ANNUAL REPORT OF THE NATURAL GAS SUPERVISOR.

OFFICE OF THE NATURAL GAS SUPERVISOR.
KOKOMO, IND., January 9, 1899.

PROF. W. S. BLATCHLEY, *State Geologist:*

SIR—In obedience to the provisions of section 7504 of the Revised Statutes of the State of Indiana, I submit herewith to you the seventh annual report from this department. It is largely confined to the work of the department during the year 1898 and a statement of the present condition of the gas field.

Acknowledging the cordial support that I have received from you during the past year, I remain,

Yours respectfully,

J. C. LEACH,
State Natural Gas Supervisor.

ANNUAL REPORT

OF THE

NATURAL GAS SUPERVISOR

INTRODUCTORY.

In the former reports from this department, the various scientific questions suggested by the generation, storage, pressure, etc., of natural gas, as well as the phenomena attending the progress of the field as it is developed, have been briefly discussed. It is not necessary to refer to these subjects in this report. Information regarding the present condition of the field, and as to what can be done to effectually combat those elements and agencies that are menacing its life and the prosperity of those industries that have been so largely benefited by it, is most sought now. This report is largely devoted to these subjects.

The duties of the Natural Gas Supervisor, as summarized in a former report, are as follows:

1. To make a personal inspection, as far as it is practicable, of all the natural gas property in the State, including wells, pipe lines, machinery, etc., giving special attention to the precautions taken to insure the health and safety of workmen engaged in opening gas wells and laying mains and pipes and those who use natural gas for any purpose.

2. To collect and tabulate certain statistics regarding the geological formation of the gas field, gas wells, pipe lines and manufacturing industries of the "gas belt."

3. To see that all the provisions of the law pertaining to the drilling of wells and the piping and consumption of natural gas are faithfully carried out and that the penalties for the violation of the same are enforced.

4. To make an annual report to the State Geologist.

I have not found it possible to inspect all the natural gas property in the State during any one year. To those persons who have a knowledge of the number of gas wells and miles of pipe line, both large and small, not to say anything about the apparatus necessary to the regulation and consumption of this fuel, the above statement will be reasonable. The purpose of the inspection determines the class of property to be inspected and how often it should be done. I have not found it necessary to give much attention to the precautions taken to insure the health and safety of either those who work with natural gas or those who use it; not that I attach no importance to this phase of the subject, but the necessary care is usually taken by the persons directly interested. Persons engaged in drilling wells or laying pipe lines are usually experienced men who fully understand the dangerous character of this fuel, and the consumer in most cases is protected by regulators and safety devices under the care of competent superintendents. In a general way I have found it more necessary to give special attention to the precautions taken to prevent the waste of this fuel than to measures adopted to insure the safety of those who use it. Then, as the chief purpose of the work is to prevent the waste of gas, the attention of the Supervisor should be directed first and principally to the avenues of greatest waste. No one questions the importance of effective work in this line. I have given most of my time to this work during the past year, and the conditions found and work done will be noticed in another chapter.

The statistical information specified by the law authorizing reports from this department has been given in former reports and in the annual reports of the State Geologist and the Bureau of Statistics.

Reference to the natural gas law, its enforcement and needed legislation is made in another section of this report.

THE INDIANA NATURAL GAS FIELD, ITS PROGRESS AND PRESENT CONDITION.

To a majority of the readers of this report the history of the discovery and exploration of the Indiana natural gas field is well known, and the brief reference made to these subjects here is on account of their logical connection with other subjects in the report, and that it may be better understood. The use of natural gas for illuminating purposes dates to 1821. It was first used in Fredonia, Chautauqua

county, New York. The supply, if it merits the name, was obtained from a water well and was, as would be expected, very small and transient. In 1843 a well 1,000 ft. deep near the Kanawha Valley, West Virginia, produced natural gas at "high pressure" and is the first of its kind of which there is any record. In Pennsylvania the first oil wells drilled (1859) produced some gas. At first it was allowed to escape into the air or was piped a safe distance from the wells and burned, but later was utilized under the boilers for drilling and pumping purposes. Natural gas was piped from what is known as the Murraysville field to Pittsburg in 1883. It soon became the domestic and manufacturing fuel of that city and vicinity and as its superiority as a fuel became better known the zeal of the prospectors in adjoining States increased. There were many failures and few successes, but these were the "beacon lights" for those exploring the earth's crust for the new fuel.

Geologists were not consulted. If gas had been found in the rocks underlying one locality or one State, why not another? Conditions, other than source, were not considered and but little thought was given it by those most actively engaged. Though "surface indications" were considered sometimes, there was nothing to indicate that like classes of the formation of the earth's crust were not deposited under like conditions and held similarly. If natural gas is found in certain formations in one region, why not in the same class of rocks in another?

If we adopt the commonly accepted theory, and the one that is vouched for by science, viz., that natural gas has its origin through the decomposition of organic matter contained in the rocks, it is reasonable to believe that it has been generated in greater or less quantities in nearly every geologic formation; and, if so generated, why is it found in commercially valuable quantities in such limited areas? The cause of this is found in the fact that a number of conditions besides source are necessary to natural gas accumulation, and it must be stored in large quantities to be valuable. Natural gas has been generated in every strata of the earth's crust containing organic matter and will continue to be as long as any organic matter remains and the necessary conditions (overlying deposits of sediment excluding the air and the proper temperature) are present. If this be true it settles all questions as to the generation of gas in any considerable quantities at present.

The conditions necessary to natural gas accumulation in any locality, named in the usual order, are source, reservoir and cover. Then, source is not the only condition necessary to gas accumulation, how-

ever important it may be. After the gas is generated it must be stored; to be so, the rock in which it is generated, or an adjoining rock, must be conditioned to hold it—must be a reservoir in which it may be imprisoned until set free by the drill. To be so conditioned, the storage rock must be porous, securely covered with a strata of rock impervious to gas or water and possess such a structural relief as will permit the various substances in the rock, gas, oil (if any) and water to arrange themselves in the order of their specific gravity. While the exploration for oil and gas that has been going on since they were discovered has not established any new laws regarding their generation, storage, etc., it has attested the correctness of the above statements. The areas of the earth's crust that are conditioned to be productive oil and gas fields are few.

Natural Gas in Trenton Limestone.

Previous to 1884 but little was known about the Trenton limestone except from its outcrops in Canada, New England, Kentucky, Iowa, Wisconsin, etc. It was thought to be a fairly uniform formation, underlying the middle States. Some deep wells had been drilled in the southern part of Ohio and other places, penetrating this limestone without any indications of oil or gas. As natural gas came into general use for fuel purposes in Pittsburg, the prospectors in Ohio became more active. "Surface indications" of natural gas had been noticed at many places, but they were especially prominent at Findlay and had been for a number of years. Water wells had been rendered useless by the presence of natural gas. It was frequently detected in sewers and other excavations. The first well to be drilled was finished November, 1884. The Trenton limestone was found at 1,092 ft., and the drill had not penetrated it far when the roar of the gas escaping from its rocky prison made it known that the efforts of the explorer had been rewarded; that a reservoir of nature's most valuable fuel had been found. This was the beginning of the natural gas industry in Ohio and Indiana. Heretofore natural gas and oil had been found in sandstones only. Now a new formation was to be explored. Ere long a sufficient number of wells had been drilled in the vicinity of Findlay to establish the fact that this limestone formation in that State was an extensive natural gas reservoir. Drilling now began in earnest. Nearly every county in the western part of the State made one or more efforts to secure the new fuel.

The State line proved no barrier to the drill. A well drilled at Portland, Jay county, Indiana, March, 1884, was a small "gasser." More successful results were obtained at Eaton, Delaware county, and Kokomo, Howard county, the same year. The drilling of numerous wells between Portland and Kokomo, and north and south of a line connecting these two cities, demonstrated the fact that Indiana had within her limits the largest and what has since proven to be the most productive natural gas field in the United States.

The Gas Reservoir.

Trenton limestone is a universal formation in Indiana, but, as elsewhere noted, not a universal gas-producing rock. The story of the drill in this field fully confirms statements made in this chapter regarding the conditions necessary to natural gas accumulation. In this field the gas is indigenous to the rocks in which it is found; that is, the Trenton limestone is both the source and the reservoir. For a geologic formation to be the source of natural gas, organic matter must have been deposited with the material that forms it. Of the Trenton limestone this is true, as is witnessed by the fossil remains shown at the outcrops. The fact that this formation is gas-producing over a comparatively small area, though underlying the entire State, is due to its textural and structural conditions in this productive area. The gas is held in the upper part of the limestone. This porous strata is not a pure limestone, the carbonate of lime having in part been displaced by carbonate of magnesia. The gas-producing rock seldom comes to the surface of the limestone, from 1 to 15 ft. of the uppermost portion usually being hard and non-porous. The porous part of the rock is very unequal in thickness. In the extreme southern part of the gas field it varies from 5 ft. to 10 ft. thick, while in a few localities of the north central part the drill has penetrated it 100 ft. without reaching the lower boundary.

The Utica shale overlies the Trenton limestone in Indiana and forms a practically impervious cover for the gas reservoir, a very necessary condition to natural gas accumulation. The necessary structural relief is furnished by an elevation in the rock known as the Cincinnati arch. The Trenton limestone, outcropping in every direction from this State, forms a large basin in which this arch is located. In Indiana it is a broad elevation crossing the State line between Lawrenceburg and Liberty and extending northwest. Where

it enters the State it is 349 ft. below the surface and 158 ft. above sea level. It descends gradually to the northwest, and has a very uneven surface, with numerous small ridges extending at various angles from the main elevation. The Trenton limestone south of the gas reservoir is nearly a pure limestone and non-porous. This is also a very necessary condition in this field, for if it were porous from the present field southward to the outcrop, most of the gas that is found imprisoned in the rocks in this State would have disappeared from these outcrops long ago. The "surface indications" would have been far from the supply. From this it is seen that all the necessary conditions for gas accumulation are present in this field and that every condition present is necessary.

Development of the Field.

As has been said, when it became known that the Trenton limestone in this section of the State was a gas-producing rock, numerous companies were organized and the drill started on its mission of exploration. Nor was the drilling confined to any particular locality, but every section of the State was anxious to secure the advantages of this gaseous fuel. Though much capital and labor were lost by prospectors, it was not without some compensation to the State, for the "gas belt" was located and much valuable knowledge concerning the geological formation of the State was gained.

The natural gas territory in Indiana is in the eastern central part of the State. It is an irregular obovate in shape and does not exceed 100 mi. in length nor 70 mi. in width. It occupies the following counties in whole or in part, viz.: Blackford, Boone, Clinton, Decatur, Delaware, Grant, Hamilton, Hancock, Henry, Howard, Huntington, Jay, Madison, Marion, Miami, Rush, Shelby, Tipton, Wabash, Wayne and Wells. A very small portion of some of these counties is in the "gas belt,"[1] while within the area a few small tracts of barren territory have been found. As would be expected, the first gas companies were organized to supply the cities and towns with fuel, and the first wells usually drilled within their limits. However, it was but a short time until "farmer companies" throughout the field were supplying the rural districts, and every resident of the field had an opportunity to use the new fuel.

[1] See map accompanying Annual Report, 1897.

The use of natural gas was not to be restricted to domestic consumers nor to those within the confines of the "gas belt" only. Resident factories were quick to adopt it. The superiority of natural gas as a manufacturing fuel was well known. The abundance of the supply was advertised far and wide, and not always by business-like methods. All classes of factories, especially large fuel consumers, were anxious to locate in the new gas field. Its advantages caused manufacturing institutions of all classes to locate, until ere long the "gas belt" became the manufacturing center of the State. The competition that arose between cities and towns to locate factories caused many unwise things to be done to show that each particular city or town was in the "heart" of the field.

The initial rock pressure of this field was 325 pounds. This was sufficient to force the gas a considerable distance from the field. People living outside of the "gas belt" were anxious to secure the new fuel. From 1888 to 1892 pipe lines were constructed from the gas field to Indianapolis, Lebanon, Crawfordsville, Frankfort, Lafayette, Logansport, Peru, Wabash, Huntington, Bluffton, Ft. Wayne, Decatur, Union City, Richmond, Connersville, Shelbyville and Chicago. A little later two lines were laid from the eastern part of the field to Ohio, there, in addition to supplying some towns, to supplement the rapidly diminishing supply of others that had been supplied from the western field in that State. Prior to the construction of these pipe lines there had been no systematic drilling in the field or effort to pre-empt the territory. Cities were supplied from wells within their limits or the immediate vicinity, and but few factories were compelled to go beyond their own yard for fuel. The pipe lines tapped the gas reservoir at the nearest point, and have been extended from year to year toward what is considered the "heart" of the field. Excepting Connersville and Shelbyville, all the pipe line cities receive their supply of gas from territory north of the south line of Madison county. That territory north of this line is usually referred to as *the* gas field, and while it is the most productive part of the field, it will probably be exhausted before the territory south is. In the territory south of Carthage, Rush county, and especially the southwestern part of this county and the northwestern part of Decatur county, the gas rock is very thin and hard, lacking the porosity found in the northern section of the field. The wells seldom show any water. The gas passes very slowly from the rock to the well, and hence they are small, the average well supplying about twenty families with fuel and light. The texture of the rock nearly precludes the possibility of overwork. Natural gas has been used in that section for domestic purposes, and

some little manufacturing, during the past eleven years, and the decline in the rock pressure has been comparatively small. The indications are that the gas in this section of the field is "water sealed" from the main gas area north.

The gas territory north of the line mentioned above is an irregular circle in shape. The geographical center of this area is near Alexandria, Madison county; but if the center of production or the "heart" of the field is that point, where the various pipe lines would appear to meet if extended along the line now indicated and uniformly each year from now on, it is about 15 mi. north of the geographical center. An examination of the map of the Indiana natural gas field accompanying my annual report for 1897 shows that the pipe lines from the west and southwest have made much greater extensions and occupy much more territory than those from the north and northwest. It does not follow from this that the territory of the former is less productive than the latter, for consumption has to do with the drilling of wells and pipe line extensions as well as the quality of the territory.

Pipe line companies soon found it necessary to plan their field of operation and hold large tracts of land under lease to protect their interests. This made it necessary for local gas companies and manufacturers to add an additional field expense. The leasing of territory has continued until practically the entire productive area is now under lease for gas and oil. I do not mean that all the territory is leased, but enough is to develop and exhaust the field. Of course, if the territory not leased were drilled, it would in a measure destroy the value of the territory that is leased. It is seldom that any gas company leases all the land in any locality, and when they do it is only for self-protection, and not that it is necessary that they may enjoy its natural gas resources.

As has been mentioned above, the pipe lines tapped the gas reservoir at the nearest point. The three companies that furnish gas to Indianapolis received their first supply from wells in southeastern Hamilton county. Since they have been compelled to extend their lines entirely through Madison county, and are drawing their gas from wells in northern Madison, southern Grant and northwestern Delaware county. The line to Crawfordsville was stopped in 1891 near Sheridan, but has since been extended 20 mi. The line to Lebanon was constructed in 1890 to the same point, and has been extended 15 mi. Frankfort was originally supplied from wells in the western part of Tipton county, but these have been long since abandoned, and the supply now comes from Duck Creek township, Madison county. The

first natural gas used at Lafayette was from wells in the northwestern township of Tipton county. Wells in Grant county are now supplying practically all the gas for that city. In 1888-89 an 8 in. line was constructed from Logansport to a point 2 mi. south of Kokomo. This line has since been extended through Howard county and 5 mi. into Grant county. The Peru line is 15 mi. farther in the field than when first constructed, and the extensions amount to twice that amount. The line to Wabash, constructed in 1888, has been extended from the south line of that county half way through Grant county. The Huntington pipe line reaches 15 mi. into the field. Ft. Wayne and Bluffton at first drew their supply from the northern part of Blackford and the western part of Jay county, but have since entirely surrounded the former county with their lines. Union City has been making extensions from year to year, and the Richmond pipe line, built in 1888, has been extended 8 mi. north of its original termination, with parallel extensions. The Indiana Natural Gas and Oil Company (Chicago) has two 10 in. lines extending into Grant county. The Ohio and Indiana Gas Company and the Redkey Transportation Company have four parallel lines extending more than half way across Delaware county. Their first supply was largely from wells in Richland township, Jay county, and the eastern half of Niles township, Delaware county. In referring to the extensions above, I have not noticed the numerous parallel and lateral lines usually built by gas companies that they may the more completely occupy the territory through which their lines pass.

An examination of a map of the gas territory in the light of what has been said regarding the location of pipe lines will show but little undeveloped territory remaining. A small area, probably 150 sq. mi., embracing parts of Grant, Madison and Delaware counties, and Licking township, Blackford county, has not been invaded by pipe lines, though the decrease in the rock pressure of wells located therein during the past year has been nearly as great as that of wells connected with the lines. This territory is practically controlled by gas companies, and if the yearly extension of pipe lines is as great in the future as it has been in the past—and there are reasons why it should be greater—it will not require to exceed two years for these lines to completely occupy this territory. I do not wish to be understood as saying that I believe the field will be completely exhausted in two years; for doubtless, after the field is completely threaded with pipe lines, many wells will be drilled. The gas rock will not be opened deep and the per cent. of failures will be large; but the result will compensate for the cost. The territory in the immediate vicinity of

the pipe lines is practically "drilled out." There are tracts of land, some of considerable size, held under lease by cities, towns and factories, that are as yet undrilled. But, as the gas rock is a universal "pipe line," the gas unless sealed in some ridge or dome in the rock, tends to equalize, and a heavy draught in one locality effects the surrounding territory. The effect is to exhaust territory without drilling.

Wells are occasionally reported in old abandoned territory with a rock pressure much in excess of that in the most productive gas area. An examination usually shows but little gas, frequently not enough to raise the water. These wells were probably sealed from the field by the salt water when the pressure was high, and the light draught since has affected them but little.

It is not possibly to say how long the supply of gas in this field would have honored the draught of local consumers. The invasion of the field by pipe line companies will result in its comparatively speedy exhaustion and also a speedy remuneration to the landowners for the privileges granted the gas companies. Many landowners are receiving annual rentals equal to two and one-half dolars per acre for their entire farm, and a few have been receiving $200 per well for a number of years. One gas company paid $66,000 lease rentals last year In view of these facts, should landowners be interested in the efforts made to husband the supply of gas and thereby extend the life of the field? For every year that the life of a well is extended the landowner is the beneficiary to the extent of the annual rental.

The Decline of the Field.

The original rock pressure of this field was 325 pounds to the square inch. The pressure was practically the same throughout the field. This did not indicate, however, that all parts of the field were alike productive. The production of a field must be judged by the volume of flow of the wells, and the rock pressure does not indicate this.[1] In the early history of the gas field, before the draught on the gas rock has brought about local conditions affecting it, when a well is closed it becomes a part of the gas reservoir, and its pressure will finally be the maximum pressure of the field. After a field has been in service for a long time, local conditions may arise that will influence the pressure of one well and not of another in the same locality,

[1] See Twenty-first Annual Report of the Department of Geology and Natural Resources of the State of Indiana, 1895, pp. 349-50.

hence the difference in the pressure of different localities in this field at present. While the rock pressure does not indicate the productiveness of one well as compared with another, any material decline of the same indicates a diminution in the supply of gas.

The heavy consumption of gas by manufacturers and pipe line towns from this field soon became apparent in the decline of the rock pressure in those localities of largest draught. This did not show in these localities only, but in the interior of the field also, though the decline was not so marked. At first the heavy consumers drew their supply from the edge of the field and in the vicinity of cities and towns, and it was at these places that the decline in the rock pressure was first noticed. The records of this office do not indicate when the pressure began to decline. It is probable, however, that it began at the extreme edge of the field with the first heavy draught. The decline in the interior and productive part of the field was not sufficient to attract much attention prior to 1890. The general decline in the pressure of this field by years has been gradual, showing greater, of course, during periods of heavy consumption. In fact, the pressure of different localities has shown signs of equalization during the summer season; thus, in some instances, showing a slight increase of pressure. As the pressure declines, it becomes less uniform throughout the field, local influences becoming more influential. In 1895 the average of eight tests of rock pressure made in various parts of the undeveloped territory, that is, territory not invaded by pipe lines, and in which wells for local consumption only had been drilled, was 264 pounds.[1] At present the average pressure of the same localities is 181 pounds.[2] This is a decrease of 83 pounds in a little more than three years, or about 26 pounds per year. The average decrease in the rock pressure of the most productive part of the field, and that part upon which the draught is heaviest is greater than in older territory; for when the pressure of a well drops to a certain point any considerable draught or decrease in the pressure works an abandonment of the well. If the pressure of the wells throughout the field continued to decline until they showed no pressure at all, and conditions were such that the draught would continue uniform until the reservoir was exhausted, the average decrease would doubtless be about the same. The average rock pressure of the entire gas-producing area, November, 1897, was 191 pounds. At present the average of the same is 173 pounds, a decrease of 18 pounds during the past year, or eight pounds less than the yearly decrease, 1895-98, in territory undeveloped in 1895.

[1] Tests made September, 1895.
[2] Tests made November, 1898.

Salt water, universally present below the natural gas and oil (if any) in this field, is the most dangerous and difficult element with which the natural gas industry has to contend. As the supply of gas diminishes, the salt water horizon advances toward the highest point in the reservoir until it finally displaces the gas entirely, or a heavy draught upon any locality invites its presence, and as the draught continues it rises higher and higher until it ultimately seals what gas is left in the rocks. The structural condition of the rock has much to do with the aggressiveness of the salt water. The western part of the field was first to succumb to its force. It appeared early in the history of the field and overcame very productive wells with a rock pressure of 260 pounds. It has been advancing eastward since, until now there are but few wells that do not show some water. Wells apparently free from it when first drilled are soon "wet." In November, 1897, I tested thirty new wells in the western part of Grant county—and there is no territory more productive—and 50 per cent. did not show any water. November, 1898, I tested thirty-six new wells in the same county, in territory nearer the "heart" of the field, and but four of them did not show water. The wells in each instance were drilled about the same depth in the gas rock. This certainly indicates a rise of the salt water horizon and a diminution in the supply of gas. On the east side of the field the water has been less intrusive. More indications of oil are noticed. The water that is present does not wield a force sufficient to overcome the gas at a high pressure. In this part of the field I have known wells to do fair service at 90 pounds pressure in the presence of water, and an occasional one to become entirely exhausted without any sign of this element. As to the pressure at which the gas wells will succumb to the salt water in the various localities of the field, it is difficult to say. On the west side of the gas territory many wells have been "drowned out" and abandoned at 250 pounds pressure, while on the east side the water has advanced very slowly. What was said of the west side of the field can be, with some modifications, said of the southern part of the main gas area as well as of the north side. In these localities it has not been quite so intrusive as on the west side. I have mentioned its presence in the territory or productive part of the field. Many old wells are practically worthless now on account of its presence. Wells registering 175 pounds pressure fail to raise the water. Much depends upon the depth to which the wells are drilled in the rock and the draught upon the territory. Great care should be taken in drilling wells. Generally the inclination is to drill deeper and possible get a little better well, but it should be remembered that a small gas well is much more valuable than a large

salt water well. The most successful gas companies watch the advance of the salt water and drill their wells accordingly.

Can anything be done to counteract the influence of the salt water? This question is often asked, and it can safely be answered in the affirmative. If the pressure in the well is strong enough to raise the water to the surface through the well tubing, it can be separated from the gas by means of an automatic separator. If any water should get into the line, drips can be arranged to catch it. If the pressure of the gas is not strong enough to lift the water through the well tubing, then the only thing to do is to reduce the size of the tubing to a point where the gas will lift it.

In concluding this chapter I will repeat the statements made in all my former reports, viz., that the past history and every condition in this gas field indicate its ultimate exhaustion. For those who are acquainted with the field and its ever-changing conditions this statement is not necessary, nor is it much more so for many who know nothing of these conditions and judge the future by the gas service in the past only. In most localities within the gas area the supply of this fuel has been ample to date, and the assertion that the supply is failing is often construed, and without just cause, as an effort in behalf of the gas companies to annul any dissatisfaction on the part of the consumer with the gas rates. I can only say that the field and its conditions are not open to gas companies only, but any citizen may personally know the true conditions. Any aid that I can give is at their command. It has been my desire that every one interested in Indiana's most valuable natural resource should be fully apprised of all the conditions affecting it. It has been very difficult to get the ordinary consumer, and in fact, some manufacturers, awakened to the conditions and a business-like appreciation of the same; to the necessity of husbanding the supply of this gaseous fuel

Summary.

Briefly summarized, the Indiana natural gas field shows the following conditions:

1. The gas resources of the territory in the gas field is practically all controlled by territory under lease, either by gas companies or manufacturers, and the pipe line companies, which are the large consumers of natural gas, have extended their lines from year to year and are apparently centering around Fairmount township, Grant county.

2. The undeveloped territory in the field, that not invaded by pipe lines and having only sufficient wells to supply local consumption, comprises about 150 sq. mi. in Grant, Madison and Delaware counties. Possibly a few square miles in Licking township, Blackford county, should be added to this.

3. If the yearly extension of pipe lines is as great in the future as it has been in the past it will not require to exceed two years to completely occupy this territory. It does not follow from what has been said that the natural gas field will be exhausted in two years; for after the field is threatened with pipe lines doubtless many wells will be drilled with results that will justify the expense.

4. The salt water that has been a menace to the natural gas interests from the beginning is becoming more intrusive day by day, there being but few wells in the field entirely free from its influence. Wells apparently free from it when drilled become wet soon after being attached to the line.

5. Rock pressure does not indicate the productiveness of one well as compared with another, but any material decline of the same indicates a diminution in the supply. The average rock pressure of the undeveloped territory in 1895 was 264 pounds. The average of the same territory at present is 181 pounds, a decrease of 83 pounds in a little more than three years. The average rock pressure of the entire gas-producing territory, November, 1897, was 191 pounds; November, 1898, the average of the same territory was 173, a decrease of 18 pounds.

6. The history of other gas fields, the past history of this and all its present conditions justify the statement that the supply of gas is failing and will finally be exhausted.

THE CONSUMPTION AND WASTE OF NATURAL GAS, AND FIELD WORK, 1898.

The work of this department has been almost wholly confined to the field during the past year. The value of natural gas as a fuel for domestic and manufacturing purposes, the progress of this field during the past twelve years and its present condition emphasize the fact that every effort possible should be directed toward the husbanding of this fuel. No waste should be permitted, and the same care and

economy should be exercised in its use as with other fuels. It has been to the ends stated above that my work has been directed this year.

Every one who is at all familiar with this field and its past history knows of the great waste of this gaseous fuel that has been permitted from the beginning. By *waste* I mean the escape of gas into the air at places other than at the point of consumption. True, an extravagant use of this fuel is a waste of it, and it is equally true that it is so used in many places. But the way that gas is used and the amount used is largely under the control of the gas companies and consumers. The most that the Supervisor can expect to do in this line is to recommend such changes in regulators, mixers, burners, etc., and in the manner of consumption as will result in the best service with the least waste.

As I have said, more or less gas has been permitted to waste in this field from the beginning, but the amount thus wasted at present is very little compared with the same during the early history of the field. And, generally speaking, it is used with more care and with much more satisfactory results than formerly. The fact remains, however, that there are but few consumers, either domestic or manufacturing, that exercise that degree of economy in the use of this fuel that its value warrants, or that they would exercise if it were measured to them by the cubic foot, and they were compelled to pay for what they use; and also that there is more or less waste throughout the field. All of this is true in the face of the fact that the supply of natural gas is limited and that every cubic foot either consumed or wasted brings us that much nearer the time when we shall have to return to other fuel.

The Consumption of Gas.

The heaviest continued draught upon the gas field is the consumption. This should be true. It would also be true if not a foot of gas was used that was not necessary. Natural gas has fulfilled its highest mission when it has been used for the comfort and benefit of mankind. The time has been in this field when there was much indifference manifested by gas companies and consumers toward the manner of using natural gas. Burning from the open end of a pipe, it was used as a light. In the stove and furnace and under the boiler it was used without mixers, and at a dangerousy high pressure. This all meant much waste and unsatisfactory results. Time has wrought a change, but not a complete one.

Natural Gas Flambeaux.

During the early history of the field, and in fact until within the last three years, the most wasteful use of natural gas to be seen were the flambeaux burning in every section of the field. In many places they were allowed to burn day and night, year in and year out. A large amount of gas has been wasted in this way. At best natural gas is a very poor illuminant, and the amount consumed by these torches, compared with the light, was certainly a very extravagant use, if not an absolute waste. In line with this idea, the General Assembly of 1891 enacted a law prohibiting the use of flambeaux for illuminating purposes. This law encountered much opposition at first. Public sentiment was against it, and it was therefore difficult to enforce. Those opposed to the law and its enforcement contended that it abridged their rights as citizens; that natural gas is property, and as such the owner had a right to use it as he desired. The enforcement of the law, the State claimed, was but a judicious exercise of its police powers; that the welfare of the public overshadows the good of the individual. Prior to 1895 the law was not enforced. October of that year a suit brought in Blackford county by the Natural Gas Supervisor to enforce its provisions was carried to the Supreme Court of the State. With little delay that tribunal rendered a unanimous decision holding the law constitutional. That practically settled the question. I have had but little occasion to appeal to the law since.

Use of Gas by Drillers.

It is reasonable to suppose that gas and oil well drillers, prompted by self-interest, if nothing else, would use this fuel with care. This is seldom true. My attention was been called frequently to the lights used by them. There is no question but that natural gas makes the most convenient and practical light for drilling purposes, but so frequently the men in charge become careless and not only use more gas than is necessary, but permit it to waste. They are apt to burn more lights than are really necessary, one light in the derrick being sufficient, and neglect to turn them off during the day. While the use of natural gas torches of any size and at any time or place for illuminating purposes is a violation of the law, I have found by practical experience that the amount of gas consumed by them, when properly arranged, is less than that used in the number of "Jumbo" burners

usually substituted where the torches are prohibited. I have endeavored during the past year to keep these lights to a reasonable limit and in so doing have been compelled to appeal to the law in six cases.

The fuel used by drillers is usually conveyed from a pipe line to the boiler through a small temporary line laid upon top of the ground. They are usually laid in a hurry and with but little pains, and seldom confine the gas as it should be. At the boiler the apparatus is crude and ill-adapted to its use, and as a consequence much more gas is used than is necessary. The remedy for all of this extravagant use or waste lies with the gas companies furnishing the gas. A little care and watchfulness on their part would stop one of the avenues of waste. I have given this subject some time during the past year, with good results.

Use of Gas by Factories.

It is difficult to believe that manufacturers would use natural gas extravagantly, much less permit it to be wasted; yet in some instances I have found both conditions existing. Manufacturers who have not been the victims of "free gas;" who have been compelled to go into the field, lease territory, construct pipe lines, etc., and consequently know something of the cost and expense of maintaining a fuel supply plant, usually practice a degree of economy in the consumption of their fuel, though seldom as rigid an economy as they observe in the consumption of other constituents of their product. Factory pipe lines, however, are usually in good condition, seldom having the service lines in the field that are maintained by gas companies, and the waste, if any, is usually in the factory. The question of factory light presents some difficulties. Natural gas makes a convenient light, but through lack of attention it often becomes a very wasteful use. The liability of breakage makes the use of glass globes or lamps almost impracticable. Any system of lights or class of burners are expensive if kept in repair and if not are soon practically flambeaux. It seems that the only practical solution of the light question is for factories, not extensive enough to warrant the maintenance of an electric light plant, to use "Jumbo" or similar burners. These to give an economical and satisfactory service should be kept in repair and used only when needed. Every factory should keep a man employed to care for their fuel supply plant. He should see that all gates, valves, etc., at the wells are in working condition; that all pipe lines and service lines are kept repaired; that the regulators are properly adjusted and

all mixers and burners are kept clean, so that combustion will be perfect and the full heating power of the gas realized. He should see that all lights are in repair, properly adjusted and lighted only when needed. This means some work, but a most profitable work, not only in saving gas, but in better service. Best results are only secured when combustion is perfect; then the full power of the gas is realized. Manufacturers are beginning to see the necessity of attention to the fuel item. In many cases it has given but little trouble in the past, but the first sign of failure of the wells that have been so faithful during the past ten years brings them face to face with the fuel question. Then it is that the question receives the proper consideration. I believe it is true that all manufacturers realize now as they never did before that the supply of this valuable fuel is limited, and that much depends upon how it is used from now on. During the past year I have found a majority anxious for suggestions regarding economical methods for using this fuel. They realize the necessity for this, and also that apparatus designed for such purpose usually gives the most satisfactory service. The manufacturers of the gas belt have given me much aid and encouragement during the past year in my efforts to enforce the law and husband the supply of this fuel. They are not all using natural gas in the manner that its value warrants, but their efforts now are in that direction.

The Use of Natural Gas by Private Consumers.

I will not detract from the merits of natural gas as a manufacturing fuel when I say that it renders the greatest service to the domestic consumer. It is clean and labor-saving, and when properly regulated maintains a uniform temperature. Imperfect service can be charged to the gas company, consumer, or both. Referring to this subject, I quote from my Annual Report, 1896:[1] "In order to realize the full heating power of natural gas, it is necessary to mix it with air. As to the proper proportion of air to gas, there is a difference of opinion; ten of air to one of gas is not far from correct. If this proportion is to be maintained, the pressure of the gas should not vary, for a mixer that will admit gas and air in the correct proportion when the gas is under a twelve-ounce pressure will admit a larger amount of gas if the pressure is increased to sixteen ounces. Ninety-six cubic feet of gas under a pressure of three-tenths of a pound will pass through a No.

[1] Twenty-first Annual Report of the Department of Geology and Natural Resources, Indiana, 1896, p. 450.

7 mixer in one hour, while under one-pound pressure 179 cu. ft. will pass through the same mixer in the same time. It is evident from the above that when a mixer is so adjusted that gas and air are admitted in the proper proportion the pressure of the gas should not be changed, unless the amount of air admitted is changed to correspond." Perfect service can only be had when combustion is complete. An economical and satisfactory gas service is invariably the result of an ample supply of gas furnished at a uniform pressure and after being mixed with the proper proportion of air, consumed in clean and scientifically arranged burners. It rests with the gas company to furnish the gas, regulate the pressure, and see that the mixers are adjusted to it, and with the consumer to keep all burners and other apparatus used in the consumption of this fuel clean and in repair. In the consumption of natural gas, the object should be perfect combustion, which always results in good service if the supply of the fuel is sufficient. Imperfect combustion means waste. The gas not consumed passes up the chimney or into the room. But incomplete combustion is not the only avenue of waste by domestic consumers. In a majority of the homes and business houses using gas, especially by the "contract system," more gas is consumed than is necessary. I believe that 50 per cent. of the heating power of the gas consumed by a large majority of gas consumers is wasted. That is to say, if furnaces, grates and stoves were properly arranged for gas, the damper adjusted and the burners and mixers clean and scientifically adjusted for the consumption of this fuel, more satisfactory service would be secured with one-half the fuel ordinarily consumed. I have especial reference to consumers within the "gas belt." The temperature of most dwellings is kept above the health limit, and not infrequently have I known the doors and windows to be opened when the gas should have been turned down. With the present system of selling gas, the "contract system," it is difficult to change conditions. However, the extravagant use and the waste of gas by domestic consumers can be reduced to a minimum and more satisfactory service rendered if both gas company and consumer make necessary and reasonable efforts in that line.

Another avenue of waste of natural gas in connection with all classes of consumption is the class of "heaters" used throughout the field. The gas used by farmers is usually conveyed through small pipes on top the ground to the consumer. The distance it is piped varies from a few rods to miles. If there be any water in the gas, and there usually is, much inconvenience is caused in winter by its freezing. To remedy this, the line is heated at intervals by gas fires. These, many times, are large open fires that result in little good. If a heater is

necessary, a small brick furnace should be built over the line, and a very little gas will be sufficient. However, the greatest waste is not in the amount of gas used, but in the fact that in many instances the gas is never turned out. It is heated when the fires in the house are out. By the aid of the gas companies that have been permitting it, I have been able to remedy this abuse to some extent during the past year.

The Waste of Natural Gas.

A spirit of seeming indifference to the waste of natural gas on the part of those most interested in the life of the gas field and its prosperity has existed from its discovery until the present time. To this general statement should be added a qualifying clause, to wit, that during the past year a change has been wrought in the minds of most manufacturers and gas companies and a few consumers which has resulted in much good. During the early history of the field public sentiment was not only indifferent to the extravagant use and vandal-like waste permitted at that time, but it was in many instances positively opposed to the enforcement of law enacted to protect Indiana's most valuable resource. The reason for all this seems to rest in the manner that it was first used. During the first two or three years after its discovery, different localities in the field seemed to vie with each other as to the amount of gas they could use (waste). Gas wells with a daily capacity of 5,000,000 cu. ft. were permitted to burn day and night for weeks, apparently illuminating the field for miles around. Arches of gas pipe were raised over the principal streets of cities and towns, supporting hundreds of natural gas torches, to welcome the manufacturers who desired to locate in the "gas belt." Flambeaux lighted not only the streets of the cities and towns, but the farm-yards throughout the field. Much of the gas necessarily consumed was by the methods referred to above employed by gas companies, promoters and "boomers" to advertise to the world that Indiana had a gas field that would last for all time. A universal inducement offered by every city and corporation to manufacturers seeking a location in the bas gelt was one or more gas wells, or "free gas" for a specified time. In every proportion and counter-proportion "free gas" was included. The very term carries with it the idea of plenty, and its free use had some influence in creating the public sentiment that existed at that time toward the use and abuse of the new fuel. But little attention was given to the question of source of generation of

gas. Those who witnessed the power exerted by this natural resource as it rushed forth from its rocky prison and enjoyed its luxury when reimprisoned were sure that nature had made provisions for its renewal—that it would last forever. It seems that everything conspired to create a feeling of security in the supply of this gaseous fuel and open-handedness in dispensing its privileges. To dislodge the erroneous ideas concerning the supply of natural gas and the limitations surrounding the same, and create a business-like sentiment in favor of reasonable economy in the use of it, has not been an easy task. Many consumers know nothing about this fuel except what they see at the point of consumption, and to those within the productive gas area there is but little evidence there that the supply is failing. However, evidence of the true condition is becoming more prominent. It is to be hoped that the citizens of the gas field will awake to a full realization of the situation and their duty in the premises at once. It is late, but not too late to do some good. Natural gas should be used with the same degree of economy as are other fuels, and not one cubic foot should be permitted to waste. The loss that the State has sustained on account of the waste of this fuel in the past can not be estimated. But it is the present that confronts us, and not the past, except only in so far as its errors and their effects serve us in the future. Can we not stop all waste and use what remains of this valuable natural resource with the care that its value warrants? The principal waste of natural gas has been by the consumer, from pipe and service lines and at the well. I have referred to the former in another section of this report.

Waste of Natural Gas from Pipe Lines.

In speaking of pipe lines I refer to large lines, fuel supply lines, and not the small one and two-inch lines usually used to convey gas from the well to the pipe line and from the pipe line to the consumer. Leaks in pipe lines are usually at the joints, caused by defective fittings or a lack of care in constructing the line. Some of the lines in this field have never caused any trouble. Every joint was perfect and the entire line tested and caulked until it was known to be absolutely tight. This is as it should be. In other instances they were constructed hurriedly and from lead joint pipe. These have caused much trouble and a waste of gas. I am glad to know that nearly, if not quite, all of these have been repaired during the past two years. The lines have been carefully inspected and air-tight clamps placed over defect-

ive joints. The pipe lines that I have been able to examine during the past year were in better repair than at any former examination. But few leaks were detected. Any material waste by this means can be prevented by watchfulness and prompt action on the part of gas companies and manufacturers.

The chief waste from gas lines is from the small lines that thread every section of the field. There are near 350 gas plants in the field, not including the fuel supply plants of factories. A majority of these distribute the gas from one or two wells through a score or more miles of small lines, varying from one-half to two inches in diameter. In addition, hundreds of miles of small lines, tributary to the pipe lines, thread the gas belt, conducting gas to farm houses. These lines have been in the past, and are at present, the source of much waste. I know how difficult it is to keep small lines lying on top the ground in repair. Being subject to a varying temperature, they may be perfectly tight one day and leak the next. The lines are mostly along the public highway, and in addition to being sources of waste, are dangerous to the public. Appreciating the importance of keeping the lines in repair, and knowing that it is not possible for the Supervisor to inspect all these lines, the Manufacturers' Association of the State employed two men last year to do this class of work. These men, under my supervision, traveled over these lines; and whenever a leak was detected, the responsible party was notified, which usually resulted in the line being repaired. Since that complete and thorough inspection the waste from this source has been small, compared with what it was before. If every gas company and manufacturer will keep their own lines in repair, the waste from this source will be practically stopped. Ordinarily, it is not necessary to urge people to care for their own property. But the indifference usually manifested toward the manner that natural gas is used is not noticed in the use of any other class of property. There is no law to compel owners of natural gas lines to keep them in repair and in a condition to confine the gas, unless what I have termed the penalty statute is broad enough to prohibit waste by this means. It would simplify matters very much and benefit the natural gas industry greatly if a law were enacted making it the duty of the Natural Gas Supervisor to have leaks in gas lines repaired, after the owner of the same had been duly notified of the necessity of the same, and making the cost of the same a lien on the line and wells attached thereto, recoverable by a civil action. If such a law were in effect it is probable that it would not be necessary to appeal to it often. Its influence would be felt without its enforcement.

The Oil Industry and Natural Gas.

Natural gas and oil are usually thought of as associated products of the earth's crust. Unquestionably, their origin and the conditions under which they were stored are the same; and it is not unreasonable that search be made for both in the same locality. Though this be true, the idea that oil always follows gas is erroneous. These hydrocarbons are sometimes found associated, but in this field it is the exception rather than the rule. In distinctively oil territory gas is sometimes found with the oil, but when oil is found in gas territory it is usually in "sand" below the "gas sand" and separated from it by a hard stratum of non-porous rock. As a rule, the "oil sand" produces some gas. The regular "gas sand" being above the "oil sand," natural gas can be produced without interfering with the oil below, but the production of the oil works a serious damage to the natural gas industry. It is claimed by some that where gas and oil are found associated, or in associated rocks, they can be separated and both products saved without detriment to either. It has not been done in this field. Oil has been found on the northeastern border of the field since 1886. What is known as the Indiana oil field occupies a portion of six counties,[1] viz.: Adams, Jay, Blackford, Wells, Grant and Huntington. This area is distinctively oil territory, and while its development has involved the waste of some gas, the amount has been insignificant compared with the value of the oil. Not enough gas is produced to operate the wells, pipe lines to the gas territory being necessary to secure gas for drilling and pumping purposes. Wells drilled too near the gas territory frequently prove to be large gas as well as oil wells. If the gas can not be used or disposed of to some gas company, it becomes necessary to close these wells. The oil companies in that part of the field have not shown a determined effort to produce oil regardless of the amount of gas wasted, as they have in some other sections. I have found it necessary to have some very productive oil wells in Blackford county closed to protect the natural gas industry, and have found the oil companies in most cases willing to comply with the law. Oil in small quantities has been noted in gas wells in a number of localities in the field, notably at Parker, Randolph county; Ohio, Hamilton county; Fortville, Hancock county, and Jonesboro, Grant county. Quite a productive field has been developed near Broad Ripple, Marion county, and while some gas has been found, it has not been wasted. The first successful attempt to develop an oil field in high pressure

[1] See "The Petroleum Industry in Indiana" (Blatchley), Twenty-first Annual Report of the Department of Geology and Natural Resources, Indiana, 1896.

gas territory was near Alexandria, Madison county, April, 1897. A well drilled on the Nimrod Carver farm, two and one-half miles northeast of that city, proved to be a good oil well, as well as a large gas well. The gas was located at the usual depth in the rock and the "oil sand" below with a stratum of hard non-porous rock between them. Some results of that "find" will never be known, viz., the value of the oil production and the value of the natural gas wasted. To those who are acquainted with the oil industry the result of the discovery of oil in territory hitherto unexplored for that product can be imagined. Oil operators flocked to Alexandria. Excitement ran high and the citizens of that city and the owners of land adjoining were jubilant over the prospects of becoming suddenly rich. For a time the future of the natural gas field in that locality looked dark, and not only of that locality, but of the entire field. Unusual rentals and large bonuses were paid for leases. Numerous companies were organized and derricks sprang up in every direction. Within three months twenty-eight wells had been drilled, of which eleven were fairly productive oil wells. From April 23, 1897, to March 4, 1898, seventy-five wells were drilled for oil. Of these, forty produced both gas and oil, thirty-three gas only, and two were "dry," producing neither oil nor gas. The gas wells were all tubed, packed and properly closed, but not as quickly as they should have been, for the reason that they were drilled for oil, and no preparation was made for tubing them until after they were drilled and found to be gas wells only. The forty oil wells remained open from the time they were drilled until March 12, 1898. From the day the first well was completed, the waste of gas from these wells was enormous, increasing, of course, with each new well. The gas escaping into the air daily from these wells just before they were closed was enough to supply any of the larger cities in the "gas belt" with fuel for all purposes. The manufacturers of Alexandria and the surrounding cities became alarmed about the future of their fuel supply; but aside from them, little heed was paid to the enormous daily waste of the fuel that had caused their city to grow from a small village to a prosperous manufacturing city. Farmers, merchants, professional men and, as improbable as it may seem, one or two manufacturers in Alexandria, became interested in oil companies and were apparently blind to the future of the gas field. Any measure that had for its object the protection of the natural gas supply at the expense of the oil industry was opposed.

In the meantime this prodigious waste went on and the rock pressure declined from 200 to 125 pounds during the summer. It was very difficult to enforce the law under the conditions, it being almost impossible to ascertain the owners of wells. Every attempt to inter-

fere with the new industry was branded as an improper interference on the part of the State with the rights of the people. I am glad that these conditions did not always remain so; that the public mind changes. As time went on the citizens became aroused to the importance of the subject. A complete change of public sentiment was wrought, but it took nine months to bring it about. Parties who drilled for oil during the early excitement finally became most enthusiastic in favor of suppressing the enormous waste of this gaseous fuel that had been going on for months.

Laws Prohibiting the Waste of Natural Gas and Oil, and Their Enforcement.

The General Assembly of 1893 enacted a law[1] prohibiting the waste of natural gas and oil from wells and inflicting a penalty for its violation of two hundred dollars ($200) for the first offense and two hundred dollars ($200) for each ten days thereafter that the gas or oil is allowed to escape from the well. It will be noticed that the law is not criminal, but involves the infliction of a penalty for its violation, the same being recoverable in a civil action in the name of the State of Indiana for the use of the county in which the well is located.

At the beginning of the development of the territory in the vicinity of Alexandria for oil, the operators were advised as to the existence of the above statute and the purpose of the State to enforce its provisions. To it they manifested a perfect indifference, claiming that the law was not constitutional and that any effort to enforce it would be resisted through the Supreme Court of the United States.

The law specifying the duties of the State Natural Gas Supervisor makes it the duty of that officer to see that the laws pertaining to the drilling of gas and oil wells and the piping and consumption of natural gas are enforced. In obedience to this law I promptly filed the necessary information (owner of well, when completed, etc.) for complaints with the prosecuting attorneys of the counties in which the wells were located. Information was filed for thirty-two complaints in Madison county, eight in Delaware county and four in Blackford county. The first case to come to trial was the "State of Indiana for the use of Madison county vs. the Ohio Oil Company." In this case, the only one that has come to trial, the State obtained judgment in the circuit court for the full amount asked in the complaint, and attorney's fees. The case was promptly appealed to the Supreme Court of Indiana, and that tribunal without delay rendered a unani-

[1] See Acts of the General Assembly of Indiana, 1893, pp. 300-302.

mous opinion sustaining the finding of the Madison county circuit court and affirming the propositions of law[1] enunciated in its decision holding the flambeaux law constitutional. An appeal has been taken to the Supreme Court of the United States.

It soon became evident that to prohibit the waste of natural gas by the statutory provision referred to above was a slow process and if relief came from this source at all it would only be after the Supreme Court of the United States had declared the law unconstitutional. The question was a pressing one. Millions of cubic feet of gas were escaping into the air daily. The subject of injunctive relief had been discussed from the beginning but no action taken. Finally the Lippincott Glass Company, of Alexandria, filed an action in the Madison county circuit court vs. the Ohio Oil Company to enjoin them from allowing natural gas to escape into the open air from an oil well. Shortly after this case was filed, similar action was brought in the same court by the Attorney-General of the State on behalf of the State of Indiana vs. the Ohio Oil Company. In each case the defendant demurred to the complaint and the court sustained the demurrer. Judgment was rendered against the plaintiffs for costs. The cases were appealed to the supreme court of the State and the finding of the circuit court was reversed. This was a victory for the State and all interested in the natural gas industry that they were not slow to take advantage of. The same day that the supreme court handed down its decision the circuit court of Delaware county issued a temporary restraining order closing all the oil wells from which gas was escaping in that county. The next day a similar order from the Madison county circuit court closed five of the most wasteful wells in that county, and within ten days the remainder of the oil wells in the gas territory had been closed and have remained so since.

As I have said, but one case, brought to enforce the penalty statute, has come to trial. Twelve cases have been settled by the payment of penalties and costs. Four of these wells were in Blackford county and owned by the Manhattan Oil Company. Since closing its wells that company has shown a commendable disposition to save the natural gas production from their oil wells. The Allegheny Oil Company, of Allegheny, Pa., the owner of five wells in Delaware county and three in Madison county, have settled all cases against them. So far as I know, no other cases under the penalty statute have been settled.

As to the adequacy of the present statute to prevent the waste of natural gas from oil wells, I have not changed my opinion from that expressed in my last annual report. With the certain infliction of a

[1] See Twenty-second Annual Report of the Department of Geology and Natural Resources, Indiana, 1897, pp. 281-282.

penalty of two hundred dollars ($200) for the first offense and two hundred dollars ($200) for each ten days thereafter, so long as gas is allowed to escape from the well, oil operating in the Indiana gas field can not be profitable. To date, it has done but little to prevent the waste of gas, but this must be charged to the fact that its constitutionality is questioned. If the decision of the supreme court of Indiana is affirmed by the Supreme Court of the United States its adequacy can be definitely settled. However, whatever the result may be, the law could be made more effective by amendments. The greatest objection is that it involves the tedious delay of a civil action, and a delay means much when millions of cubic feet of gas are escaping in the air daily. Quite a number of the oil companies that operated in the Alexandria field were organized in other States and were represented in the field by an agent or manager who was not financially responsible. The difficulty in the case is plain. The law should be more drastic. Its violation should constitute a crime, punishable by a fine and imprisonment, if necessary, of the parties present and managing the oil property. This should render injunctive relief unnecessary. If the law prohibiting the waste of natural gas and oil is held to be constitutional by the supreme court of the United States, and when amended as indicated above, it is not probable that injunctive relief would be necessary in the future, but if it should be necessary, it would facilitate the proceedings very much if the State could be relieved from giving bond.

Needed Legislation to Protect the Natural Gas Industry.

In the light of the present condition of the gas field and the past experience of this department in trying to regulate the use of natural gas and prevent its waste, the following amendments to the present law are recommended:

1. The law prohibiting the flow of gas or oil from any well to escape into the air should be amended so that its violation would constitute a crime, punishable by a fine and imprisonment, if necessary, of the parties present and managing the oil property.

2. In case injunctive relief is necessary the State should be relieved from giving bond.

3. To prohibit the waste from all classes of natural gas lines, a law should be enacted making it the duty of the Natural Gas Supervisor to have all leaks in gas lines for the transportation of natural gas repaired, after a reasonable notice to the owner of the same of the necessity for such repairs, and making the cost of the repairs made a lien on the line and wells attached thereto.