurement of the ratio of the electrical resistivity, Ro, of a porous medium completely saturated with brine to the resistivity, RW, of the water in the pores. Figure 7 illustrates the relative insensitivity of this factor to overburden conditions. A simulated reservoir condition of 2500 psi net of external less internal pressure was used. The brine used was a synthetic brine containing:

102,000 ppm Sodium
168,000 ppm Chloride
5,100 ppm Calcium
800 ppm Magnesium
1,100 ppm Sulphate

The effect in this case was a negligible increase in FRF under overburden conditions. This is due in part to the extremely high conductivity of the saturating brine and possibly to some extent to the modest reduction in total porosity effected by the application of overburden pressure. Several low porosity points are anomalously off-trend. The cause of these spuriously low FRF values in the low porosity samples is not known. It is possibly related to microfracturing resulting in a short-circuiting of the normal electrical path thus producing anomalously low FRF values. It might also result from improper sample preparation permitting a brine film to act as a parallel conductance path along the outside of the plug. Normally, the application of reservoir pressure to these jacketed samples eliminates both the microfracturing and brine film problems. For purposes of this study the majority of the reservoir lies above 10% porosity and, as such, a lithological exponent m (the slope of the relationship of FRF and ϕ) of 1.71 was selected as representative of reservoir conditions. This value too is anomalously low; normal FRF relationships for dolomites range between an m of 2.0 and 2.4.

With the anticipated highly water wet nature of the Souris River Porosity reservoir a saturation index, n, of 2.0 was selected. The above mentioned variables were combined for solution of the standard Archie relationship for water saturation:

$$Sw^{-n} = Rt/Ro$$

where: Rt = True resistivity

Ro = FRF * Rw and,

$FRF = 1/\phi^{m}$

Thus:

$$Sw^{-2.0} = \frac{Rt}{0.033\ \phi^{-1.71}}$$

Results of the petrophysical evaluations of each well on the Daly Structure are contained in Appendix D herein.

GEOLOGY

GENERAL GEOLOGY

Based on well data arising out of the drilling of 7-18, 10-7, 11-19-10-27 W1M and 10A-12-10-28 W1M, a fairly definitive geologic/reservoir model has been established. Cross section (Figure 8) and structural contour map (Figure 9) illustrate the structural interpretation on top of the Souris River porosity. As was originally indicated by seismic, a structural high trending northeast-southwest exhibits some 100 to 125 feet of structural closure; this structure is the probable result of salt solution effects and consequent draping.

CAPROCK INTEGRITY

Drilling has confirmed the existence and integrity of a Souris River porosity seal in the Daly structure. Proof of caprock sealing quality is substantiated by three observations:

1) Core examinations have confirmed the presence of massive anhydrite beds immediately above the Souris River Porosity Zone; these anhydrites are correlatable both north-south as well as east-west across the field.

2) Based on log evaluations, some porous stringers above the sealing anhydrites and within the Souris River interval are water bearing above the gas intervals within the Souris River Porosity Zone. Such a situation

could not exist if vertical communicability were present.

3) Based on tests and log evaluation, separate water levels have been proven to occur in Zones 1 and 3. Zone 1 is gas bearing a minimum of 42 feet lower than proven water-up-to in Zone 3 (refer to the cross section Figure 8). Since a gas-down-to of 1947 feet subsea has been defined in Zone 1, and Zone 2 indicates a water level to occur in the interval 1949 to 1954 feet subsea, it is uncertain, based on present data, whether Zones 1 and 2 are separate or common reservoirs.

STRUCTURAL MAPPING

Since a number of wells drilled in the subject area do not penetrate the Souris River section, the seismically derived Bakken structure was assumed as a "base" structural horizon. Isopachs of the interval Bakken to top Souris River porosity were established for non-penetrating wells by correlation to nearest control and projection to Souris River level. An isopach interpretation was thus prepared, which, when added to the Bakken structure, resulted in the derivation of a structural contour map on top of the Souris River Porosity (Figure 9). Recognizing individual zone reservoirs, as per the foregoing discussion, a series of structural contour maps on top of Zones 2 and 3 (Figures 10 and 11) and base Zone 3 (Figure 12) were derived by isopach addition to the structure map on top of Zone 1 (Figure 9). Table 3 presents the tops summary utilized in this mapping phase.

VOLUMETRICS

On the basis of the petrophysical evaluation data shown on Table 2, the structural interpretations and the fluid level data derived from existing and recent drilling, a series of capacity maps were constructed. Figures 12, 14 and 15 incorporate the gas-down-to and water-up-to information in conjunction with structure to define the areal limits of nitrogen gas on a per zone basis. These porosity foot maps were planimetered to establish total pore volume per zone on a gas-down-to basis for all Zones; in Zones 2 and 3 a water-up-to capacity was established for comparison purposes. Since a finite water level has not been established for Zone 1, the gas pore volume shown for this zone is a minimum value.

Applying weighted average water saturation data on a per zone basis and a computed gas expansion factor, a proven gas-in-place was calculated and tabulated per zone. Table 4 provides the summary of gas-in-place per Souris River Porosity Zone. The critical reservoir parameters utilized were:

Pressure	1531 @ 1910 feet subsea
BHT	92^{o} F
Pc	492.8
Tc	227.3
Zi	0.98
Ei	99.9

BASIC DATA

All the basic data, both geological and petrophysical, were forwarded to Norcen on a continuous basis during the evaluation work of Phase I. In order to provide a complete dossier, a number of prepared data items previously provided have been assimilated and included in the Appendix herein.

REPORT PREPARATION

Intercomp Resource Development and Engineering Ltd.

Responsible Professional Engineers:

C. B. Austin, P. Eng.

C. B. Austin for:
N. M. Thachuk, P. Eng.

THE ASSOCIATION OF PROFESSIONAL ENGINEERS OF ALBERTA
PERMIT NUMBER P 5 1 0
Intercomp Resource Development & Engineering Ltd.

T A B L E S

TABLE 1

FULL DIAMETER vs SMALL PLUG ANALYSES

SOURIS RIVER FORMATION

DALY GAS #1 7-18-10-27-W1

Zone	Interval Represented	Drilled From Whole Core No.	SMALL PLUG ANALYSIS Porosity %	Permeability md	Grain Density	WHOLE CORE ANALYSIS Porosity %	Permeability md	Grain Density
1	3525.4 - 3526.2	63	24.3	379	2.807	25.9	430.00	2.82
	3526.2 - 3527.7	64	28.8	-	2.798	26.5	676.00	2.82
	3527.7 - 3529.5	65	26.4	-	2.822	19.8	33.55	2.81
2	3536.1 - 3536.9	66	16.0	27.8	2.819	17.2	27.70	2.85
	3538.3 - 3539.1	68	12.1	-	2.831	22.9	21.80	2.83
	3539.1 - 3539.9	69	21.5	43.5	2.819	23.4	46.50	2.84
	3539.9 - 3540.6	70	27.0	141	2.806	29.4	131.00	2.83
3	3544.2 - 3545.6	72	5.3	-	2.840	9.2	1.43	2.80
	3546.7 - 3547.4	74	5.6	2.03	2.828	5.6	4.70	2.86
	3549.8 - 3550.8	78	14.0	-	2.829	12.2	29.40	2.81
	3551.7 - 3552.3	80	22.3	-	2.821	18.8	73.30	2.83
	3556.2 - 3557.1	85	15.4	405	2.838	14.8	68.30	2.83
	3558.7 - 3559.5	88	5.4	1.11	2.838	8.5	53.50	2.83
	3561.1 - 3562.0	91	5.1	0.01(1)	2.834	6.1	18.10	2.84
	3563.0 - 3564.0	93	20.4	322	2.833	20.3	184.00	2.81
	3566.4 - 3567.4	96	8.8	4.13	2.833	11.2	17.10	2.83
	3567.4 - 3568.4	97	13.5	56.9	2.847	17.2	134.00	2.83
	3569.4 - 3570.3	99	13.5	-	2.848	14.3	23.50	2.85
	3571.0 - 3571.9	101	23.4	-	2.846	26.6	120.00	2.82
	3573.2 - 3573.8	103	15.9	-	2.841	17.1	20.60	2.84
	3574.7 - 3575.6	105	16.0	-	2.834	15.5	18.70	2.83
	3575.6 - 3576.4	106	19.1	25.6(1)	2.828	14.5	15.50	2.85
	3576.4 - 3577.2	107	11.6	-	2.851	21.4	34.40	2.82
	3578.2 - 3579.1	109	9.5	0.820	2.840	11.8	4.60	2.83
	3581.0 - 3582.2	112	12.4	-	2.831	12.6	3.70	2.82

TABLE 2

PETROPHYSICAL SUMMARY SHEET

DALY AREA

SOURIS RIVER POROSITY

WELL	ZONE 1				ZONE 2				ZONE 3			
	Reservoir Development Ft.	Net Pay Ft.	Average Porosity %	Avg. Water Saturation %	Reservoir Development Ft.	Net Pay Ft.	Average Porosity %	Avg. Water Saturation %	Reservoir Development Ft.	Net Pay Ft.	Average Porosity %	Avg. Water Saturation %
10-7-10-27W1M	8.0	8.0	16.5	39	5.0	0.0	20.5	100	35.0	0	9.4	100
7-18-10-27W1M	9.5	9.5	19.2	12	4.5	4.5	21.7	16	38.9	0	13.0	100
15A-18-10-27W1M	8.0	8.0	18.9	*	4.0	4.0	19.5	*	34.0	34.0	17.7	19*
11-19-10-27W1M	9.4	9.4	17.2	19	3.8	3.8	25.9	32	35.3	0	16.6	100
10A-12-10-28W1M	9.0	9.0	15.8	17	5.0	5.0	20.0	17	32.0	0	17.9	100
8-14-10-28W1M	7.0	*	18.5	*	5.0	*	19.0	*	30.0	0	14.1	100

* Log type and resolution does not permit valid saturation calculations.

TABLE 3

DALY AREA

Souris River Porosity

Formation Tops Summary

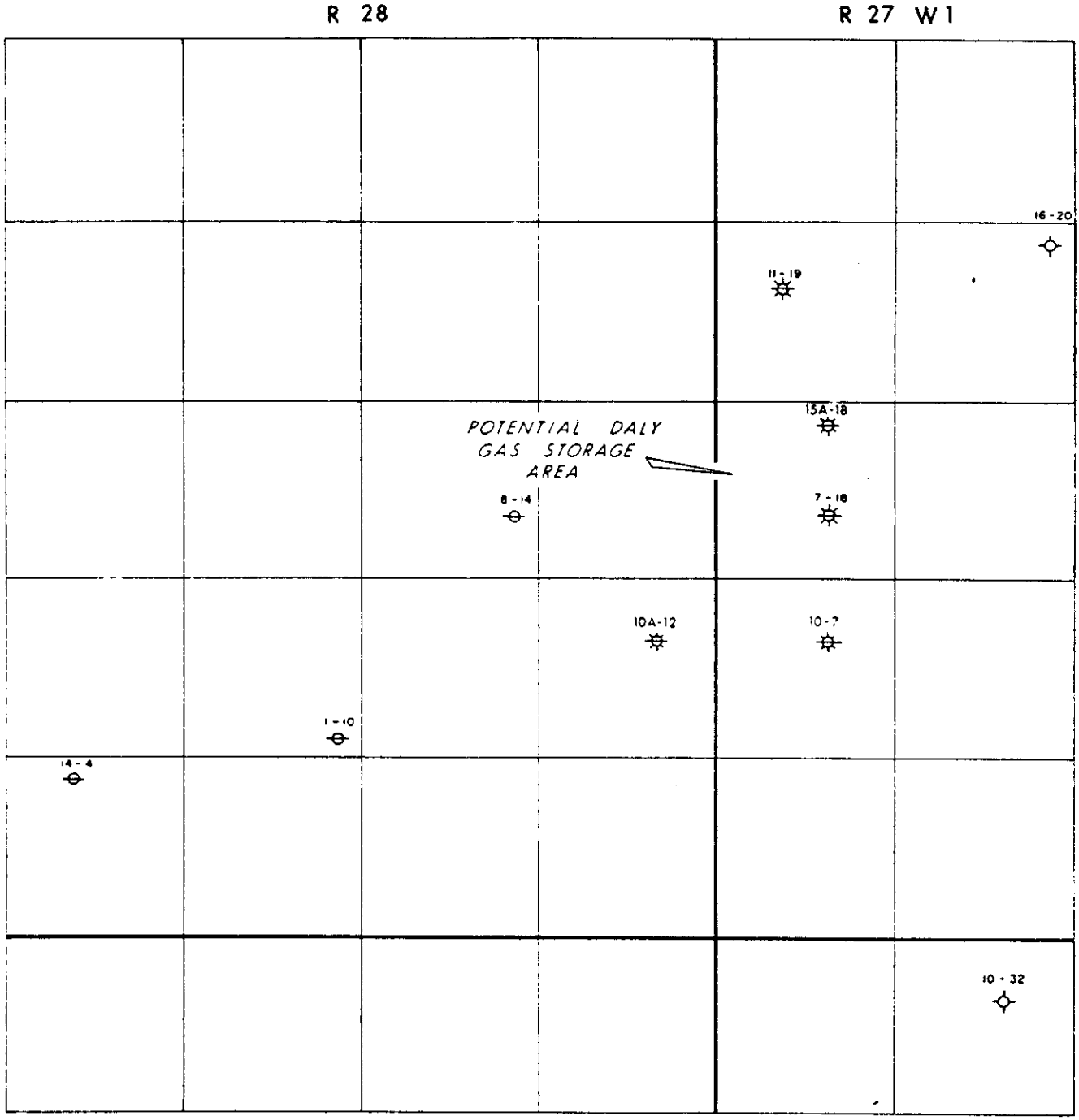
WELL	KB	SOURIS RIVER POROSITY												TD	
		Zone 1				Zone 2				Zone 3					
		Top		Base		Top		Base		Top		Base			
		KB	SS	KB	SS	KB	SS	KB	SS	KB	SS	KB	SS	KB	SS
10-32-9-27W1	1625	3758E	2133E												
10-7-10-27W1	1605	3540	1935	3552	1947	3559	1954	3565	1960	3568	1963	3605	2000	3660	2055
07-18-10-27W1	1629	3516	1887	3528	1899	3536	1907	3540	1911	3543	1914	3581	1952	3624	1995
15-18-10-27W1	1620	3460	1840	3472	1852	3480	1860	3484	1864	3488	1868	3518	1898	5370	3750
11-19-10-27W1	1613	3537	1924	3550	1937	3558	1945	3562	1949	3566	1953	3601	1988	4093	2480
16-20-10-27W1	1601	3616E	2015E												
1-10-10-28W1	1653	3638E	1985E												
10-12-10-28W1	1629	3513E	1884E												
10A-12-10-28W1	1628	3504	1876	3518	1890	3524	1896	3530	1902	3533	1905	3568	1940	3640	2012
8-14-10-28W1	1636	3562	1926	3577	1941	3581	1945	3587	1951	3589	1953	3623	1987	3649	2013

TABLE 4

PER ZONE SUMMARY OF NITROGEN RESERVES
DALY AREA - SOURIS RIVER RESERVOIR

Zone	Gas Areal Extent Acres	Gas Area Reservoir Pore Volume Acre-Ft.	Weighted Zone Water Saturation %	Gas Pore Volume Acre Ft.	Gas Volume Factor	Nitrogen In-Place Bcf
			BASED ON GAS-DOWN-TO			
1	3996	4994	21	3906	100	17.0
2	3044	2545	22	1985	100	8.6
3	789	1935	19	1567	100	6.8
					TOTAL	32.4
			BASED ON WATER-UP-TO			
1	-	-	-	-	-	-
2	3423	2947	22	2299	100	10.0
3	967	2099	19	1700	100	7.4

F I G U R E S



— INTERCOMP —

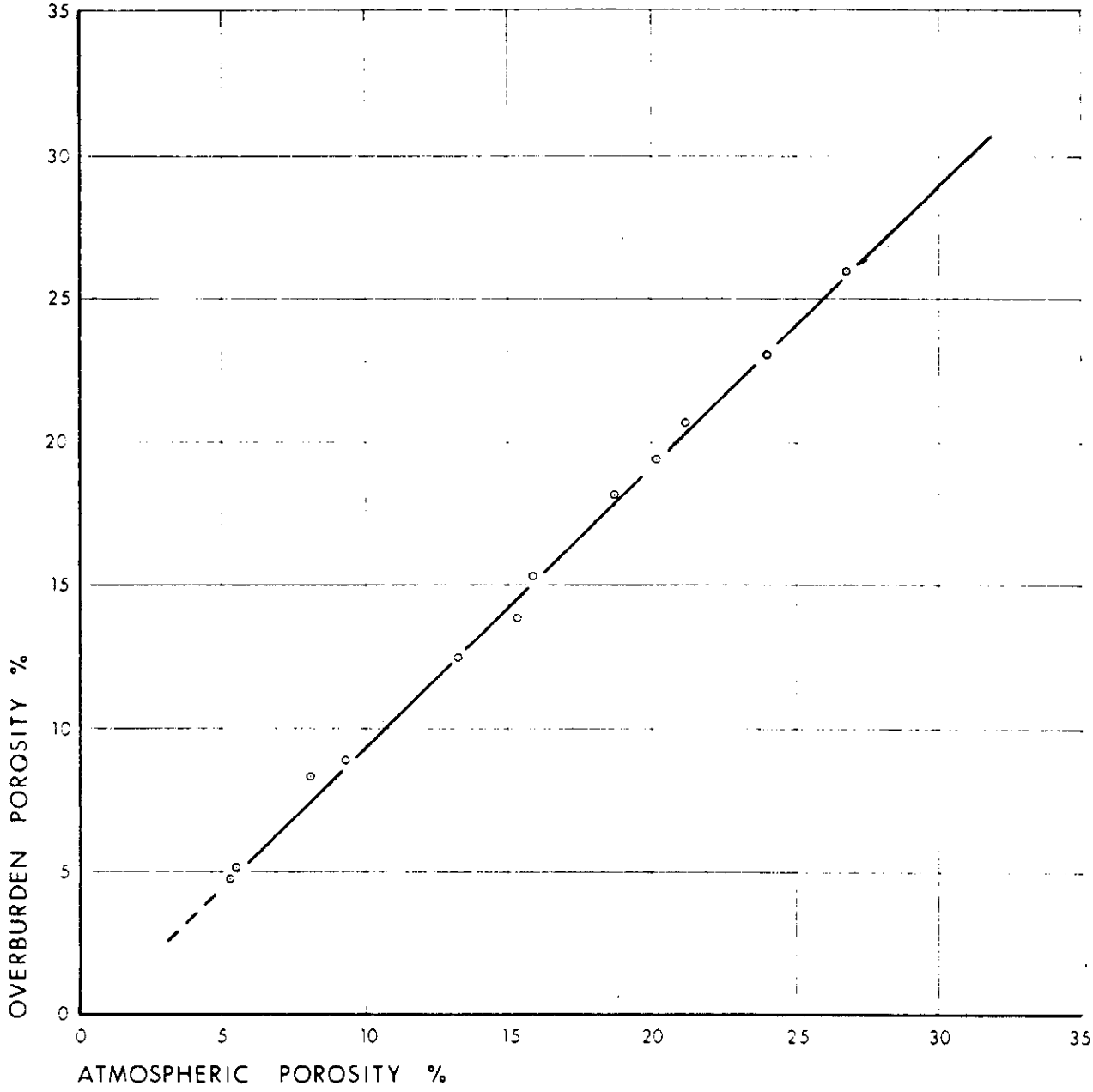
DALY AREA

LOCATION

&

WELLSPOT BASE

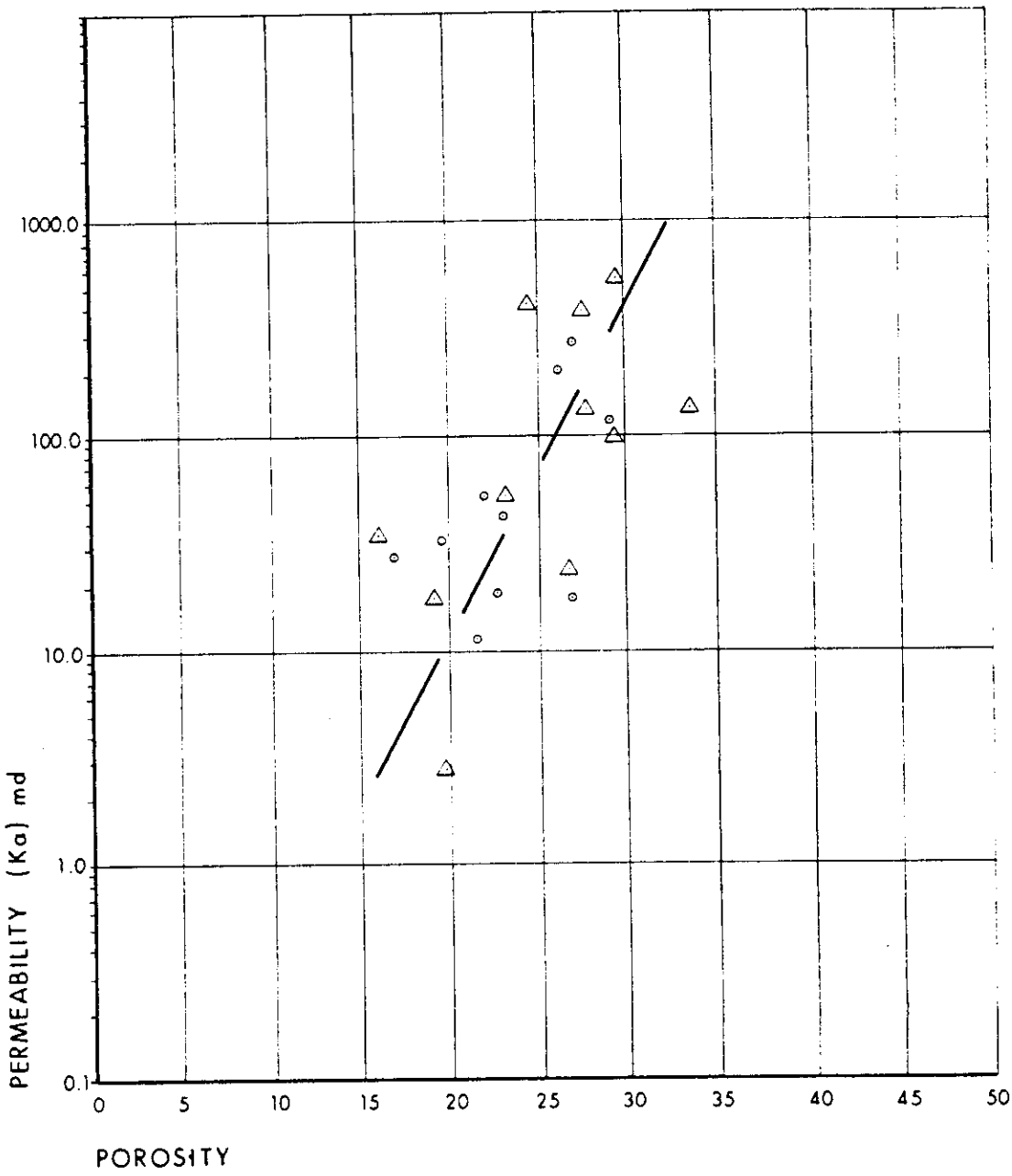
DR. BY: N. THACHUK	DATE: DEC. 1976
REV. DATE: NOV. 1977	FIGURE NO. 1



- INTERCOMP -

DALY GAS No. 1
(7-18-10-27 W1)
OVERBURDEN vs ATMOSPHERIC
CORE POROSITY

DR BY	DATE MARCH, 1977
	FIGURE No. 2



△ DALY GAS No 1

o DALY GAS No 2

- INTERCOMP -

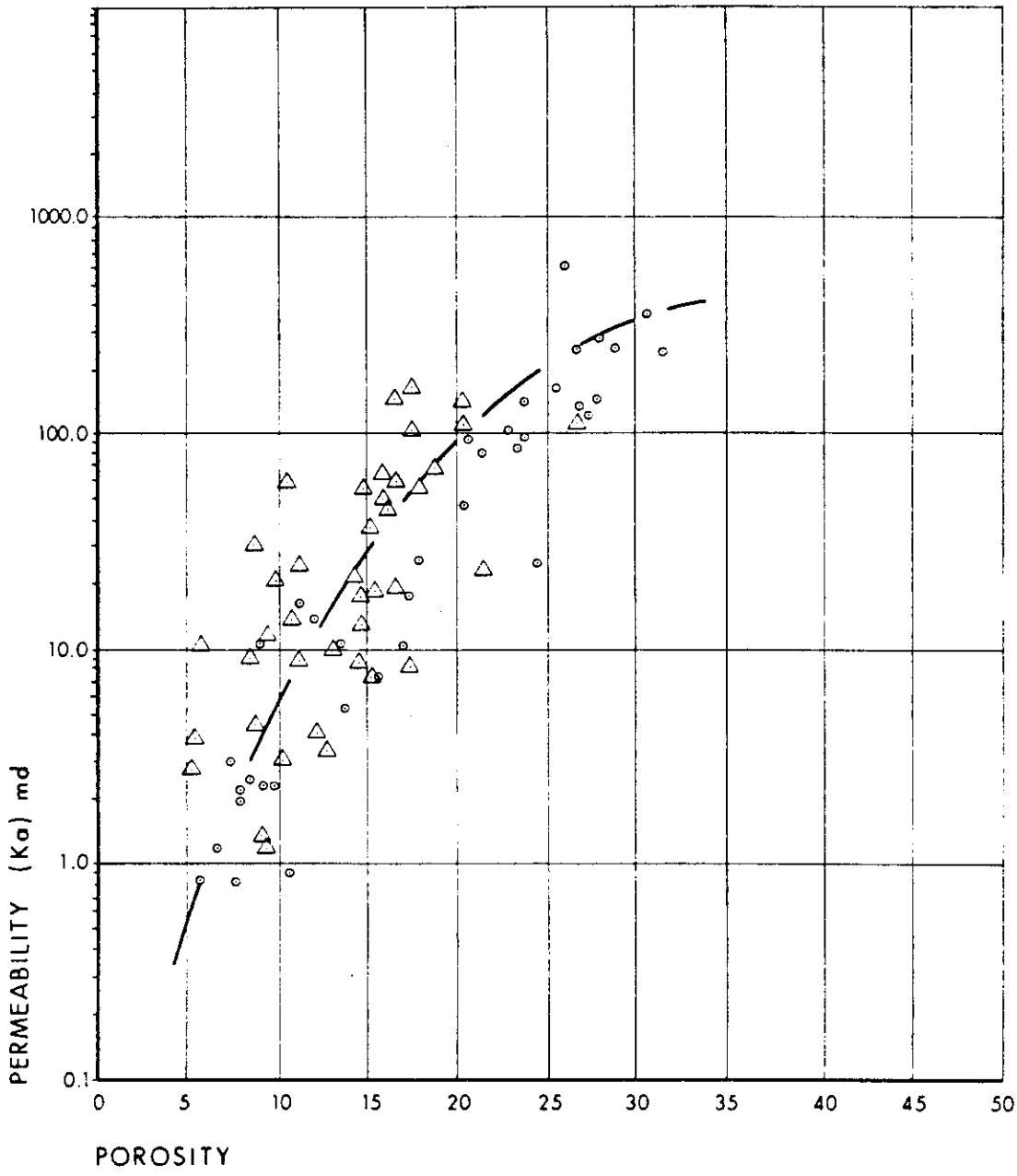
DALY GAS STORAGE LTD.

SOURIS RIVER FORMATION

Ka vs Ø ATMOS.

ZONES 1 & 2

DRAWN BY: CBA	DATE: MARCH 1977
	FIGURE No: 3



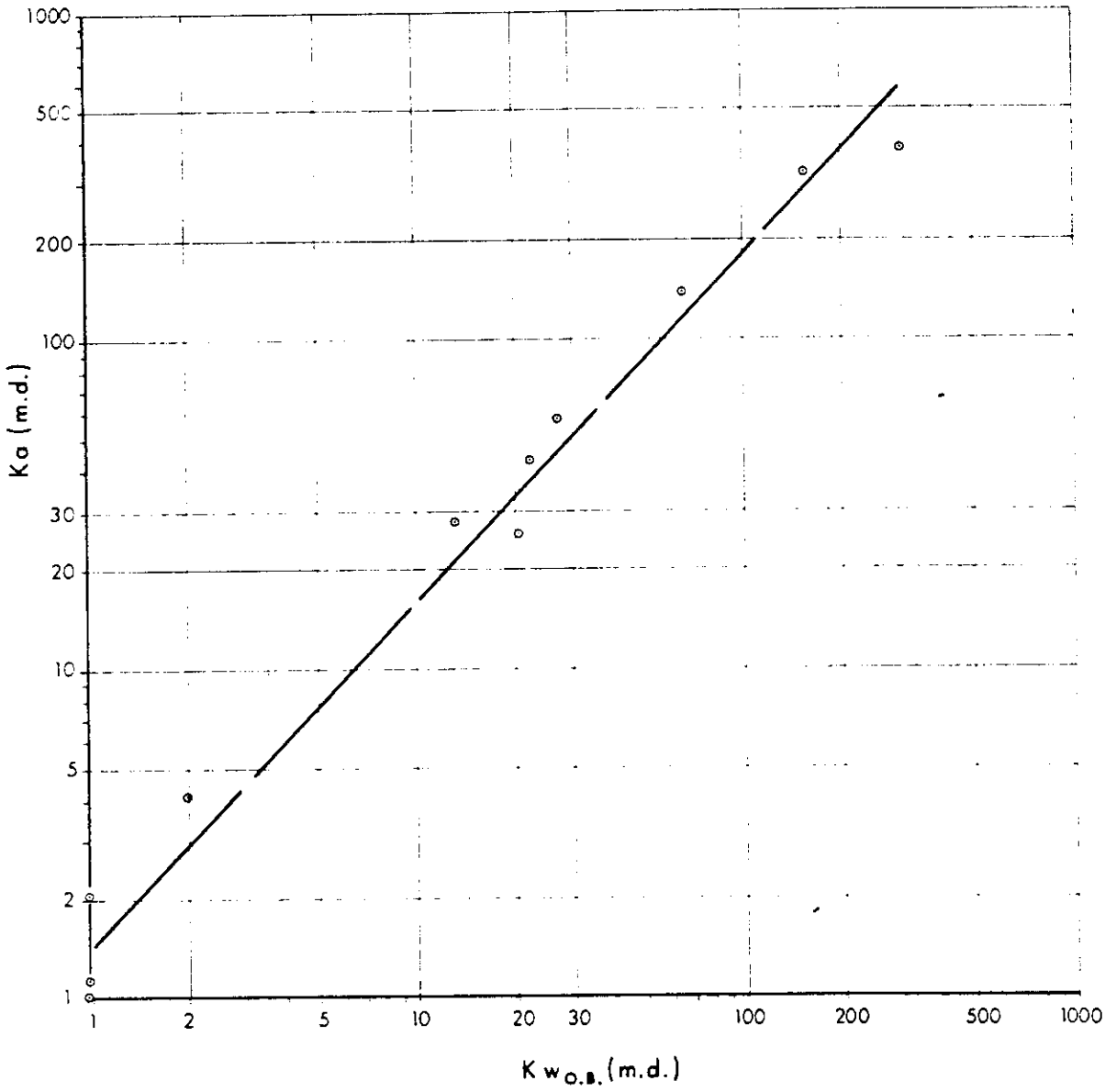
△ DALY GAS No. 1

○ DALY GAS No 2

- INTERCOMP -

DALY GAS STORAGE LTD.
SOURIS RIVER FORMATION
Ka vs Ø ATMOS.
ZONE 3

DRAWN BY: CBA	DATE: MARCH, 1977
	FIGURE No.: 4

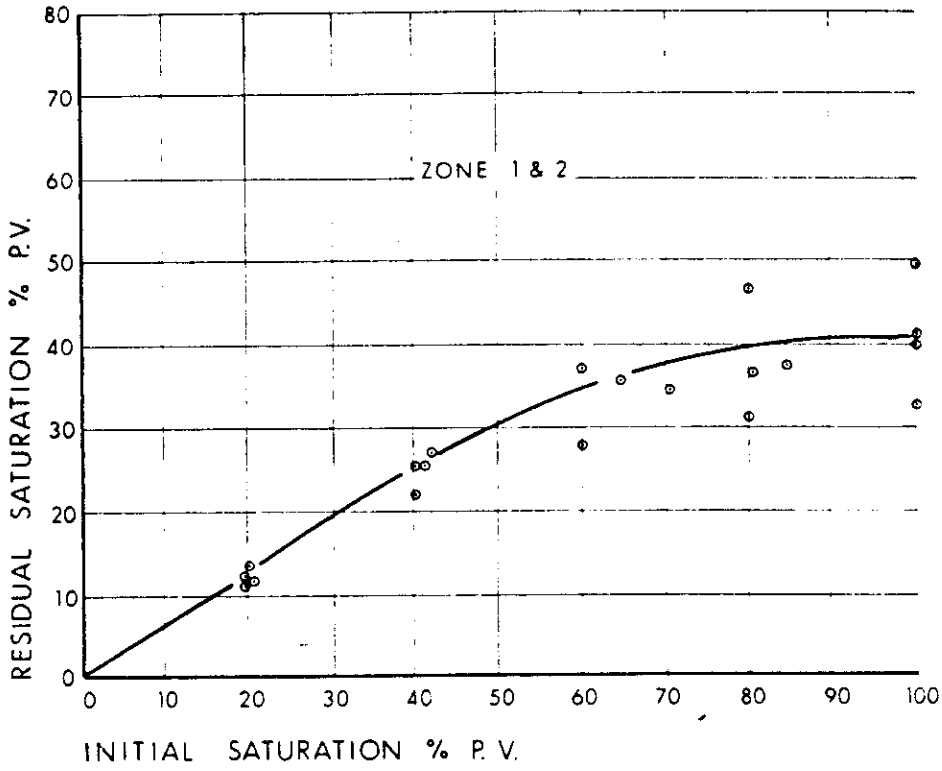


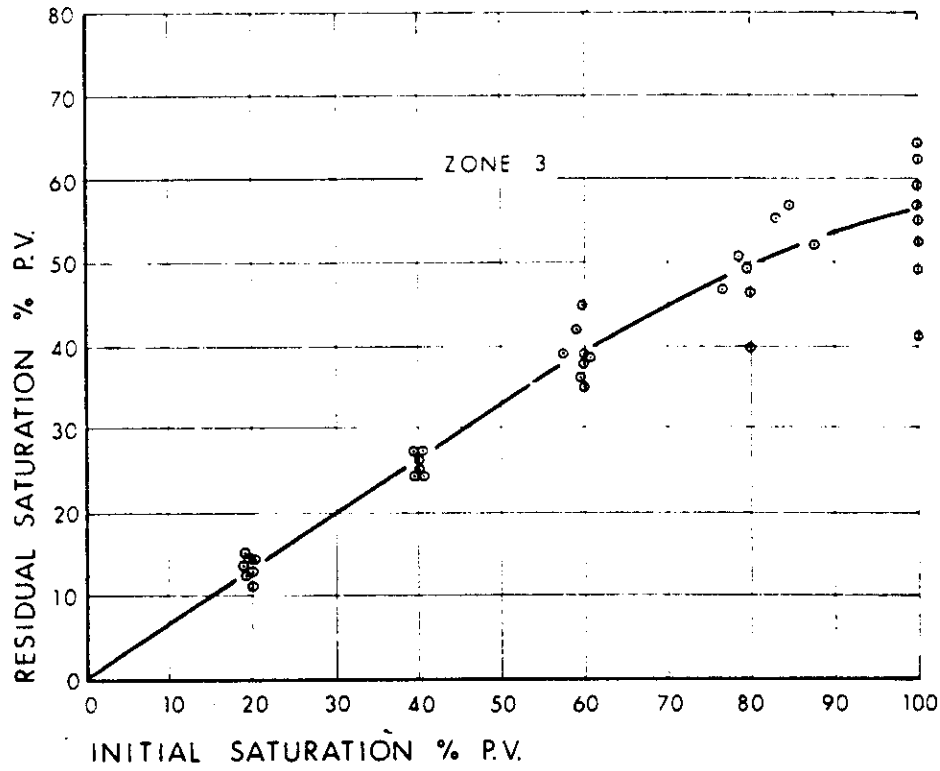
- INTERCOMP -

DALY GAS No. 1
(7-18-10-27 W1)

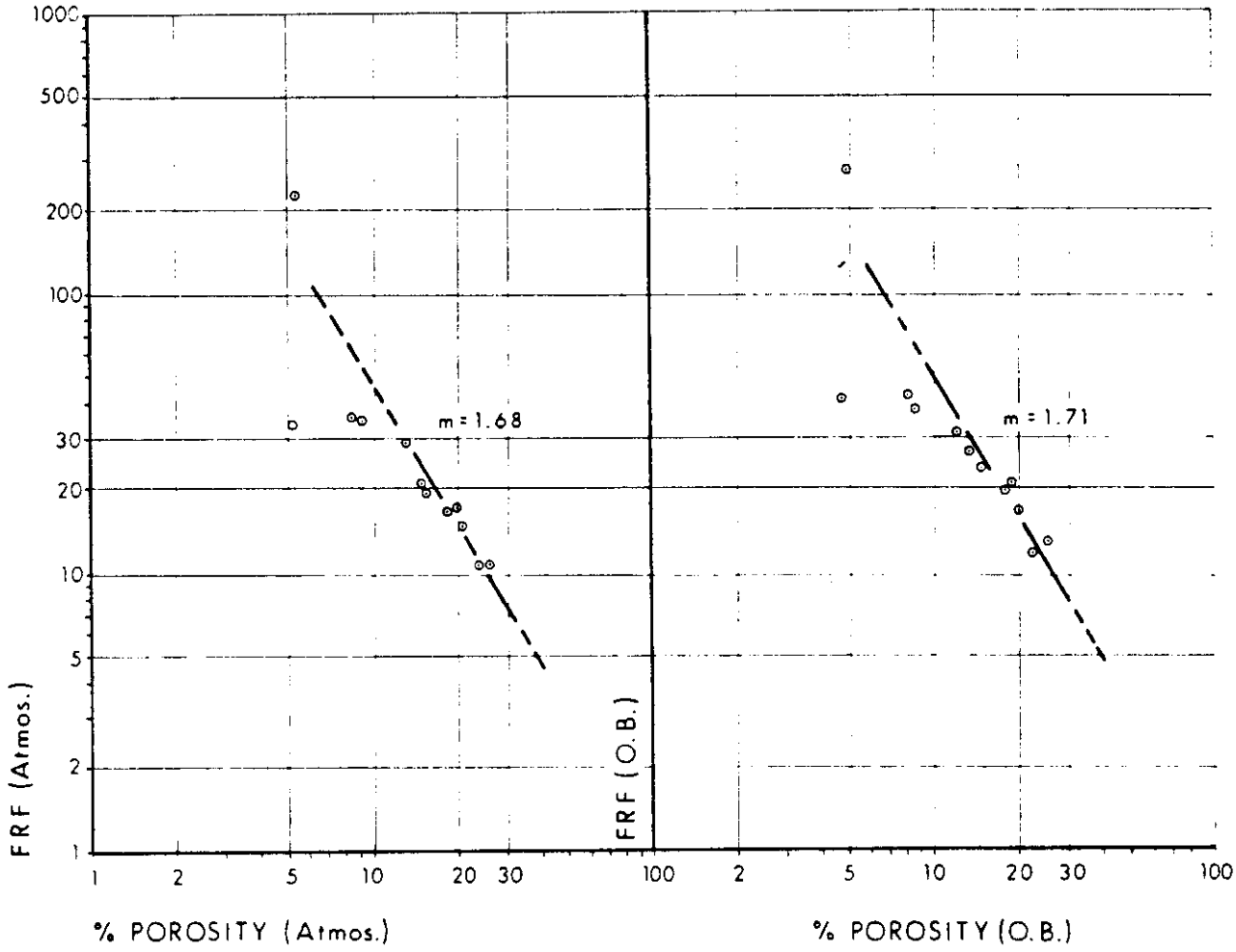
$K_{air_{atmos}}$ vs $K_{water_{O.B.}}$

DR BY	DATE MARCH, 1977
	FIGURE No 5

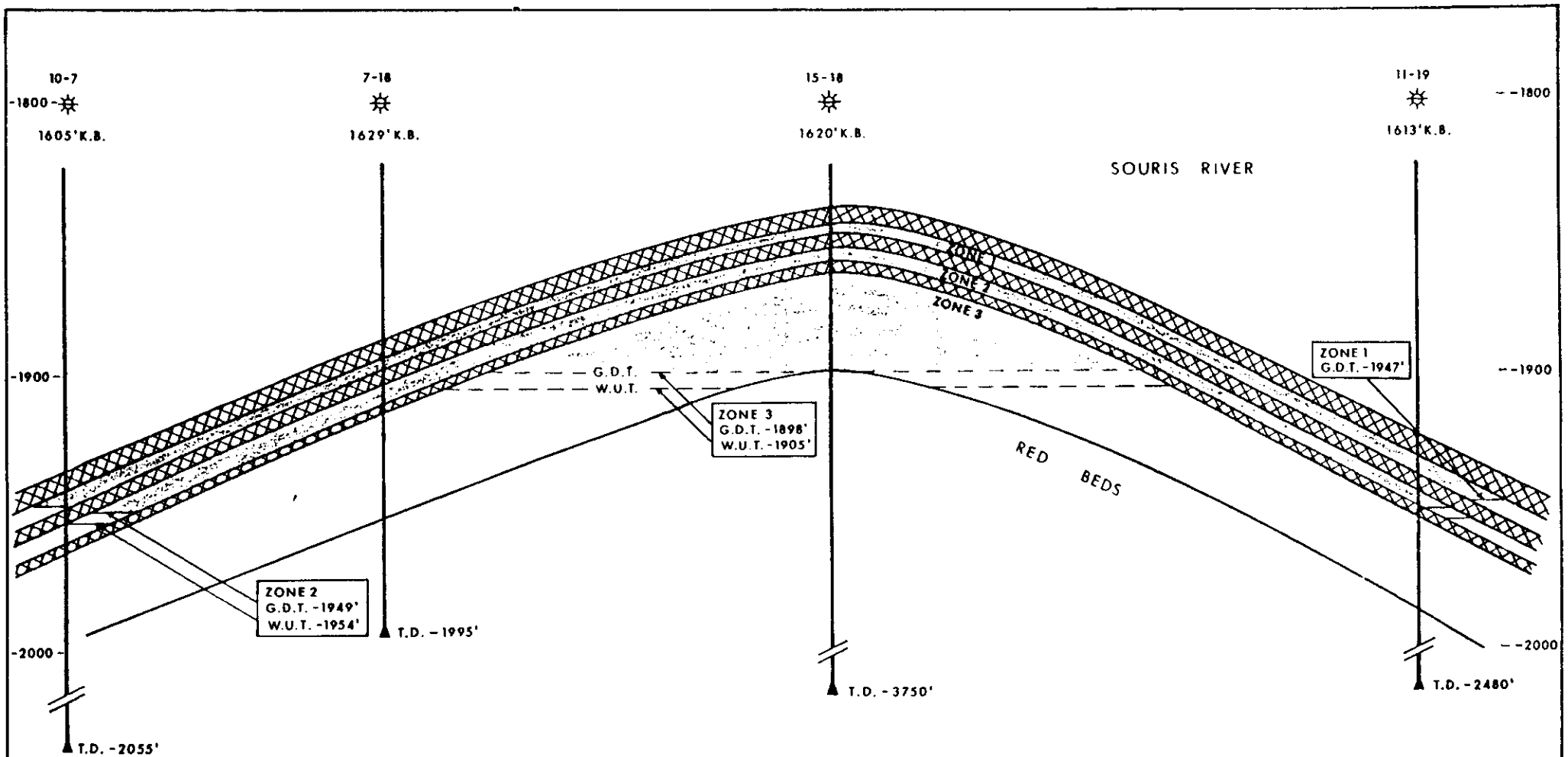




-INTERCOMP-	
DALY GAS No. 1 AIR-LIQUID IMBIBITION INITIAL / RESIDUAL SATURATION	
DR. BY	DATE MARCH 1977
	FIGURE No. 6



- INTERCOMP -	
DALY GAS No. 1 (7-18-10-27 W1) ATMOSPHERIC - OVERBURDEN FRF vs POROSITY	
DR BY:	DATE MAR 1977
	FIGURE No. 7



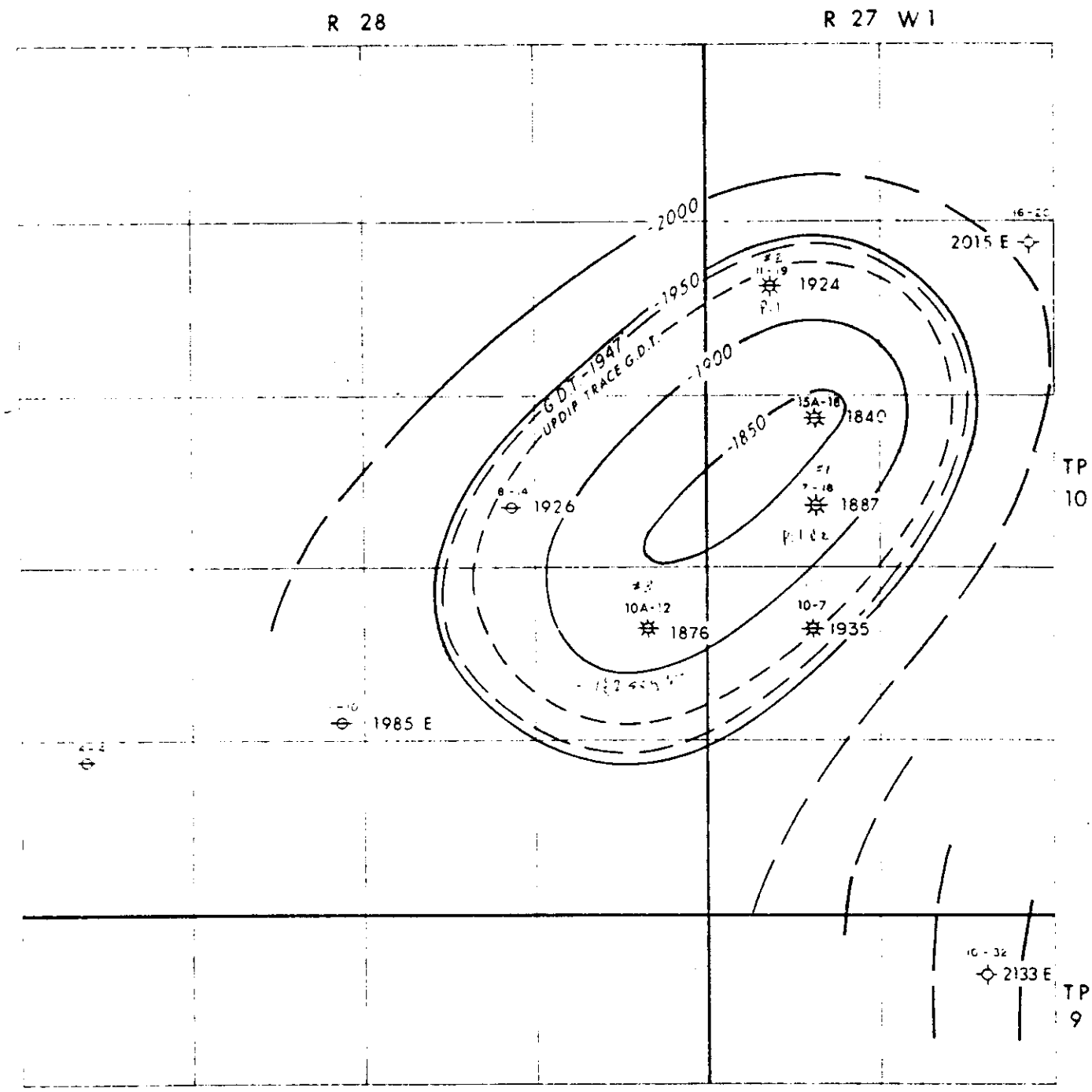
LEGEND

- GAS
- WATER
- ANHYDRITE

DALY AREA
TWP 10 R 27 W 1
STRUCTURAL X-SECTION
SOURIS RIVER POROSITY

DR BY: N. THACHUK
DATE: DEC 1976
REV. DATE: NOV. 1977
FIGURE NO. 8

– INTERCOMP –



LEGEND

⊖ 1925 DEPTH SUBSEA TOP SOURIS RIVER POROSITY

NP NOT PENETRATED

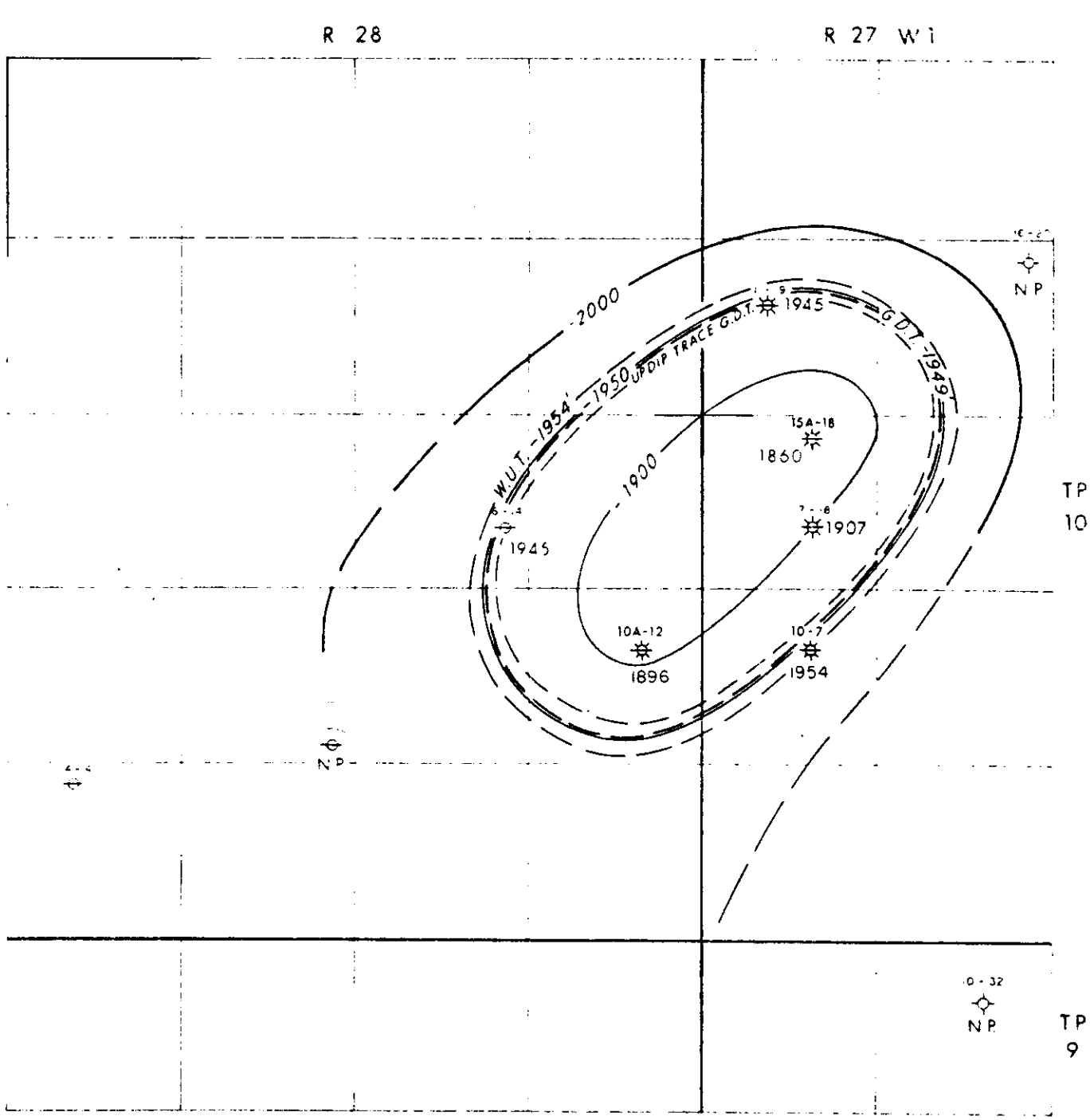
E ESTIMATED VALUE

— INTERCOMP —

DALY AREA

STRUCTURAL CONTOUR MAP
TOP ZONE 1
SOURIS RIVER POROSITY

DR BY N THACHUK	DATE DEC 1976
REV. DATE: NOV. 1977	FIGURE NO. 9



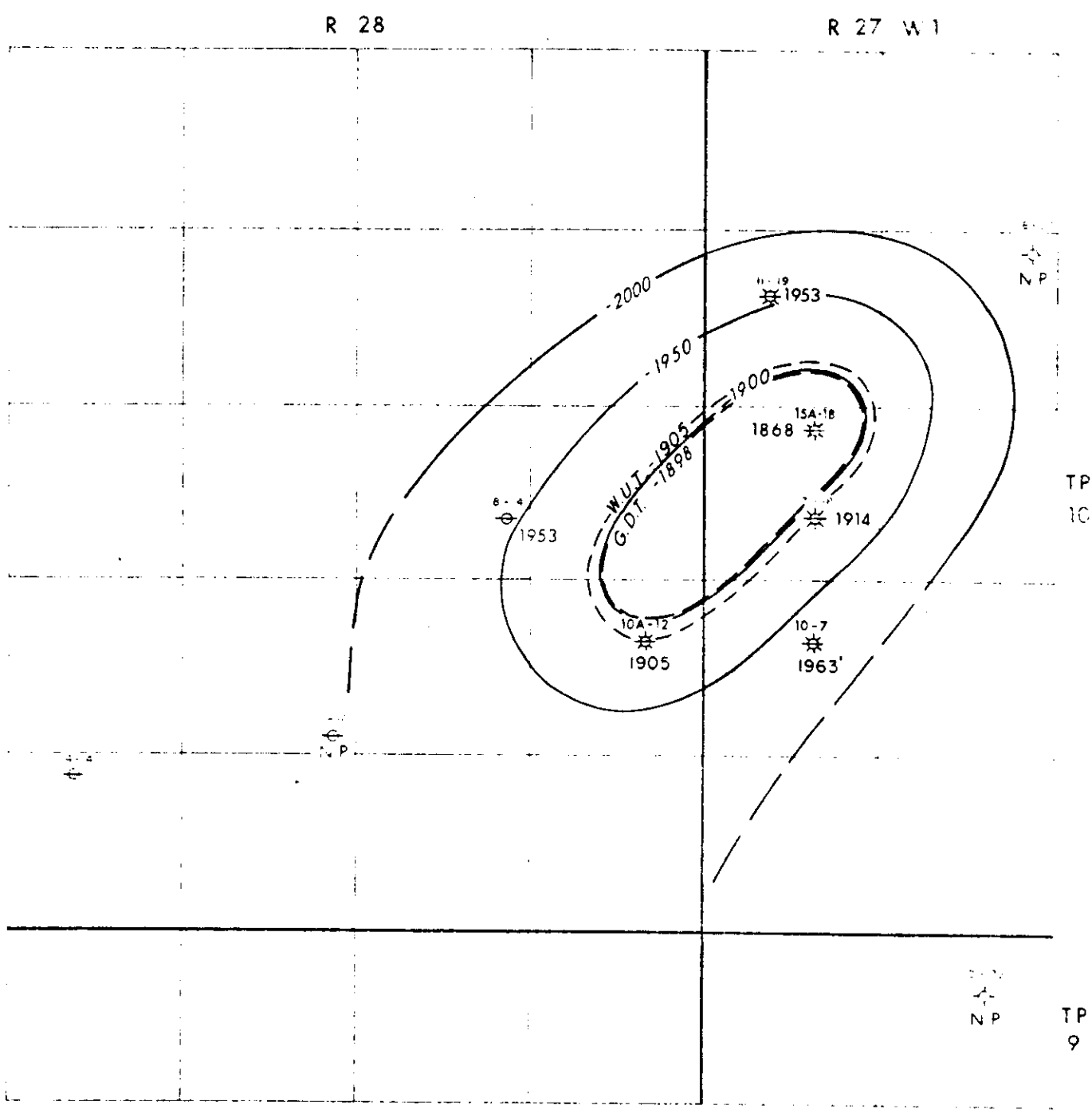
LEGEND

⊖ 1925 DEPTH SUBSEA SOURIS RIVER – ZONE 2 POROSITY

N P NOT PENETRATED

E ESTIMATED VALUE

	INTERCONP...
DALY AREA STRUCTURAL CONTOUR MAP TOP ZONE 2 SOURIS RIVER POROSITY	
DR BY N. THACHUK	DATE DEC 1976
REV. DATE: NOV. 1977	FIGURE NO 10



LEGEND

⊖ 1925 DEPTH SUBSEA SOURIS RIVER – ZONE 3 POROSITY

N P NOT PENETRATED

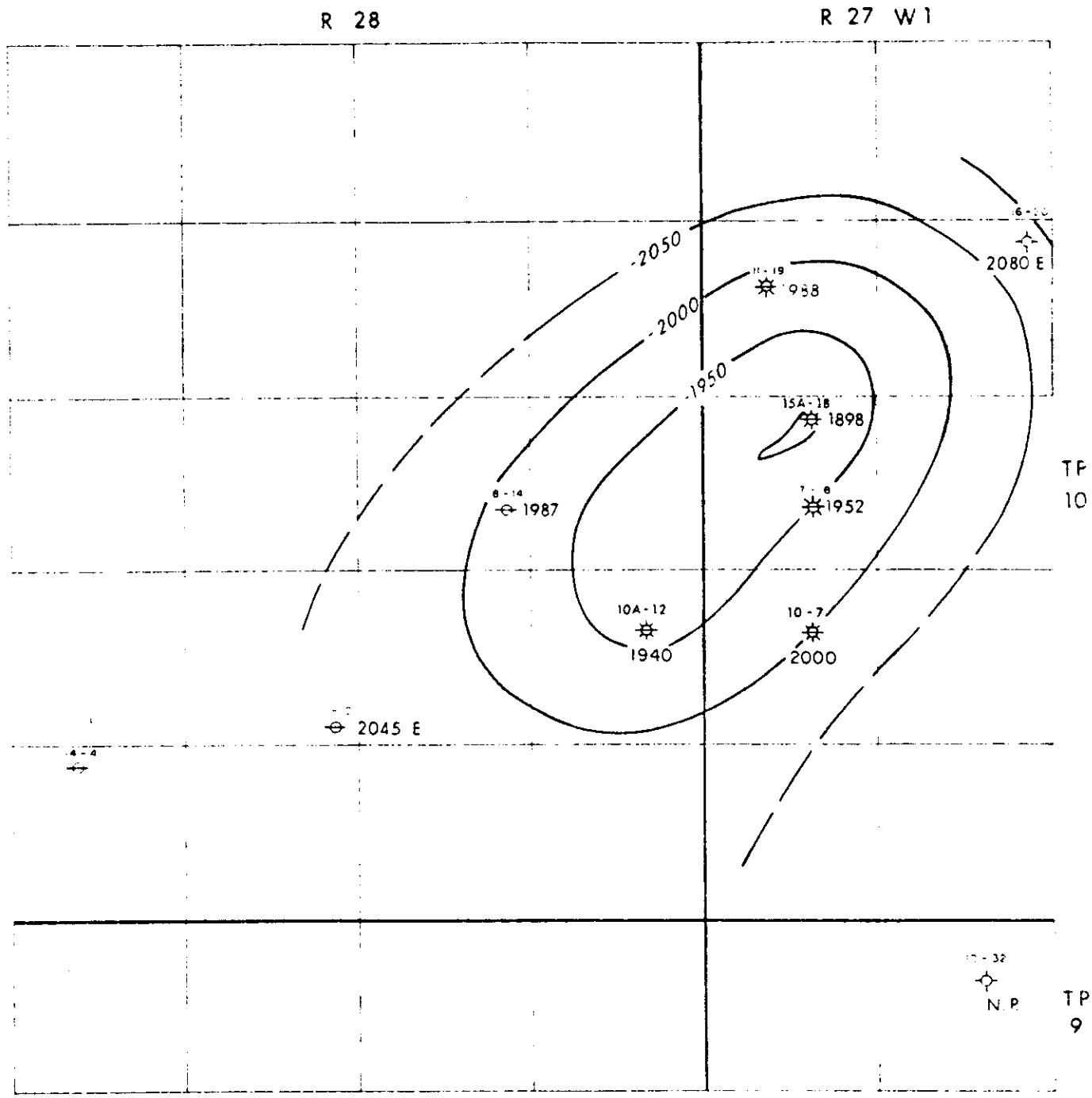
E ESTIMATED VALUE

INTERLAKE

DALY AREA

STRUCTURAL CONTOUR MAP
TOP ZONE 3
SOURIS RIVER POROSITY

DR BY [illegible]	DATE [illegible] 976
REV. DATE: NOV. 1977	FIGURE NO. 11



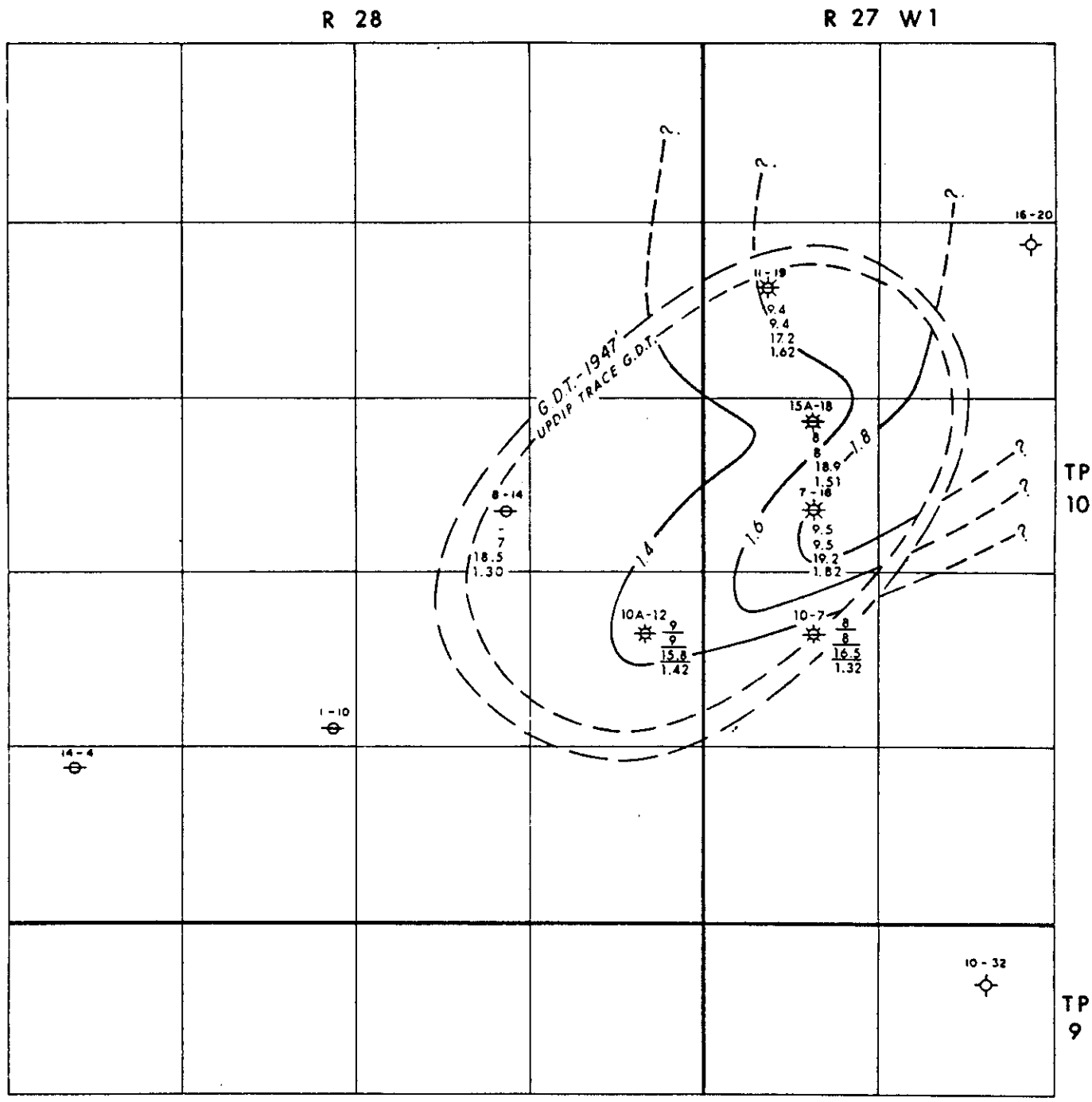
LEGEND

⊖ 1925 DEPTH SUBSEA BASE SOURIS RIVER POROSITY
N.P. NOT PENETRATED
E ESTIMATED VALUE

INTERNATIONAL

DALY AREA
STRUCTURAL CONTOUR MAP
BASE SOURIS RIVER POROSITY

DR BY N. THACHUK	DATE DEC 976
REV. DATE NOV 1977	FIGURE NO 12



LEGEND

9.5	NET PAY (FT.)
9.5	TOTAL RESERVOIR DEVELOPMENT (FT.)
19.2	AVERAGE POROSITY (%)
1.82	POROSITY (FRACTIONAL) × FT. RESERVOIR DEVELOPMENT

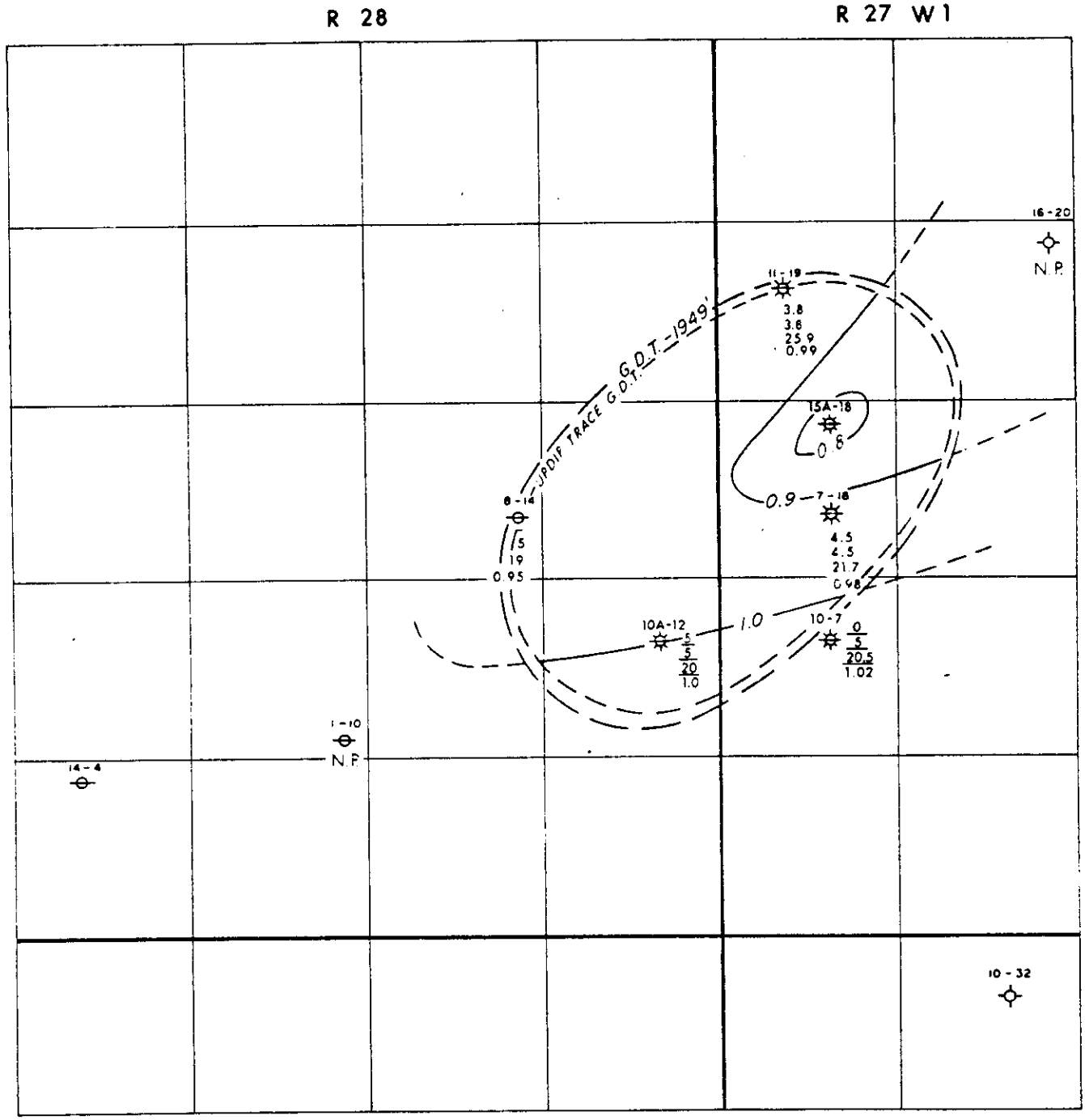
——— NET PAY × POROSITY (FRACTIONAL)

– – – – POROSITY × FEET OF TOTAL RESERVOIR DEVELOPMENT BELOW GAS-DOWN-TO-LEVEL

— INTERCOMP —

DALY AREA
POROSITY FOOT MAP
ZONE 1
SOURIS RIVER POROSITY

DR. BY: N. THACHUK	DATE: DEC. 1976
REV. DATE: NOV. 1977	FIGURE NO. 13



LEGEND

4.5	NET PAY (FT.)
4.5	TOTAL RESERVOIR DEVELOPMENT (FT.)
21.7	AVERAGE POROSITY (%)
0.98	POROSITY (FRACTIONAL) × FT. RESERVOIR DEVELOPMENT

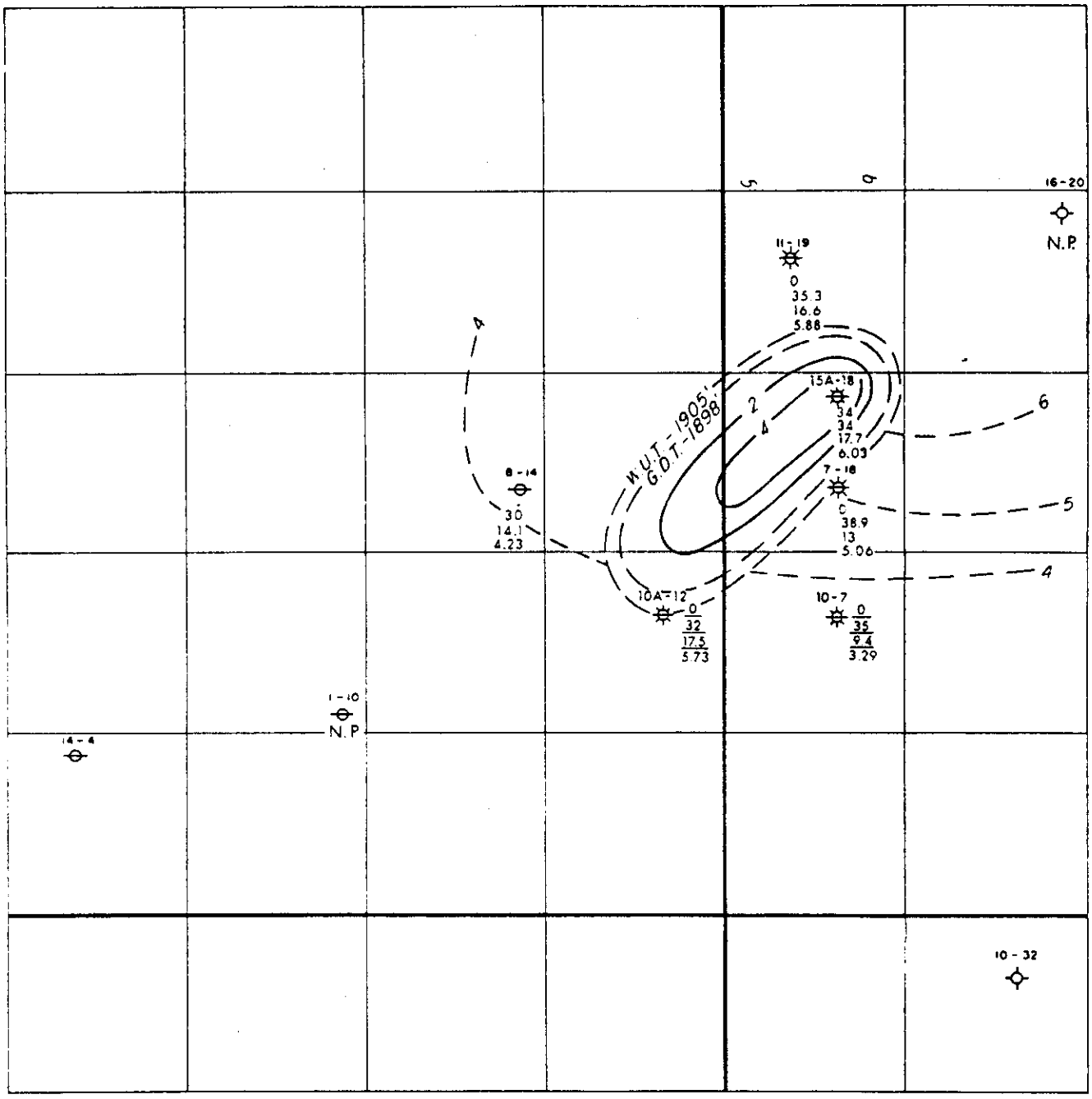
——— NET PAY × POROSITY (FRACTIONAL)

— — — POROSITY × FEET OF TOTAL RESERVOIR DEVELOPMENT BELOW GAS-DOWN-TO-LEVEL

— INTERCOMP —

DALY AREA
POROSITY FOOT MAP
ZONE 2
SOURIS RIVER POROSITY

DR. BY: N. THACHUK	DATE: DEC. 1976
REV. DATE: NOV. 1977	FIGURE NO. 14



LEGEND

34 NET PAY (FT.)
34 TOTAL RESERVOIR DEVELOPMENT (FT.)
17.7 AVERAGE POROSITY (%)
6.03 POROSITY (FRACTIONAL) × FT. RESERVOIR DEVELOPMENT

——— NET PAY × POROSITY (FRACTIONAL)

– – – POROSITY × FEET OF TOTAL RESERVOIR DEVELOPMENT BELOW GAS-DOWN-TO-LEVEL

— INTERCOMP —

DALY AREA
POROSITY FOOT MAP
ZONE 3
SOURIS RIVER POROSITY

DR BY: N. THACHUK	DATE: DEC 1976
REV. DATE: NOV. 1977	FIGURE NO. 15

A P P E N D I C E S

CP-9 (Rev. 4/

COMPANY	WELL NAME	DIVISION	FIELD OR AREA	LAG TIME	PAGE	MUD PROPERTIES					
						TYPE	WT.	VIS	WL	CAKE THICK	% OIL
Norcen	Daly Gas No.1		Virden	16/17	1	KCl					

LOCATION	R.B. ELEVATION	DATE	EXAMINER	MARKERS
7-18-10-27WPM	1628.6	23/10/76	W. M. Mitchell	Mississippian 2173(-544) Crinoidal Mkr 2320(-691)

DEPTH	DRILL. TIME MIN/FT.	SHALE %	CARBONATES %	CARBONATES LITH.	CARBONATES TYPE	CARBONATES XL SIZE	CARBONATES POROSITY	CARBONATES ARG. CONT.	SANDSTONES %	SANDSTONES GRAIN SHAPE	SANDSTONES GRAIN SIZE	SANDSTONES CEMENT TYPE	SANDSTONES CONSOLIDATION	SANDSTONES POROSITY	OTHERS %	OTHERS NAME	SHOWS STAIN	SHOWS FLUOR.	SHOWS CUT	SHOWS CUT FLUOR.	SHOWS GAS	COMMENTS
2150		TRIP SAMPLE MOSTLY CAVINGS																				
60	1.4	70	GREEN &		RED	GREY	SILTY		10	SA	SR	VAF	SIL	CONS	NVP	20	SILTST	NS				TR SHELL FRAG CRINOID STEM
70	318	60	30	DOL	EARTHY SUCROSIC		BUFF/BN		SUCROSIC	HAS	SOME	VUGGY Ø			Ø VUGS	IN EARTHY		INFILLED	10%SLT			TR SHELL FRAG
80	9110	60	40	DOL	EARTHY	BUFF/BN	30%					SHALE	GY GN -		GN-RED	GY GN	SH	CALC				SEVERE CAVINGS
90	5.5	70	30			AA								AA				AA				AA
2200	5.0	60	40			AA								AA				AA				AA
10	7.0	70	30			AA			TR	SILT/VFSDST				AA				AA				AA
20	5.7	90	10			AA			SAMPLE ALMOST ALL CAVINGS													
30	7.2	80	10			AA			10	ANHYDR												
40	8.7	80							20	ANHYDR	WHITE			SHALE	MOSTLY	CAVINGS						
50	5.2	50	10			AA			20	ANHYDR	WH/W PURPLE MOTTLED PORTIONS				10	CHERT	BN/RDBN					SHALE-CAVINGS
60		40	20			AA	MOTTLED BUFFY/PUR		30	DOL	SUCROSIC		BUFF		TR	AA		MINOR	PPØ			AA SUGARY DOL AA OIL STAINED
70		30	20		AA		AA		40	AA		BUFF	MOTTLED		TR	AA		AA				AA "
80		60	10	LMY	DOL	BUFF/MOTTLED			30	AA								AA				AA "
90		70	10		AA				20	AA												AA "
2300		80	20		AA				TR	AA					TR	AA						SHALE-CAVINGS
10		90	10		AA				TR	AA					TR	AA						AA
20		70	30		AA				TR	AA	CRINOID FRAG		MINOR	PPØ			30%	DOL STRAINED,				AA
30		70	10		AA				20	AA		AA				AA		SUCROSIC DOL STAIN				AA
40		80	10		AA				10	AA		AA				AA		VERY LITTLE STAIN				AA
50		40	40	LMY DOL/ LST	DOL	BUFF	MOTTLED		20	AA						AA		TR ST IN SUCR DOL				AA
60		30	60	LST	BUFF	MOTTLED			10	SILTY	LST	RED										
70		20	70		AA				10	AA												
80		30	40		AA				30	AA						SAMPLE MOSTLY CAVINGS						
90		40	60		AA				TR	AA												
2400		50	50		AA				TR	AA												
05		60	40		AA				TR	AA												
10		40	60		AA				TR													
15																						

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COMPANY	WELL NAME	DIVISION	FIELD OR AREA	LAG TIME	PAGE	MUD PROPERTIES: TYPE	WT.	VIS.	WL.	CAKE THICK.	% OIL
					2						

LOCATION	K.B. ELEVATION	DATE	EXAMINER	MARKERS
				BAKKEN 2557 (-928)

DEPTH	DRILL. TIME MIN/FT.	SHALE %	CARBONATES: %	LITH.	TYPE	XL SIZE	POROSITY	ARG. CONT.	SANDSTONES: %	GRAIN SHAPE	GRAIN SIZE	CEMENT TYPE	CONSOLIDATION	POROSITY	OTHERS: %	NAME	SHOWS: STAIN	FLUOR.	CUT.	CUT FLUOR.	GAS	COMMENTS
2415																						
20		40	60	LST	WH	PINK EARTHY																CRINOID FRAGMENTS
25		20	80	LST	WH/	PINK EARTHY/XLINE			TR	DOL		SUCROSIC		STAINED								
30		20	80	LST	COH	MOTTLED PINK&PURPLE EARTHY/FRAGM			TR	DOL					AA							AA
35		30	70		AA												MORE FRAG LST					AA
40		10	90	LST	AA																	
45		TR	100	LST	PINK/WHITISH PINK XLINE DOLOMITIC																	
50		TR	100	LST	WHITISH PINK/PINK	EARTHY/XLINE																
55		10	90	LST	PINK	EARTHY/XLINE			TR	WH MOTTLED LST												
60		20	80	LST	AA																	
65		TR	80	LST	AA				20	WHITISH PINK EARTHY LST												
70		TR	60	LST	PINKISH WH EARTHY				40	ANHYDRITE PINK												CRINOID FRAG
75			70		AA				30		AA											AA
80			70		AA				10		AA				20	XLINE DOL						AA
85		M	60		AA				30		AA				10		AA					AA
90			70			COLOUR CHANGE TO MORE WHITE COLOR			30						TR							AA
95			70		AA				20		AA				10	DOL LST XLINE				10	CHERT WH	
2500			60	LST	WH/TR BUFF EARTHY				TR						20					20	CHERT WH	
05			80		AA				TR						TR					20	AA	
10			90			AA														10	AA	
15		TR	90		AA				TR		AA				TR		AA			10	AA	
20		TR	100		AA															TR	AA	CRINOID FRAG
25			100						TR		AA				TR		AA			TR		AA
30			70		AA										TR		AA			30	AA	AA
40			100		AA										TR		AA			TR	AA	
45			100		AA																	
50			100		AA															TR	AA	
55		10	90		AA																	SHALE GY GN
60		40	60		AA										SHALE		GN & GY GN			SILTY		

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COMPANY	WELL NAME	DIVISION	FIELD OR AREA	LAB TIME	PAGE
					3

MUD PROPERTIES

TYPE	WT.	VIS.	WL	CAKE THICK.	% OIL

LOCATION	K.B. ELEVATION	DATE	EXAMINER

MARKERS DEVONIAN (THREE FKS) 2595 (-966)
NISKU 2650 (-1021)

DEPTH	DRILL. TIME MIN/FT.	SHALE %	CARBONATES %	LITH.	TYPE	XL SIZE	POROSITY	ARG. CONT.	SANDSTONES %	GRAIN SHAPE	GRAIN SIZE	CEMENT TYPE	CONSOLIDATION	POROSITY	OTHERS %	NAME	SHOWS STAIN	FLUOR.	CUT.	CUT FLUOR.	GAS	COMMENTS
2560		80	20	LST	WH/PINK EARTHY										SHALE GN		& GY	GN SILTY				
65		80	20			AA											AA					
70		80	10			AA			10	SILTSTONE							AA					
75		70	30			AA			TR	AA							AA					
80		70	20			AA			TR	AA							AA					10% SOFT RED SHALE
85		50	20			AA											AA					30 AA
90		70	20			AA																10 AA
95		10	10			AA																80 AA
2600		10	TR			AA																90 AA
05			30	LST	WH/BUFF EARTHY/XLINE																	70 AA
10		TR	10		AA																	90 AA
15		TR	20		AA																	80 AA
20		TR	30		AA																	70 AA
25		10	20		AA																	70 AA
30			30	DOL	FX SUCROSIC WH/PR																	70 AA
35			50		AA																	50 AA
40		SAMPLE MISSING																				
45		TR	10		AA																	90 AA
50		TR	30		AA SUCROSIC/XLINE																	70 AA
55			90	XLINE BUFF	DOL				MINOR		PPØ				10	ANHYDRITE						TR AA
60			70		AA										20	AA						10 AA
65			100	LST	XLINE BUFF				MINOR		PPØ											TR AA
70		10	80		AA										10	AA						TR AA
75		TR	90		XLINE/SUCROSIC BUFF										10	AA						TR AA
80			80		AA				MINOR		PPØ				20	AA						
85			70		AA				PPØ	20% of SAMPLE					30	AA						
90			80		AA				PPØ	ABUNDANT					20	AA						TR AA
95			70		AA					AA					30	AA						
2700																						

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COMPANY	WELL NAME	DIVISION	FIELD OR AREA	LAG TIME	PAGE	MUD PROPERTIES: TYPE	WT.	VIS.	WL.	CAKE THICK.	% OIL
					4						

LOCATION	K.B. ELEVATION	DATE	EXAMINER	MARKERS
				DUPEROW 2770 (-1141)

DEPTH	DRILL. TIME MIN/FT.	SHALE %	CARBONATES: %	LITH.	TYPE	XL SIZE	POROSITY	ARG. CONT.	SANDSTONES: %	GRAIN SHAPE	GRAIN SIZE	CEMENT TYPE	CONSOLIDATION	POROSITY	OTHERS: %	NAME	SHOWS: STAIN	FLUOR.	CUT.	CUT FLUOR.	GAS	COMMENTS
2700			40	LST	BUFF	XLINE	MINOR	Ø	30	DOL	BUFF	SUCROSIC	GPP	Ø	30	ANHYDRITE						
05			20		AA				60	AA	Ø on 90% of chips				20	AA						
10			10		AA				80	AA					10	AA						
15			20		AA				70	AA					10	AA						
20			60		AA				20	AA					20	AA						
25			80		AA				10	AA					10	AA						
30			100		AA				TR													
35			100		AA																	
40			100		AA																	
45			100		AA																	
50			100		AA																	CRINOIL FRAG
55			100		AA				TR		AA	TRPPØ										
60			100		AA				TR		AA	"										
65			80	DOLTC	LST	BUFF	XLINE		TR		AA				20	LST XLINE/EARTHY BUFF						RED COLORING SHALE
70		30	70		AA										TR							RED SILTY SHALE
75		30	70		AA																	RED & GY GN SILTY SH
80		40	50		AA										10	ANHYDR						AA
85		50	40		AA										10	AA						AA
90		40	40		AA				10		AA				10	AA						AA
95		20	70		AA				10		AA				TR	AA						MOSTLY GY GN SH
2800		40	60		AA	EARTHY/XLINE									TR	AA						"
05		30	70		AA										TR							"
10		40	60		AA																	"
15		50	20		AA				30	DOL LST	GY SUCROSIC											"
20		70	20		AA				10		AA											"
25		80	20		AA				TR		AA				TR	AA						"
30		40	40		AA				30		AA				TR	AA						"
35		40	30		AA				30		AA											"
40																						

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COMPANY	WELL NAME	DIVISION	FIELD OR AREA	LAG TIME	PAGE	MUD PROPERTIES: TYPE	WT.	VIS.	W...	CAKE THICK	% OIL
					5						

LOCATION	K.B. ELEVATION	DATE	EXAMINER	MARKERS

DEPTH	DRILL. TIME MIN/FT.	SHALE %	CARBONATES %	LITH.	TYPE	XL SIZE	POROSITY	ARG. CONT.	SANDSTONES %	GRAIN SHAPE	GRAIN SIZE	CEMENT TYPE	CONSOLIDATION	POROSITY	OTHERS %	NAME	SHOWS STAIN	FLUOR.	CUT.	CUT FLUOR.	GAS	COMMENTS
2840																						
45		20	50	DOL LST EARTHY/XLINE GY					30	DOL LST EARTHY BUFF					TR	ANHYDRITE						
50		20	40		AA				40		AA											
55		10	70		AA	EARTHY			20		AA											
60		10	80		AA				10		AA				TR	AA						
65		TR	80		AA				10		AA				10	AA						
70		20	70	DOL	AA	EARTHY/SUCR BF			TR	DOL LST GY					10	AA						
75		30	60		AA										10	AA						
80		20	80		AA	MINOR PPØ			TR	VUGS												
85		20	60		AA		AA		AA						20	DOL LST EARTHY/SUCR GY						
90		10	30		AA		AA								60		AA	MINOR PPØ GY/BFF				TR ANHYDRITE
95		10	30		AA	NVP									50		AA		AA TR VUGS			10 AA
2900		20	60	DOL LST	AA										20		AA		AA		AA	TR AA
05		TR	100		AA										TR							
10			100		AA	MINOR PPØ TR VUGS																
15			100		AA		AA	✓														
20		TR	70		AA		✓	✓							20	DOL XLINE GY						10 ANHYDRITE
25		TR	60		AA		✓	✓							20		AA					20 AA
30			20		AA			60	DOL LST	BUFF/BN SUCROSIC					20		AA					TR ✓
35			60		AA			20		AA					10		AA					10 AA
40			20		AA			70		AA	MINOR PPØ TR VUGS											10 AA
45			20		✓			80		AA	✓	✓		✓								TR ✓
50			10		✓			90		AA												
55			40		✓	MINOR PPØ		60		AA	✓	✓		✓								
60			20		✓		✓	80		AA	FAIR PPØ					TR VUGS						
65			60		✓			40		AA												
70			70		AA		✓	30		AA	MINOR PPØ					TR VUGS						
75			60	LST	EART/XLINE BUFF			40		AA	✓			✓								
80			70		AA			30		aa												

APP. A-5

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COMPANY	WELL NAME	DIVISION	FIELD OR AREA	LAG TIME	PAGE 6	MUD PROPERTIES: TYPE	WT.	VIS	WL.	CAKE THICK.	% OIL

LOCATION	K.B. ELEVATION	DATE	EXAMINER	MARKERS

DEPTH	DRILL. TIME MIN/FT.	SHALE %	CARBONATES: %	LITH.	TYPE	XL SIZE	POROSITY	ARG. CONT.	SANDSTONES: %	GRAIN SHAPE	GRAIN SIZE	CEMENT TYPE	CONSOLIDATION	POROSITY	OTHERS: %	NAME	SHOWS: STAIN	FLUOR.	CUT	CUT FLUOR.	GAS	COMMENTS
2980			80	DOL LST XLINE/EARTHY BUFF											20	DOL LST	SUCROSIC BUFF/BN MINOR PPØ					TR ANHYDRITE
85			20		AA										80		AA		✓		✓	
90			TO		AA				80	DOL	XF GRANULAR GY				10		AA					
95			30		AA				50		AA				20		AA		✓		✓	
3000			~~TRIP TO CORE #1 and 2~~						~~DUPPEROW~~													
3115			80	20	AA																	~~TRIP SAMPLES~~
20			70	30	AA																	
25			10	90	LST	EARTHY GY/BUFF																
30			70	80		AA	TR	PPØ	10	DOL	LST EARTHY/SUCR BUFF											CRINOLD FRAG
35				60		AA			40		AA											
40				50		✓			50		✓											AA
45				40		✓			60		✓											✓
50			30	30		✓			70		✓				TR	ANHYDRITE						
55				50		✓			50		✓				TR	✓						
60				70		✓			30		✓				TR	✓						
65				60		✓			30		✓				TR				10	Sucrosic		DOL LST PPØ
70				70		✓			10		✓				TR	✓			20	SUCR/XLINE		✓ ✓
75				70		✓			TR		✓								30		✓	✓ ✓
80				40		✓			10		✓								50		AA	✓ ✓
85				20		✓			30		✓								50		✓	✓ ✓
90				10		✓			40		✓								50		✓	✓ ✓
95				40	DOL LST EARTH/XLINE				40		✓								20		✓	✓ ✓
3200				10		✓			50		✓				TR	ANHYDRITE			40		✓	✓ ✓
05				20	AA	XLINE TRPPØ			60		✓								20		✓	✓ ✓
10				20	AA	✓	✓		50		✓	PPØ				GASTLO BDS			30		✓	✓ ✓
15				10	✓				50		✓				TR	Anhydrite			40		✓	✓ TR VUGS
20				30	✓				60		✓				TR	✓			10		✓	✓ ✓
25																						

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COMPANY	WELL NAME	DIVISION	FIELD OR AREA	LAG TIME	PAGE
					7

MUD PROPERTIES					
TYPE	WT.	VIS	WL	CAKE THICK	% OIL

LOCATION	K.B. ELEVATION	DATE	EXAMINER	MARKERS
				SOURIS RIVER 3290 (-1621)

DEPTH	BRILL. TIME MIN/FT.	SHALE %	CARBONATES						SANDSTONES						OTHERS		SHOWS					COMMENTS
			%	LITH.	TYPE	XL SIZE	POROSITY	ARG. CONT.	%	GRAIN SHAPE	GRAIN SIZE	CEMENT TYPE	CONSOLIDATION	POROSITY	%	NAME	STAIN	FLUOR.	CUT.	CUT FLUOR.	GAS	
3225			20	XLINE	FOL	LDY BUFF	TRØ	TRVUGS	20	EARTHY		LST	BUFF/BN			60	SUCROSIC/XLINE		DOL		LST	PPØ & TR VUGS
30			30		AA				10				AA			60		AA				TR ANHYDRITE
35			40		AA				10							50		AA				TR ✓
40			20		AA				TR			AA				60		AA			20	LIMEY DOL GY SUC/XLINE
45			40		AA		CRIN FRAG		TR			AA				50		AA		LIMEY DOL	10	AA
50			30		AA											60		AA			10	AA
55			20		AA				10	ANHYD						50		AA		DOL LST	20	AA
60			30		AA				10	✓						60		AA			TR	AA
65			30		AA				TR	✓						70		AA			TR	AA
70			20		AA				10	✓						70		AA			TR	✓
75			20		AA											80		AA				
80			10		AA											90		AA				
85			TR		AA											80		AA			20	DOL LST GY SUC/XLINE
90																20		AA			80	AA
95			100	DOL	LST	XLINE	GY															
3300			60		AA				40	EARTHY		LST	BUFF									
05			40		AA				40			AA				20	SUCROSIC/XLINE		BUFF		DOL	LST
10			20		AA				50			AA				30		AA				
15			30		AA				30			AA				40		AA				
20			50		AA				20			AA				30		AA				
25			30		AA				20			AA				50		AA				TR ANHYDRITE
30			20		AA				40			AA				40		AA				AA
35			40		AA				20			AA				40		AA				AA
40		10	30		AA				30			AA				20		AA				10 AA
45		TR	30		AA				20							30		AA				20 AA
50			10		AA				40			AA				50		AA		TR	PPØ & MUGSTR	AA
55			TR						20							80						TR AA
60			10						20							40						30 AA
65																						

CP-9 (Rev. 4/

COMPANY	WELL NAME	DIVISION	FIELD OR AREA	LAG TIME	PAGE 8	MUD PROPERTIES: TYPE	WT.	VIS.	WL.	CAKE THICK	% OIL

LOCATION	K.B. ELEVATION	DATE	EXAMINER	MARKERS

DEPTH	DRILL. TIME MIN/FT.	SHALE %	CARBONATES: %	LITH.	TYPE	XL SIZE	POROSITY	ARG. CONT.	SANDSTONES: %	GRAIN SHAPE	GRAIN SIZE	CEMENT TYPE	CONSOLIDATION	POROSITY	OTHERS: %	NAME	SHOWS: STAIN	FLUOR.	CUT.	CUT FLUOR.	GAS	COMMENTS
3365		10	60	LST	EARTHY BUFF										30	ANHYD						
70		10	20		AA				60	DOL	SUCUROSIC/XLINE			BN	10	✓						
75		30	10						40						20	✓						POOR SAMPLE CARINGS
80		TR	20		AA				80		AA			BUFF	TR	✓						
85		TR	70		AA				20		AA				10	✓						
90		TR	10		AA				80	DOL	LST AA				10	✓						DIRTY SAMPLE
95			40		AA				40		AA				20	✓						
3400			70		✓				20		✓				10	✓						SHALE LT/DK GY
05			40		✓				60		✓				TR	✓						
10		20	40		✓				40		✓		TRØ &	VUGS	TR	✓						TR COAL
15		40	30						30		✓			/	TR	✓						
20		30	10		✓				50		✓			/	10	✓						
25		10	TR		✓				80		✓			/	10	✓						
30		10	TR		✓				90		✓				TR	✓						
35		30	10		✓				60		✓				TR	✓						
40		10	70		✓				20		✓				TR	✓						
45		10	30		✓				50		✓				10	✓						
50		40	10		✓				50		✓				10	✓						
55		60	TR		✓				40		✓				TR	✓						
60		70	TR		✓				30		✓				TR	✓						
65		80	TR		✓				20		✓	TR Ø &	VUGS		TR	✓						
70		70	10		✓				20		✓				TR	✓						5% GLAUC SHALE
72		CUT	CORES #3 & 4		3472 - 3592				REC 120'													
3592		90	TR	SUCROSIC	DOL	LST	BN		10	DOL	LST	XLINE		BUFF/BN		TR	ANHYDRIDE					
3595		80	TR		✓				20		AA											TR PINK COLOR
3600		40	TR		✓				10		AA								20	DOL	LST	EARTHY BUFF
05		20	TR		✓				TR		AA								80			
10		TR							30		AA		GY/GN						60			
15		TR	30	DOL	LST	XLINE		BUFF/BN	50		AA		/			TR	/		20		/	
20		TR	20						40		AA		/			TR	/		40		/	

SIDEWALL SAMPLES AND CORES
HYDROCARBON SHOWS

Type Sampler		Logging Job No./Run No. Core #1	Interval	Well Name
Date	Examiner	Sidewall Gun Run No.	3000-	Daly Gas No. 1
		Recovery 60 of 60' shots	3060	7-18-10-27wlm

	Depth *	Rec. **	HYDROCARBON SHOWS								Lith. Description and Remarks
			% Oil Stain	H.C. Odor	Fluorescence %	Fluorescence Intens.	Fluorescence Color	Cut Color of Cut	Cut Cut Fluor.	Show No. Avg.	
1	3000-										Dolomite XF/VF grained anhydrite
2	3003.2										infilled large coral inclusion
3											@ 3002 Several smaller corals
4											@ 3001.7 Visible vugs in Calc
5											infill & @ 3002.3 - 3003.2
6	3008.2										Grey Xline sucrosic dol
7	4.8										Visible vugs 3003.5 - 3004. Churned
8	3004.8										Anhydrite W/Minor inclusions
9	30016.7										Xline dense dolomite clear/BN
10											External core color is grey.
11	30016.7-										Interbedded BN earthy/Xline dol
12											LST & Grey dol. Beds> 1cm to 2 cm
13											Increasing in thickness to btm
14											Fracture @ $\approx 60^{\circ}$ to hole from
15											17.8 → 19.4. Bedding displacement
16											$\approx \frac{1}{2}$ cm. Porous Bed @ 20.6 to
17											20.8
18	3021.7										Xline/Sucrosic dol LST visible
19	39.5										vugs $\approx \frac{1}{4} \rightarrow \frac{1}{2}$ cm scattered
20											throughout. Brach? @ 22.5 No
21											definite bedding churned
22											appearance possibly bored
23											Bedding Planes apparent @
24											3026.6 - 6.9, 28.1 - 28.3, 3030,
25											31.7 - 32
26	3039.5-										Anhydrite slightly dol
27	42.5										
28											
29											
30											

* UNLESS OTHERWISE NOTED DEPTH IS SAME AS RESISTIVITY LOG (eg. DIL OR DLL)

** RECOVERY CODE: INCHES OF RECOVERY, or
MF - MISFIRED
SO - SHOT OFF
MT - EMPTY
RR - RUBBLE

SIDEWALL SAMPLES AND CORES
HYDROCARBON SHOWS

Type Sampler		Logging Job No./Run No. Core #1	Interval 3000-3060	Well Name Daly Gas No. 1 7-18-10-27wlm
Date	Examiner	Sidewall Gun Run No.		
		Recovery 60 of 60' shots		

	Depth *	Rec. **	HYDROCARBON SHOWS: % Oil Stain	H.C. Odor	Fluorescence: %	Fluorescence: Intens.	Fluorescence: Color	Cut: Color of Cut	Cut: Cut Fluor.	Show No. Avg.	Lith. Description and Remarks
1	3042.5-										Anhydrite & Doltc LST. Appears
2	45.4										to be churned zone. No distinct
3											bedding. LST Xline/Sucrosic Buff/
4											BN
5	3045.4-										Interbedded Grey Sucrosic/XLINE LST
6	48.6										Buff/BN XLINE/SUCR DOL LST. Bottom
7											1' churned Dol LST W/Anhydrite
8											Inclusions
9	3048.6-										Buff/BN Dol LST & DK BN Anhydrite
10	50										No apparent bedding. Increase in
11											Anhydrite towards base
12	3050-										Sucrosic LST Buff/BN minor
13	56.7										bedded anhydrite. Some porosity
14											apparent @ 3050 - 51,
15											3054 - 3055, 3056 - 56.7
16	3056.7-										Churned anhydrite & dol LST
17	58.4										LST %age increases towards
18											Base
19	3058.4										Anhydrite W/Minor beds of
20	-60										Dol LST up to 1 cm thick.
21											
22											
23											
24											
25											
26											
27											
28											
29											
30											

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SIDEWALL SAMPLES AND CORES
HYDROCARBON SHOWS

Type Sampler		Logging Job No./Run No. Core #2	Interval	Well Name
Date	Examiner	Sidewall Gun Run No.	3060-3120	Daly Gas No. 1 7-18-10-27w1
		Recovery 60 of 60' shots		

	Depth *	Rec. **	HYDROCARBON SHOWS: % Oil Stain	H.C. Odor	Fluorescence: %	Fluorescence: Intens.	Fluorescence: Color	Cut: Color of Cut	Cut: Cut Fluor.	Show No. Avg.	Lith. Description and Remarks
1	3060-										Finely laminated Anhydrite
2	60.8										and dol. LST beds more dolomitic
3											towards base
4	3060.8-										Chalky dolomite Gy w/40% anhydrite
5	61.3										inclusions
6	3061.3-										Churned earthy limey dolomite (BN)
7	62.6										and anhydrite up to 60% anhydrite.
8	3062.6-										Dol LST sucrosic w/major anhydrite
9	67.1										inclusions @ 64, 64.5, 65.2
10											65.5 - 66 and 66.3
11	3067.1-										Finely bedded dol LST earthy/
12	68										sucrosic ½" Bed @ top has
13											some vuggy ø
14	3068-				70		Yellow	N	N		Dol sucrosic stained yellow fluor
15	70.7										No cut or CF minor anhydrite incl.
16	3070.7-						AA	✓	✓		60 sucrosic 40 earthy dol LST
17	73.6										Sucrosic LST stained & exhibits fluo
18											as noted. Large cabbage strom
19											@ 72.75 - 73.2. Appears churned
20	3073.6-				100		AA	✓	✓		sucrosic dol LST BN minor
21	74.5										anhydrite inclusions
22	3074.5-										Finely bedded sucrosic dolomite
23	76.3				90		AA				LST Minor anhydrite interbeds
24	3076.3										Sucrosic/XLINE BN/GyGn Dolomite LST
25	77.6										finely bedded becoming churned
26											@ base ends a styolite @ 77.6
27	3077.6-										Dol LST top 3" churned GyGn w/Bn
28	80.2										incl. No distinct bedding features
29											In Bn sucrosic LST. Some P.P ø on
30											broken surface.

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SIDEWALL SAMPLES AND CORES
HYDROCARBON SHOWS

Type Sampler		Logging Job No./Run No.	Interval	Well Name
Date	Examiner	Sidewall Gun Run No.		
		Recovery of shots		

	Depth *	Rec. **	HYDROCARBON SHOWS								Lith. Description and Remarks
			% Oil Stain	H.C. Odor	Fluorescence %	Fluorescence Intens.	Fluorescence Color	Cut Color of Cut	Cut Fluor.	Show No. Avg.	
1	3080.2-						Yellow	N	N		Gy Gn/Bn churned XLINE dol LST
2	81										PP ø & small vugs apparent.
3	3081 -						Nil	/	/		Fuff/Bn earthy/sucrosic dolomite LST
4	82.6										Tr Xul infilled vugs and PP ø on
5											broken surface.
6	3082.6-										Earthy fossiliferous LST Many
7	85.4										crinoids on face broken @ 83.5
8	3085.4-										Sucrosic Bn dol LST contains
9	86.4										mainly strom frag which
10											exhibit good vuggy ø.
11	3086.4										Earthy/sucrosic LST minor
12	89										anhydrite laminar VF bedding
13											some vuggy porosity throughout.
14	3089 -										Earthy/XLINE dol LST. Distinct
15	91										bedding
16	3091 -										Earthy/sucrosic dol LST
17	96.6										Distinct bedding visible
18	3096.6-						Light Yellow	N	N		sucrosic Bn Dol LST. No
19	99.9										distinct bedding. Minor anhydrite
20											inclusions. Mottled LT and DK BN
21	3099.9-						Nil	✓	✓		sucrosic dol LST Dk Bn @ top
22	3103.3										to alternate LT and Dk Bn. Minor
23											brachs
24	3103.3-										Sucrosic dolomite LST AA
25	04.5										
26	3104.5-				60		Yellow	✓	✓		XLINE/sucrosic limey dol mottled
27	8.8										Gy Bn/Dk Bn Minor PPø and small
28											vugs visible on broken surfaces
29	3108.8-				70		Light Yellow	✓	✓		sucrosic/XLINE dol LST mottled
30	9.8										No porosity visible.

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SIDEWALL SAMPLES AND CORES
HYDROCARBON SHOWS

Type Sampler		Logging Job No./Run No.	Interval	Well Name
Date	Examiner	Sidewall Gun Run No.		
		Recovery of shots		

	Depth *	Rec. **	HYDROCARBON SHOWS: % Oil Stain	H.C. Odor	Fluorescence: %	Fluorescence: Intens.	Fluorescence: Color	Cut: Color of Cut	Cut: Cut Fluor.	Show No. Avg.	Lith. Description and Remarks
1	3109.8-						Nil	N	N		Earthy dol LST 40% Earthy/sucrosic
2	11.9										dol LST 60%. Latter Dk Bn
3	3111.9-						✓	✓	✓		earthy/sucrosic dol LST.
4	16.5										
5	3116.5-										Banded Lt grey and Dk Gy Gn XLINE
6	31.20										LST.
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
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26											
27											
28											
29											
30											

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SIDEWALL SAMPLES AND CORES
HYDROCARBON SHOWS

Type Sampler		Logging Job No./Run No. Core #3	Interval	Well Name
Date	Examiner	Sidewall Gun Run No.	3472-	Daly Gas No. 1
		Recovery 60 of 60' shots	3532	7-18-10-27wlm

	Depth *	Rec. **	HYDROCARBON SHOWS: % Oil Stain	H.C. Odor	Fluorescence: %	Fluorescence: Intens.	Fluorescence: Color	Cut: Color of Cut	Cut: Cut Fluor.	Show No. Avg.	Lith. Description and Remarks
1	3472 -										Dk green slightly dolomitic anhydrit
2	72.7										
3	3742.7-										Anhydrite brownish translucent
4	78.7										
5	3478.7-										Churned intermixed anhydrite
6	79.9										and XLINE dolomite
7	3479.9-										Anhydrite Bn Translucent
8	80.6										
9	3480.6-			84 - 85	10%		Bitumen	No Fluor			Dolomitic limestone Buff/Dk Bn
10	85.6							Cut	or Cut F		Laminar beds @ top massive beds for
11											most part. Large ripple @ 82.7 - 2.
12				1 cm Black Shale Bed @ 83.73							XLINE/F sucrosic to 82.7 Dolomitic
13				Sacrosic LST exhibits Tr Vuggy ø							F sucrosic 82.7 - 85.6 Limestones
14	3485.6-										Grey green argillaceous dolomitic
15	3500.1										limestone. Anhydritic. Increasing
16											dolomitic anhydr towards base. Shale
17											beds @ 98.8-98.85 & 99.85-500.1
18											Shale Dk Grey waxy
19	3500.1-										Anhydrite gnish bn Massive
20	01.5										
21	3501.5-										Dolomitic limestone bedded XLINE
22	02.05										Stylolitic, anhydrite inclusions
23	3502.05-										Anhydrite brown massive
24	03										
25	3503 -										Dolomitic limestone XLINE bedded
26	04.9										apparent vugs near top completely
27											Anhydrite infilled. Anhydrite
28											filled fracture (Vert) 03.6 - 06.3
29	3504.9-										Dolomite XLINE green anhydritic ?
30	10.4										

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SIDEWALL SAMPLES AND CORES
HYDROCARBON SHOWS

Type Sampler		Logging Job No./Run No. Core #3	Interval 3472-3537	Well Name Daly Gas No. 1 7-18-10-27wlm
Date	Examiner	Sidewall Gun Run No.		
		Recovery 60 of 60' shots		

	Depth *	Rec. **	HYDROCARBON SHOWS: % Oil Stain	H.C. Odor	Fluorescence: %	Fluorescence: Intens.	Fluorescence: Color	Cut: Color of Cut	Cut: Cut Fluor.	Show No. Avg.	Lith. Description and Remarks
1	3510.4-										Interbedded Gn XLINE dol & tan earth
2	11.7										dol LST 10.4-10.8, 10.8-11.1 Earthy
3											dol LST finely bedded, 11.1-11.7
4											Churned Dol LST AA Dk Bn w/Gn dol
5											inclusions.
6	3511.7-										Dolomite Gn XLINE V. argillaceous
7	16										
8	3516 -										16-17 earthy/XLINE dol LST buff/Bn
9	19.8										Minor anhydrite. Incl 17-18.7
10											Heavily worked dol LST earthy/sucr
11											Many strom fragm. Anhydrite incl
12											18.7-19.8 laminar bedded sucr dol
13											LST and anhydrite.
14	3519.8-										Anhydrite Bn Translucent.
15	22.9										
16	3522.9-										Dol LST BUFF/TAN sucrosic vugs visibl
17	29										from 25.8-28 on 20% of core face.
18											Anhydrite infilled fractures (two
19											vert) 26.9-28.8
20	3529 -										Anhydrite Bn/Gn
21	30										
22	3530 -										Crystalline dolomitic limestone
23	32										Grey Bn/Grey Green No porosity
24											visible
25											
26											
27											ø 3522.9 - 29
28											
29											
30											

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SIDEWALL SAMPLES AND CORES
HYDROCARBON SHOWS

Type Sampler		Logging Job No./Run No. Core #4	Interval 3582-3592	Well Name Daly Gas No. 1 7-18-10-27wlm
Date	Examiner	Sidewall Gun Run No.		
		Recovery 60 of 60' shots		

	Depth *	Rec. **	HYDROCARBON SHOWS: % Oil Stain	H.C. Odor	Fluorescence: %	Fluorescence: Intens.	Fluorescence: Color	Cut: Color of Cut	Cut: Cut Fluor.	Show No. Avg.	Lith. Description and Remarks
1	3532 -										Interbedded anhydrite & earthy dol
2	32.8										LST XF
3	3532.8-										Anhydrite Bn translucent
4	34.3										
5	3534.4-										Interbedded VF sucrosic/earthy
6	35.3										dol LST and anhydrite
7	3535.3-										Dolomitic limestone sucrosic
8	39.3										VF brown minor beds earthy
9											Dol LST @ 3536.8-37. Minor anhy incl
10	3539.3-										Anhydrite brown translucent
11	41.8										1 cm bed earthy/XLINE dol LST
12											@39.9 0.4' Gy Gn earthy dol
13											LST @ 40.8-41.1
14	3541.8-										Dol LST XFXLINE/sucrosic Buff/lt bn
15	43.3										41.8-42.7 Bedded w/Gn anhydritic
16											Dol and anhydrite inclusions becomin
17											more massive LST @ base
18	3543.3-						No Shows				Dark Bn/Blk Bituminous? Dolomite
19	44.										
20	3544 -				30%	Lt Yell	or Fluor	NC	NCFYF		Sucrosic/XLINE dol LST Bn PPø. Some
21	45.4										laminar bedding apparent
22	3545.4-										Dolomitic limestone sucrosic/XLINE
23	46.9	Tr stain	Tr	Straw	yellow fluor			NC	NCF		PPø 5% small vugs on chip sample vug
24		68% yellow or Fluor									become apparent on core surface
25											46.5 5% of sample
26	3546.9-										XLINE/sucrosic dol LST gy/bn good
27	47.4										vuggy ø 20%
28	3547.4-										XLINE dol LST bn Tr sucrosic same
29	48.1										vuggy ø @ top. Bituminous shale @
30											47.5.

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** RECOVERY CODE: INCHES OF RECOVERY, or
MF - MISFIRED
SO - SHOT OFF
MT - EMPTY
RR - RUBBLE

SIDEWALL SAMPLES AND CORES
HYDROCARBON SHOWS

Type Sampler	Logging Job No./Run No. Core #4	Interval 3532-3592	Well Name Daly Gas No. 1 7-18-10-27wlm
Date / Examiner	Sidewall Gun Run No.		
	Recovery 60 of 60' shots		

	Depth *	Rec. **	HYDROCARBON SHOWS: % Oil Stain	H.C. Odor	Fluorescence: %	Fluorescence: Intens.	Fluorescence: Color	Cut: Color of Cut	Cut: Cut Fluor.	Show No. Avg.	Lith. Description and Remarks
1	3548.1-										Sucrosic/XLINE dol LST Tr PPø rare
2	48.5										vugs Bn anhydrite infills some
3											large vugs and a small ver fracture.
4	3548.5-										Mottled Bn and Buff Dolomitic
5	54										limestone VF Gr sucrosic buff
6											F Gr sucrosic Bn No large vugs
7											apparent. Abundant small vugs & PPø
8											on chip faces. Some small dolomite
9											replaced corals. Dolomite rhombs
10											abundant.
11	3554 -										Gy bn XLINE & bn sucrosic dol LST
12	61.4										extremely vuggy from 1cm to 3 or 4
13											in size. XLINE mat'l less visible ø
14											than sucrosic 5 & 20% respectively
15											becomes increasingly more sucrosic
16											towards base & anhyd. Infilled large
17											vugs increase w/depth.
18	3561.4-										Mottled Bn XLINE/sucrosic & buff
19	75.2										sucrosic dol limestone. XLINE/sucr
20											mat'l exhibits rare PPø & 5% vuggy
21											ø (small vugs) sucrosic mat'l
22											exhibit 10-15% small vuggy ø &
23											abundant PPø. Many large anhydrite.
24											Infilled vugs throughout.
25	3575.2-										Gy Bn XLINE/sucrosic dolomitic lime-
26	80.3										stone very rare vuggy ø on chip faces
27											very rare PPø.
28	3580.3-										Gy gn dense dol LST/limey dol. Some
29	92										bedding & churned appearance
30											apparent @ 80.3-81. Min anhyd incl throughout.

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CORE REPORT FORM

Company NORCEN Well Name & Location NORCEN DALY GAS #2 11-19-10-27 W1M

Date 18/11/76 Examiner N. M. Thachuk Elevation 1613' K.B. Field or Area Daly

Formation Souris R. Core No. 1 Interval 3489-3549.5 Recovery 60.5 Core Size 4"

From / To	ROCK DESCRIPTION (in following order) Lithology	Archie Descr.	Grain Size	Cement Type	Consol-idation	Porosity %	SHOWS (in following order) Stain	Fluor	Cut	Cut Fluor	Gas	STRUCTURE (in following order) Dip of Beds	FRACTURES Angle	Freq	Open or Closed	COMMENTS
3489 / 3490.5	Anhyd.											Horiz.				Dolomitic Anydrite having Brecciated internal structure.
3490.5 / 3493	Dolo. II, II/III		F-M			B20	nil					Horiz				Light brown chalky with scattered Anhydrite inclusions.
3493 / 3501	Anhyd.											Horiz	45°	1	closed	Mod to highly Argillaceous. Varies from laminated to brecciated.
3501 / 3505.5	Anhyd.											Horiz				White-tan massive containing bands of II Dolomite. Contorted to slump bedding as well as lithoclastic/ brecciated mixed dolomite-Anhydrite.
3505.5 / 3509.5	Dolo. II, III/II					B18-20						Horiz				Brown/tan dolomite showing relict calcarentic texture. Numerous small anhydrite blebs. Section grades downward into progressively increased shale content.
3509.5 / 3524	Shale											Horiz				Anhydrite grey green shale interbedde with thin bands of shaly anhydrite.
3524 / 3527.9	Shale / Anhydrite											Horiz				Interbedded grey-green shale and tan/brown anhydrite.

Note: GRAPHICAL PLOT OF DRILLING TIME ON 5 INCH TO 100 FT SCALE IS TO BE ATTACHED TO CORE REPORT

CORE REPORT FC

Company NORCEN Well Name & Location NORCEN DALY GAS #2

Date _____ Examiner _____ Elevation _____ Field or Area _____

Formation Souris R. Core No. 1 Interval _____ Recovery _____ Core Size _____

From / To	ROCK DESCRIPTION (in following order) Lithology	Archie Descr.	Grain Size	Cement Type	Consol-idation	Porosity %	SHOWS (in following order) Stain	Fluor	Cut	Cut Fluor	Gas	STRUCTURE (in following order) Dip of Beds	FRACTURES Angle	Freq	Open or Closed	COMMENTS
3527.5 / 3528.5	Anhyd.											Horiz				Massive vitreous greenish/tan anhydrite.
3528.5 / 3631	L.S.											Horiz				Dolomitic tan limestone thinly bedded showing supratidal structures (borings and birdseye texture).
3531 / 3536.5	Shale											Horiz				Banded green shale and anhydritic shale interbedded with small bands of limestone.
3536.5 / 3537.5	Dolo.	II, II/III				B15						Horiz				Anhydritic dolomite containing lithoclasts of anhydrite and anhydritic shale.
3537.5 / 3542.5	Shale / Anhyd.											Horiz				Interbedded dark green/brown shale and tan anhydrite. Some brecciated structure. Massive anhydrite bed at base of section.
3542.5 / 3545.5	Limy Dolo. / Dolomitic L.S.	II				B20						Horiz				Buff/brown limy dolomite grading downward into zone of dolomitic banded algal plate and stromatoporoid limestone.
3545.5 / 3549	Anhyd.											Horiz				Green/grey anhydrite containing whisps and bands of calcareous bioclastic debri.
3549 / 3549.5	Dolo.	II, II/III				B20-25						Horiz				Buff-brown anhydritic dolomite.

Note: GRAPHICAL PLOT OF DRILLING TIME ON 5 INCH TO 100 FT SCALE IS TO BE ATTACHED TO CORE REPORT

CORE REPORT F 4

Company NORCEN Well Name & Location NORCEN DALY GAS #2 11-19-10-27 WlM

Date 20/11/76 Examiner N. M. Thachuk Elevation 1613 Field or Area Daly

Formation Souris R. Core No. 2 Interval 3549.5-3610 Recovery 59.2 Core Size 4"

From / To	ROCK DESCRIPTION (in following order) Lithology	Archie Descr.	Grain Size	Cement Type	Consol-idation	Porosity %	SHOWS (in following order) Stain	Fluor	Cut	Cut Fluor	Gas	STRUCTURE (in following order) Dip of Beds	FRACTURES Angle	Freq	Open or Closed	COMMENTS
3549.5 / 3555.5	Dolo.	II, II/III, III	F-M			B 20-30						Horiz				Tan/brown crystalline dolomite varying from chalky at top of sectio to medium grained xtalline dolomite at base.
3555.5 / 3561.5	Anhyd.											Horiz				Slightly argillaceous dolomitic anhydrite grey-green interbedded wit thin zones of brown chalky dolomite. Section shows supratidal thin-bed character. A few thin laminae of sha are present and some minor slump features are evident.
3561.5 / 3566.5	Dolo.	II,II/III	F			B18-20						Horiz				Tan/brown dolomite containing intercrystalline porosity. A thin zone of stromatoproids occurs at the top of the interval.
3566.5 / 3569.5	Anhyd.											Horiz				Thinly banded translucent slightly dolomitic anhydrite interbedded with grey-green argillaceous anhydrit
3569.5 / 3572.5	Dolo.	II	F			B15-20						Horiz				Tan/brown dolomite with stroms at to of section. Numerous anhydrite inclusions.

Note: GRAPHICAL PLOT OF DRILLING TIME ON 5 INCH TO 100 FT SCALE IS TO BE ATTACHED TO CORE REPORT

CORE REPORT FC 1

Company NORCEN Well Name & Location NORCEN DALY GAS #2 11-19-10-27 WIM

Date _____ Examiner _____ Elevation _____ Field or Area _____

Formation _____ Core No. _____ Interval _____ Recovery _____ Core Size _____

From / To	ROCK DESCRIPTION (in following order) Lithology	Archie Descr.	Grain Size	Cement Type	Consol-idation	Porosity %	SHOWS (in following order) Stain	Fluor	Cut	Cut Fluor	Gas	STRUCTURE (in following order) Dip of Beds	FRACTURES Angle	Freq	Open or Closed	COMMENTS
3572.5 / 3588	Dolo.	II, II/III	VF-M			B18-25 C 2-3						Horiz				Dark brown crystalline dolomite varying from thinly laminated to massive. Scattered stroms and section of bioclastic-lithoclastic material.
3588 / 3592.8	Dolo.	I,I/II				B 5-10 D3-4						Horiz				Argillaceous grey/tan dense dolomite containing some anhydrite infill and secondary vuggy porosity. Scattered stroms in section.
3592.8 / 3598.2	Dolo.	I,III/I				B 5-10 C5 D3						Horiz	90°	1	Inter	Mottled tan/brown anhydritic dolomite. Contains large (2-3cm) vugs of which 50-75% completely infilled with anhydrite. Relict bioclastic ruddite texture. Vertical fracture running length of section. Partially open with closures being affected by anhydrite xtalline overgrowth.
3598.2 / 3605.2	Dolo.	I	VF									Horiz				Dense dark grey/brown argillaceous dolomite. Patches of fossil void infilled by anhydrite. Mottled texture.
3605.2 / 3608.7	Shale											Horiz				(TOP RED BEDS) Mottled grey-green slightly dolomitic shale. Pseudo micro-boudinage internal structure.

Note: GRAPHICAL PLOT OF DRILLING TIME ON 5 INCH TO 100 FT SCALE IS TO BE ATTACHED TO CORE REPORT

DRILL STEM TEST REPORT

WELL NAME: Daly Gas No. 1 DATE: Nov. 2, 1976

LOCATION: 7-18-10-27wlm TEST NO.: 1

TESTING COMPANY: Johnston OPERATOR:

FORMATION: Duperow INTERVAL: 3050-3090

TYPE TEST: Straddle SIZE OF PACKERS: NO. OF PACKERS: 4

HOLE SIZE: $8\frac{3}{4}$ TOTAL DEPTH DRILLER: 3625 TOTAL DEPTH LOG: 3625

MUD WEIGHT: 10.0 VISCOSITY: 50 WATER LOSS: 20

JARS: Yes SAFETY JOINT: Yes PUMPOUT SUB: Yes

TIMES (MINUTES): PREFLOW: 5 INITIAL SHUT IN: 60

VALVE OPEN: 60 FINAL SHUT IN: 120

RECOVERY (FEET)		DESCRIPTION	GAS RATE MCF/DAY	MINUTES
- - - - - - - -	OIL			
- - - 360 - - -	WATER	Mud Cut		
- - - 120 - - -	MUD			
480	TOTAL FLUID			

SAMPLE CHAMBER RECOVERY INFORMATION: Salt Water

GAS MEASUREMENT: BLOW ON PREFLOW Faint

GAS/FLUID TO SURFACE N/A

BLOW DURING FLOW PERIOD Faint

TIME	PRESSURE	PLATE SIZE	RATE	DESCRIPTION OF FLOW
	N A			

PRESSURES: (P.S.I.G.)

I.H.P.	1574	I.F.P.	90	I.S.I.P.	1369
F.H.P.	1574	F.F.P.	192	F.S.I.P.	1318

BOTTOM HOLE TEMPERATURE NA GRAVITY OF RECOVERED OIL: NA

PREFLOW: 130 P.P.M. CHLORIDES IN RECOVERED WATER 64,300 NaCl

MISCELLANEOUS INFORMATION: Four fluid samples taken @ 480' 28,600 ppm @ 240' 44,600 ppm @ Top tool 60,7000 ppm From MFE sampler 64,300 ppm NaCl.

DRILL STEM TEST REPORT

WELL NAME: Daly Gas No. 1 DATE: Nov. 3, 1976

LOCATION: 7-18-10-17wlm TEST NO.: 2

TESTING COMPANY: Johnston OPERATOR:

FORMATION: Souris River INTERVAL: 3545-3625

TYPE TEST: Bottom SIZE OF PACKERS: NO. OF PACKERS: 2

HOLE SIZE: $8\frac{3}{4}$ TOTAL DEPTH DRILLER: 3625 TOTAL DEPTH LOG: 3625

MUD WEIGHT: 10.0 VISCOSITY: 50 WATER LOSS: 20

JARS: SAFETY JOINT: PUMPOUT SUB:

TIMES (MINUTES): PREFLOW: 5 INITIAL SHUT IN: 60

VALVE OPEN: 60 FINAL SHUT IN: 120

RECOVERY (FEET)	DESCRIPTION	GAS RATE MCF/DAY	MINUTES
	OIL		
2620'	WATER		
180'	MUD		
	TOTAL FLUID		

SAMPLE CHAMBER RECOVERY INFORMATION: Shipped to Corelab for analysis

GAS MEASUREMENT: BLOW ON PREFLOW Good

GAS/FLUID TO SURFACE None

BLOW DURING FLOW PERIOD Good

TIME	PRESSURE	PLATE SIZE	RATE	DESCRIPTION OF FLOW

PRESSURES: (P.S.I.G.)

I.H.P. 1800 I.F.P. 745 I.S.I.P. 1522

F.H.P. 1860 F.F.P. 1471 F.S.I.P. 1522

BOTTOM HOLE TEMPERATURE GRAVITY OF RECOVERED OIL:

PREFLOW: P.P.M. CHLORIDES IN RECOVERED WATER

MISCELLANEOUS INFORMATION: 3 samples of fluid rec'd for lab analysis. #1 midpoint recovery, #2 @ 1000' ablove tool, #3 60' above tool. NaCl count stabilized at approx. 250,000 ppm over bottom 1000 ft.

DRILL STEM TEST REPORT

WELL NAME: Daly Gas No. 1 DATE: Nov. 3, 1976

LOCATION: 7-18-10-27wlm TEST NO.: 3

TESTING COMPANY: Johnston OPERATOR:

FORMATION: Souris River INTERVAL: 3515-3540

TYPE TEST: Straddle SIZE OF PACKERS: 7 3/4" NO. OF PACKERS: 4

HOLE SIZE: 8 3/4 TOTAL DEPTH DRILLER: 3625 TOTAL DEPTH LOG: 3625

MUD WEIGHT: 10.0 VISCOSITY: 50 WATER LOSS: 20

JARS: Y SAFETY JOINT: Y PUMPOUT SUB: Y

TIMES (MINUTES): PREFLOW: 5 INITIAL SHUT IN: 60

VALVE OPEN: 90 FINAL SHUT IN: 180

RECOVERY (FEET)	DESCRIPTION	GAS RATE MCF/DAY	MINUTES
- - - - - - - -	OIL		
Approx 10	WATER Clean, sli saline	6730 mcf/d	
- - - - - - - -	MUD		
	TOTAL FLUID		

SAMPLE CHAMBER RECOVERY INFORMATION: Sent to Core Lab for analysis

GAS MEASUREMENT: BLOW ON PREFLOW Strong

GAS/FLUID TO SURFACE Gas to surface in 1 min.

BLOW DURING FLOW PERIOD 6.37 incr. to 6.73 in 35' - steady

TIME	PRESSURE	PLATE SIZE	RATE	DESCRIPTION OF FLOW
5:45 PM	142#	1 3/8	6.37 mm	Strong
7:00 PM	150#	1 3/8	6.73 mm	Strong, sli hint of water in blow

PRESSURES: (P.S.I.G.)

I.H.P. 1829 I.F.P. 1011 I.S.I.P. 1523

F.H.P. 1829 F.F.P. 1113 F.S.I.P. 1523

BOTTOM HOLE TEMPERATURE 92°F GRAVITY OF RECOVERED OIL:

PREFLOW: 1011 P.P.M. CHLORIDES IN RECOVERED WATER

MISCELLANEOUS INFORMATION: Rec'd 10' clear water. Tested w/Refractometer @ 55400 ppm NaCl.

COMPANY Daly Gas Storage Ltd.
WELL Daly Gas No. 4 10-7-10-27 W4M
COUNTRY Daly, Manitoba
KB 1605 BHT 92°F (Ext.) at
GL 1594 TOTAL DEPTH 3654 at

intercomp

PETROPHYSICAL DATA

ANALYST C. B. Austin
DATE November 6 1977

FORMATION INTERVAL (4)	FT.	POR. DEV.	NET PAY	RAW LOG DATA: SP	GR	ρ_b	μ sec.	SNP/CNL	CALCULATED POROSITY % from: ρ_b	μ sec.	SNP/CNL	EFF ϕ %	ϕ h	ϕh Sw	RESISTIVITY: Ro	Rt	(3) FRF	(2) Ro	I	(5) Sw %	REMARKS: LITHOLOGY - DST - HYDROCARBON INDICATION - ETC
Main Souris River Porosity 3540(-1935)																					
Zone 1																					DST #2 3540-3556 TO 5/60 SI 60/120
								SLS													Nitrogen Gas to surf. immed. on PF.
3540-3544	4	3	3**			2.63	67	20				12.5	—	—	2.1	2.1				74	Nitr. GTS on VO steady for 60' @ 125
3544-3547	3	0	0	Anhydrite																	psi on 1/5" orifice (6.95 MMCF/D)
3547-3550	3	3	3			2.43	78	19				21.5	0.64	.12	13	13				19	1.5' brackish water, 44,000 ppm PF 1017 SIP
3550-3552	2	2	2			2.55	71	18				15.0	0.30	.11	6	6				38	1511/1593 HMP 1830/1840 FP 1028/1100
3552-3559	7	0	0	Shale and Anhydrite																	Gas down to 3552(-1947)
Zone 2																					
3559-3565	6	5	0			2.48	78	32				20.5			0.52	0.52				100	No Tests.
3565-3568	3	0	0	Anhydritic																	
Zone 3																					
3568-3571	3	3	0			2.70	58	21				9.2	.28		3.1	3.1				100	No Tests.
3571-3577	6	6	0			2.77	53	20				5.5	.33		4.5	4.5				100	
3577-3582	5	5	0			2.64	62	28				12.0	.60		1.4	1.4				100	
3582-3586	4	4	0			2.76	53	18				5.7	.23		6.	6.				100	
3586-3590	4	4	0			2.60	61	28				14.0	.56		1.3	1.3				100	
3590-3600	10	8	0			2.67	57	25				10.5	.84		1.9	1.9				100	
3600-3605	5	5	0			2.70	53.5	22				9.0	.45		3.5	3.5				100	
													3.29								

RESERVOIR SUMMARY

3540 ft. TO 3605 ft.

	Souris River Porosity Zone 1		Zone 2	Zone 3
GROSS POROSITY DEVELOPMENT	8'	Ft.	5'	35'
NET RESERVOIR (PAY)	8'**	Ft.	0'	0'
AVERAGE POROSITY (NET)	16.5	%	20.5%	9.4%
AVERAGE WATER SATURATION	39	%	100%	100%

** The net pay figure shown includes a 3 foot stringer at the top of Zone 1. Although the Sw exceeds conventional cutoffs for net pay inclusion the zone does lie above the G/W for the zone and is simply exhibiting a capillary effect due to its low Ø and proximity to the G/W contact.

Appendix D-1

PETROPHYSICAL CONTROL

(1) POROSITY CNL-FDC - Sonic
(2) FORMATION WATER Rw = 0.033 @ 92°F
(3) "FRF" RELATIONSHIP m = -1.71
(4) BASELOG FOR DEPTH DILL (LL8)
(5) I-Sw RELATIONSHIP-"n" n = -2.0

COMPANY Daly Gas Storage Ltd.
WELL Daly Gas #1 (7-18-10-27WlM)
COUNTRY Manitoba
KB 1629 BHT 92°F at
GL 1616 TOTAL DEPTH 3625 Ft. at

Mud pH - 9.5
Mud W.L. - 20.0cc
Mud Rmf - 0.283 @ 55°F
Bit Size - 8 3/4"

intercomp

PETROPHYSICAL DATA

ANALYST C. B. Austin
DATE March 1977
PAGE 1 OF 1

FORMATION INTERVAL (4)	FT.	POR DEV.	NET PAY	RAW LOG DATA SP	GR	ρ_b	µsec	SNP/CNL	CALCULATED POROSITY % from ρ_b	µsec	SNP/CNL	EFF Ø %	Ø h	Øh Sw	RESISTIVITY Ro	Rt	(3) FRF	(2) Ro	I	(5) Sw %	REMARKS: LITHOLOGY - DST - HYDROCARBON INDICATION - ETC
Main Souris River Porosity				3516 (-1887)				CNL													
Zone 1								LSTØ													
3516-3520	4	3.5	3.5			2.56	71	16				13.1	0.46	15.50	18		32	1.07	17	24	DST #3 3515-3540 TO 5/90 SO 60/180
3520-3524	4	0	0	Dense																	SAB on PF and VO. GTS in 1 min. on PF @
3524-3530	6	6	6			2.32	88	26				22.6	1.36	15.49	60		12.7	.42	143	8	6.37 MMCF/D. Incr. to 6.73 MMCF/D at end
3530-3536	6	0	0	Desne																	of VO period. Rec'd 10' clear water
		9.5	9.5										1.82	15.65							(57000 ppm NaCl) SIP 1523/1523 BHT - 92°F
Zone 2																					
3536-3541	5	4.4	4.5			2.38	88	24				21.7	0.98	241.0	17		13.6	.45	38	16	GAs-down-to 3541 KB (-1912)
3541-3543	2	0	0	Dense																	
		4.5	4.5										0.98	241.0							
Zone 3																					
3543-3550	7	6.5	0			2.63	64	22				10.4	0.68	49.21	10	*	48	1.6	6.3	40	Water-up-to 3543 KB (-1914)
3550-3557	7	7.3	0			2.57	64	27				15.2	1.11	535.4	3.7	*	25	.83	4.5	47	* Laterolog resistivity profile strongly
3557-3563	6	5.9	0			2.67	57.5	18				7.5	0.44	251.2	18	*	84	2.8	6.5	40	indicative of severe mud filtrate invasio
3563-3577	14	14.2	0			2.57	67	27				16.0	2.28	1092.	3.2	*	23	.76	4.2	49	This zone is wet by DST#2 3545-3625.
3577-3582	5	5	0			2.65	60	21				11.0	0.55	26.3	7.2	*	44	1.44	5.0	45	TO 5/60, SI 60/120 GAB on PF and VO. No
																					fluid to surf. Rec'd 2620 ft. SW
																					(280170 ppm NaCl) 180 ft. mud. SIP 1522/152
																					The relatively low water saturation
																					calculations are a result of a mixture
																					of mud filtrate and formation water - the
																					mud filtrate being more resistive. The
																					high water loss is the main cause.

RESERVOIR SUMMARY

MAIN SOURIS RIVER POROSITY

3516 ft TO 3582 ft.

		Zone 1	Zone 2	Zone 3
GROSS POROSITY DEVELOPMENT	9.5 Ft.		4.5'	38.9'
NET RESERVOIR (PAY)	9.5 Ft.		4.5'	0'
AVERAGE POROSITY (NET)	19.2 %		21.7%	13.0%
AVERAGE WATER SATURATION	12 %		16%	100%

PETROPHYSICAL CONTROL

Appendix D-2

(1) POROSITY O. B. Core Analysis
(2) FORMATION WATER Rw = 0.033 @ 92°F
(3) "FRF" RELATIONSHIP m = -1.71
(4) BASELOG FOR DEPTH DLL
(5) I-Sw RELATIONSHIP -"n" n = -2.0(est)

COMPANY Daly Gas STorage Ltd.
WELL 15A-18-10-27WIM
COUNTRY Manitoba
KB 1620 BHT 92°F
GL 1607 TOTAL DEPTH 3628

intercomp

PETROPHYSICAL DATA

ANALYST N. M. Thachuk
DATE March 16 19 77
PAGE 1 OF 1

FORMATION INTERVAL (4)	FT.	POR. DEV.	NET PAY	RAW LOG DATA: SP	GR	ρ_b	µsec.	SNP/CNL	CALCULATED POROSITY % from: ρ_b	µsec	SNP/CNL	EFF. ø %	ø h	øh Sw	RESISTIVITY: Ro	Rt	(3) FRF	(2) Rw	I	(5) Sw %	REMARKS: LITHOLOGY - DST - HYDROCARBON INDICATION - ETC
Main Souris River Porosity 3460 (-1840)																					
																					* Values of Rt from E log
Zone 1																					dubious for accurate
3460-3461	1	0	0	Dense																	saturation control.
3461-3464	3	3	3				66					11	0.33			20*					
3464-3467	3	0	0	Dense																	
3467-3468.5	1.5	1.5	1.5				87					26	0.39			20					
3468.5-3470	1.5	1.5	1.5				77					19	0.29			20					
3470-3472	2	2	2				86					25	0.50			20					
3472-3480	8	0	0	Dense																	
			8.0										1.51								
Zone 2																					
3480-3481	1.0	1.0	1.0				76					20	0.20			20					
3481-3482	1.0	1.0	1.0				70					16	0.16			25					
3482-3484	2.0	2.0	2.0				77					21	0.42			25					
3484-3488	4	0	0	Dense																	
			4.0										0.78								
Zone 3																					
3488-3490	2	2	2				72					22	0.44			28	13.1	.43	65	12*	
3490-3492	2	2	2				61					13	0.26			28	32.7	1.08	26	20*	
3492-3496	6	6	6				72					22	1.32			30	13.3	.44	68	12*	
3496-3504	8	6	6				64					16	0.96			30	22.9	.76	40	16*	
3504-3506	2	2	2				73					23	0.46			28	12.3	.407	63	12*	
3506-3510	4	4	4				70					20	0.80			20	15.7	.52	38	16*	
3510-3513	3	3	3				75					24	0.72			18	11.5	.38	48	15*	
3513-3517	4	4	4				61					13	0.52			16	32.7	1.09	15	26*	
3517-3522	5	5	5				58					11	0.55			12	43.5	.44	83	35*	
			34										6.03								

RESERVOIR SUMMARY

_____ ft TO _____ ft.

	Zone 1		Zone 2	Zone 3
GROSS POROSITY DEVELOPMENT	8.0	Ft	4.0	34
NET RESERVOIR (PAY)	8.0	Ft	40	34
AVERAGE POROSITY (NET)	18.9	%	19.5	17.7
AVERAGE WATER SATURATION	-	%	-	19*

Appendix D-3

PETROPHYSICAL CONTROL

(1) POROSITY Sonic/Core Wells 11-19 and 7-18
(2) FORMATION WATER _____
(3) "FRF" RELATIONSHIP .033
(4) BASELOG FOR DEPTH _____
(5) I-Sw RELATIONSHIP - "n" _____

COMPANY Daly Gas Storage Ltd.
WELL Daly Gas#2 (11-19-10-27WI)
COUNTRY Daly, Manitoba
KB 1613 BHT 92°F
GL 1600 TOTAL DEPTH 4078

Mud pH - N.A.
Mud W.L. - 5.0 cc
Mud Rmf - 0.29 @ 64°F
Bit Size - 8 3/4"

intercomp

PETROPHYSICAL DATA

ANALYST C. B. Austin
DATE March 1977

FORMATION INTERVAL (4)	FT.	POR. DEV.	NET PAY	RAW LOG DATA: SP	GR	ρ_b	µ sec	SNP/CNL	CALCULATED POROSITY % from: ρ_b	µ sec	SNP/CNL	Avg. Core EFF ø %	O.B. Core ø h	KH øh-Sw	RESISTIVITY: Ro	Rt	(3) FRF	(2) Rw	I	(5) Sw %	REMARKS: LITHOLOGY - DST - HYDROCARBON INDICATION - ETC
Main Souris River Porosity 3537 (-1924)												O.B.		Atm.							
Zone 1								LST													Core #1 3484-3544 (Adjusted Depths)
3537-3541	4	3.4	3.4			2.56	63	15				8.8	0.30	5.29	6.5	6.5	64	2.1	3.1	57	
3341-3545	4	0	0	Dense																	Core #2 3544-3604 (Adjusted Depths)
3545-3551	6	6	6			2.30	81	14				22.0	1.32	1431.	45	45	13.3	.44	102	10	
3551-3558	7	0	0	Dense																	
		9.4	9.4										1.62	1436							
Zone 2 3558 (+1945)																					
3558-3562	4	3.8	3.8			2.30	83	23				25.9	0.99	278.	3.3	3.3	10.1	.33	9.9	32	
3562-3565	3	0	0	Dense																	
		3.8	3.8										0.99	278							
Zone 3 3565 (+1952)																					
3565-3568	3	3.2	0			2.60	58	23				8.7	0.28	7.7	1.9	1.9		2.1		100	
3568-3583	15	15.3	0			2.37	74	35				24.0	3.67	2836	0.35	0.35		.38		100	
3583-3597	12	11.7	0			2.63	56	20				13.3	1.56	788.2	2.7	2.7		1.04		62	
3597-3602	5	5.1	0			2.68	53	17				7.2	0.37	10.0	5.0	5.0		3.		77	
		35.3											5.88	3642							

Appendix D-4

RESERVOIR SUMMARY

3537 ft TO 3602 ft

MAIN SOURIS RIVER POROSITY

	Zone 1		Zone 2	Zone 3
GROSS POROSITY DEVELOPMENT	9.4	Ft.	3.8'	35.4'
NET RESERVOIR (PAY)	9.4	Ft	3.8'	0 '
AVERAGE POROSITY (NET)	17.2	%	25.9%	16.6%
AVERAGE WATER SATURATION	19	%	32 %	100 %

PETROPHYSICAL CONTROL

(1) POROSITY O.B. Core Analysis
(2) FORMATION WATER Rw = 0.033 @ 92°F
(3) "FRF" RELATIONSHIP m = -1.71
(4) BASELOG FOR DEPTH DIL
(5) I-Sw RELATIONSHIP-"n" n = -2.0 (est.)

COMPANY Daly Gas Storage Ltd.
WELL Daly Gas No. 3 10A-12-10-28 WIM
COUNTRY Daly, Manitoba
KB 1628.2 BHT 92°F
GL 1617 TOTAL DEPTH 3640

intercomp

PETROPHYSICAL DATA

ANALYST C. B. Austin
DATE September 19 77
PAGE 1 OF 1

FORMATION INTERVAL (4)	FT.	POR. DEV.	NET PAY	RAW LOG DATA SP	GR	ρ_b	µ sec.	SNP/CNL	CALCULATED POROSITY % from ρ_b	µ sec.	SNP/CNL	EFF. Ø %	Ø h	Øh Sw	RESISTIVITY Ro	Rt	(3) FRF	(2) Rw	I	(5) Sw %	REMARKS: LITHOLOGY - DST - HYDROCARBON INDICATION - ETC
Souris River Porosity 3504(-1876)																					DST #1 3512-3532 TO 5/90 SI 60/180
Zone 1								%LS			%Dol.										Nitrogen Gas to surface. Steady @ 6.85
3504-3508	4	3.5	3.5			2.51	70	9			3.0	13.0	0.46	.13		14				28	MMCF/D on 1¼" choke. No water.
																					FP 893/864/884 SIP 1527/1527
3512-3518	6	5.5	5.5			2.38	81	9			3.0	17.5	0.96	.11		50				11	Mud RMF 0.58 @ 70°F.
3518-3524	6	0	0	Shale and Anhy.																	
Zone 2																					
3524-3530	6	5	5			2.33	75	12			5.0	20.0	1.00	.17		17				17	
Zone 3	Net	14	14								Net	Øh	2.42	.41							Rt/RILD = 0.83.
3533-3536	3	2	0			2.60	70	29				14.5			1.2	1.0				95	
3536-3543	7	7	0			2.48	72	35				21.0			0.6	0.5				98	
3542-3549	6	6	0			2.39	75	36				25.5			0.31	0.26				100	
3549-3552	3	3	0			2.52	70	31				18.8			0.7	0.6				100	
3552-3561	9	7	0			2.59	64	27				15.0			1.2	1.0				100	
3561-3568	7	7	0			2.65	57	22				12.0			2.7	2.3				100	

Appendix D-5

RESERVOIR SUMMARY

3504 ft TO 3568 ft — Main Souris River Porosity

	Zone 1		Zone 2	Zone 3
GROSS POROSITY DEVELOPMENT	9	ft	5'	32'
NET RESERVOIR (PAY)	9	ft	5'	0'
AVERAGE POROSITY (NET)	15.8	%	20.0%	17.9%
AVERAGE WATER SATURATION	17	%	17%	100%

PETROPHYSICAL CONTROL

(1) POROSITY CNL-FDC - Corr. for Gas & Lith
(2) FORMATION WATER 0.033 @ 92°F
(3) "FRF" RELATIONSHIP m = -1.71
(4) BASELOG FOR DEPTH DIIL
(5) I-Sw RELATIONSHIP - "n" n = -2.0

COMPANY Daly Gas Storage Ltd.
WELL 8-14-10-28WIM
COUNTRY Manitoba
KB 1636 BHT 92°F
at at
GL ____ TOTAL DEPTH 3642

intercomp

PETROPHYSICAL DATA

ANALYST N. M. Thachuk
DATE March 16 19 77
PAGE 1 OF 1

FORMATION INTERVAL (4)	FT.	POR. DEV.	NET PAY	RAW LOG DATA SP	GR	ρ_b	µsec	CPS SNP/CNL	CALCULATED POROSITY % from ρ_b	µsec	SNP/CNL	EFF ø %	ø h	øh Sw	RESISTIVITY Ro	Rt	(3) FRF	(2) Rw	I	(5) Sw %	REMARKS: LITHOLOGY - DST - HYDROCARBON INDICATION - ETC
Main Souris River Porosity (3562) Zone 1																					
3562-3565	3	0		Dense																	
3565-3567	2	2						224				13*	0.26								* Porosity values are tentative being
3567-3570	3	0		Dense																	based on dense anhydrite and
3570-3573	3	3						185				22	0.66								core max porosities per zone indexed
3573-3575	2	0		Dense																	to minimum/maximum zone readings in
3575-3577	2	2						199				19	0.38								this well.
		7											1.30								
Zone 2																					
3577-3582	5	0		Dense																	
3582-3584	2	2						199				19	0.38								
3584-3587	3	3						189				19	0.57								
3587-3589	2	0		Dense									0.95								
		5																			
Zone 3																					
3589-3594	5	4						217				15	0.60								
3594-3603	9	9						189				19	1.71								
3603-3606	3	3						242				11	0.33								
3606-3611	5	5						227				13	0.65								
3611-3614	3	0		Dense																	
3614-3616	2	2						217				15	0.30								
3616-3620	4	4						249				10	0.40								
3620-3623	3	3						259				8	0.24								
		30											4.23								

RESERVOIR SUMMARY

____ ft TO ____ ft	Zone 1	Zone 2	Zone 3
GROSS POROSITY DEVELOPMENT	7 ft.	5'	30'
NET RESERVOIR (PAY)	– ft	–	–
AVERAGE POROSITY (NET)	18.5* %	19.0*%	14.1*%
AVERAGE WATER SATURATION	%		

PETROPHYSICAL CONTROL

(1) POROSITY
(2) FORMATION WATER
(3) "FRF" RELATIONSHIP
(4) BASELOG FOR DEPTH
(5) I-Sw RELATIONSHIP - "n"

APPENDIX C

APPENDIX 'C'

DALY GAS STORAGE LTD.

STUDY OF CUSHION GAS REQUIREMENTS

METHODOLOGY AND RESULTS

A preliminary study has been made of the feasibility of using the Daly Field for the purpose of gas storage. This study consisted of a review of the geological data and the production test data in order to provide a reservoir model description which can be used to study the effects of the in-situ mixing of the native gas with the storage gas, the cushion gas requirements and the optimum reservoir pressure level at which to start injecting the storage gas.

For the reservoir simulation study, it was postulated that the study could be done on one zone and the results interpreted and applied to the other zones. Therefore, only the upper zone was modelled to determine the effects of mixing native and storage gases. Due to the shape and structure of the reservoir and to minimize cost an element of symmetry consisting of ¼ of the reservoir was simulated. In this way maximum resolution of the mixing effects could be achieved with fewer grid cells. It was assumed that the total reservoir would contain 14 BSCF of nitrogen originally-in-place and that this reservoir would cycle 8.900 BSCF of gas per year at injection and production rates of 50 MMSCF per day.

Three different operating schemes were investigated. The first two schemes assumed injection and production would take place only in the central portion of the reservoir with initial blow-down of 56.5% and 76.2% of the original gas-in-place respectively. The third scheme assumed that injection and production would take place on larger well spacing in the reservoir and that in-

itial blow-down would be 56.5% of the original gas-in-place (as in the first scheme).

The results of the model predictions indicate a high degree of mixing of the native and storage gases in all cases. Even in the most optimistic case (i.e., 76.2% initial blow-down), the produced gas stream is only 78% storage gas at the end of the first cycle and 89% storage gas at the end of the fifth producing cycle. Spreading of the production wells, investigated in case three, results in a more gradual increase in the fraction of native gas produced (nitrogen) with a lower final fraction of native gas. It also results in a smaller pressure gradient across the field which, by itself, would provide an operating advantage in well injectivity/deliverability and in maintaining caprock integrity.

All results obtained indicate that the mixing of the gas will be important to the success of the scheme. The degree to which the lower Btu content can be tolerated will dictate the need to consider and optimize the blow-down level of the native state gas. Associated with this is increased costs to replace the native gas with cushion gas to ensure the scheme can be operated at a reasonable pressure level.

CONCLUSIONS

1. If the storage scheme is implemented without blowing down the nitrogen, there will be substantial mixing of storage gas with any native gas remaining in the reservoir. This precludes the use of any significant quantity of nitrogen as cushion gas unless either the nitrogen can be economically separated at the surface, or the requirements for high Btu content gas in the sales gas stream are not restrictive, or the Btu content of the gas can be supplemented by injection of hydrocarbon liquids.

2. Continued operation of the storage scheme will result in clean up of the storage gas as a consequence of the extensive mixing of the native and storage gases such that the produced gas composition will approach 100% storage gas with an increasing number of operating cycles.

3. The cushion gas requirements and operating pressure levels must be determined consistent with the reservoir storage capacity, the flow capacity, the well spacing and completion design, the compression facilities (for both production and injection) and the projected production.

4. There is a high degree of uncertainty regarding the extent of each of the three reservoirs. The uncertainty includes both the amount of gas originally-in-place and the size of the associated aquifers.

5. Assuming a reservoir pressure cycle of 700 psia to 2200 psia, an original gas-in-place of 14.0 BSCF of nitrogen and a volumetric reservoir, the cushion gas requirements would be 7 BSCF of storage gas and the working gas capacity would be 18 BSCF of storage gas. This working gas capacity

would allow an average deliverability of 190 MMSCFD over a 100 day period. Either zones one or three would therefore provide sufficient storage capacity to meet the proposed 5 BSCF working gas requirement. It is important that the facilities be designed to meet peak demand towards the end of winter when demand can still be very high but the reservoir pressure has already been drawn down to meet early and mid-winter demand.

6. In the crestal injection cases investigated, the flow capacity of the modelled reservoir is not high enough to allow production of the rates imposed upon the model. This indicates that any storage scheme using zone one and requiring high producing rates will require a combination of operating conditions involving a high volume of cushion gas (high end of season pressure) and a large number of wells spread over a large area of the pool.

7. If it is decided to blow down the original field as far as practical, the required additional studies to design and optimize the storage system can be done using a gas-water or dry gas model which would be less expensive than using the compositional model. The choice of the model would depend on the perceived influence of the aquifer system on the reservoir performance.

8. Zone three (well 15A-18) has the highest flow capacity. This higher flow capacity may provide operational advantages for any storage scheme implemented if further testing confirms the potential of this zone for storage.

RECOMMENDATIONS

At this point, further pursuit of the design of a gas storage facility in the Souris River formation in the Daly Field requires obtaining additional information in three areas. These are:

1. the tolerance of the producing stream to nitrogen content,
2. the caprock integrity,
3. the reservoir definition.

It is recommended that these areas be evaluated as follows:

A. Nitrogen Fraction in Producing Stream - ascertain the nitrogen fraction that can be tolerated in the producing stream either through direct acceptance by the pipeline or surface separation to acceptable levels.

B. Caprock Integrity - whole core permeability measurements on samples of the caprock in order to establish safe upper reservoir pressure operating limits.

C. Reservoir Definition - run production and buildup tests on zones one and three only while monitoring the pressure in zone two. These tests should be conducted in a manner which will allow definite determination of the amount of aquifer influence on the system and the effects of the draw-downs on zone two.

APPENDIX D

APPENDIX 'D'

DALY GAS STORAGE LTD.

STATEMENT OF EXPLORATORY DRILLING AND DEVELOPMENT COSTS
1976 to 1981

1976	1977	1978	1979	1980	1981	Total December 31, 1981
16,768	$ 82	$(2,937)	$(3,726)	$(4,021)	$(4,557)	$ 1,609
	734	2,936	-	210	-	19,192
	40	1,100	1,500	1,000	800	7,310
	1,522	5,474	5,527	5,528	8,889	44,945
	809	1,846	8,866	4,264	2,348	19,050
	-	2,958	4,000	35,752	-	42,710
	$3,187	$11,377	$16,167	$42,733	$7,480	$134,816
	$62,833	$15,083	$134	$158	-	$244,894
	100,377	16,517	262	248	-	256,193
	143,230	35,817	261	249	-	179,557
	108,969	34,702	154	244	-	144,069
	-	109,294	164	232	-	109,690
	$415,409	$211,413	$975	$1,131	-	$934,403
	$418,596	$222,790	$17,142	$43,864	$7,480	$1,069,219

DALY GAS STORAGE LTD.

DETAIL EXPENDITURES 1976 - 1981
WELLS 1 AND 2

	1976	1977	1978	1979	1980	1981	Total December 31, 1981
Well No. 1 (7-18-10-27)							
Preliminary Work	$3,302	$3,412	$1,515	-	-	-	$8,229
Surface Casing & Cementing	13,430	-	-	-	-	-	13,430
Drilling	84,831	5,062	-	-	-	-	89,893
Service & Supplies - Drilling	31,539	14,047	-	-	-	-	45,586
Geological & Engineering	-	27,157	-	-	-	-	27,157
Miscellaneous	-	650	-	-	-	-	650
Production Casing & Cementing	7,372	(259)	-	-	-	-	7,113
Services & Supplies - Completion	9,032	12,497	(61)	-	-	-	21,468
Production Equipment	17,180	267	2,456	-	-	-	19,903
Reservoir Testing	-	-	11,173	133	159	-	11,465
Total Well No. 1	$166,686	$62,833	$15,083	$133	$159	-0-	$244,894
Well No. 2 (11-19-10-27)							
Preliminary Work	$2,300	$4,461	$2,310	-	-	-	$9,071
Surface Casing & Cementing	19,763	6,270	-	-	-	-	26,033
Drilling	70,094	9,936	-	-	-	-	80,030
Service & Supplies - Drilling	7,798	31,460	-	-	-	-	39,258
Geological & Engineering	-	16,034	-	-	-	-	16,034
Miscellaneous	-	650	-	-	-	-	650
Production Casing & Cementing	28,627	6,581	-	-	-	-	35,208
Services & Supplies - Completion	-	17,372	(62)	-	-	-	17,310
Production Equipment	10,207	7,613	3,266	-	-	-	21,086
Reservoir Testing	-	-	11,003	262	248	-	11,513
Total Well No. 2	$138,789	$100,377	$16,517	$262	$248	-	$256,193

DALY GAS STORAGE LTD.

DETAIL EXPENDITURES 1976 - 1981
WELLS 3 AND 4

	1976	1977	1978	1979	1980	1981	Total December 31, 1981
Well No. 3 (10-12-10-28)							
Preliminary Work	-	$3,501	$1,500	-	-	-	$5,001
Surface Casing & Cementing	-	12,888	-	-	-	-	12,888
Drilling	-	44,839	-	-	-	-	44,839
Service & Supplies - Drilling	-	15,394	349	-	-	-	15,743
Geological & Engineering	-	4,986	916	-	-	-	5,902
Miscellaneous	-	-	-	-	-	-	-
Production Casing & Cementing	-	24,832	445	-	-	-	25,277
Services & Supplies - Completion	-	20,185	10,682	-	-	-	30,867
Production Equipment	-	16,605	7,820	-	-	-	24,425
Reservoir Testing	-	-	14,105	261	249	-	14,615
Total Well No. 3	-	$143,230	$35,817	$261	$249	-0-	$179,557
Well No. 4 (10-7-10-27)							
Preliminary Work	-	$3,278	$2,513	-	-	-	$5,791
Surface Casing & Cementing	-	10,763	-	-	-	-	10,763
Drilling	-	44,245	-	-	-	-	44,245
Service & Supplies - Drilling	-	15,944	1,145	-	-	-	17,089
Geological & Engineering	-	2,676	3,312	-	-	-	5,988
Miscellaneous	-	-	-	-	-	-	-
Production Casing & Cementing	-	26,052	516	-	-	-	26,568
Services & Supplies - Completion	-	88	8,507	-	-	-	8,595
Production Equipment	-	5,923	10,431	-	-	-	16,354
Reservoir Testing	-	-	8,278	153	245	-	8,676
	-	$108,969	$34,702	153	245	-0-	$144,069

DALY GAS STORAGE LTD.

DETAIL EXPENDITURES 1976 - 1981
WELL 5

	1976	1977	1978	1979	1980	1981	Total December 31, 1981
Well No. 5 (15A-18-10-27)							
Preliminary Work	-	-	$4,605	-	-	-	$4,605
Surface Casing & Cementing	-	-	-	-	-	-	-
Drilling	-	-	19,585	-	-	-	19,585
Service & Supplies - Drilling	-	-	15,925	40	-	-	15,965
Geological & Engineering	-	-	2,895	-	-	-	2,895
Miscellaneous	-	-	-	-	-	-	-
Production Casing & Cementing	-	-	21,353	-	-	-	21,353
Services & Supplies - Completion	-	-	8,501	-	-	-	8,501
Production Equipment	-	-	23,394	-	-	-	23,394
Reservoir Testing	-	-	13,036	124	232	-	13,392
Total Well No. 5	-0-	-0-	$109,294	$164	$232	-0-	$109,690