IMPROVED RECOVERY IN THE NATURALLY-FRACTURED QUEENSTON FORMATION USING GEOLOGIC/ENGINEERING ANALYSIS AND DEVIATED WELL TECHNOLOGY

Final Report

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Notice

Abstract

The gas industry has drilled and completed hundreds of vertical wells during the past 10 years into the Queenston sandstone formation in the Auburn Field in Seneca and Cayuga Counties, New York. Initial production rates and long-term ultimate recoveries vary significantly between wells despite similar openhole log profiles and stimulation treatments. The Queenston formation is generally believed to be a "tight", gas-bearing formation with marginal economics. Preliminary production mapping illustrates high productivity fairways exist in certain portions of the Auburn Field. Cursory analysis suggests these fairways are caused by natural fracture patterns, which provide higher permeability than the matrix permeability. Encountering natural fractures may be the difference between an economic and an uneconomic well. Despite the abundance of step-out and infill well locations, there is little if any new well development in this formation due to the low gas prices and the unpredictability of intersecting natural fractures with vertical wellbores.

The primary overall project goal is to demonstrate technology that will lead to New York oil and gas producers drilling additional deviated wells in the future with improved recoveries. The purpose of drilling deviated wells is to encounter additional natural fracture patterns not intersected in vertical wells. This study will quantify the natural fracture orientation and density in the Auburn Field and the production to be gained by drilling deviated wells compared to vertical wells. The geologic/engineering study will evaluate optimal well placement for step-out and infill wells in the Auburn Field. Other New York naturally-fractured formations shall be identified and the technology will be disseminated to operators quickly.

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Summary

This report summarizes an evaluation performed by Schlumberger Holditch–Reservoir Technologies Consulting Services (H-RT), regarding drilling deviated wells through the Queenston formation in the Fayette-Waterloo gas field in Seneca County, New York. Meridian Exploration Corp. (Meridian) drilled the Freir #1 well in an attempt to encounter additional natural fracture patterns not intersected in vertical wells. The Queenston formation is generally believed to be a "tight", gas-bearing formation with marginal economics. Numerous vertical wells were drilled in this field prior to the Freir well with extremely variable production responses after hydraulic fracturing. The response was attributed to variable, and possibly, anisotropic natural fracture systems. A geological evaluation combined with engineering analysis was performed to determine the best location for the deviated well. The location was selected in an area that contained natural fractures and the reservoir had not been depleted.

The well was designed to be drilled at an angle of 40 degrees from vertical in a cross-strike direction (southeast) perpendicular to the main natural fracture orientation. The primary natural fracture direction was estimated based on lineament analysis and production data analysis.

The well was drilled to a measured depth of 2,812 ft (2,350 ft true vertical depth) and encountered no natural gas shows. Review of the directional drilling data indicated the wellbore deviation angle was less than 30 degrees through the Queenston formation. Considering the lack of natural gas shows and the deviation being less than the planned 40 degrees, the decision was made to sidetrack the well in the same direction. The sidetrack wellbore reached a measured depth of 3,006 ft (2,320 ft true vertical depth) and angle was maintained at over 40 degrees through the Queenston. The new wellbore also encountered no natural gas shows.

Conventional openhole geophysical logs were run along with a Formation Micro Scanner™ (FMS) log to identify any possible natural fractures. Fourteen small fractures were identified by the FMS log and all appeared to be very small and healed. Meridian decided not to stimulate or complete the well and it was plugged on September 15, 1997. The project results suggest that even though natural fractures were present, stimulation treatments must be performed to make an economic well.

1 INTRODUCTION

The Fayette-Waterloo gas field is located in the Finger Lakes Region of Central New York at the northern terminus of Cayuga, and Seneca Lakes (**Figure 1**). The field is located in Seneca County, southeast of the Town of Geneva encompassing a large portion of Fayette and Varick Townships. The Upper Ordovician Queenston formation is the major natural gas producing reservoir within this field and is encountered at a depth of 2,000 ft to 2,500 ft. Arial extent of the field is approximately 20 square miles.

The objective of the geologic evaluation is to develop a geologic model for the Queenston formation in the Fayette-Waterloo field using the available surface and subsurface data. The interpretation developed by the geologic model was combined with engineering analysis to select a location for drilling a deviated wellbore. At the project beginning, it was hoped that new core data could be obtained in the deviated wellbore to supplement the model by providing a matrix description and a better understanding of the natural fracture components of the Queenston formation. The core was not cut by the operator due to budget constraints. An FMS log was run to identify the natural fractures encountered.

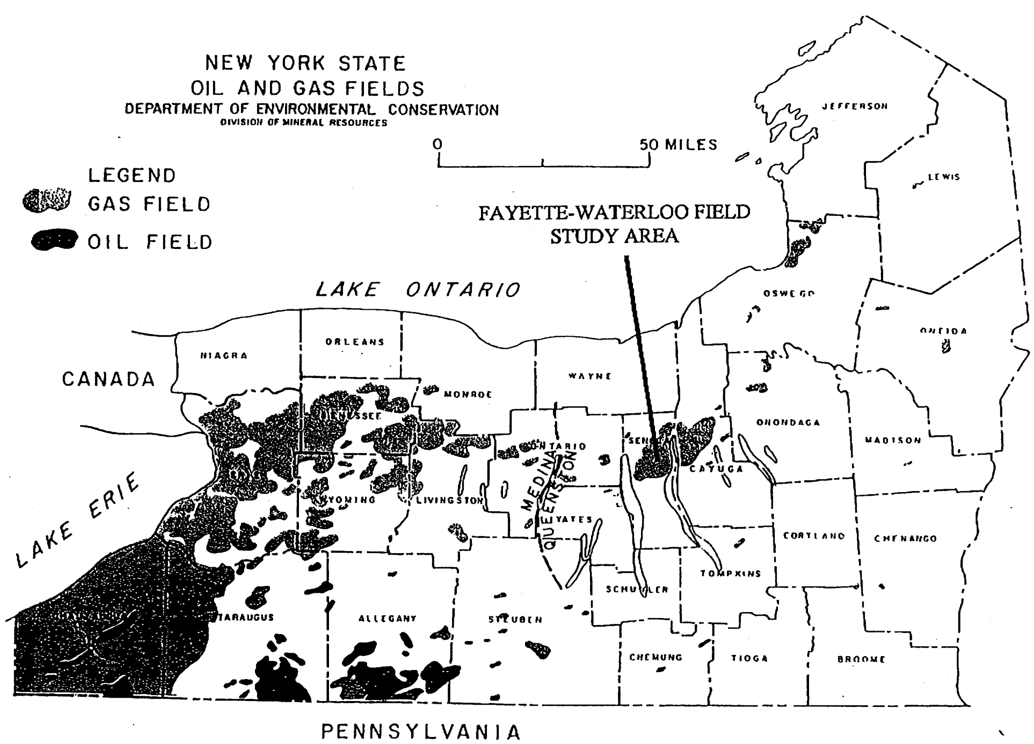


Figure 1 – Location of the Fayette-Waterloo gas field.

2 GEOLOGY

Seneca County is situated up-dip, on the northern flank of the Appalachian Basin. The regional structure in this area of the basin strikes east to west with a homoclinal dip to the south at 40 ft –50 ft per mile. Indicative of a subtle regional anomaly, local structural strike within the field area deviates to a northwest-southeast orientation in Seneca County. Structural folds indicative of closure or faulting at the Queenston horizon are not evident within the field. However, minor interruptions in regional dip indicate possible fracture traces, which may result from basement faulting, and may create important zones of secondary permeability. The fracture traces or trends are postulated to occur in response to two factors.

One of the postulated influences on fracturing is the structural condition of the pre-Cambian Basement through the Ordovician Trenton interval. Although seismic data is not available, aeromagnetic data and regional mapping indicate the postulated occurrence of basement structures including reactivation of basement faults occurring throughout Ordovician and Silurian deposition. This type of feature is believed to have influenced field production. Basement faults create numerous fissures and micro-fractures, which enhance reservoir permeability. Another likely cause of reservoir fracturing is isostatic rebound (i.e., vertical readjustment) resulting from the retreat of Pleistocene-age glaciers and its associated erosion, mass unloading, and weight removal of post-Devonian-age sediments.

Individual fracture planes have high-angle or near vertical dips and originated post-depositionally and contemporaneously with crustal unloading and deep-seated structural activity. These tectonic activities had an effect on production. **Figure 2** shows the date each well was drilled in two groups – prior to mid-year 1988 or after. In the Fayette-Waterloo field, the tectonic influence is reflected in narrow fracture trends which is evident on **Figure 3,** a “First Year Color-Filled Production Map”. High productivity wells align in a series of northeast to southwest trends and the better producing wells within individual trends align northwest to southeast. **Figure 4** shows the same data in a bubble format, (i.e., larger bubbles represent a better first year performance). The alignment of these productive trends is probably due to conjugate sets of fractures with the primary set aligned NE-SW and the secondary set aligned NW-SE. Wells drilled at the intersection of the two fracture trends provide the highest production in the field.

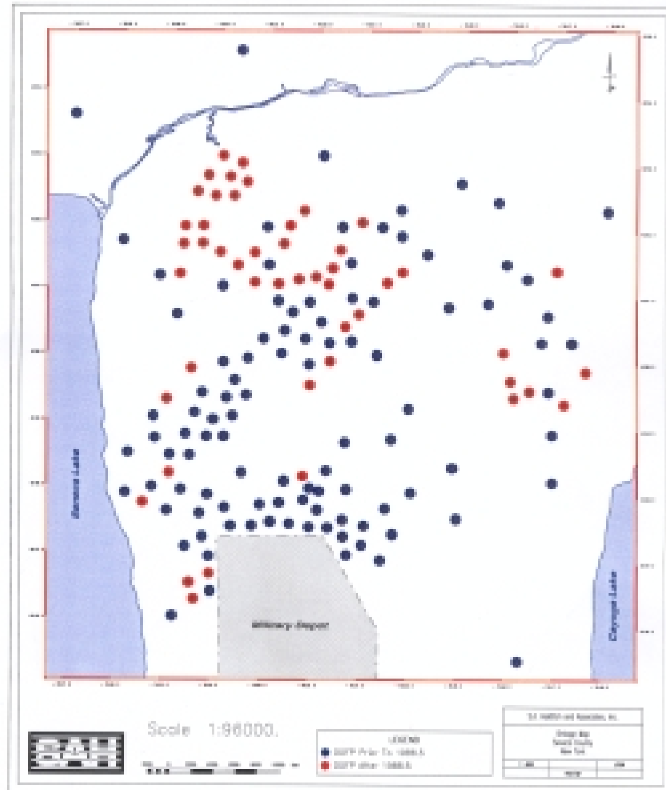


Figure 2 – Date wells drilled prior to mid-1988 or after.

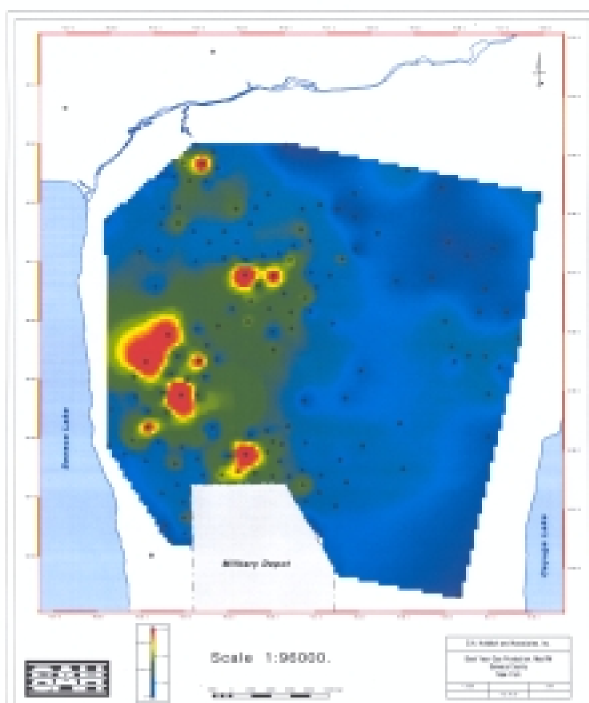


Figure 3 – First year color-filled production map.

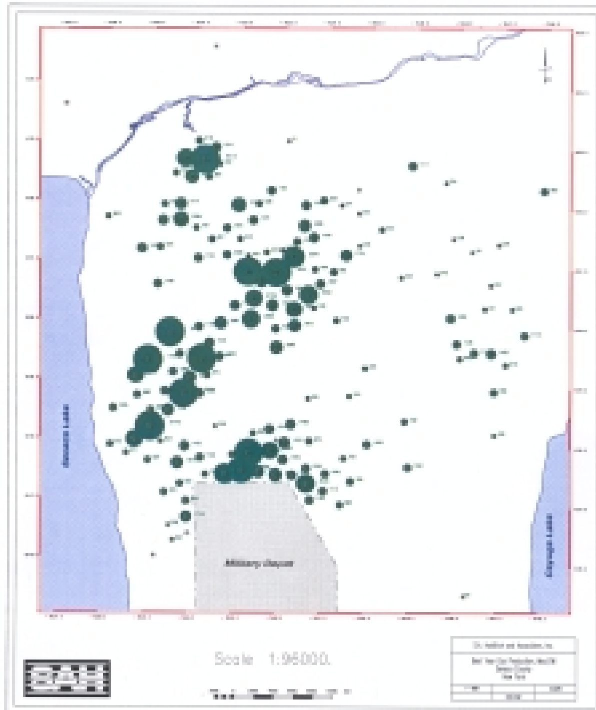


Figure 4 – First year bubble format production map.

Upper Ordovician clastics entered the Appalachian depositional basin during the medial pulse of the Teconic Orogeny. The Queenston formation represents the uppermost section of Ordovician sediments preserved in the area and is composed of multiple stacked channel deposits. Due to the angler nature of the quartz matrix it is evident that deposition occurred in a fluvial environment with only limited reworking of matrix material. The streams and rivers in which the channels developed flowed over a low gradient coastal plain close to sea level. The sands and shales of the Queenston were derived from the reworking and recycling of previously lithified sedimentary sequences originating from the highlands to the east. These materials were eroded and transported westward toward into the inland basin.

The producing zones are channel lag deposits and vary from braided fluvial to tidal inlet sands. The slope of the ancient plain and shallow, near-shore marine region was very gentle and sea level changes had a tremendous affect on reservoir distribution. These eustatic fluctuations influenced erosion in depositional cycles resulting in attrition during stages of low seal level, followed by channel-fill deposition during periods of higher sea level. This cycle of erosion and subsequent deposition created the stacked channel deposits that make up the Queenston formation.

Disconformably overlying the Queenston is the lower Silurian Medina Group. Though the Queenston extends 800 ft below the unconformity, only the uppermost 300 ft contain the enhanced porosity intervals that comprise the reservoir in the Fayette-Waterloo field. Hydrocarbon production from depths greater than 300 ft below the unconformity is rare. The disconformable contact between the Queenston and Medina progressively truncates updip in the older stratigraphic beds within the Queenston. Truncation on upper Queenston sediments reduced the amount of reservoir available for hydrocarbon production. Common pay zones typically occur in the same stratigraphic units from well to well. Reservoir quality within the stratigraphic units is heterogeneous with significant changes in porosity occurring from well to well. During depositional periods of great sediment supply, the sand are cleaner and thicker. Subsequent decrease in supply allowed for weathering and reworking of the sediments and resulted in higher porosity in these zones. The type log prepared for this report clearly illustrate the porous units that are locally designated as units 1, 1A, 2 and 2A (**Figure 5**).

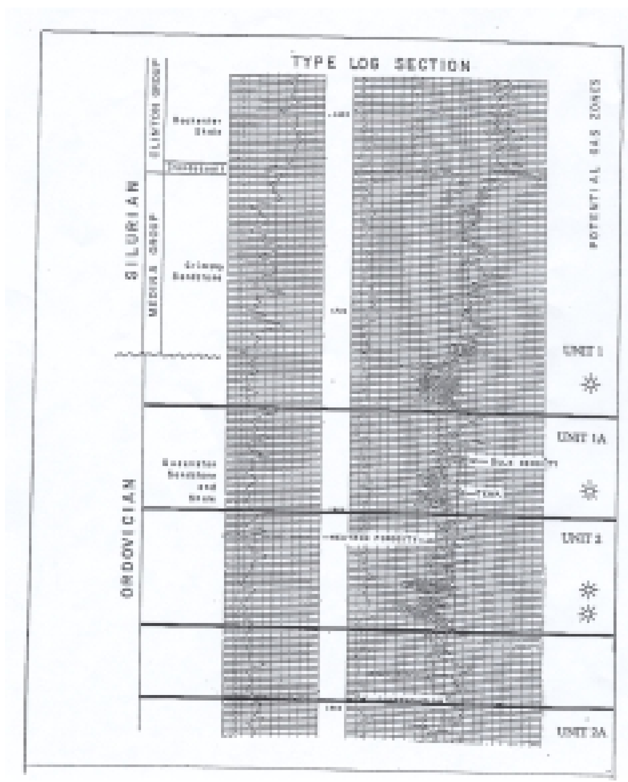


Figure 5 – Type log with porous units illustrated.

Reservoir aspects of the Queenston formation in the Fayette-Waterloo field are primarily related to fracture enhancement of the reservoir. Porosity intervals encountered in the field occur in stacked units which are correlative throughout the field. However, the sand units generally develop low permeability and do not provide significant production of hydrocarbon without fracture enhancement of the reservoir. The primary productive controls in the field are provided by narrow fracture trends. Production within the fracture trends has occurred from the Queenston sandstone, Medina sandstone, Sodus shale, and Rochester shale. Natural shows of gas occur within the fracture trend with five wells producing at economic rates without the aid of hydraulic fracturing. However, not all wells with natural shows produce at economic rates.

Numerous maps were constructed for the project. These maps were utilized in an attempt to develop a relationship between the mapped parameter(s) and well production. Net pay maps of porosity units 1, 1A, 2, and 2A were developed. The units were mapped based on net feet of pay with a bulk density reading of 2.45 gm/cc or less. Using this density cutoff enables for high-grading areas with attractive porosity development, and provides definition of channel geometry. The net pay thickness decreases with lower stratigraphic intervals. Unit 1 is at the top of the Queenston and contains on average more net pay than units 2 or 2A. A map of all four pay zones was also developed using the same net pay cutoff (**Figure 6**). A structure map on the top of the Queenston formation was constructed using a contour interval of 20 ft (**Figure 7**) and clearly shows the structure dipping to the south-southwest. Production trends can be seen on the map of best year production. This map used actual production data for the best twelve months a well produced (**Figures 3** and **4**). Review of the net pay and structure maps shows little correlation between production trends and net pay, however there is a significant correlation between production trends and structure. The higher productive wells are located on, or near, high structure anomalies.

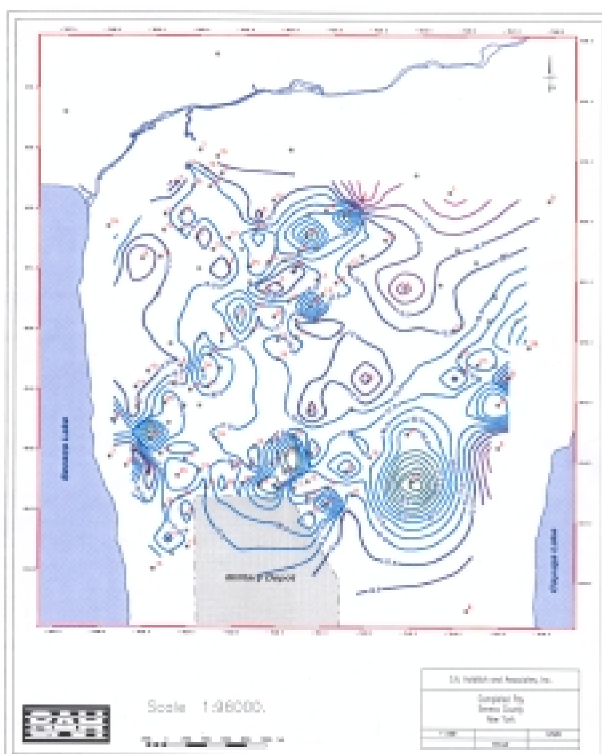


Figure 6 – Queenston formation net pay map.

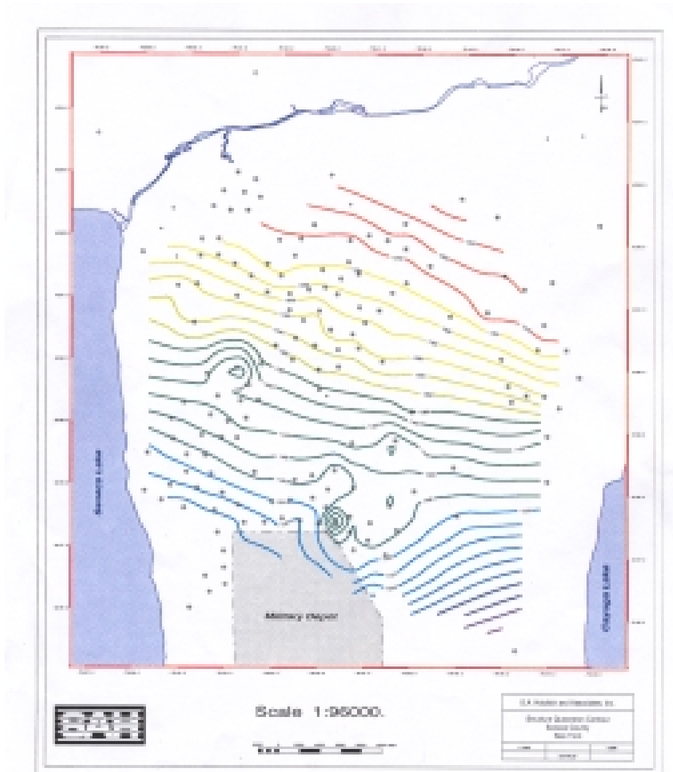


Figure 7 – Queenston formation structure map.

Cross-sections correlating the pay units were constructed in order to identify faulting within the stratigraphic section (not included in report). Two cross-sections traverse northwest to southeast and the third section traverses in a northeast to southwest direction. The sections show the stratigraphic position of the porous units within the Queenston and reveal no indication of sudden changes in unit thickness resulting from faulting. Based on the review of these sections it is concluded that no significant faults dissect the Queenston horizon within the Fayette-Waterloo gas field.

Stream course lineaments were identified and included on a map containing outlines of the drainage system divides (**Figure 8**). Stream course lineaments are apparent when several stream courses aligned in a linear fashion, or where individual streams maintain a linear pattern over a significant distance. The map indicates a correlation between a single productive trend and a stream course lineament through this correlation does not hold true for all of the productive trends identified on the Best Year Production map. Several lineaments are associated with poor producing wells and some production trends are not associated with a lineament. Primary drainage is northward parallel to Seneca and Cayuga Lakes and into the Seneca River which flows between the northern terminuses of the lakes.

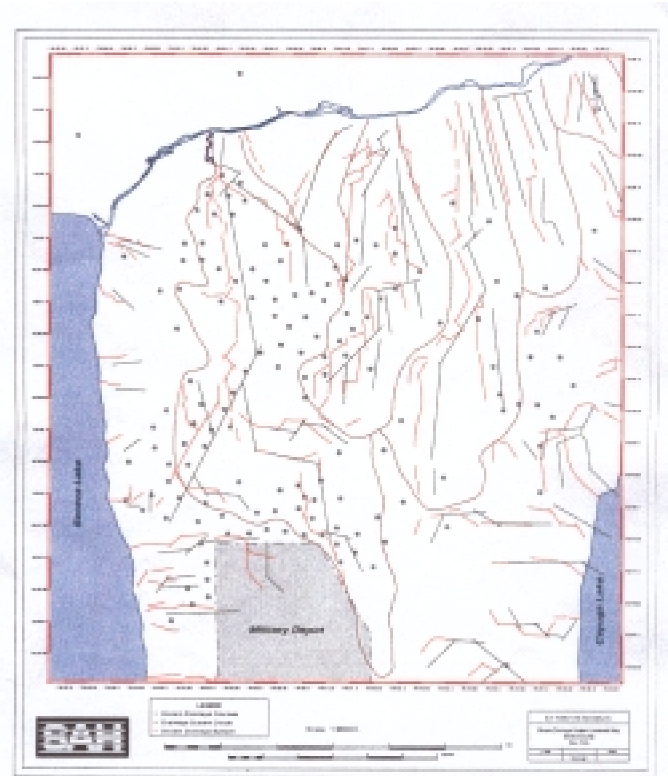


Figure 8 – Stream course lineaments and drainage system divides map.

The reservoir description was developed using old core data of the Queenston formation. This information was available in the Fayette-Waterloo field and the West Auburn field, (located in Cayuga County, just east of the Fayette-Waterloo field). The reservoir is a reddish brown, very fine to medium grained, hematite stained, quartz arenite containing over 70% subrounded to subangular grains. Authigenic clay coats the intergranular pore spaces and comprises an additional 20%. The remaining 10% of the rock includes fragments of feldspar, chert, quartz overgrowth, and dolomite cement. Small amounts of salt minerals (0.5% to 2%) were noted on one core analysis.

Hematite is the most significant mineral from a reservoir evaluation standpoint and forms on sand grains and fringes of clay particles from oxidation of iron-bearing grains within the Queenston. The presence of this iron-bearing mineral has a considerable affect on geophysical well logs, particularly when determining formation water saturations. Iron bearing minerals usually conduct electrical current, thereby artificially lowering resistivity measurements used to calculate formation water saturations. The low resistivity measurement from conventional resistivity logs prevent an accurate determination of reservoir water saturation.

As stated early, the upper 300 ft of the 800 ft thick formation contains sufficient porosity to be of reservoir quality. The higher porosity found in the Upper Queenston is due primarily to presence of illite and lack of secondary silica overgrowths. The primary cause of porosity preservation is also the major inhibitor of permeability. Illite found in the Queenston inhibits permeability and retards the flow of fluids through the pore spaces. Unfortunately, these same illite clays greatly reduce the ability of gas flow to the wellbore particularly if completion fluids are held by the clay particles.

The reservoir displays effective porosity values generally averaging less than 10%, however, total porosity commonly exceeds 10%. The permeability is low at less than 1.0 md.

Geophysical logs were analyzed by Meridian's geologist for selected wells to support production data analysis conducted by S. A. Holditch & Associates, Inc. The logs were evaluated for porosity, net feet of pay, and water saturation as shown in **Table 1**. An initial group of 47 wells were evaluated with an additional group of fourteen wells evaluated as a follow-up to the initial evaluation. Porosity and gas saturation determination was conducted using the density-resistivity method of analysis specific to air-filled wellbores. Shaly formation evaluation utilizing a dual-water model was then applied to the total porosity and total water saturation values to provide effective porosity and water saturation values. The values for the effective porosity and water saturation, utilizing a five percent porosity cutoff, were provided for analysis. As noted previously during the discussion of reservoir description, the Queenston formation contains iron-bearing minerals that will artificially raise water saturation values calculated from log analysis. Therefore, values for water saturation as calculated from geophysical well logs would be greater than actual reservoir water saturations. Resolution of the log calculated versus actual water saturation will require additional formation coring and detailed laboratory analysis, which exceeds the scope of this project.

As previously mentioned, the best production in the Fayette-Waterloo gas field appears to be controlled by natural fracture systems. The fractures planes are believed to be high angle, approaching vertical and oriented in a northeast to southwest direction. Wells that encounter the fracture system exhibit attractive production characteristics occasionally associated with high natural flow rates (up to 10,000 Mcf/D). Several fracture trend wells produced over 100 MMcf of gas during the first year of production. On average, production from fracture-trend wells in the Fayette-Waterloo Field approaches 50 MMcf of gas during the first year of production. Wells drilled outside the fracture trends average less than 15 MMcf of gas during the first year of production.

Table 1
Summary of Geophysical Log Evaluation

			TOTAL WELL									
PERMIT NO.	WELL NAME	MEC NO.	EFFECTIVE POR-FT	WEIGHT-AVE Sw	ZONE POR-FT	ONE Sw	ZONE POR-FT	ONE A Sw	ZONE POR-FT	TWO Sw	ZONE POR-FT	TWO A Sw
20523	LARSEN 2	818	0.95	43%	0.48	40%	0.19	41%	0.29	49%		
20524	SIGRIST 2	819	2.35	41%	0.75	41%	0.97	37%	0.42	49%	0.21	42%
20526	SHAFFER 2	821	3.46	40%	1.57	38%	0.96	35%	0.94	48%		
20102	HURST 1	968	3.31	39%	1.57	32%	0.6	43%	1.14	45%		
20700	KEEFER 1	970	2.7	52%	1.22	53%	0.37	48%	0.8	51%	0.31	57%
21241	SAELI 1	982	3.27	50%	0.97	46%	1.18	50%	0.63	52%	0.5	58%
20707	CLEMENS 2	991	2.38	54%	0.63	50%	0.2	55%	1.56	55%		
20708	FREIR	994	3.16	46%	1.03	41%	0.75	46%	1	51%	0.38	47%
21258	FREIR	995	0.78	44%	0.58	44%			0.19	45%		
21248	HURRIN 1	1001	1.88	55%	0.44	48%	1.01	56%	0.44	58%		
21233	DEWALL 3	1004	1.82	42%	1.04	38%			0.79	48%		
21369	STEIN	1016	1.62	44%	0.47	42%	0.38	41%	0.58	47%	0.18	47%
21249	CHRISTENSEN 1	1018	4.55	41%	1.33	34%	1.35	41%	0.83	44%	1.05	49%
20627	P. SIGRIST 3	1041	1.78	38%	0.83	40%	0.41	33%	0.54	40%		
20628	P. SIGRIST 4	1042	0.7	45%	0.28	45%			0.42	45%		
20629	LARSON 3	1059	2.36	43%	0.83	37%	0.8	46%	0.74	47%		
20683	P. SIGRIST 6	1066	0.97	48%	0.48	46%	0.18	50%	0.31	50%		
21352	KIME	1123	1.57	39%	1.11	37%	0.27	50%	0.19	42%		
21297	CHRISTENSEN 2	1125	1.22	41%	0.57	35%			0.65	45%		
21387	PRATT	1126	2.75	43%	1.28	40%	0.42	40%	1.05	48%		
21250	LYND 2	1128	1.02	41%	0.82	39%	0.2	48%				
21236	SWARTLEY 1	1131	1.05	45%	0.86	44%	0.2	49%				
21269	JOHNSON 1	1135	1.49	56%	1.09	56%	0.41	54%				
21293	D. J. FARMS	1158	2.84	46%	1.15	46%	0.45	51%	1.24	45%		
21286	JENSEN 1	1160	2.29	45%	0.41	36%	0.41	43%	1.29	48%	0.18	47%
21298	R. JENSON 2	1173	1.51	39%	0.44	35%	0.52	39%	0.54	42%		
21355	MARTIN	1187	0.84	37%	0.84	37%	0.69	47%	0.77	58%		
21315	T. E. LARSON	1194	2.45	43%	0.56	43%	1.06	45%	0.48	46%	0.35	37%
21319	JENSEN	1200	2.04	40%	1.25	39%	0.39	44%	0.4	42%		
21232	ROBSON	1201	0.8	47%	0.2	43%	0.19	44%	0.41	50%		
21324	ROBSON 2	1202	2.97	46%	1.14	44%	0.54	47%	1.28	47%		
21348	WAGNER	1203	2.25	43%	0.92	41%	0.17	35%	1.16	45%		
21392	JARMAN	1204	3.72	48%	1.08	42%	0.2	47%	0.98	43%	1.47	56%
21321	LARSON 1	1205	1.62	44%	0.95	41%			0.67	47%		
21354	L. FREIR	1210	2.17	46%	1.21	45%	0.57	48%	0.38	47%		
21359	STEIN	1214	3.43	40%	1.36	37%	0.28	37%	1.26	44%	0.54	43%
21358	JENSEN	1216	2.77	36%	1.33	35%	1.24	38%	0.19	36%		
21372	WEALZ	1224	1.52	38%	0.8	36%	0.34	36%	0.38	43%		
21363	RASMUSSEN	1225	2.2	42%	1.6	41%	0.18	46%	0.41	42%		
21387	PRATT	1226	1.78	39%	1.3	39%	0.48	39%				
21357	MORMAN CHURCH	1229	0.89	46%	0.51	44%	0.38	48%				
21382	WRIGHT	1238	1.14	41%	0.41	40%	0.36	39%	0.37	44%		
21391	CLISE	1240	0.62	41%	0.2	43%	0.42	39%				
21398	JENSEN	1246	2.12	42%	0.55	39%	0.63	41%	0.93	45%		
21404	JENSEN	1247	1.54	38%	0.75	35%	0.41	39%	0.38	42%		
21384	CHURCH OF J. C.	1248	3.43	48%	1.11	44%	0.29	52%	0.61	50%	1.42	50%
21407	WAGNER	1292	0.91	43%	0.63	42%	0.19	45%	0.09	48%		
	AVERAGE		2.02	43%	0.87	41%	0.51	44%	0.68	47%	0.60	49%
	TOTAL		94.99		40.93		21.24		28.41		6.59	

Portions of the Fayette-Waterloo field remain undeveloped. Several high productivity wells were not offset and the potential for infill drilling to exploit untested fractures within currently defined trends has not been assessed. The natural-fracture trends that control production are difficult to encounter using conventional vertical drilling techniques. The low historic success rates in the Fayette-Waterloo field have discouraged continued field development. Directional drilling techniques are thus appealing to fracture plays of this type. A proposed directional well site was identified based on the data provided from the initial portions of this project. Directional drilling in the SE quadrant will allow for wellbore orientation perpendicular to the strike of the fracture planes, increasing the probability of encountering a productive fracture or several productive fractures with one borehole. The well was sited at distances greater than 4,000 ft from two producers to minimize any depletion effects.

3 CONCLUSIONS

1. The well failed to encounter the predicted high flow rates from encountering extensive natural fractures in both deviated wellbores.

2. Geologic data provides accurate maps of structure and reservoir quality, but provides limited insight into fracture location and intensity.

3. Due to concerns of reservoir depletion, the subject location was selected being more than 4,000 ft from the nearest offset well. The lack of wells reduced the control on fracture existence in the area.

4 RECOMMENDATIONS

1. Future deviated wells should be drilled closer between highly productive wells to ensure the existence of a fracture system.

2. If future deviated wells fail to encounter high flow rates during drilling, they should be hydraulically fracture stimulated.

3. Use seismic data to assist in fracture identification for deviated well site location.

5 PRODUCTION DATA ANALYSIS

S. A. Holditch & Associates performed production data analysis on 137 wells completed in the Queenston formation in the Fayette-Waterloo field. The gas shows while drilling, the completion, the stimulation, and the reservoir pressure data were also evaluated. Log analysis was performed on some wells as discussed in the geologic section. The purpose of our evaluation on the historical data was to (1) understand which intervals produced gas while drilling, (2) understand the typical completion and stimulation methods, and (3) characterize the range of productivity throughout the field.

In this field, Meridian provided production data on 53 Meridian wells and 92 wells drilled by offset operators. Meridian also provided log, completion, and stimulation information on all their wells. From this data, production indicators were generated that represent a short-term production value from which to estimate long-term productivity. Production indicators are another method to quickly make comparisons between wells besides just plotting the entire production history for each well and making comparisons.

Each well's best year (average monthly rate during the best year of production) and five-year cumulative production was calculated. The best year usually comes in the first year or 15 months of production. Meridian also provided estimated ultimate recovery (EUR) for many of the wells. The best year and the five –year cumulative typically correlate, and they both typically correlate to EUR.

Figure 9 shows a graph of best year versus five-year cumulative for 105 wells that produced for at least five years. There is an excellent correlation coefficient of 0.961 for this dataset. Thus, when a well has produced for 12 to 15 months, the five-year cumulative can be estimated with excellent accuracy. The range of best year was large at 250 to 22,000 Mscf/month. The five-year cumulative was also large ranging from 10,000 to 800,000 Mscf.

The variation in productivity can be attributed to significant changes in natural fracture systems, since the net pay thickness and porosity do not vary substantially. Net pay and porosity were also not found to correlate with well performance. The best year is mapped in **Figures 3** and **4** in the geologic section. These maps show the few wells that encountered significant natural fracture systems and their abnormally high productivity.

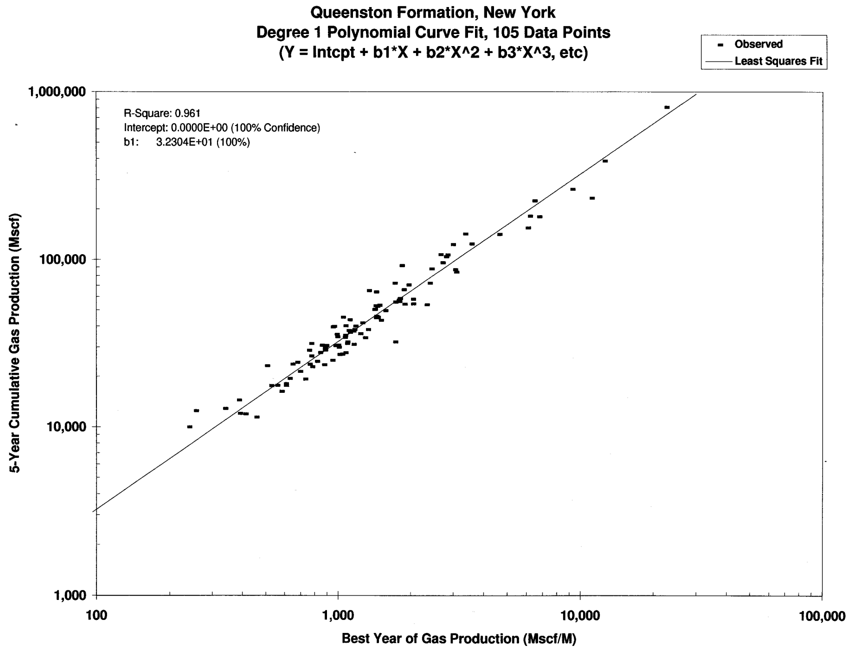


Figure 9 – Five-year cumulative gas production versus best year gas production.

Figure 10 shows the best year graphed versus EUR for 99 wells that we were provided EUR estimates. There is an excellent correlation with this dataset indicating that the best year can be used to estimate a well's EUR in this field. Note again the wide range of EUR from 18,000 Mscf to 2 Bscf. **Figure 11** is the best year graphed for 137 wells on a probability scale. The mean and median best year are 1,780 and 1,067 Mscf/month. **Figure 12** shows the EUR data for each well across the field. The EUR's are grouped in three categories - <200,000 Mscf, between 200,000 and 400,000 Mscf, and >400,000 Mscf. This figure mimics the best year production data results shown in **Figures 3** and **4**.

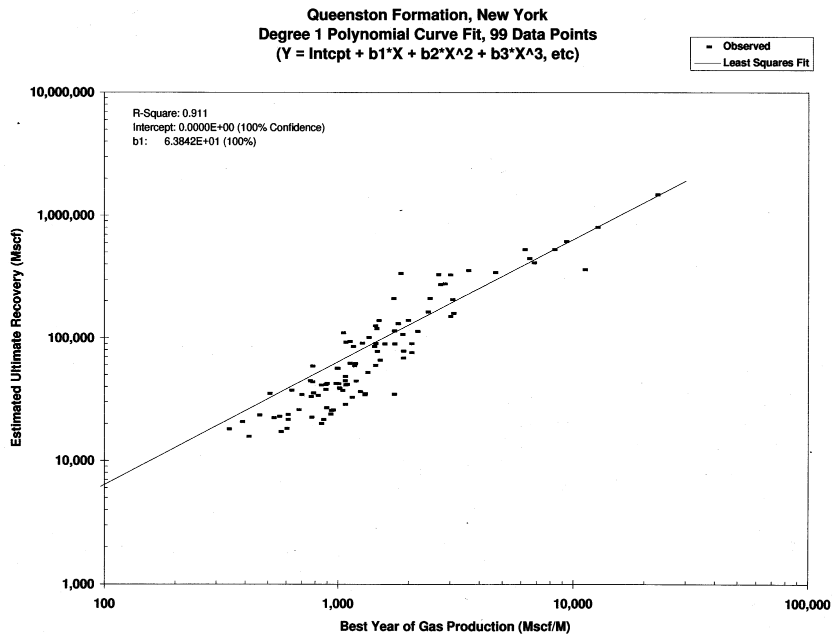


Figure 10 – Estimated ultimate recovery versus best year of gas production.

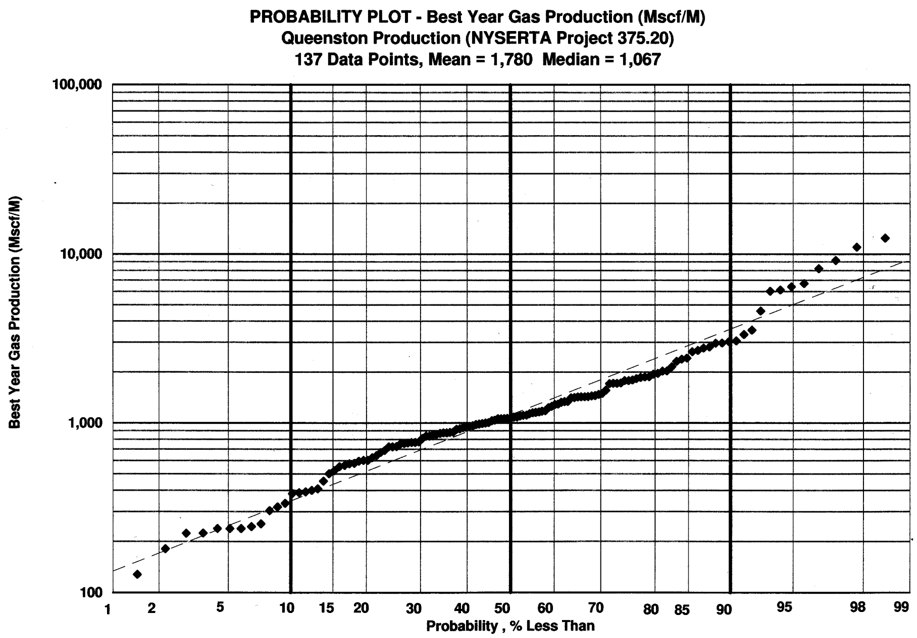


Figure 11 – Best year of production for 137 wells on a probability scale.

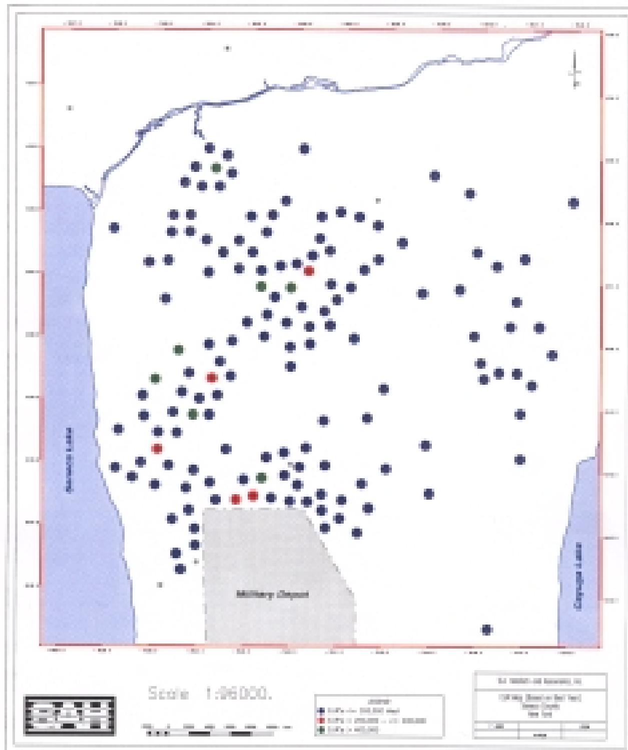


Figure 12 – Estimated ultimate recoveries based on best year gas production.

We further plotted the best year data versus date of first production as shown in **Figure 13**. There were wells of good and bad productivity drilled throughout the field's life. This is a qualitative indication that depletion effects are not evident on a field-level, however, localized depletion can not be evaluated with this plot.

Figure 14 was constructed to evaluate possible localized depletion effects. The wells with a red dot show possible signs of depletion or worse completions than their offsets. The wells with a green dot show improved performance relative to their offsets – probably due to better natural fractures or a better completion. There is only one area that shows red dots in the field and it cannot be determined if depletion effects or poorer completion methods cause these results. The deviated well was drilled in an area where there should have been no depletion effects.

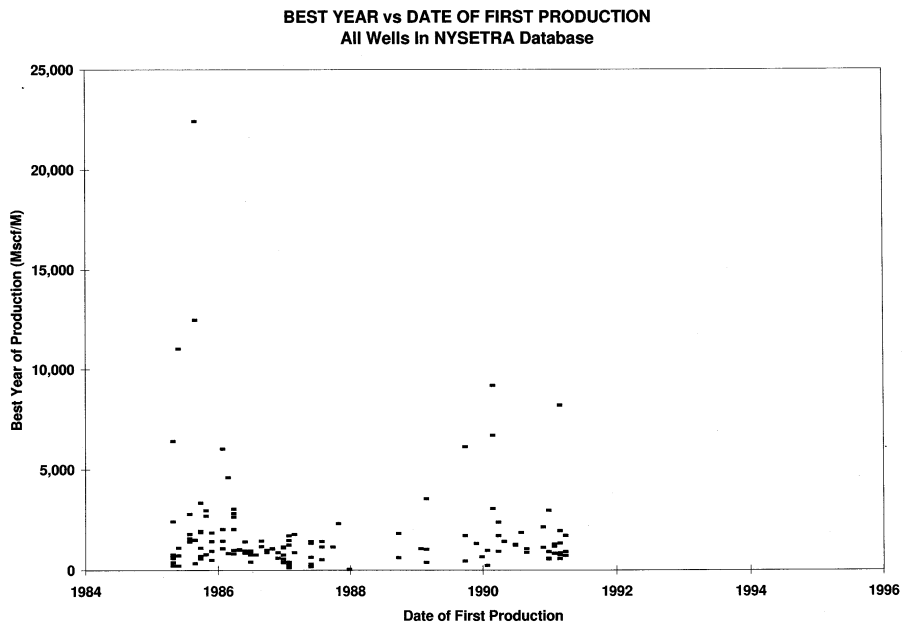


Figure 13 – Best year of production versus data of first production.

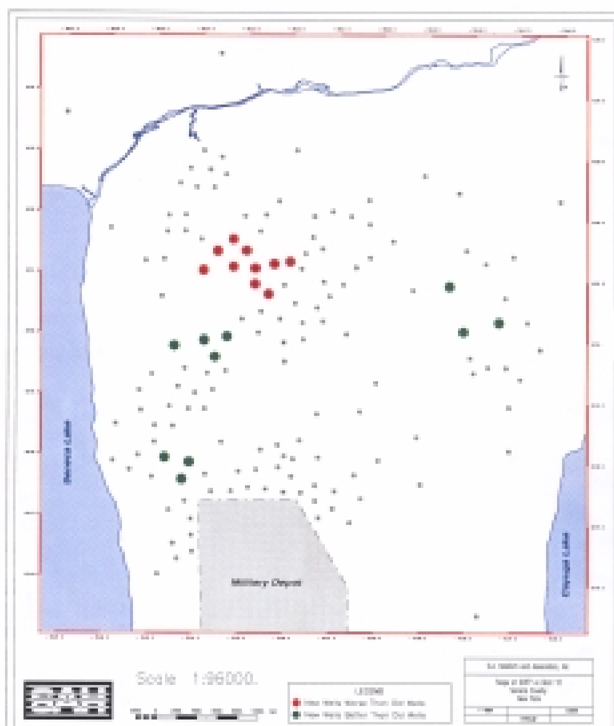


Figure 14 – Comparison of new wells versus old offset wells.

To generate the data in **Figure 14**, each well's best year was compared with all its offsets within 2,000 acres (domain comparison). By plotting all wells versus their date of first production, the newer wells could be evaluated to determine if they performed greater than or less than their surrounding domain wells. All wells were the center of a domain of wells in a 2,000 ac radius. If newer wells performed better than their older offsets, a green dot was plotted. If newer wells performed worse than their offsets, a red dot was plotted.

The gas show, completion, and stimulation information was reviewed for wells throughout the field. **Figure 15** shows the intervals that exhibited a gas show while air drilling. It is likely that only intervals with natural fractures will exhibit a gas show while drilling. The geologic evaluation broke the Queenston interval into four zones – Zones 1, 1A, 2, and 2A. All zones indicated gas shows across the field, but Zones 1, 1A, and 2 provided the most shows. This indicates that a deviated well has a probability to encounter natural fractures throughout most of the Queenston formation.

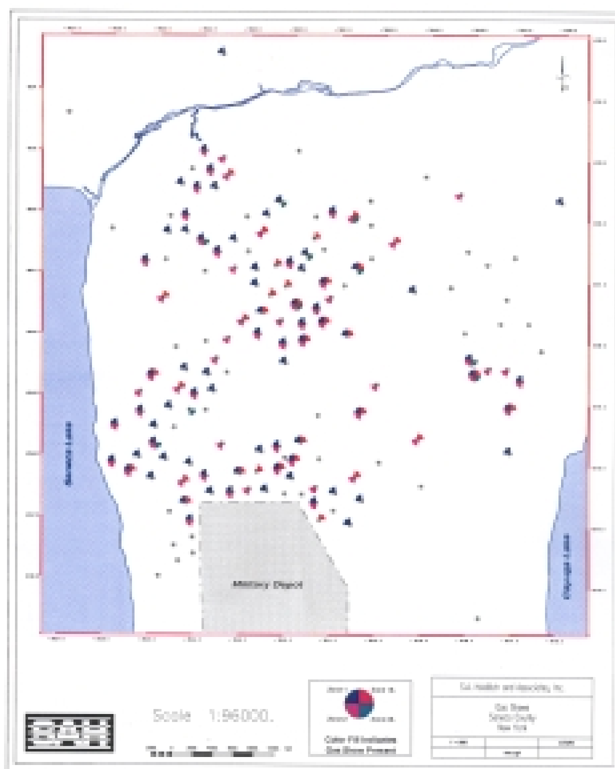


Figure 15 – Intervals that exhibited gas shows while drilling.

Figure16 is the completed intervals in the study wells. The first three zones were typically completed. Zone 2A was not completed very often, presumably due to the lack of gas shows while drilling. The net pay thickness in this zone may also be limited.

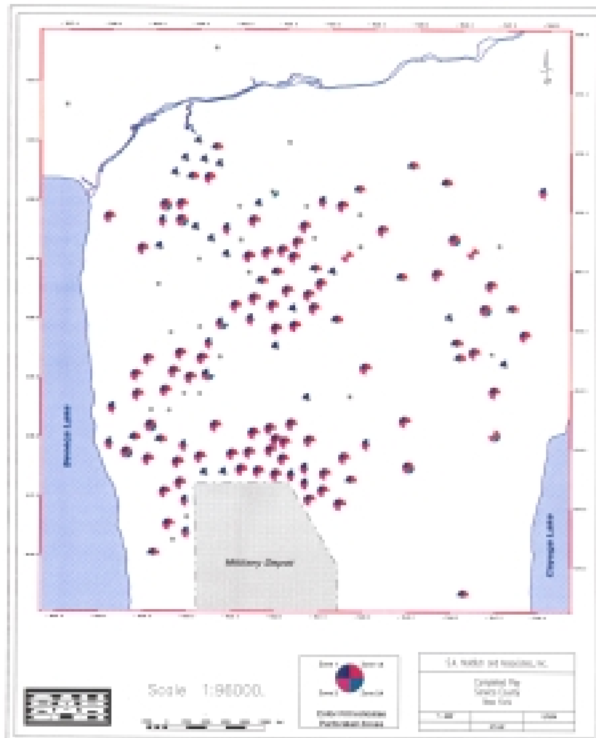


Figure 16 – Completed pay intervals.

The stimulation methods used in these wells were briefly reviewed. A foamed treatment with proppant was typical, however, other stimulation fluids were also used. Both single- and multi-stage treatments were used. We did not observe any trends showing better productivity with a particular treatment method. This further supports our conclusion that productivity is dominated by the degree of natural fractures encountered in drilling and stimulation.

Figures 17 and **18** show a zero-time and a chronological-time graph of an average production profile for 145 wells. The zero-time plot normalizes the starting time for all wells. The data are plotted for a 10-year period. The zero-time graph can be used to represent an average well in the field.

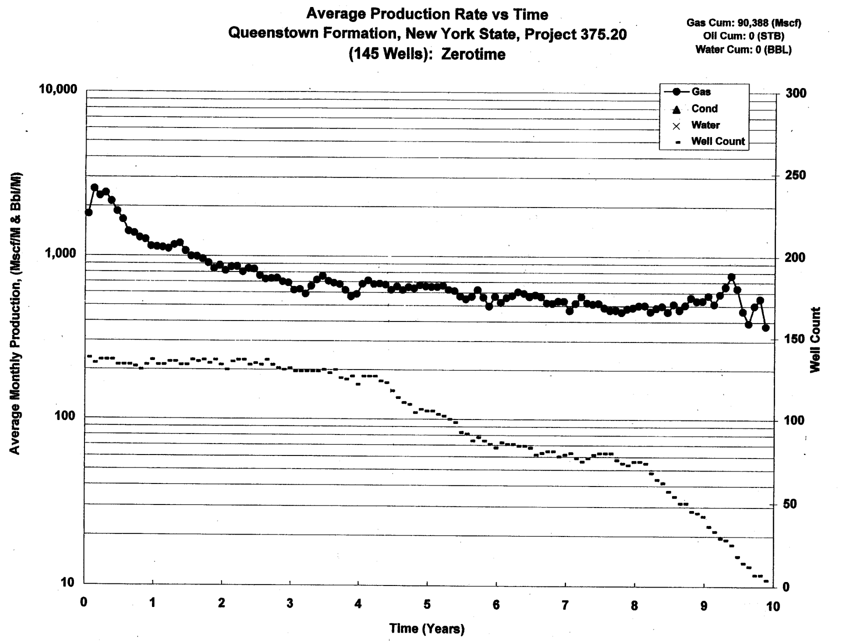


Figure 17 – Average monthly production on a zero-time graph.

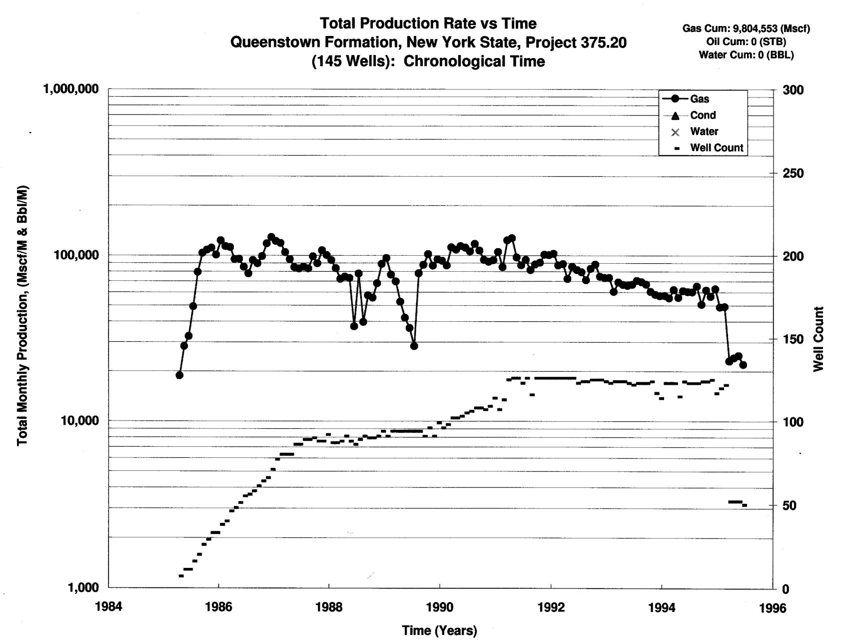


Figure 18 – Total monthly production on a chronological-time graph.

6 DRILLING DIRECTIONAL WELL

Combining geologic maps and cross sections with S. A. Holditch & Associates production analysis provided several acceptable well sites from which the Freir No. 1 location was selected. Infill locations that did not allow for adequate wellbore spacing from producing wells were avoided due to concerns related to reservoir depletion. The Freir No. 1 directional well (API 31-99-21690) was designed to provide a wellbore orientation perpendicular to the interpreted fracture trend orientation traversing the Upper Queenston formation with a deviated wellbore angle of greater than 40 degrees from vertical. A wellbore orientation in the southeast direction and deviation angle greater than 40 degrees allows for significant increase in formation exposure in the wellbore and increases the possibility of intersecting productive fractures. The pre-drilling well proposal is attached as Appendix 1.

Drilling began on the Freir No. 1 well in December 1996. The initial wellbore was drilled to a measured depth of 2,812 ft (2,350 ft true vertical depth). The well encountered no natural gas shows. Review of direction drilling data indicated the wellbore deviation angle was less than 30 degrees through the Queenston formation. Considering the lack of a significant gas show and the deviation angle being less than the planned 40 degrees, the decision was made to sidetrack the well. Drilling procedures were modified in a second attempt to drill a 40 degree deviated wellbore in the same direction through the Queenston formation. The drilling of the sidetrack wellbore was completed in January 1997. The sidetrack wellbore reached a measured depth of 3,006 ft (2,320 ft true vertical depth) (**Figure 19**). Note that the north direction is pointing to the west in **Figure 19**. The wellbore angle was maintained at over 40 degrees through the Queenston formation. Unfortunately, shows of gas were not encountered indicating a major fracture system was not encountered. The wellbore traversed 1,614 ft in a southeast direction. The wellbore provided a horizontal distance of 440 ft through the Queenston formation.

In the second deviated wellbore, conventional openhole geophysical logs were run along with a Formation MicroScanner™ (FMS) log to identify any possible natural fractures. Schlumberger Well Services ran the well logs and Schlumberger GeoQuest processed the FMS log. Evaluation of the openhole well logs for the Freir No. 1 indicate porosity zones were encountered in Units 1, 1A, 2, and 2A.

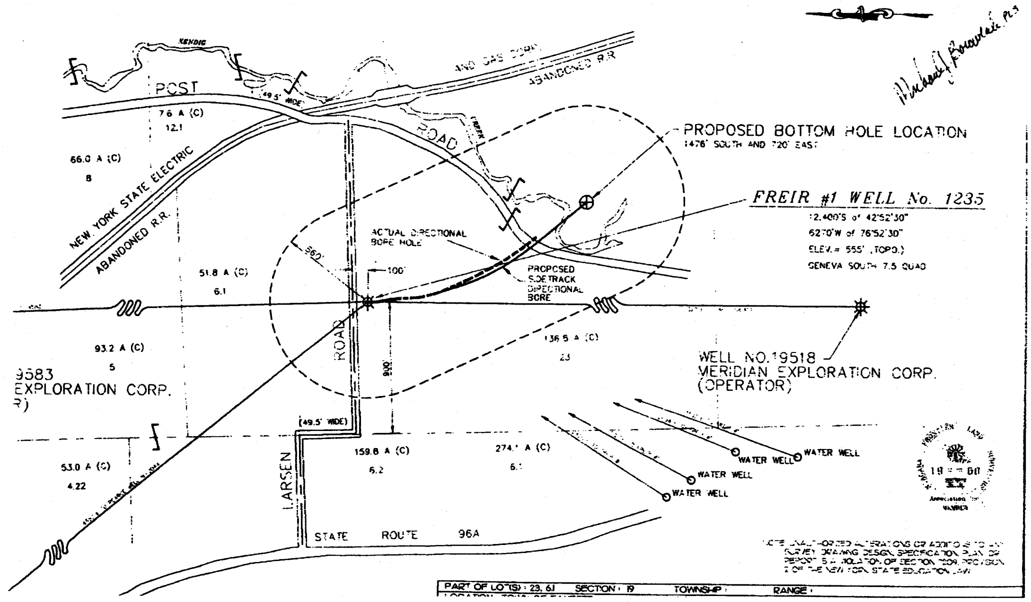


Figure 19 – Bottomhole location plot.

Fourteen small fractures were identified on the FMS log with dips ranging from 85 degrees to 30 degrees. Nine of the fractures have dips greater than 50 degrees. The primary fracture orientation is north 50 to 70 degrees east with a secondary fracture orientation of north 50 degrees west. It should be noted the fractures identified on the FMS log were very small and appeared to be healed. Considering the lack of any significant show of gas encountered during drilling of the well, and the small size of the fractures, caution should be taken when extrapolating fracture orientation and dips identified from the Freir No. 1 well.

The Freir No. 1 directional well did not encounter the type of fractured reservoir targeted in the project. The present geologic model for the field was developed utilizing available surface and subsurface data. This data provides accurate maps of structure and reservoir quality but provides limited insight into fracture location and intensity. Natural fractures are critical to obtain economic gas reserves and to justify the additional cost of directional drilling technology. Utilizing the current data available in the field, accurate measurements of fracture dip are not ascertainable. The mechanisms that created the fractures cannot be quantified without additional geophysical data. Recommendations to continue evaluation of the fracture geology within the field using modern seismic data are currently being considered. Detailed seismic data across the field would allow for identification of basement structure(s) that may have provided the mechanisms for reservoir fracturing. Directional well locations considered in the future should be located closer to known fracture enhanced wells. This will increase the possibility of encountering productive fractures.

Reservoir depletion will remain a concern, therefore, it is imperative that the geometry of productive fractures be more accurately defined.

Directional drilling technology is utilized routinely in numerous basins of the United States and as a matter of course in exploration and development of offshore hydrocarbon resources. Application of the technology to the Appalachian Basin and more specifically in development of hydrocarbon fields in the state of New York is in its infancy.

Fractured reservoirs provide excellent targets for directional well projects due to the above average production and low "hit" ratios. Directional wellbores can be steered to intersect targeted fracture planes. With a better understanding of fracture geometry, drilling of one wellbore through several fracture planes should provide additional increases in productivity. The additional gas will offset costs associated with directional wellbores. However, as this project has illustrated, detailed subsurface geology may not provide sufficient information to delineate fracture systems. Information related to events that created the fractures at basement depths can only be identified utilizing seismic data. Accurate measurement of these parameters early in the development of a fractured reservoir provides critical information for future development of the hydrocarbon resource.

Considering all the factors presented, several New York reservoirs provide excellent targets for application of detailed geologic and geophysical evaluation in combination with directional drilling technology to exploit untapped hydrocarbon reserves. The Trenton/Black River and Bass Island reservoirs of New York represent ideal candidates for application of this technology. Successful wells within these fields typically provide hydrocarbon reserves in sufficient quantity to justify the additional cost associated with acquisition of seismic data and directional drilling. Historic activity in these fields most likely included acquisition of some seismic data. The seismic data when combined with a detailed reservoir study should provide excellent targets for directional wells.

A second area of interest for detailed geologic study to evaluate the use of directional drilling technology is the area north of the Finger Lakes. The Blue Tail Rooster field of Cayuga County, Memphis and Baldwinsville fields of Onondaga County and the North and South Fulton fields along with the larger Pulaski and Sandy Creek fields of Oswego County have provided hydrocarbon controlled by fracturing. These fields are currently abandoned or inactive. A limited amount of detailed information is available concerning these fields. Recent wells drilled near the Baldwinsville and Memphis fields employed directional drilling techniques in an attempt to revive production in the fields. Unfortunately, the activity did not lead to the discovery of untapped hydrocarbon reserves.

APPENDIX

FREIR #1
PROPOSED DIRECTIONAL WELL
SENECA COUNTY, NEW YORK

Production in the Fayette-Waterloo gas field is controlled by natural fracture systems postulated to have developed in response to basement structures. The fracture plains are believed to be high angle, approaching vertical and oriented in a northeast to southwest direction. Wells which encounter the fracture system provide attractive production occasionally exhibit high natural flow rates (up to 10,000 mcf/d). It is not uncommon for wells which encounter the fracture system to produce over 100 mmcf of gas during the first year of production. The proposed Freir #1 directional well is designed to traverse a northeast-southwest oriented fracture system by drilling directionally perpendicular to the productive trend. This technique will increase the likelihood of encountering the natural fracture system essential for significant gas production.

The Queenston formation is considered the primary reservoir in the Fayette-Waterloo field. The Queenston formation is about 800' in thickness within the field, however only the upper 350 to 400 develops porosity. The lower portion of the Queenston is sparsely tested in the field with limited success. Therefore, the lower section of the Queenston is not considered a target in the initial directional well. Within the fracture systems, significant production has been encountered in the overlying tight sands and shales of the Medina, Sodus, Rochester, and Herkimer formations (refer to Appendix II: Well Prognosis, "Formation Tops" for stratigraphic sequence). The target section for the directional well includes not only the Queenston formation but also the Medina, Sodus, Rochester, and Herkimer formations. This provides total vertical section targeted in the proposed directional well of nearly 750 feet.

The natural fracture system which control production in the field are difficult to encounter using conventional vertical drilling techniques. Low success rates are common to fracture plays of this type without utilization of directionally drilled wells. The low historic success rates in the Fayette-Waterloo Field have discouraged continued field development with portions of the field remaining undeveloped. Several significant wells were not offset and the potential for infill drilling to exploit untested fractures within defined trends has not been attempted. Directional drilling techniques lend itself to fracture plays of this type. Directional drilling will allow for well bore orientation perpendicular to fracture strike thereby increasing the probability of encountering a productive fracture or several productive fractures with one wellbore. With initial success, extension of current field production limits and discovery of additional fracture systems is possible.

The Freir #1 is the first directional well proposed to be drilled in the Fayette-Waterloo gas field. A directional well prognosis is provided in Appendix II for the Freir #1 well.
The proposed site is located within one of three fracture systems currently identified in the field. This well site is strategically located between two wells which encountered natural fractures. The proposed Frier #I is 4500 feet northeast of the Neilson #1 well and 5000 feet southwest of the Harris #1 well. The Neilson #1 well was drilled by Meridian Exploration Corp. in 1990. The well encountered a natural flow of over 5 rnmcf per day during drilling of the Rochester shale formation. The well was completed as a natural producer in the Rochester shale and was not drilled to the deeper Queenston formation. The Neilson #1 produced over 80 mmcf of gas during the first full year of production. The well has produced 196 mmcf of gas in six years. The Harris # I well was drilled by Union Drilling, Inc. in 1984 and encountered a natural flow of gas reported at a rate of 15 to 20 mmcf per day in the Medina formation. The Harris # I produced over 110 rnmcf during the first year of production and to date has produced 284 mmcf of gas.

Two additional wells are within the fracture system targeted in the Freir # I well. The additional wells are located southwest of the Freir #1 and provide significant gas production. However, unlike the Harris #1 and Neilson #1, these wells encountered small natural flows of gas (less than 200 mcf per day) and were completed using a hydraulic fracture treatment in the Queenston formation. Production data on the two additional wells, Lynd #1 (1128) and G. Neilson #1 (4129), indicate significant reserves of natural gas were encountered. Appendix I provides production plots and history's for the four (4) referenced wells.

The natural flows of gas reported in the Neilson #1 and Harris #1 were encountered in shale and tight sand formations which typically do not develop porosity and permeability ..sufficient to provide the production rates encountered. The significant flows of gas and linear alignment of high1y productive wells are indicative of natural fractures being encountered in the well bore. This natural fracture system is the target for the proposed Freir #1 directional well. Clearly, wells which do not encounter the fracture trend are of limited economic interest.

The occurrence and orientation of the fracture systems targeted in the Freir #1 well are identified using available subsurface information and production data provided by existing wells. Geophysical well log data and core information provide most of the subsurface information. Projections as to the orientation and angle of the fractures within the system were developed using trend analysis, regional structures, and other interpretive techniques. A quantitative determination of dip on specific fractures within the system has not been determined. In a effort to determine the dip of any fractures encountered in the proposed Freir # I well, the use of a modem fracture identification log is planned.

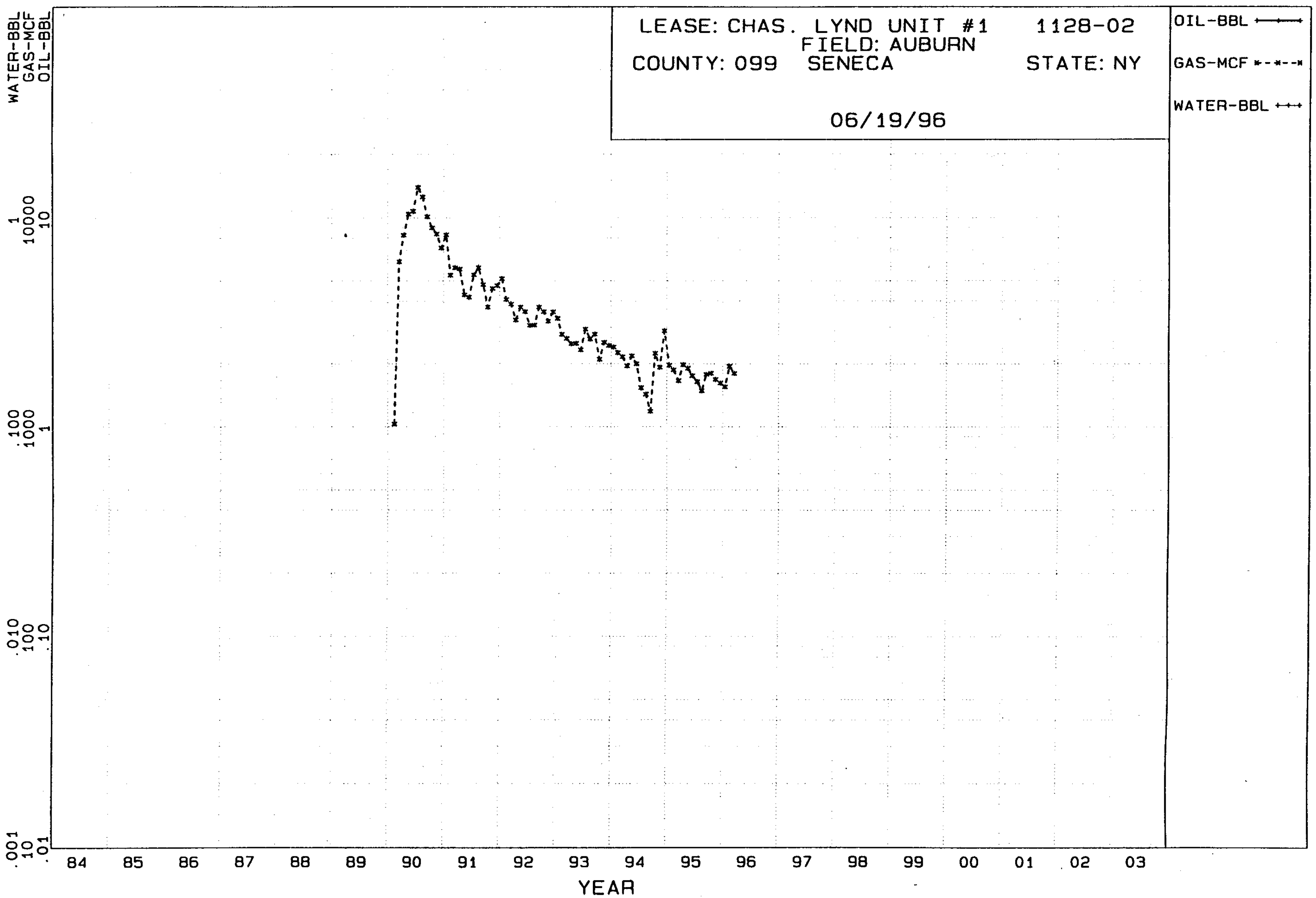
APPENDIX I

FREIR #1
PROPOSED DIRECTIONAL WELL

TARGETED FRACTURE SYSTEM
REFERENCE WELL PRODUCTION

SUMMARY OF WELL PRODUCTION WITHIN TARGETED FRACTURE SYSTEM

WELL NAME	ORIGINAL OPERATOR	OPERATOR NUMBER	YEAR 1 PROD.	CUM. PROD. AS OF 3/96	FIRST PROD. DATE
LYND #1 (2)	MERIDIAN	1128	110 MMCF	286 MMCF	3/90
NEILSON (1)	MERIDIAN	1146	80 MMCF	196 MMCF	3/90
NEILSON (2)	UNION DRILLING	4129	31 MMCG	166 MMCF	3/86
HARRIS #1 (1)	UNION DRILLING	4049	132 MMCF	285 MMCF	5/85


LEASE: CHAS. LYND UNIT #1 1128-02
FIELD: AUBURN
COUNTY: 099 SENECA STATE: NY
06/19/96
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GAS-MCF
WATER-BBL
WATER-BBL
GAS-MCF
OIL-BBL
.001
10
.01
.010
100
.10
.100
1000
1
1
10000
10
84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03
YEAR

CASE: 83 CHAS. LYND UNIT #1 1128-02
M.FIELD
099 SENECA , NY
MEC PRODUCTION ACCOUNT

DATE: 06/19/96
TIME: 14:15:36
PAGE: 1

P R O D U C T I O N   L E D G E R

DATE	OIL, BBL	GAS, MCF	WATER, BBL	GOR, CF/BBL	WATER CUT, %	CUM OIL, BBL	CUM GAS, MCF
PRIOR	0	0	0	0	0.00	0	0
2/90	0	1032	0	0	0.00	0	1,032
3/90	0	6179	0	0	0.00	0	7,211
4/90	0	8272	0	0	0.00	0	15,483
5/90	0	10425	0	0	0.00	0	25,908
6/90	0	10755	0	0	0.00	0	36,663
7/90	0	13907	0	0	0.00	0	50,570
8/90	0	12555	0	0	0.00	0	63,125
9/90	0	10130	0	0	0.00	0	73,255
10/90	0	8962	0	0	0.00	0	82,217
11/90	0	8366	0	0	0.00	0	90,583
12/90	0	7179	0	0	0.00	0	97,762
TOT/90	0	97762	0	0		0	97,762
1/91	0	8286	0	0	0.00	0	106,048
2/91	0	5325	0	0	0.00	0	111,373
3/91	0	5776	0	0	0.00	0	117,149
4/91	0	5694	0	0	0.00	0	122,843
5/91	0	4290	0	0	0.00	0	127,133
6/91	0	4183	0	0	0.00	0	131,316
7/91	0	5352	0	0	0.00	0	136,668
8/91	0	5789	0	0	0.00	0	142,457
9/91	0	4809	0	0	0.00	0	147,266
10/91	0	3747	0	0	0.00	0	151,013
11/91	0	4598	0	0	0.00	0	155,611
12/91	0	4745	0	0	0.00	0	160,356
TOT/91	0	62594	0	0		0	160,356
1/92	0	5130	0	0	0.00	0	165,486
2/92	0	4075	0	0	0.00	0	169,561
3/92	0	3874	0	0	0.00	0	173,435
4/92	0	3249	0	0	0.00	0	176,684
5/92	0	3744	0	0	0.00	0	180,428
6/92	0	3565	0	0	0.00	0	183,993
7/92	0	3070	0	0	0.00	0	187,063
8/92	0	3072	0	0	0.00	0	190,135
9/92	0	3747	0	0	0.00	0	193,882
10/92	0	3558	0	0	0.00	0	197,440
11/92	0	3212	0	0	0.00	0	200,652
12/92	0	3547	0	0	0.00	0	204,199
TOT/92	0	43843	0	0		0	204,199

CASE: 83 CHAS. LYND UNIT #1 1128-02
M.FIELD
099 SENECA , NY
MEC PRODUCTION ACCOUNT

DATE: 06/19/96
TIME: 14:15:37

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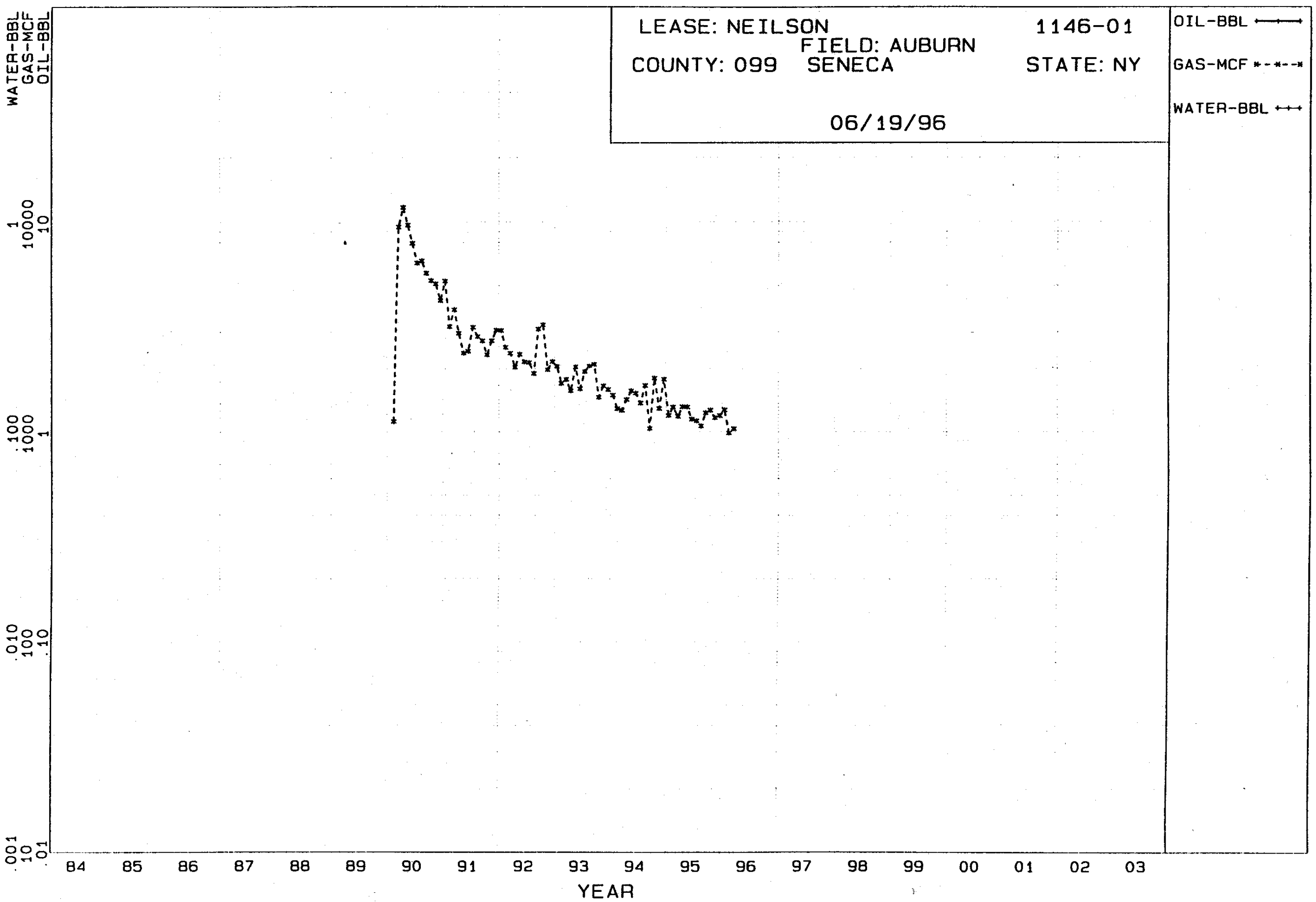
1/96	0	1552	0	0	0.00	0	282,663
2/96	0	1947	0	0	0.00	0	284,610
3/96	0	1799	0	0	0.00	0	286,409
YTD/96	0	5298	0	0		0	286,409
TOTAL	0	286409	0	0		0	286,409



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1146-01
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COUNTY: 099 SENECA
STATE: NY
06/19/96
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WATER-BBL
GAS-MCF
OIL-BBL
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YEAR

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M.FIELD
099 SENECA , NY
MEC PRODUCTION ACCOUNT

DATE: 06/19/96
TIME: 14:15:37
PAGE: 4

P R O D U C T I O N   L E D G E R

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3/90	0	9464	0	0	0.00	0	10,584
4/90	0	11678	0	0	0.00	0	22,262
5/90	0	9674	0	0	0.00	0	31,936
6/90	0	7935	0	0	0.00	0	39,871
7/90	0	6399	0	0	0.00	0	46,270
8/90	0	6551	0	0	0.00	0	52,821
9/90	0	5731	0	0	0.00	0	58,552
10/90	0	5286	0	0	0.00	0	63,838
11/90	0	5102	0	0	0.00	0	68,940
12/90	0	4238	0	0	0.00	0	73,178
TOT/90	0	73178	0	0		0	73,178
1/91	0	5261	0	0	0.00	0	78,439
2/91	0	3177	0	0	0.00	0	81,616
3/91	0	3834	0	0	0.00	0	85,450
4/91	0	2954	0	0	0.00	0	88,404
5/91	0	2381	0	0	0.00	0	90,785
6/91	0	2432	0	0	0.00	0	93,217
7/91	0	3159	0	0	0.00	0	96,376
8/91	0	2854	0	0	0.00	0	99,230
9/91	0	2722	0	0	0.00	0	101,952
10/91	0	2336	0	0	0.00	0	104,288
11/91	0	2726	0	0	0.00	0	107,014
12/91	0	3058	0	0	0.00	0	110,072
TOT/91	0	36894	0	0		0	110,072
1/92	0	3047	0	0	0.00	0	113,119
2/92	0	2536	0	0	0.00	0	115,655
3/92	0	2376	0	0	0.00	0	118,031
4/92	0	2038	0	0	0.00	0	120,069
5/92	0	2347	0	0	0.00	0	122,416
6/92	0	2162	0	0	0.00	0	124,578
7/92	0	2144	0	0	0.00	0	126,722
8/92	0	1897	0	0	0.00	0	128,619
9/92	0	3097	0	0	0.00	0	131,716
10/92	0	3247	0	0	0.00	0	134,963
11/92	0	1983	0	0	0.00	0	136,946
12/92	0	2167	0	0	0.00	0	139,113
TOT/92	0	29041	0	0		0	139,113
TOTAL	0	139113	0	0		0	139,113

CASE: 89 NEILSON 1146-01
M.FIELD
099 SENECA , NY
MEC PRODUCTION ACCOUNT

DATE: 06/19/96
TIME: 14:15:37
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P R O D U C T I O N   L E D G E R

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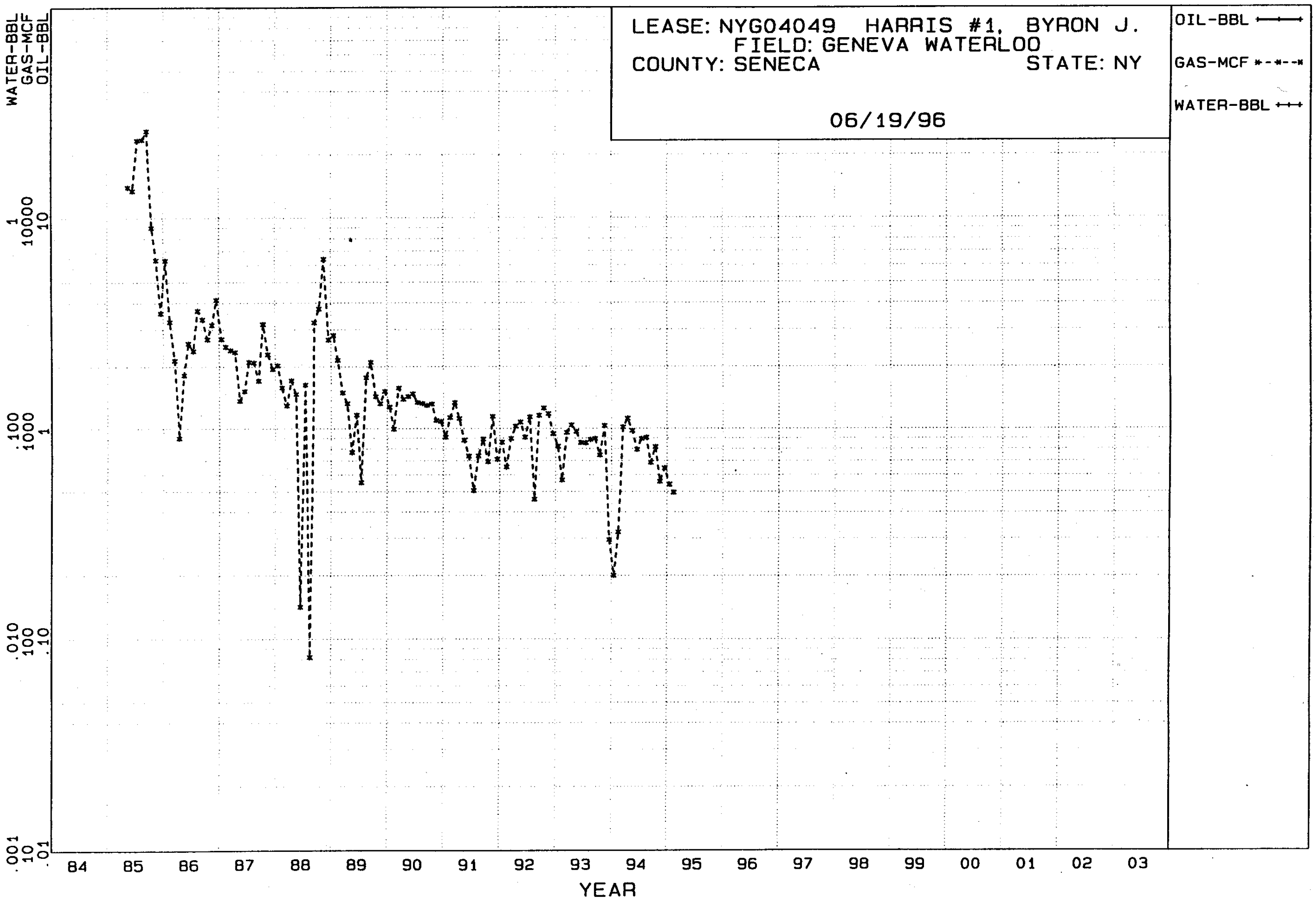
2/93	0	1703	0	0	0.00	0	142,871
3/93	0	1778	0	0	0.00	0	144,649
4/93	0	1569	0	0	0.00	0	146,218
5/93	0	2045	0	0	0.00	0	148,263
6/93	0	1602	0	0	0.00	0	149,865
7/93	0	1941	0	0	0.00	0	151,806
8/93	0	2065	0	0	0.00	0	153,871
9/93	0	2102	0	0	0.00	0	155,973
10/93	0	1461	0	0	0.00	0	157,434
11/93	0	1653	0	0	0.00	0	159,087
12/93	0	1589	0	0	0.00	0	160,676
TOT/93	0	21563	0	0		0	160,676
1/94	0	1494	0	0	0.00	0	162,170
2/94	0	1291	0	0	0.00	0	163,461
3/94	0	1267	0	0	0.00	0	164,728
4/94	0	1425	0	0	0.00	0	166,153
5/94	0	1565	0	0	0.00	0	167,718
6/94	0	1525	0	0	0.00	0	169,243
7/94	0	1371	0	0	0.00	0	170,614
8/94	0	1661	0	0	0.00	0	172,275
9/94	0	1036	0	0	0.00	0	173,311
10/94	0	1799	0	0	0.00	0	175,110
11/94	0	1293	0	0	0.00	0	176,403
12/94	0	1780	0	0	0.00	0	178,183
TOT/94	0	17507	0	0		0	178,183
1/95	0	1198	0	0	0.00	0	179,381
2/95	0	1313	0	0	0.00	0	180,694
3/95	0	1186	0	0	0.00	0	181,880
4/95	0	1317	0	0	0.00	0	183,197
5/95	0	1314	0	0	0.00	0	184,511
6/95	0	1149	0	0	0.00	0	185,660
7/95	0	1129	0	0	0.00	0	186,789
8/95	0	1065	0	0	0.00	0	187,854
9/95	0	1234	0	0	0.00	0	189,088
10/95	0	1268	0	0	0.00	0	190,356
11/95	0	1168	0	0	0.00	0	191,524
12/95	0	1197	0	0	0.00	0	192,721
TOT/95	0	14538	0	0		0	192,721
TOTAL	0	192721	0	0		0	192,721

CASE: 89 NEILSON 1146-01
M.FIELD
099 SENECA , NY
MEC PRODUCTION ACCOUNT

DATE: 06/19/96
TIME: 14:15:37
PAGE: 6

PRODUCTION LEDGER

DATE	OIL, BBL	GAS, MCF	WATER, BBL	GOR, CF/BBL	WATER CUT, %	CUM OIL, BBL	CUM GAS, MCF
PRIOR	0	192721	0	0	0.00	0	192,721
1/96	0	1273	0	0	0.00	0	193,994
2/96	0	986	0	0	0.00	0	194,980
3/96	0	1036	0	0	0.00	0	196,016
YTD/96	0	3295	0	0		0	196,016
TOTAL	0	196016	0	0		0	196,016



LEASE: NYG04049 HARRIS #1, BYRON J.
FIELD: GENEVA WATERLOO
COUNTY: SENECA STATE: NY
06/19/96
OIL-BBL
GAS-MCF
WATER-BBL
WATER-BBL
GAS-MCF
OIL-BBL
1
10000
10
.100
1000
1
.010
100
.10
.001
10
.01
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
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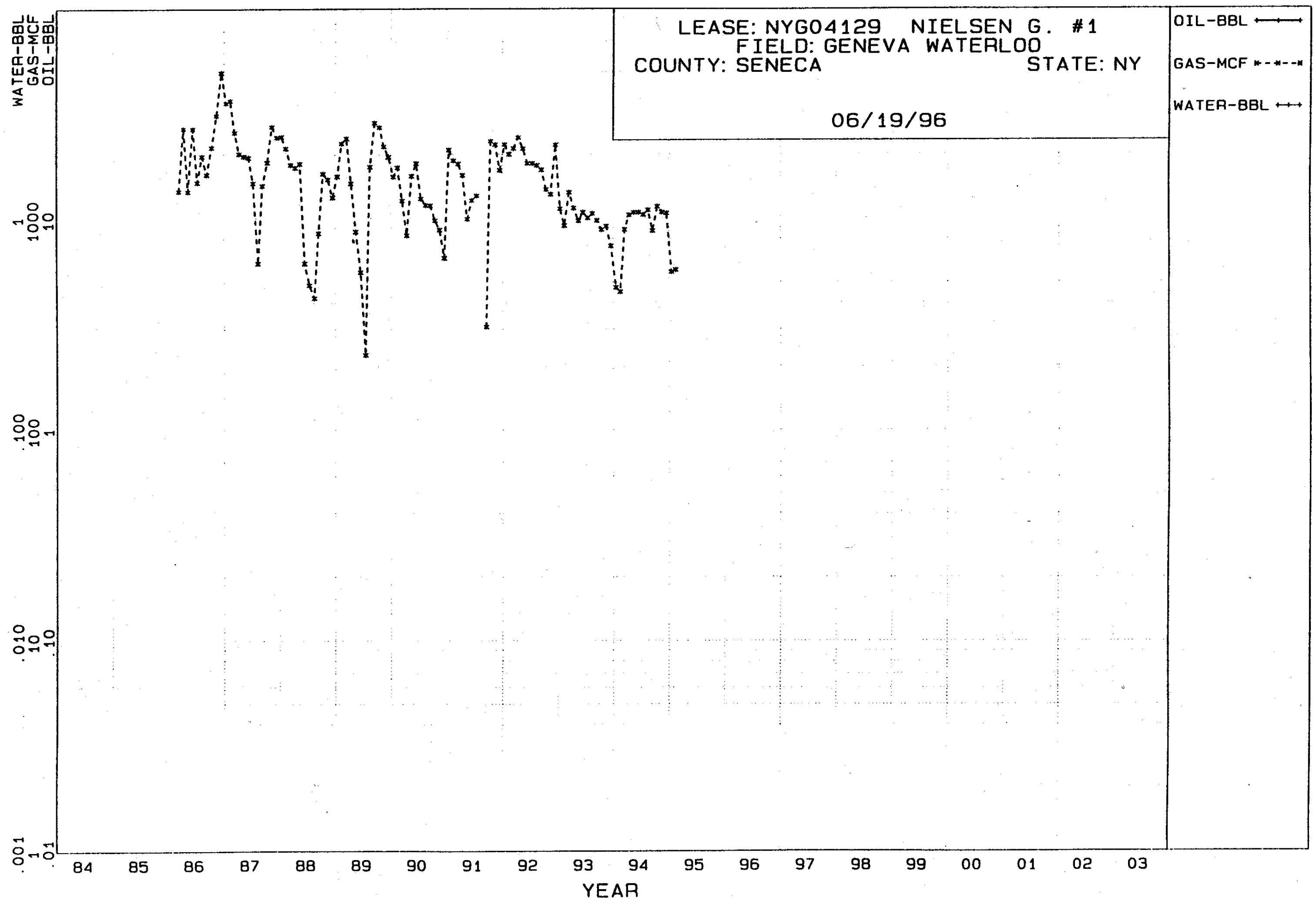
00
01
02
03
YEAR


LEASE: NYG04129 NIELSEN G. #1
FIELD: GENEVA WATERLOO
COUNTY: SENECA STATE: NY
06/19/96
OIL-BBL
GAS-MCF
WATER-BBL
WATER-BBL
GAS-MCF
OIL-BBL
.001 1 .01
.010 10 .10
.100 100 1
1 1000 10
84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03
YEAR

CASE: 69 NYG04129 NIELSEN G. #1
M.FIELD
SENECA , NY
EREX (OTHER APP.)

DATE: 06/19/96
TIME: 14:21:11
PAGE: 5

PRODUCTION LEDGER

DATE	OIL, BBL	GAS, MCF	WATER, BBL	GOR, CF/BBL	WATER CUT, %	CUM OIL, BBL	CUM GAS, MCF
PRIOR	0	0	0	0	0.00	0	0
1/86	0	0	0	0	0.00	0	0
2/86	0	0	0	0	0.00	0	0
3/86	0	1341	0	0	0.00	0	1,341
4/86	0	2667	0	0	0.00	0	4,008
5/86	0	1335	0	0	0.00	0	5,343
6/86	0	2663	0	0	0.00	0	8,006
7/86	0	1474	0	0	0.00	0	9,480
8/86	0	1958	0	0	0.00	0	11,438
9/86	0	1604	0	0	0.00	0	13,042
10/86	0	2157	0	0	0.00	0	15,199
11/86	0	3092	0	0	0.00	0	18,291
12/86	0	4973	0	0	0.00	0	23,264
TOT/86	0	23264	0	0		0	23,264
1/87	0	3549	0	0	0.00	0	26,813
2/87	0	3641	0	0	0.00	0	30,454
3/87	0	2553	0	0	0.00	0	33,007
4/87	0	2011	0	0	0.00	0	35,018
5/87	0	1955	0	0	0.00	0	36,973
6/87	0	1930	0	0	0.00	0	38,903
7/87	0	1464	0	0	0.00	0	40,367
8/87	0	616	0	0	0.00	0	40,983
9/87	0	1422	0	0	0.00	0	42,405
10/87	0	1829	0	0	0.00	0	44,234
11/87	0	2720	0	0	0.00	0	46,954
12/87	0	2409	0	0	0.00	0	49,363
TOT/87	0	26099	0	0		0	49,363
1/88	0	2433	0	0	0.00	0	51,796
2/88	0	2136	0	0	0.00	0	53,932
3/88	0	1784	0	0	0.00	0	55,716
4/88	0	1728	0	0	0.00	0	57,444
5/88	0	1802	0	0	0.00	0	59,246
6/88	0	616	0	0	0.00	0	59,862
7/88	0	486	0	0	0.00	0	60,348
8/88	0	422	0	0	0.00	0	60,770
9/88	0	851	0	0	0.00	0	61,621
10/88	0	1620	0	0	0.00	0	63,241
11/88	0	1520	0	0	0.00	0	64,761
12/88	0	1251	0	0	0.00	0	66,012
TOT/88	0	16649	0	0		0	66,012
TOTAL	0	66012	0	0		0	66,012

CASE: 69 NYG04129 NIELSEN G. #1
M.FIELD
SENECA , NY
EREX (OTHER APP.)

DATE: 06/19/96
TIME: 14:21:11

P R O D U C T I O N   L E D G E R

DATE	OIL, BBL	GAS, MCF	WATER, BBL	GOR, CF/BBL	WATER CUT, %	CUM OIL, BBL	CUM GAS, MCF
PRIOR	0	66012	0	0	0.00	0	66,012
1/89	0	1572	0	0	0.00	0	67,584
2/89	0	2255	0	0	0.00	0	69,839
3/89	0	2387	0	0	0.00	0	72,226
4/89	0	1456	0	0	0.00	0	73,682
5/89	0	865	0	0	0.00	0	74,547
6/89	0	559	0	0	0.00	0	75,106
7/89	0	227	0	0	0.00	0	75,333
8/89	0	1743	0	0	0.00	0	77,076
9/89	0	2840	0	0	0.00	0	79,916
10/89	0	2697	0	0	0.00	0	82,613
11/89	0	2179	0	0	0.00	0	84,792
12/89	0	1940	0	0	0.00	0	86,732
TOT/89	0	20720	0	0		0	86,732
1/90	0	1565	0	0	0.00	0	88,297
2/90	0	1729	0	0	0.00	0	90,026
3/90	0	1206	0	0	0.00	0	91,232
4/90	0	830	0	0	0.00	0	92,062
5/90	0	1579	0	0	0.00	0	93,641
6/90	0	1809	0	0	0.00	0	95,450
7/90	0	1232	0	0	0.00	0	96,682
8/90	0	1150	0	0	0.00	0	97,832
9/90	0	1146	0	0	0.00	0	98,978
10/90	0	975	0	0	0.00	0	99,953
11/90	0	881	0	0	0.00	0	100,834
12/90	0	651	0	0	0.00	0	101,485
TOT/90	0	14753	0	0		0	101,485
1/91	0	2096	0	0	0.00	0	103,581
2/91	0	1864	0	0	0.00	0	105,445
3/91	0	1796	0	0	0.00	0	107,241
4/91	0	1589	0	0	0.00	0	108,830
5/91	0	989	0	0	0.00	0	109,819
6/91	0	1209	0	0	0.00	0	111,028
7/91	0	1272	0	0	0.00	0	112,300
8/91	0	0	0	0	0.00	0	112,300
9/91	0	308	0	0	0.00	0	112,608
10/91	0	2309	0	0	0.00	0	114,917
11/91	0	2223	0	0	0.00	0	117,140
12/91	0	1680	0	0	0.00	0	118,820
TOT/91	0	17335	0	0		0	118,820
TOTAL	0	118820	0	0		0	118,820

CASE: 69 NYG04129 NIELSEN G. #1
M.FIELD
SENECA , NY
EREX (OTHER APP.)

DATE: 06/19/96
TIME: 14:21:11
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PRODUCTION LEDGER

DATE	OIL, BBL	GAS, MCF	WATER, BBL	GOR, CF/BBL	WATER CUT, %	CUM OIL, BBL	CUM GAS, MCF
PRIOR	0	118820	0	0	0.00	0	118,820
1/92	0	2223	0	0	0.00	0	121,043
2/92	0	1994	0	0	0.00	0	123,037
3/92	0	2129	0	0	0.00	0	125,166
4/92	0	2410	0	0	0.00	0	127,576
5/92	0	2124	0	0	0.00	0	129,700
6/92	0	1807	0	0	0.00	0	131,507
7/92	0	1809	0	0	0.00	0	133,316
8/92	0	1769	0	0	0.00	0	135,085
9/92	0	1684	0	0	0.00	0	136,769
10/92	0	1364	0	0	0.00	0	138,133
11/92	0	1290	0	0	0.00	0	139,423
12/92	0	2216	0	0	0.00	0	141,639
TOT/92	0	22819	0	0		0	141,639
1/93	0	1105	0	0	0.00	0	142,744
2/93	0	920	0	0	0.00	0	143,664
3/93	0	1319	0	0	0.00	0	144,983
4/93	0	1112	0	0	0.00	0	146,095
5/93	0	969	0	0	0.00	0	147,064
6/93	0	1061	0	0	0.00	0	148,125
7/93	0	998	0	0	0.00	0	149,123
8/93	0	1047	0	0	0.00	0	150,170
9/93	0	970	0	0	0.00	0	151,140
10/93	0	880	0	0	0.00	0	152,020
11/93	0	913	0	0	0.00	0	152,933
12/93	0	739	0	0	0.00	0	153,672
TOT/93	0	12033	0	0		0	153,672
1/94	0	472	0	0	0.00	0	154,144
2/94	0	450	0	0	0.00	0	154,594
3/94	0	881	0	0	0.00	0	155,475
4/94	0	1032	0	0	0.00	0	156,507
5/94	0	1059	0	0	0.00	0	157,566
6/94	0	1060	0	0	0.00	0	158,626
7/94	0	1036	0	0	0.00	0	159,662
8/94	0	1088	0	0	0.00	0	160,750
9/94	0	870	0	0	0.00	0	161,620
10/94	0	1128	0	0	0.00	0	162,748
11/94	0	1062	0	0	0.00	0	163,810
12/94	0	1049	0	0	0.00	0	164,859
TOT/94	0	11187	0	0		0	164,859
TOTAL	0	164859	0	0		0	164,859

CASE: 69 NYG04129 NIELSEN G. #1
M.FIELD
SENECA , NY
EREX (OTHER APP.)

DATE: 06/19/96
TIME: 14:21:12

P R O D U C T I O N   L E D G E R

DATE	OIL, BBL	GAS, MCF	WATER, BBL	GOR, CF/BBL	WATER CUT, %	CUM OIL, BBL	CUM GAS, MCF
PRIOR	0	164859	0	0	0.00	0	164,859
1/95	0	559	0	0	0.00	0	165,418
2/95	0	571	0	0	0.00	0	165,989
3/95							
4/95							
5/95							
6/95							
7/95							
8/95							
9/95							
10/95							
11/95							
12/95							
TOT/95	0	1130	0	0		0	165,989
TOTAL	0	165989	0	0		0	165,989

APPENDIX II

FREIR #1
PROPOSED DIRECTIONAL WELL

WELL PROGNOSIS
AND
LOCATION MAP

SENECA COUNTY DIRECTIONAL WELL SITE
FREIR #1

WELL PROGNOSIS

I Location:

The Freir #1 directional well site will have a surface location in Fayette Township of Seneca County about 2 miles east of Seneca Lake and 4 1/2 miles Southeast of the town of Geneva. The proposed well site will be 1500' east of New York State Route 96A and just south of Larsen Road.

II Drilling and Directional Information:

1) Projected Total Depth: 2350' TVD
2) Deepest fresh water: ± 450'
3) Deepest salt water: ± 1000' TVD
   Casing: 9 5/8" @ 475': 7" @ 1050' TVD
4) Top of potential fractured interval: 1460' TVD
5) Top of Queenston: 1880' TVD
6) Thickness of potential fractured interval: 890' (Herkimer thru Queenston)
6) Horizontal distance through fractured interval: ±1000'
7) Horizontal distance through Queenston Formation: ±400'
8) Well Bore Orientation: South 25° East

III Well Spacing and offset production:

1) Current plan allows for 4500' from the proposed location to the nearest on trend well.

2) Well 21292 (1146): Southwest offset
   Year 1 Production: 81 mmcf
   Well producing natural from Sodus shale

3) Well 17575 (4049): Northeast offset
   Year 1 Production: 132 mmcf
   Well producing natural from Medina formation.

V Open Hole Geophysical Logging Program:

1) The following well logs will be used in the well as the standard suite.

Gamma-Ray	LithoDensity
Dual Induction*	Temperature*
Neutron	

Note: Temperature and Dual Induction logs can only be used if borehole is not fluid filled. If borehole is filled with formation brine a temperature log can not be used and a Dual Laterolog will be substituted for the Dual Induction log.

2) Fracture Identification log.

A Formation Microscanner (FMS) log will be run if the well bore can be successfully filled with formation brine. Should a large flow of gas be encountered, running the FMS log may not be advisable if fluid in the borehole will impede well production. The fluid should be of sufficient brine content to allow proper operation of Formation Microscanner log.

Seneca County Directional Well
Freir #1

FORMATION TOPS AND ANTICIPATED WATER DEPTHS

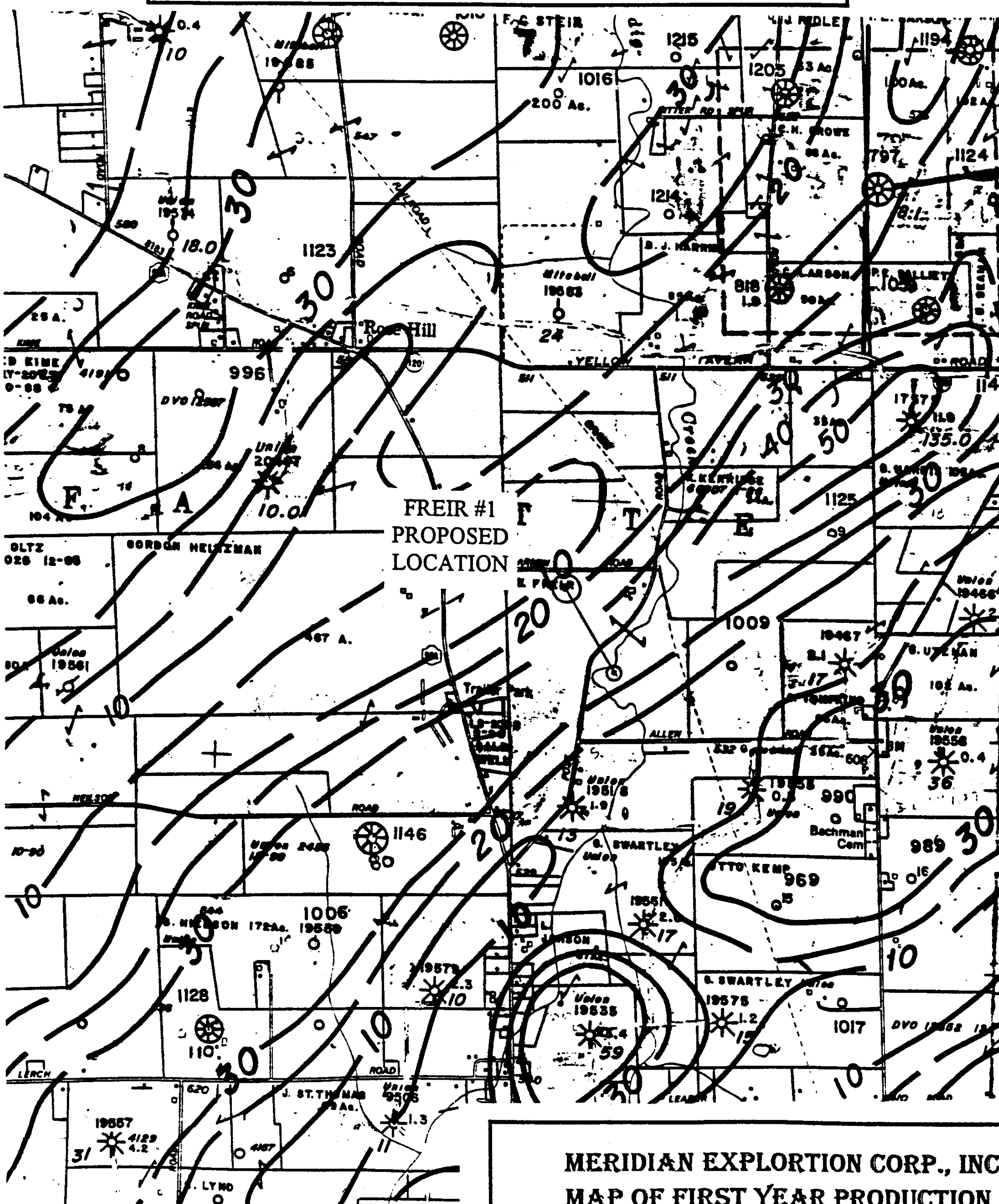
Elevation ± 500' GL
(All depths are TVD)

Formation	Depth	Comment
Glacial till, shale, unconsol, gravel, sands.	0 to 205'	Expect **large fresh water** flows.
Cherry Valley Limestone	205' to 225'	Limestone encased in shale (15' above, 75' below)
Onondaga Limestone	225' to 315'	Limestone, possible **large** flow of **fresh water**.
Rondout	315' to 337'	Limestone
Bertie	337' to 392'	Limestone, possible **large** flow of **fresh water.**
Camillus	392' to 617'	Shale, Siltstone, and limestone interbedded. Possible **salt water**.
Syracuse	617' to 900'	Interbedded shales, salt, with minor Limestone. Large flows of **salt water** common. Salt water as deep as 1100' in offset wells.
Vernon	900' to 1295'	Interbedded salt and shale common in upper 150 - 200'. Predominantly shale in lower Vernon (lower 250').
Lockport	1295' to 1460'	Upper 50' all Limestone with minor 5' to 10' shale at top. 35' shale at 1440'. 70' of limestone at base of Lockport.
Herkimer	1460' to 1605'	Silstone with interbedded shale, minor sandstone.

Formation	Depth	Comment
Rochester Shale	1605' to 1680'	Shale
Wolcott Lime	1680' to 1705'	Limestone, silty-shaley
Sodus Shale	1705' to 1780'	Shale
Medina	1780' to 1880'	Irondeque at top, oxidized sandstone with abundant pyrite. Remaining formation interbedded sands & shales
Queenston	1880' to 2350'	Sands, shales, siltstones all interbedded, abundant clay and Iron oxide minerals.

Note: Significant natural flows of gas have occured at depths below the Lockport formation. Target formations therefore include the Herkimer, Rochester Shale, Wolcott Lime, Sodus Shale, Medina and Queenston Formations.

SENECA COUNTY DIRECTIONAL WELL
FREIR #1 LOCATION



MERIDIAN EXPLORTION CORP., INC
MAP OF FIRST YEAR PRODUCTION
(MMCF)