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CHARLES D. WALCOTT, DIRECTOR

GEOLOGY AND WATER RESOURCES

OF THE

PATRICK AND GOSHEN HOLE QUADRANGLES

IN

EASTERN WYOMING AND WESTERN NEBRASKA

BY

GEORGE I. ADAMS

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DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
Washington, D. C., May 15, 1902.

SIR: I have the honor to transmit herewith a manuscript by Mr. George I. Adams, assistant geologist of this Survey, upon the geology and water resources of a portion of eastern Wyoming and western Nebraska, and to request that it be published in the series of Water-Supply and Irrigation Papers. The field work upon which this is based was done during August and September, 1901. The report, while largely geologic in character, deals with some of the problems of water supply for this area and discusses conditions which are to be found over a considerable part of the public-land area. For this reason it is desirable to print the paper at the present time, while these matters are being discussed by the public.

Very respectfully,

F. H. NEWELL,
Hydrographer in Charge.

Hon. CHARLES D. WALCOTT,
Director of United States Geological Survey.

GEOLOGY AND WATER RESOURCES OF THE PATRICK AND GOSHEN HOLE QUADRANGLES, IN EASTERN WYOMING AND WESTERN NEBRASKA.

By GEORGE I. ADAMS.

INTRODUCTION.

Area described.—The area discussed in this report lies for the most part in eastern Wyoming, but includes on its eastern border a narrow strip of Nebraska, about 2½ miles wide. It has a width of approximately 25 miles from east to west and a length of 68 miles from north to south, and is bounded by meridians 104° and 104° 30′ and parallels 41° 30′ and 42° 30′. It constitutes, accordingly, two quadrangles—i. e., two of the units employed in topographic and geologic mapping by the Geological Survey—each one-half a degree square. The northern of these is the Patrick quadrangle and the southern the Goshen Hole. The longitude of the meridians which bound the quadrangles is reckoned from Greenwich. The boundary line between Nebraska and Wyoming is meridian 27° west reckoned from Washington, which falls west of meridian 104° from Greenwich, and the portion of Nebraska here described lies between these two lines. The accompanying sketch map (fig. 1) shows the geographic relations of the area.

General statement.—The Patrick and Goshen Hole quadrangles lie in that portion of the semiarid region of the Great Plains plateau which has presented peculiar and difficult problems to those who have attempted to settle it and utilize its natural resources. The country is best adapted to grazing. Experience has shown that crops can be grown without the aid of irrigation only in exceptional years or in favored localities. In the absence of irrigation enterprises the lands were left to the use of ranchmen, who, enjoying the advantage of a wide and free range, were able to depend upon the grass and the limited natural meadows for the support of their herds. In the earlier days of occupancy the lands for which titles were obtained were practically only such as were necessary for home ranches. The locations were widely separated and usually were chosen relative to a stream, spring, timber, natural meadow, or shelter. On the passing of the

"desert-lands act," providing for the sale of lands reclaimed by irrigation, a new factor entered. The lands to which water could be conducted lay along the streams, and ownership of them brought with it the exclusive use of the streams for the watering of stock. In view of the crowding of herds this privilege was very desirable, since it made possible the controlling of the range. The construction of irrigation ditches presented no special difficulties, and was largely done by those

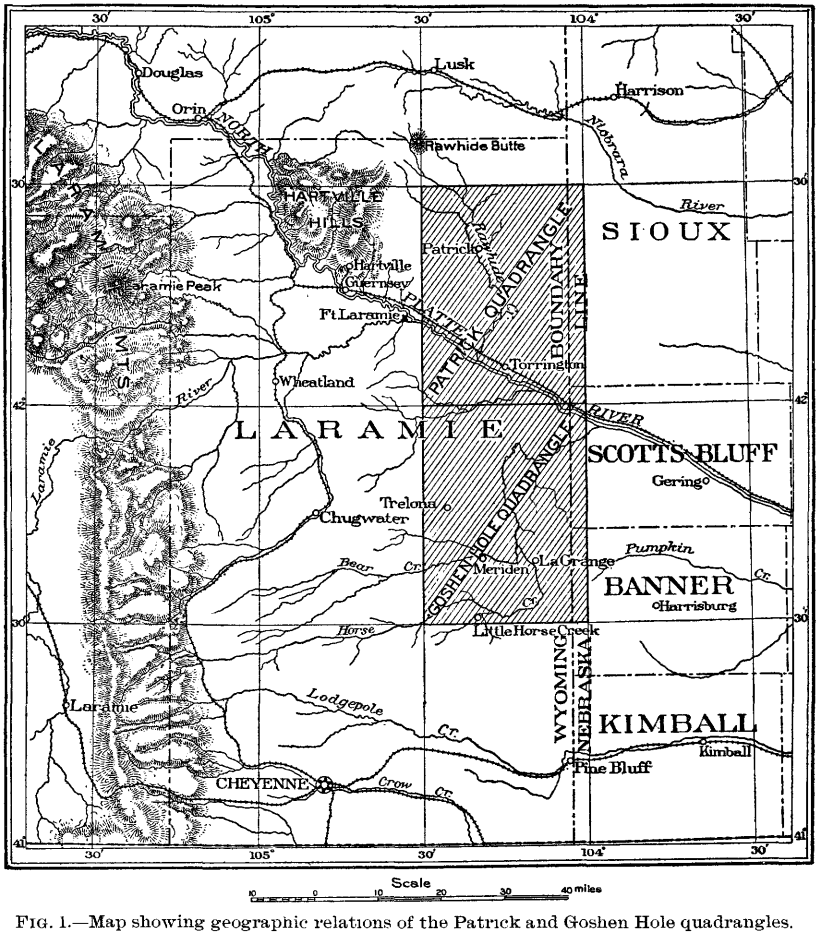


FIG. 1.—Map showing geographic relations of the Patrick and Goshen Hole quadrangles.

interested in stock raising. Many of the ditches paralleled the streams, and the water, not being easily conducted far from the valleys, was carried as far as possible along them. In a short time so much land had been entered under the desert-lands act that a ranchman desiring to establish himself was obliged to first find open water.

The lands irrigated consisted chiefly of natural meadows or fields of alfalfa. With the exception of the Platte River all the available water was in a short time appropriated, and in many cases ditches

VIEW FROM THE HEAD OF BOX ELDER CANYON, LOOKING FROM THE UPLAND INTO THE GOSHEN HOLE LOWLAND.

were constructed which were never of practical benefit, except in obtaining titles to the lands before the rulings by the General Land Office required their actual reclamation. The irrigation now being conducted is principally for the purpose of raising hay and forage, which is used as winter feed. This permits of a much greater number of cattle being grazed, since it reduces the amount of grass which must be reserved for winter pasture.

With the taking up of the lands, so that but little "open water" remained, the ranchmen were enabled to utilize the remaining portion for grazing, and, having made mutual agreements, felt in a measure secure, and even ventured to fence public lands which they wished to reserve for their own use. Lately the sinking of deep wells and the use of windmills and gasoline engines for pumping has developed a new situation. The leasing of a small tract of State lands or the entry of public lands and the maintenance of a watering place in this manner has enabled the ranchmen to establish themselves in the open range, and the gradual crowding is resulting in the disappearance of illegal fences. There is little hope that the country will be thickly settled except in such localities as can be irrigated, because of the fact that very large tracts are required for grazing, a common estimate being that 20 acres per head is necessary for summer and winter pasturage. Enterprises which are now being promoted are in accordance with the Carey act. Under its provisions the land must be actually reclaimed, and this is possible with only a small percentage of the area. There is at present a feeling that some arrangement should be made which would insure the rightful and exclusive use of the grazing lands of the public domain, and the question of the Government's leasing them is receiving consideration. In the following discussion the general character of the country, soil and rock formations, grazing industry, surface features, water supply, irrigation enterprises, and settlement and occupancy are reviewed and discussed.

GEOLOGY.

GENERAL GEOLOGY OF THE REGION.

The formations represented in the region under consideration are broad sheets of rocks which extend from the foothills of the mountains eastward onto the Great Plains plateau and have a dip that is a little less than the grade of the surface. They consist of two series, differing materially in character and having discordant relations. The older formations consist of Cretaceous rocks and their substructure of Paleozoics, which were deposited before the present ranges of the Rocky Mountains were developed. They have been flexed upward along the foothills by the movements which accompanied the mountain making, and their edges outcrop in narrow belts parallel to the mountains. Although the thickness of these rocks is thousands of

feet, they may be passed over in a short distance where they abut against the igneous and metamorphic rocks of the mountain ranges and have steep dips. In the portion of the plains here described the rock sheets are nearly horizontal, and the individual formations have a wide extent. The younger and higher ones only are reached in the deep borings and are found as surface outcrops. In the accompanying map (Pl. II) the general geology of the region is shown. The area in which the older rocks are seen as a result of the mountainous structure is the Hartville Hills. The horizontal portion of the older rocks, which is generally embedded, appears at the surface in the locality of Goshen Hole and the lower valley of Horse Creek, where, as a result of the removal of the younger series, the Laramie Cretaceous is exposed.

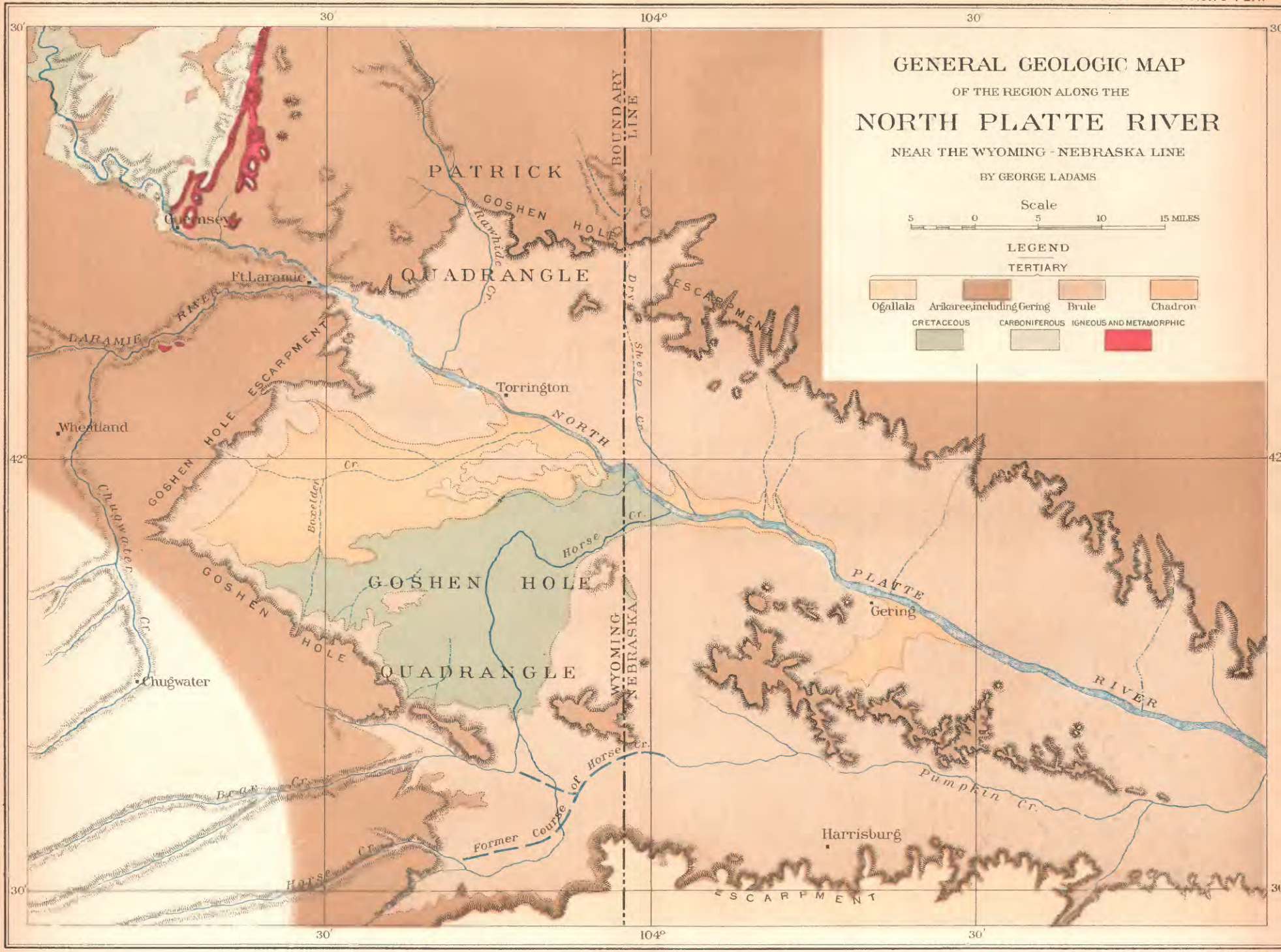
Lying on the floor of older rocks is the Tertiary series, which has been spread over them as sheets of clay and sand, extending from the mountains toward the plains with diminishing thickness. The source of this material was evidently the mountain region to the westward, which was elevated at the beginning of Tertiary time, and in which the rapid disintegration of the rocks under the processes of erosion furnished sediments for the younger series. The Tertiary formations of this portion of the country bear evidence, in the character and distribution of materials as well as in the fossil remains which are found in them, of having been deposited upon the surface of the continent principally through the agency of fresh water. The formations overlap one another toward the mountains and formerly extended farther upon their flanks, the zone of deposition seemingly having migrated toward the mountains as time progressed.

In recent times destructional processes have been operative and the Tertiary has been largely eroded, so that in places its upper divisions are worn away, and in the locality of Goshen Hole and near the mouth of Horse Creek the beds have been completely removed, revealing the underlying Cretaceous.

DESCRIPTION OF FORMATIONS.

CRETACEOUS.

Laramie formation.—This formation has but a limited occurrence, and the outcrops are largely concealed by surficial deposits (see Pl. III). It consists of yellowish and greenish sands, variegated clays, and local beds and lenses of a bluish siliceous limestone, which upon weathering breaks into irregular fragments and has a yellowish color. The sands are cross bedded and current bedded and form a friable sandstone which disintegrates readily and suffers erosion through the agency of wind. The limestones and certain indurated sands which are well cemented appear as bowlders in some of the outcrops (see



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Pl. IV, *B*). The formation is generally considered a brackish or fresh-water deposit. Along Dry Creek, which is a branch of Horse Creek entering the latter west of Table Mountain, there are ledges several feet thick that consist almost wholly of oyster shells (*Ostrea glabra*), with which is mingled some sand. Outcrops of coal are reported to occur in the valley of Horse Creek near J Pen, where the creek flows in a southeasterly course. In the vicinity of Hawk Springs and from there to Big Willows some prospecting has been done and small outcrops of coal are reported to have been found. The drilling in these localities has thus far failed to discover the presence of coal beds considered of sufficient value to be worked in a commercial way. The presence of the coal is evidence of the conditions which existed during the deposition of the beds. It is lignitic in character and represents the remains of forests which flourished during a time when the Cretaceous seas were shallowed and land areas were present in this region.

The surface of the Cretaceous, on which the Tertiary was deposited, seems to have been very irregular, and the contact shows a decided unconformity. The area of exposure of the Laramie is not sufficient, in view of its obscure outcrops and the friable nature of its sands, to determine its structure beyond the prevalence of low dips. From the attitude of the overlying beds it would seem that there was in this area a ridge or an anticlinal elevation which determined the extent of the lowest Tertiary formation. Adjacent to the area of outcrop but little drilling has been done which reveals the presence of the beds at any depth beneath the Tertiary, and its relations can not be very satisfactorily demonstrated, since outcrops do not occur except in widely distant localities.

TERTIARY.

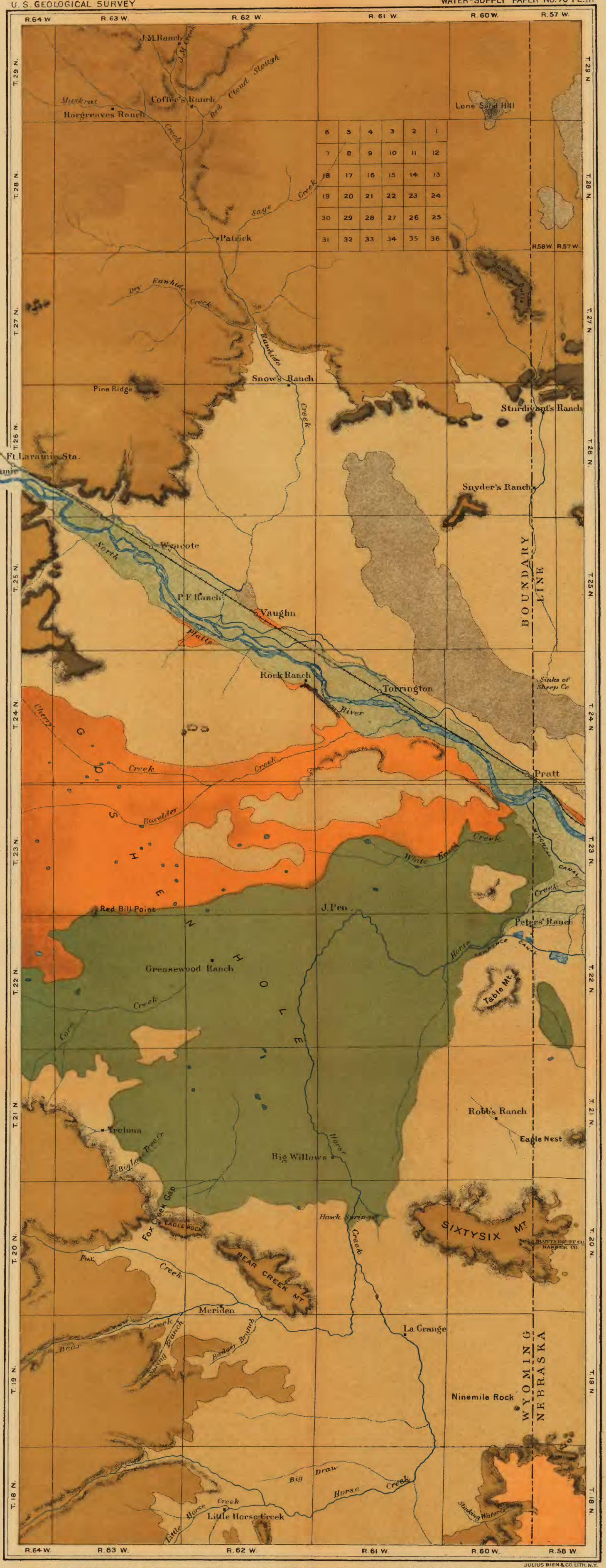
Chadron formation.—The basal formation of the Tertiary is known as the Chadron, from a locality in northeastern Nebraska, where it is typically developed. On the accompanying geological map it may be seen as an irregular belt extending from the Platte River, where it crosses the Wyoming and Nebraska line, westward into Goshen Hole. It is also exposed in two small areas on either side of the Platte Valley in the vicinity of Vaughn. The principal portion of the beds consists of a more or less sandy clay having a greenish-gray color, variegated with dark-red and olive beds, which are by far the more conspicuous because of the vividness of their hue. The portion of this formation which outcrops most prominently consists of coarse cross-bedded sandstones of a grayish color (Pl. IV, *A*). They appear to be channel- or current-bedded phases in the formation, and occur at varying horizons. In places they are separated by only a few feet from the underlying Cretaceous, and in other localities they occur well up toward the top. In the western part of Goshen Hole are a

number of low points which are capped by remnants of these sandstones. The most conspicuous among them for its altitude is Red Bill Point, although there are a number of ridges of greater extent. Along the Platte River, in the absence of better building stone, these beds have been quarried where they are of fairly uniform texture, and supply a durable stone, although it is difficult to work. This formation appears to have been limited southward by a Cretaceous ridge, outcrops of which are seen in the southern part of Goshen Hole. The area of Chadron shown on the map is confined wholly to the north slope of this ridge, if such it be, and south of it the formation evidently is absent.

Brule formation.—Succeeding the Chadron beds and lying unconformably upon them, or in their absence upon the Cretaceous, is a thick mass of clay which has very uniformly a pinkish or flesh-colored tint, except at some localities of limited area, where its basal portion assumes a varying phase. In these places it is a whitish clay having grayish and greenish tinges, with a thin bed of white limestone of particularly uniform character occurring in the locality of Table Mountain and the elevated point 3 miles north of it and in the small knobs $2\frac{1}{2}$ miles north of Trelona. The pink clay is generally homogeneous in character, seldom containing conglomeratic beds. These occur, however, in limited areas, but are usually composed of small gravels. They are not found at any particular horizon, but appear to represent local current phases of deposition.

The Brule clay weathers readily and is transported over the slopes, where the wash from it forms a thin, pinkish veneer. Where it occurs in vertical walls as a result of the protecting cap of higher beds, or in small knobs and points, it is usually quite destitute of vegetation and is seen to have a jointed structure, and a slight deposit of limy material is often present along the joint planes. In weathering, these joint planes are often made bare by the removal of angular fragments and give the surface an exfoliated appearance. The limestones above mentioned are the only beds which determine in any way definite erosional forms, and they give rise to table-like hills in which the limestone is nearly at the summit. In the absence of better material the stone has been quarried and used in building, although it supplies only slabby material a few inches in thickness.

Arikaree formation.—The Arikaree formation represents a decided change in the character of sediments from those which were deposited in the time of the Brule. Instead of clay the material consists almost wholly of sands, which were deposited unconformably upon the older beds. The Arikaree sand is slightly cemented, so that it forms a protecting cap to the underlying formations, and it occurs frequently in the escarpments of the region (see Pl. V). It has several phases, which range both horizontally and vertically through its extent. The simplest of these is homogeneous sand without any distinctive struc-



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MAP SHOWING GEOLOGY OF THE PATRICK AND GOSHEN HOLE QUADRANGLES

BY GEORGE I. ADAMS.

Scale

0 1 2 3 4 5 6 7 8 9 10 11 12 miles

LEGEND

RECENT: Dune sand; Alluvium

TERTIARY: Chadron; Brule; Arikaree; Conglomerates in Arikaree; Ogallala

CRETACEOUS: Laramie

ture, but having the peculiarity of weathering in vertical columns or walls. Another phase is that in which concretions occur, usually of a tabular or pipy form, with an occasional development of nodules having a vertical position in the beds. The concretions are of sandstone, well cemented. On weathering they form projecting points and lenses in the vertical walls and ledges and protecting caps on the pinnacles. They give bizarre forms to the pinnacled and chimney rocks which are so common throughout the area of the formation. Another phase of the Arikaree are the conglomeratic beds, which represent channel or current deposits and which occur at varying horizons (see Pl. VI, *A*). These are commonly found at the base of the formation where it is in contact with the Brule clay, and show the unconformable relations of the two deposits resulting from contemporaneous erosion and deposition. The individual lenses vary in thickness, and at any particular locality the variation extends from a few feet to 200 feet. The fact that this phase is present at the base of the Arikaree does not necessarily indicate that it was deposited contemporaneously, since it is probable that the conglomerates were deposited as the sediments encroached upon the higher levels. Their occurrence in the upper horizons is due to the later oscillation of the channels as the thickness of the sediments increased. On the geologic map this phase has been represented and to it has been given the name Conglomeratic beds in the Arikaree. These may not represent a formation in the sense that the Gering does, although the beds differentiated as such in the country to the east, on the south side of the Platte Valley, are in every way similar. The relation of these lenses is best seen in the locality of Spoon Butte, in the Patrick quadrangle, and for a short distance to the south. In the escarpment and lone hills north of Sturdivant's ranch, conglomerates are seen resting on Brule clay, or separated from it by a very thin bed of Arikaree sand. In Spoon Butte the lenses are coarse sandstones exhibiting a cross-bedded structure, and their occurrence is 400 feet above the lowest exposed portion of the Arikaree. In the intermediate localities the lenses occur at somewhat lower horizons and seem to justify perfectly the interpretation here placed upon them. In Pine Ridge and the small knobs near the eastern border of the Patrick quadrangle there is a conglomerate which does not now have a very wide extent, since it occurs on the tops of these hills.

The gravels and materials that constitute the conglomeratic lentils contain many varieties of rocks which are found in the Rocky Mountain region. They vary in size from small, much-worn fragments up to bowlders, and are cemented in a matrix of sand. The disintegration of this conglomerate has given rise to terraces which maintain their form as a result of the heavy deposit of gravel lying upon them (see Pl. VI, *B*). These terraces occur at levels somewhat lower than the conglomerate beds, and the connection between the two may be readily

seen by tracing the material from the ledge past the talus slopes to the veneering of gravel. An example of such a terrace is the somewhat elevated land lying between the mouth of Rawhide Creek and the Platte River. Such terraces may be considered as indicating the former greater extent of the conglomerate beds. The transportation of these gravels has given rise to stream terraces in certain localities, and has supplied in part the gravels found in the stream channels. They are of local occurrence inasmuch as the conglomerate beds themselves are a local phase. The gravels of the stream terraces and the streams are no doubt blended with more recent gravels which have been transported from other localities. This is particularly true along the Platte River and the streams heading in the foothills and mountains.

In the Arikaree there are narrow sandstone dikes which on weathering protrude above the surface and are conspicuous because of the comb-like structure which they have when the adjacent formation weathers away (see Pl. VII). They were noted northeast of Pine Ridge and west of Spoon Butte. They have a strike N. 20° to 30° E., and apparently have been developed along fractures, which have been produced by some general cause. Those which occur northeast of Pine Ridge are the more important and can be seen for several miles, although possibly the outcrops do not belong to the same dikes at the different localities. They extend as far as Patrick, where they may be seen on either side of the valley of Rawhide Creek, in the crests of the hills. The material which constitutes the dikes is principally sand, with some infiltered calcareous material. On weathering the calcareous matter has a honeycombed appearance, the loosely cemented sand disappearing. The width of the dikes is only a few feet, sometimes only a few inches. Those west of Spoon Butte extend for short distances and are relatively narrow. The direction of the dikes is approximately parallel to the structure in the Hartville Hills, and it is not unlikely that they have been produced by dislocations or movements along inherent lines of weakness in the deeper formations. These dikes have attracted some attention, but an examination has shown that there is nothing to warrant prospecting in them for minerals. The material of which they are constituted has evidently been derived from the wall rock. There apparently has been some slipping and consequent slickensiding of the dike material since they were formed.

Ogallala formation.—This formation is represented in this area only in the southeast corner of the Goshen Hole quadrangle, where it occurs on the upland overlying the Arikaree. It consists of beds of sandy and calcareous material with local conglomeratic phases, developed particularly at its base. Within the area here described it does not attain its characteristic development, since but a thin remnant of it remains on the upland. The pebbles and fragments of crystalline

A. CHADRON SANDSTONE NEAR BOX ELDER CREEK, WEST END OF GOSHEN HOLE.

B. LARAMIE BEDS NORTHWEST OF HAWK SPRINGS.

rocks that are scattered through it are variable in character, and the sands it contains are cemented by carbonate of lime, which in places develops into what are known as mortar-bed ledges. It contains considerable clay or marl, which has a slightly creamy or pinkish color. Not uncommonly this formation is called "magnesia," although the word here is a misnomer if it signifies that the formation is magnesian. South of the valley of Horse Creek the Ogallala extends farther westward. Its principal area, however, is in Nebraska, northeastern Colorado, and the northwest corner of Kansas.

SURFICIAL DEPOSITS.

Mantle of detritus.—In this region disintegration is more active than transportation, so that there has accumulated a considerable veneering of surficial material. It consists of sand and clay mingled with humus from the decaying vegetation. This material is found to grade from coarse talus adjacent to the cliffs into slope wash, and in places it is a soil which is firmly held by the sod. It has resulted from gravitative action, solution and transportation by water, and the eroding and carrying power of the wind. The materials are largely derived from the rocks of the area. The sand is from the Arikaree, Chadron, and Laramie formations, while the clay is principally the result of disintegration of the Brule. The gravels are from the breaking down of local conglomerates, and in part are brought into the region by the streams. At many places they are so intermingled that they can not be mapped separately.

During the dry season the surface mantle of sand and clay is transported by the wind in its prevailing direction and accumulates on the higher places. At times of flood the material is carried down the slopes and transported along the valleys by the storm water. When the creeks flow with large volume they carry the accumulated sands and spread them along their courses, but this material does not form alluvium, since it is not stratified, but is simply dropped where the current is retarded. Moreover, its position is not permanent, since when it dries it may be swept away by the wind, or a succeeding cloudburst may transport it farther. Inasmuch as the wind and run-off waters in the sum total of their activities are about balanced, the surficial materials oscillate in their position between the condition of wind-blown accumulations on the ridges and surface wash on the slopes and in the valleys. Finally, however, they are either transported down the streams or lodge in the sand hills, where they are held by the vegetation.

The mantle of unconsolidated detritus apparently dates back to the time when the region was occupied by primitive horses and elephants, and accordingly it is in part early Pleistocene. The material at the places where these fossils have been found is, however, not essentially different from that which has but recently been deposited.

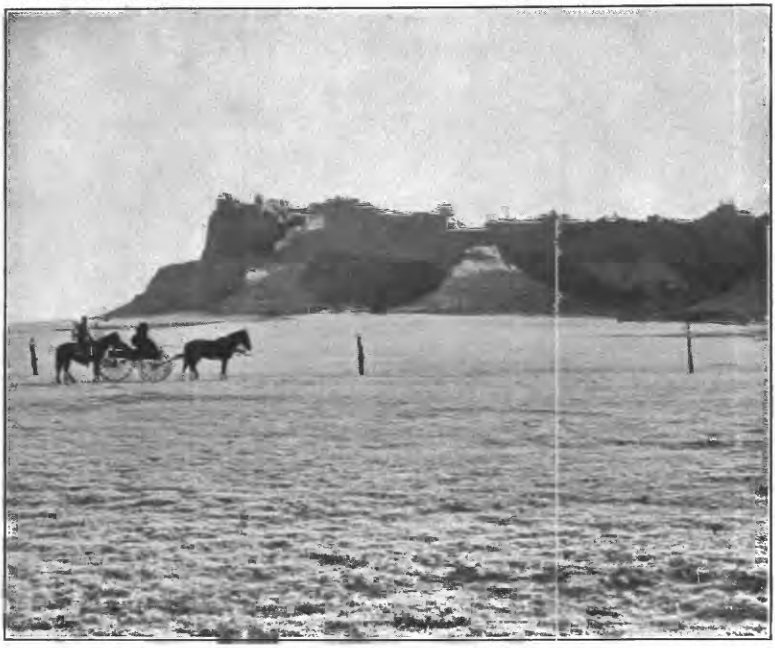
Accordingly, no attempt is made to classify these deposits. Moreover, their thickness is exceedingly variable and is frequently disguised by the even covering of sod. They range from a thin veneer of clay to beds of slope wash as much as 50 feet thick. The accumulations of sand at some of the localities mapped as dunes rise fully 100 feet above the general level of the older formations.

Alluvium.—The only area in which alluvium is shown on the accompanying map is the recent flood plain of Platte River. The deposit consists of silt and the sediment from the stream, with which is mingled considerable gravel. Where the river enters the Patrick quadrangle through the narrows the valley floor is about a mile wide. Below this point it is not restricted by bluffs. In the vicinity of the P. F. ranch and Torrington it is about 3 miles wide. The channel of the Platte is broad and is occupied by sand bars and islands, and evidently has shifted frequently. The alluvial deposits do not differ in any way from the material now carried by the river. Although they are loose, and frequently sandy and gravelly, they are relatively fertile and furnish the most valuable agricultural lands because of their proximity to the source of water for irrigation. Nearly all of this land is now under irrigation ditches.

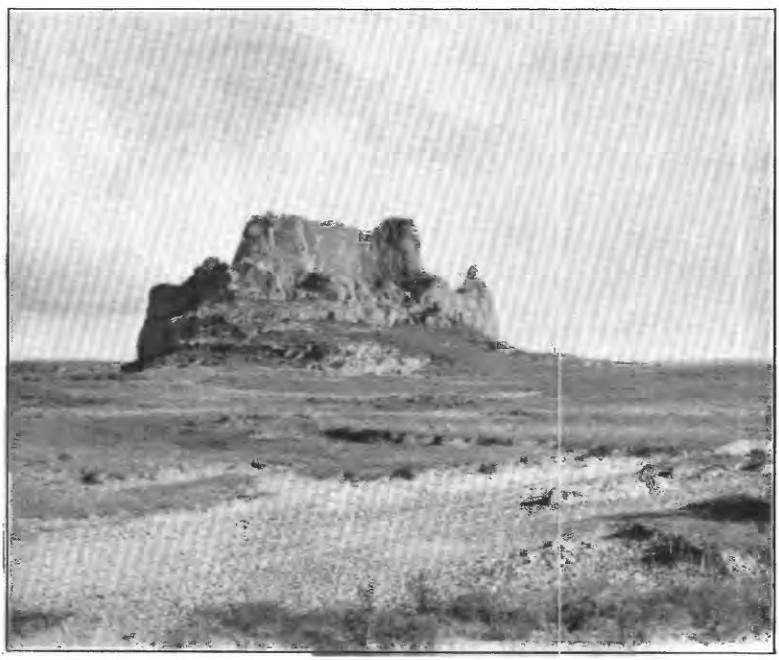
It might seem that the larger streams tributary to the Platte would be bordered by alluvium. No such deposits have been mapped, and it is questionable whether they should be distinguished, for the reason that the streams are not bordered by true flood-plain deposits. They flow only in certain seasons of the year, and when they carry their largest volume of water the material transported is that which is washed from the slopes by the cloudbursts and heavy rainfall, and consists of the loose sand and clay which are described above as eolian and creep deposits and surface wash. Moreover, along the valleys of these streams the country rock is exposed at many places within their channels.

Stream gravels from outside areas.—Except in the case of the Platte River, which has its source in the mountains, the streams do not carry a large amount of gravel. When the Platte is at low stages its bed not uncommonly appears to be paved with cobblestones. These pebbles and bowlders, on examination, are found to represent a great variety of rocks such as are found in the mountains to the west. No doubt when the river flowed at former grades it transported these materials and deposited them in terraces. At some places the river terrace gravels may be seen covering the surface, but usually they have been transported by the erosion of sand and clay and gravitative action, so that the terrace feature is obscured. Moreover, there are other gravels which are not unlike them, and it is therefore difficult to distinguish the river gravels as a distinct class of deposits.

Stream gravels of local origin.—The conglomerate beds which occur at the base of the Arikaree and locally at higher horizons within that formation have already been described. The gravels which consti-



A. WEST END OF 66 MOUNTAIN.



B. EAGLE ROCK AT FOX CREEK GAP.

tute them are not unlike the gravels which have been transported from the Rocky Mountain region, and upon the disintegration of the conglomerate they are transported by the streams and distributed along the valleys tributary to the Platte, so that they blend with the gravels of Platte River. Evidently they were derived from about the same classes of rocks, and possibly from the same general area in the Rocky Mountains. The conglomerates which are now present and exposed within the quadrangles may readily be seen to be the source of these gravels. The gravels, however, have a wider extent than is consistent with their derivation from the areas within which the conglomerates are now found. In the absence of any other source for the stream gravels it is natural to conclude that they indicate a former wider extension and occurrence of the conglomerate beds. It is altogether probable that the exposures which have been referred to as basal beds of the Arikaree were continuous between the areas where they are now found in place, and the breaking down of such a deposit would have furnished a large quantity of bowlders and gravel.

In the valley of Horse Creek and its former extension into Pumpkin Creek there are stream gravels which do not seem to have been derived from conglomerate beds within the area here described. On the general map it will be seen that the drainage of Horse Creek heads at the base of the Laramie Mountains, and it is not improbable that the gravels which occur along its valleys are derived from localities near its source. In that case they would sustain the same relation to this area which the Platte River gravels sustain, and by their occurrence in terraces they would indicate the former grades of the streams.

Terrace gravels from disintegration in place.—Adjacent to the beds of conglomerate there are gravel terraces which in certain localities have a considerable extent. They have originated through the breaking down of the conglomerate, and retain their form because the gravels make a protecting mantle. The best example of this occurrence of gravel terraces is on the point or divide between the lower part of Rawhide Creek and the Platte River. The source of the gravels may be seen in a ledge which is conspicuous to the west of the terrace and which occurs somewhat higher. Another example of this class of gravel terrace may be seen south of the Platte, on the high point to the east of the conglomerate beds which occur in the southeast corner of the Patrick quadrangle.

Where the conglomerates have been so largely removed that the relation between the gravels and the original beds is not clearly traceable, this type of deposit is not so readily distinguished. Moreover, when there has been a sufficient period of erosion to accomplish this removal, the gravels on the terraces have likewise suffered gravitative action, and occur as an indefinite deposit blending with the stream gravels and the detritus of the valley slopes. Accordingly there are

localities in which the stream gravels and the terrace gravels are indistinguishable.

Sand hills or dunes.—There is more or less sand and wind-blown material distributed over nearly the entire area which is here discussed. The source of the wind-blown sand is principally the Arikaree formation, which consists of sand only slightly cemented, and which upon weathering disintegrates into easily-transported material. Within the area designated as sand hills on the map this drifting material has accumulated into dunes. Some of the sand hills are sodded over and may be spoken of as inactive. In others the sand is constantly shifting. When for any reason the sod on a sand hill is removed or broken, the hill immediately begins to change its form and shift its position according to the direction of the wind. In Nebraska the sand hills are much more extensive than in Wyoming. Those which are seen in the Patrick quadrangle are at the western end of what is known as the great sand-hill area in Nebraska.

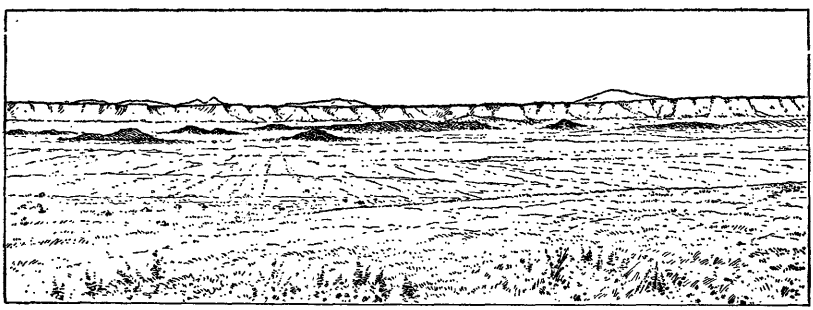
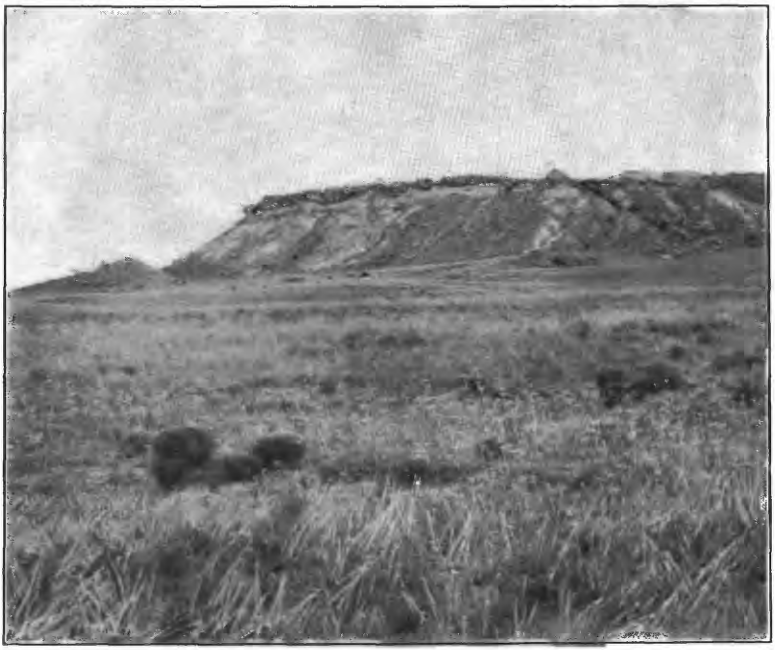


FIG. 2.—Sketch showing the west end of Goshen Hole, the Goshen Hole escarpment and the Laramie Mountains in the distance.

A considerable portion of the sand which forms dry bars in the Platte River is blown onto the upland. In this way the material transported into the area by that stream is contributed to the surficial deposits during the dry season. The sand hills north of Torrington and Pratt may be in part the result of this action.

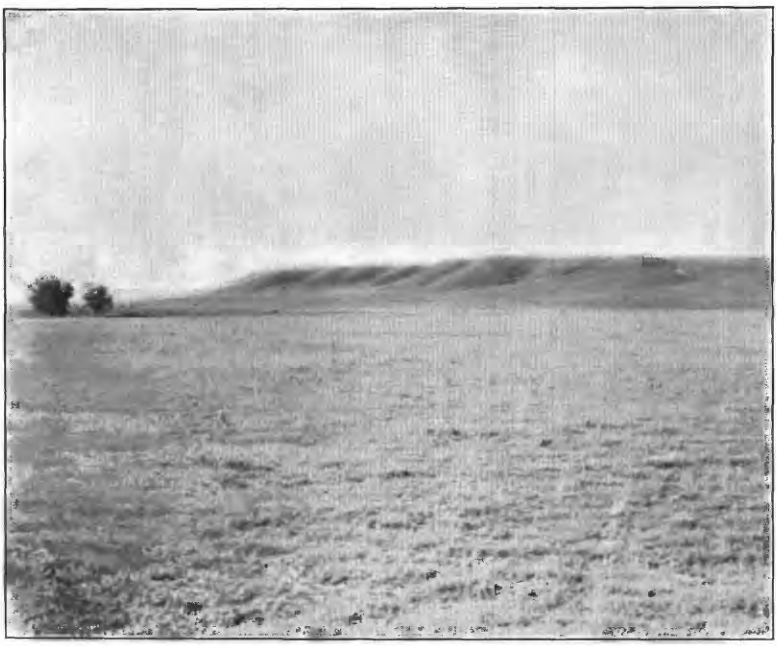
SURFACE FEATURES.

General relations and elevations.—The region is a portion of the Great Plains plateau, which extends from the Rocky Mountains eastward, sloping gradually toward the Mississippi Valley. The Laramie Mountains lie 40 miles west of the border of the area described, and on a clear day Laramie Peak and some of the lesser peaks are visible on the horizon (see fig. 2). To the northwest, and but a short distance from the Patrick quadrangle, are the Hartville Hills and the lone point known as Rawhide Butte. The elevations within the quadrangles vary from 3,920 feet in the river valleys to 5,300 feet on the highest points.



A. POINT OF ROCKS, EAST OF SNOW'S RANCH.

Shows conglomerate near the base of the Arikaree formation, with Brule clay below.



B. GRAVEL TERRACE FORMED BY THE DISINTEGRATION OF THE CONGLOMERATE, WEST OF RAWHIDE CREEK, NEAR ITS JUNCTION WITH THE NORTH PLATTE.

Goshen Hole escarpment.—The formations which outcrop within the area consist largely of clays and sandstones which yield readily to erosion, and in some cases have the peculiarity of forming nearly vertical walls. A conspicuous feature of the region is an escarpment which forms the western border of Goshen Hole. (See Pl. I.) It is represented more or less regularly to the north of the Platte in the bluffs which extend from the vicinity of the Narrows, below Fort Laramie, in an irregular line north of Snow's ranch and Sturdivant's ranch. Bear Creek Mountain and 66 Mountain (see Pls. V, *A* and IX, *A*), in the southeastern part of the area mapped, are isolated portions of this escarpment, which is found continuous again from the southeast corner of the Goshen Hole quadrangle into Nebraska. This escarpment may be regarded as separating the lowland from the upland.

Upland.—Previous to the development of the present stream valleys and basins the country evidently was a nearly smooth plain. Evidences of this are seen in the nearly even elevation of the higher tables and escarpments, which have a slight eastward slope. The grade of the original plain is the gradual slope from the mountains toward the Mississippi Valley. Considered with respect to its physiographic relations, it is a portion of what is denominated the Great Plains plateau. It was formed in Tertiary time by the deposition of sediments in broad, apron-like sheets spread eastward from the mountains. It has been largely preserved to the present time, and the undissected areas form the High Plains. They constitute the upland of the area here discussed.

Lowland.—Along the Platte Valley, where there are a number of small streams which have a grade dependent upon that of the Platte River and reaching up the larger tributaries for a considerable distance, a lowland has been developed, which is gradually being extended as the escarpments recede and the isolated hills are removed by erosion. Goshen Hole, the name of which is unfortunately suggestive of an inclosed basin, is a portion of this lowland plain which is open eastward to the valleys of the Platte and Horse Creek. Its western rim is the escarpment which has been already referred to as marking the line between the general upland and lowland.

The origin of the Goshen Hole lowland appears to have been due to the fact that the Brule clay, which is found throughout the region, is readily eroded when once the protecting covering of the Arikaree sands is removed. This process is hastened by the issuance of ground water as a seepage flow and as springs at the line of contact between the two formations. At this horizon erosion progresses by sapping, which undermines the cliffs and causes the escarpment to retreat. The western limit of the lowland along the Platte River is practically at the Narrows, a few miles below the point where the Laramie River enters the Platte, on the western border of the Patrick quadrangle. At this place the contact between the Brule and the Arikaree is at

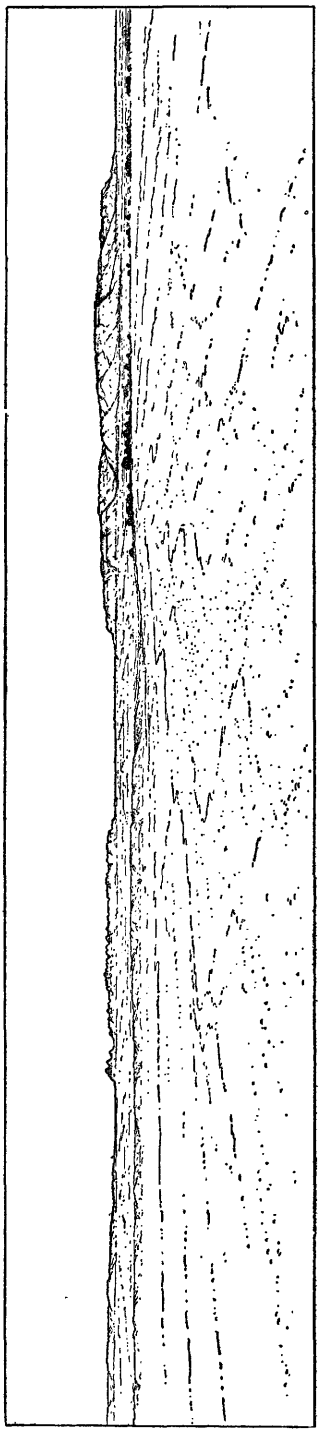
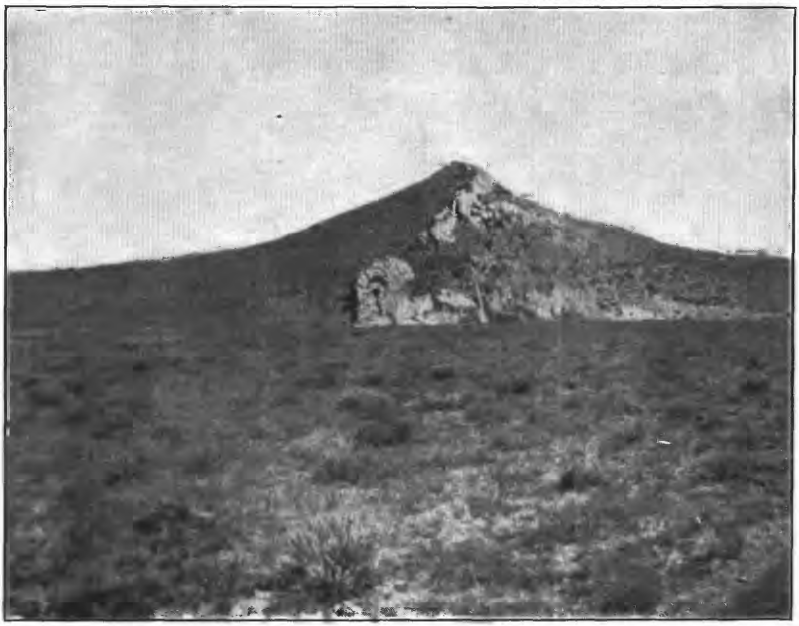


FIG. 3.—Sketch of Bear Creek Mountain and Fox Creek Gap, seen from the southeast.

the level of the river. Along Rawhide Creek the limit of the lowland is similarly at this line of contact north of Snow's ranch. Where the Goshen Hole escarpment is well developed the contact between the two formations occurs in its face, as at the Point of Rocks, east of Snow's ranch and the hills north of Sturdivant's ranch. In Nebraska north of the Platte River the escarpment is not conspicuous except at a few points.

The principal cause of the escarpment being best defined at the western border of Goshen Hole is the fact that practically no streams enter the lowland from that side. Upon examining the general map it will be seen that the drainage which flows eastward from the Laramie Mountains north of Bear Creek is diverted into the Laramie River by Chugwater Creek, which has a northerly course west of Goshen Hole. The Goshen Hole escarpment has accordingly not been broken by streams, but has retreated as the result of the sapping at its base by the headwaters of the minor drainage.

In the southwestern part of the Goshen Hole quadrangle there is a gradually eastward-sloping surface which corresponds to a former grade of the streams, so that the escarpment is not clearly developed along Bear Creek and Horse Creek, but at many places the contact between the formations is beginning to appear in the more recently developed breaks and bluffs. Following the escarpment which borders the lowland eastward along Pumpkin Creek, we find the Ogallala formation occurring at its summit, the contact between the Ogallala and Arikaree falling in the face of the escarpment well toward its upper part. While the presence of the lowland is here also dependent



A. SANDSTONE DIKE CUTTING THE ARIKAREE FORMATION NORTHEAST OF PINE RIDGE.

B. SANDSTONE DIKE CUTTING THE ARIKAREE FORMATION ON DRY RAWHIDE CREEK.

upon the occurrence of the easily eroded Brule clays, the development of the escarpment is to some extent also the result of the character of the Ogallala, which, like the Arikaree, acts as a capping and protecting member to the clays. A short distance east of the junction of Pumpkin Creek with the Platte the Goshen Hole lowland loses its importance and blends with and becomes simply the Platte Valley. In this portion the Arikaree formation is absent, and the Brule and Ogallala are the formations into which the streams have cut their valleys. The channel of the Platte does not lie so much below the contact between the formations as it does in the Goshen Hole country, and this, together with the absence of the Arikaree, probably accounts for the topographic forms being of less pronounced character. The floor of the Goshen Hole lowland is very largely the Brule clay, but at certain points along the Platte and in Goshen Hole proper erosion has exposed the underlying formations, which are the Chadron and the Laramie.

The forms of relief which are conspicuous within the area of the lowland are the so-called mountains and small mesas or table-lands that are left as remnants of the upland which once extended in a narrow tongue between the North Platte River and the former Horse Creek-Pumpkin Creek Valley[a] (see fig. 3). Eagle Rock, 66 Mountain, Eagle Nest, and the very irregular mountains in Scotts Bluff County, Nebraska, of which Scotts Bluff is a part, are what now remains of this tongue. With the extension of the lowlands back from the streams this divide was gradually dissected until the drainage of the southern valley was diverted through the gap between Bear Creek Mountain and 66 Mountain, following the course of what is now Horse Creek. Since the time of this capture, which deprived Pumpkin Creek of the larger portion of the water that it received from the west, its tributaries in the vicinity of 66 Mountain, which received the run-off water, have become relatively more conspicuous than the old channel, which may now be found indistinctly marked in the nearly level country lying to the east of the bend of Horse Creek, at the point where that stream was diverted to the north.

WATER SUPPLY.

Streams.—The streams of the area flow in a generally eastward direction and are all tributary to the North Platte, which has a southeasterly course through the southwestern part of the Patrick quadrangle and the northeast corner of the Goshen Hole quadrangle. The region is one in which the rainfall is limited. With the exception of the larger streams the channels are dry throughout most of the year. The North Platte, having its source in the mountains of Colorado and receiving large tributaries in Wyoming, which are fed by the melting

[a] The North Platte was considered by Darton (Nineteenth Ann. Rept., Pt. IV, p. 729) as having at one time flowed through the valley of Pumpkin Creek. A study of this area lying to the west, which he did not visit, justifies the explanation above given and accordingly accounts for the nature of the Pumpkin Valley, independent of such a hypothesis.

snows, is perennial and of the greatest importance as a source of water supply. The next largest stream is Horse Creek, which enters the southeast corner of the Goshen Hole quadrangle, then flows northward through its middle portion, and thence eastward to the Platte, which it joins a short distance beyond the border of the area in Nebraska. Its principal tributary is Bear Creek, which is of nearly equal importance to the point of its junction with Horse Creek.

These streams head in the foothills of the southern extension of the Laramie Mountains, and have long, narrow drainage basins. They flow throughout the year, although in places, as a result of the diversion of water for irrigation and the disappearance of the remaining small flow in the gravels and sands, their channels are sometimes nearly dry. Some of the shorter streams which are fed by springs and seeps and flow for a short portion of their course during the dry season are Stinking Water, Spring Branch, and Big Lone Tree Creek. Their courses are indistinct, owing to the fact that they soon sink into the surficial sands which fill the lower portions of their channels.

Fox Creek and Little Horse Creek receive their waters from springs, but, having longer courses and draining larger basins, are almost constant in their flow, although supplying but a limited amount of water. In Goshen Hole, as it is usually limited, there are no perennial streams. Cherry Creek, Box Elder Creek, and Corn Creek are represented on the map as intermittent streams. During a season of heavy rains or cloudbursts the run-off water spreads in a broad sheet along the line of their indistinct channels and for some time after stands in long pools. In the dry seasons they contain a limited amount of water in the canyons at their heads, which is supplied by springs. The larger number of ponds, or water holes as they are commonly called, which are found in Goshen Hole act as natural catchment basins into which the run-off water of the higher lands drains and remains throughout most of the year. A careful survey of the country adjacent to them shows that they have a relation to the indistinct drainage system which exists in the low but very irregular relief. The origin of these ponds or basins will be discussed later in this paper. In the Patrick quadrangle Rawhide Creek is a perennial stream in its upper portion, where its valley is confined between relatively regular bluffs. It has a number of small tributaries which are fed by springs and along which water holes and small channels are found. Along the lower portion of Rawhide Creek the country is nearly level and the water sinks into the surficial sands and gravels except during flood times. In the vicinity of Spoon Butte there are springs which form the head of Sheep Creek. Along the upper part of this stream there are some short tributaries which are likewise fed by springs, and there is a limited amount of water present even during the dry seasons. But where Sheep Creek has a broad valley it is dry for long stretches except during heavy rains. The water which is present rises as springs from the underflow along the

channel. The lower portion of its course, in the southeast corner of Patrick quadrangle, is blocked by a range of sand hills, and the water disappears under them in what is known as the sinks of Sheep Creek. Farther on the channel is again distinct and some water stands in it even in the dry season.

From the foregoing account it will be seen that the country is one in which stream water is a limited resource and is of great importance for the purpose of irrigation as well as in supporting the grazing industry.

Springs.—The principal horizon at which springs occur is the contact between the Brule clay and the Arikaree formation. The Arikaree consists largely of sands, through which the water falling on it percolates until it reaches the underlying clay. This clay is fine-grained and homogeneous and is practically impervious. As a result, where the contact between the clay and the overlying Arikaree is exposed the ground water finds issuance in case the dip is such as to bring it to that point. There does not appear to be a very large supply of ground water in any of the formations. This is probably due to the fact that the country is in the semiarid region and the rainfall occurs at irregular intervals and often in the nature of cloudbursts, so that it is carried away as run-off water by streams.

Although there are many springs at the contact above mentioned, they are not strong. In many cases the ground water is only sufficient to keep the upper surface of the clay moistened. Along the face of the escarpments the line of issuance is marked by a darker color, resulting from the presence of water in the clay, and where there is vegetation it is more luxuriant. At the heads of the gulches and small canyons the water from the springs, following under the talus of the slopes, usually unites to form a stream for a short distance. These localities are frequented by cattle and have been taken advantage of for home ranches by the stockmen. The supply from such springs is very limited, and the water usually sinks into the sands of the stream bed in a relatively short distance. Examples of this type of spring may be found at the head of Stinking Water Creek, the spring branches south of Gordon's ranch, the spring branch southwest of Meriden post-office, Fox Creek, Big Lone Tree Creek, the State Line Springs on 66 Mountain, and the tributaries of Sheep Creek north of Sturdivant's ranch.

Within the area of the Arikaree formation there are a number of places at which springs occur. These do not appear to issue at any particular horizon, and in many cases are simply the reappearance of the seepage water which follows along the valleys under the sand. Such springs are found on Red Cloud Slough, J. M. Creek, and the head of Sheep Creek north of Spoon Butte.

Hawk Springs, at the west end of 66 Mountain, is perhaps the largest so-called spring in the Goshen Hole country. At this locality the ground is seepy, and the water rises at a number of places. It has

been dammed in so as to form a small pond, and an irrigation ditch has been constructed to carry the flow onto pasture lands. The source of the water can not be definitely determined. From examination of the valley of Horse Creek, farther south, and a study of the wells adjacent to it, it appears that a considerable quantity of ground water passes laterally from the creek into gravels and sands, and it is not improbable that Hawk Springs is the point of issuance of this water, which follows a natural channel now obscured by surficial material.

Ponds.—Within the area of Goshen Hole there are many shallow ponds, in a large number of which water stands nearly all the year. These ponds are commonly spoken of as water holes (see Pl. X, *B*). They are usually shallow, seldom being over 2 or 3 feet in depth. Their bottoms are filled with mud, which is tramped up by the cattle, and when the water evaporates it leaves a mire in which cattle sometimes stick fast.

The water holes occur in moderate depressions which have a relation to the lines of drainage. These depressions, however, are not infrequently 20 feet below the grade of the channel. Careful instrumental surveys are required in some places to determine in what direction water would flow in case of flood, since the relief is very irregular, and no definite drainage system can be made out by studying channels. The origin of the ponds or water holes is a question of considerable interest. They appear to have been produced in the following ways:

In times of flood the water carries a heavy load of sediment. This sediment, together with the débris of the vegetation, finds lodgment in the greasewood and sagebrush along the streams, and causes a slight damming of the channel. In this way the water courses are ponded. After the run-off water has ceased to flow the ponds are frequented by cattle, which tramp the mud and puddle it so that it holds water much better the second time that it is filled. The cattle in going away carry a considerable quantity of the mud on their feet, and by tramping form an irregular rim at the border of the water.

Another cause of the ponding of the channels is due to the fact that when a stream enters at right angles to the channel its sediments form an alluvial fan. In case of heavy rainfall the sand from a slope down which a stream flows with considerable velocity is carried and deposited as a barrier across the channel. Sometimes a trail crossing a stream breaks the sod, so that a quantity of sand sufficient to obstruct the channel is brought down during a heavy rain. Examples of ponding of this kind may be seen in many of the streams, particularly in the area of the Arikaree formation, which consists largely of sand.

Another probable method of ponding is by solution. The water along the stream channels sinks into the ground at certain places and in percolating carries with it materials in solution, so that a depression is formed where this process continues for a long time. Localities at which this would naturally take place are where the under-

lying formations are porous and capable of carrying a large quantity of ground water. The sinks which originate in this way are readily transformed into water holes when silted up with fine clay.

The wind which carries away the sand and loose clay from the margins of the water holes is also an agency in producing depressions. For a considerable distance around the standing water the ground is made bare by the tramping of the cattle, and the grass is either grazed off by the herds or cut down by the prairie dogs, which have their towns near by. The wind carries away all the loosened material, and in the course of time is undoubtedly a conspicuous factor in deepening the depression. Where the surface formation is of a sandy nature and has beneath it a clay, the action of the wind is undoubtedly sufficient to blow out a considerable basin, and when the sand is carried away down to the depth at which the clay occurs the conditions are supplied for a pond, when there is any large amount of rainfall. Within the area of Goshen Hole there is nearly everywhere present a considerable amount of surficial material, which is largely sand. Blowouts, as they are called, which have a depth of 10 to 15 feet, are not unusual. The bottoms of these are usually the clays or undisturbed and original formations, which are relatively impervious to water. It is probable that the alignment of some of the water holes which seems to indicate a former channel may be the result of the direction of the wind, which has produced a number of blowouts at a locality where, for some reason, the sod has been removed and deflation rendered possible.

Perhaps the most common cause of ponding of stream channels within this area is the drifting of sand. The most notable example of it may be seen on Sheep Creek, where the valley is crossed by a high range of sand hills. Above the barrier of sand the water disappears in what is known as the sinks of Sheep Creek. At this place the stream sinks into the sand and appears lower in the valley, where the channel is unobstructed. The sand hills at the sinks of Sheep Creek, however, do not cause a permanent ponding of water, because they are porous and the basin has not become silted up with clay so as to hold the water. The drifting of the sand occurs on a smaller scale at many places in the area of the Goshen Hole. When once the barrier of sand accumulates across a line of drainage it may become sodded over, and where the relief is low the lines of drainage soon become obscured.

Wells.—Inasmuch as the settlements have usually been made near running water or springs, the wells that have been dug have mostly been shallow ones and obtain the ground water which is found along the valleys of the streams. Lately, however, settlers on the upland have dug wells for domestic use, and deep wells have been drilled in order to supply stock water.

In the southeast corner of the Goshen Hole quadrangle, on the high land, the depth to water is practically the distance which must be

drilled in penetrating from the surface to the level of the Brule clay. The wells in this locality are reported to be from 220 to 300 feet in depth. In the northern part of the Patrick quadrangle, in the vicinity of Lone Sand Hill, deep wells have been drilled to obtain water for cattle, and they reach a depth of from 180 to 250 feet. Inasmuch as this locality is a considerable distance from any known outcrop of the Brule clay and the information as to what was passed through in drilling is not very definite, it can not be determined with certainty whether these wells reach the line of contact between the Arikaree and Brule clay. The probability is, however, that this is the case, since the Arikaree is seldom found to contain much water, and the wells are not exhausted when pumped steadily by means of windmills.

In the portion of the area here discussed in which the surficial materials overlying the Brule clay have a considerable thickness, shallow wells have been found where there are local basins of water held by the irregular surface of the clay. Examples of wells of this class may be found east of La Grange, on the relatively level country south of 66 Mountain. They have a depth of from 20 to 75 feet, some of the deeper ones apparently having penetrated a considerable distance into the clay.

Within the area of Goshen Hole where the Cretaceous formations outcrop some deep wells have been drilled with the hope of finding a supply of water for cattle, and other borings have been made in prospecting for coal along Horse Creek. In all these cases an abundance of water has been found, but it is not of good quality. It is commonly spoken of as being "alkali" or salty. This is not an uncommon characteristic of the water in the Cretaceous formations, and indeed of large areas in Wyoming where the rocks are of other ages. The source of the mineral salts which are contained in the water is not easily explained. Inasmuch as the water at nearly all points is equally bad, the supposition is that the salts are diffused throughout the formation and may be an orginal constituent deposited at the time the sediments were formed.

Where irrigation is carried on the percolation of the water renders the ground springy and wells are sunk only a few feet. The water obtained in such cases, however, is not of good quality, inasmuch as it is the seepage from irrigation, and where the land has been irrigated for a number of years it is apt to contain mineral salts as a result of the long-continued evaporation. These salts are usually spoken of as "alkali." They are in reality sodium chloride or common salt, sodium sulphate, calcium sulphate, or gypsum, and magnesium sulphate, together with certain other salts in smaller quantities. They have the property of making the water hard and rendering it undesirable for domestic use.

Artesian wells.—Thus far no artesian wells have been obtained within the Patrick and Goshen Hole quadrangles which are indicative of general artesian conditions. In prospecting for coal along Horse

Creek some of the wells which reach a considerable depth are reported to have flowed a steady stream, but these wells, inasmuch as the water was not soft and fresh, were not thought worth preserving. Near Robb's ranch there is a shallow well, generally reported to be from 20 to 40 feet deep, which flows a small but steady stream. It is not cased up, and the water which rises in it forms a pool a few feet in diameter, from one side of which the flow escapes. The locality is frequented by stock as a watering place. Nothing could be learned concerning the structure of the formations at this place which was at all conclusive. The surficial materials are extensive in this locality, and the Brule clay apparently underlies them. The depth of the well could not be learned with certainty, and no information was available as to what was passed through in digging it. The probability is that the flow comes from a local basin in which the ground water accumulates.

As to the existence of artesian water at considerable depths in this country, it may be well to state that in case it should be found in the Cretaceous it would probably be in character like that which has been described from the wells in Goshen Hole, not suitable for domestic use and only fairly acceptable for stock water. The water which is found in deep wells drilled on the upland often rises for a considerable distance in the wells, but it does not have sufficient head to flow, and when pumped steadily falls lower, so that it is necessary to pump from the bottom of the well in nearly every case where a large supply is needed. The quality of the water found in the Tertiary is usually good, although not always abundant.

IRRIGATION.

The irrigation enterprises in the Patrick and Goshen Hole quadrangles comprise a large number of ditches. Some of them, however, are short. This is particularly true of those which derive their water from the small streams. Along the Platte River the amount of water available for irrigation purposes is more abundant and the canals are wider and have been carried for several miles. The bottom land of this valley includes most of the cultivated tracts and is at present nearly all under ditches. The canals have not been surveyed in detail, and inasmuch as the water rights have not been adjudicated by the State, the flowage and capacity of many of them is not a matter of record. On the accompanying map, Pl. VIII, the areas which are shown as cultivated land under irrigation are those which were noted and mapped by Mr. Ernest F. Burchard, who assisted in the survey of the region. Not all the ditches have been mapped, since some of them are used only for diverting the water onto meadow and pasture lands. The cultivated area under any ditch varies in size from year to year with the condition of the ditch and the enterprise of the farmer. From time to time contests have arisen as to priority of rights, and because of the limited amount of water available certain canals which are well located have been abandoned. In some cases the water from the

streams is utilized by ditches which do not divert it onto lands that can be economically cultivated.

Little Horse Creek ditches.—Little Horse Creek does not have a very large amount of water in it, except at flood times, but its usual flow is appropriated by small ditches, as are also the flows from spring branches in its valley. The ditches which divert it are the Springdale, Herrick, Gordon, Lykens, and Hoyt.

Horse Creek ditches.—The valley of Horse Creek for a considerable distance in the area here discussed is narrow and somewhat canyon-like. Ditches have been constructed along this portion of its course, but practically all of them have been abandoned, although some of the small ones are used for irrigating gardens and limited meadow lands. The first important ditch within the area here discussed is known as the Code ditch. This diverts the water into what evidently was formerly a valley of Horse Creek before its flow was captured by Little Horse Creek. This valley is known as the Big Draw and has a gentle grade, so that the water is economically applied. This ditch is so situated that it could utilize the entire flow of the stream at its head gate except at flood times. By constructing reservoirs a considerable quantity of flood water might be stored.

On Horse Creek, in the vicinity of La Grange post-office, the flow of the stream is considerable at practically all seasons of the year and is utilized by the La Grange ditches. These are located several miles below the Code ditch, and the flow of the stream at this point is considerably increased over that which passes the head gate of the Code ditch. Below the La Grange ditch the T. M. Herrick ditch and some others are so situated as to utilize the water which passes the La Grange. A small ditch has recently been constructed at Little Willows. It irrigates a narrow tract in the immediate valley of the creek. The next point at which the flow is available for irrigation purposes is near the State line. The Lawrence ditch, which has been constructed at this place, is provided with storage reservoirs and irrigates a considerable tract. There is in addition, a short distance below, the Brazil and Marsh ditch, which is connected with the Lawrence, and the Hockster, Foster, and Roberts ditches, which irrigate small tracts.

Bear Creek ditches.—The valley of Bear Creek, where it is contracted within canyon-like walls, has no large ditches. At nearly every ranch some water is diverted onto narrow meadow lands or garden patches, but the amount irrigated in this way is inconsiderable. These ditches are not shown on the map. To the west of Meriden post-office Spring Branch enters Bear Creek. Its flow is utilized by the Dater ditch, which irrigates only a few acres. Below this point Bear Creek ditch diverts the water on the lands in the vicinity of Meriden post-office. The flow of the stream farther on is utilized by the Vanwedel and Goshen ditches.

Fox Creek ditches.—This stream has a very limited flow, but an

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MAP SHOWING CULTIVATED LANDS UNDER IRRIGATION, AND DISTRIBUTION OF TIMBER

BY ERNEST F. BURCHARD

Scale

0 1 2 3 4 5 6 7 8 9 10 11 12 miles

LEGEND

Irrigated tracts

Pine and cedar

Cottonwood and willow

effort has been made to utilize it by the Fox Creek and Kessler ditches. The amount of water is sufficient for only small tracts. Lands onto which it is diverted are, however, favorably situated.

Rawhide Creek ditches.—Rawhide Creek has too limited a flow during the dry season to justify the construction of large ditches. The Bartlett, Patrick, and Snow ditches utilize the water of this stream. In addition there are small ones which divert the water onto meadow lands.

Platte River ditches.—On the north side of the Platte River the canals which have been constructed from the vicinity of Fort Laramie

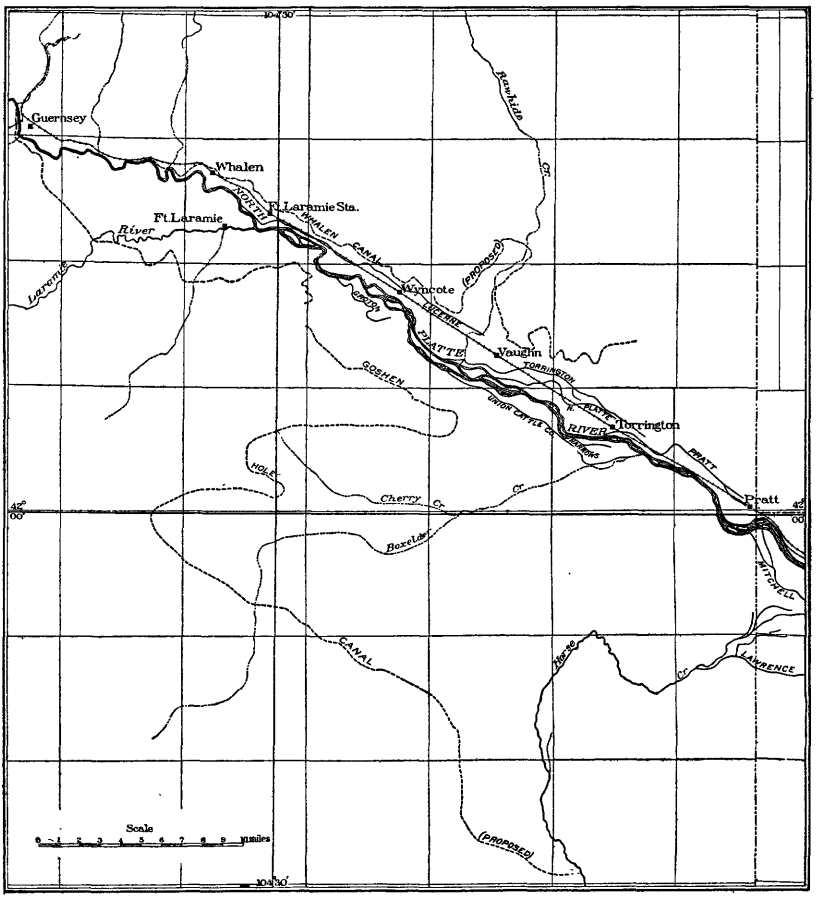


FIG. 4.—Map showing constructed and proposed canals along North Platte River.

eastward are the Lucerne, Torrington, North Platte, and Pratt. The Farmers canal has its head gate at the eastern border of the area. Its flow is utilized principally to the eastward of the area here discussed. On the south side of the river the Grotton, Union Cattle Company, Narrows, and Mitchell ditches are in operation. The last-named one (which irrigates a large tract farther east, in Nebraska) has a second head gate, known as the Gering Branch. The Platte River ditches

are so situated that they are practically above all the alluvium of the valley. This area, however, is not all suitable for cultivation, since some of it is too uneven and other portions are so sandy and gravelly that the water can not be economically applied. With further preparation of the land and by successive saturation of the soil areas which are now not cultivated will be rendered suitable for farm land.

It has been proposed to divert the waters of the North Platte near Guernsey, to the west of the area here discussed, and carry it by means of a long ditch into the Goshen Hole country (see fig. 4). Surveys have been made along the line where this ditch is expected to run, but the cost of construction has been considered relatively too great, and because of having to cross streams and to maintain the canal through a rough country, promoters of this enterprise have been deterred from carrying out their plans. The country in Goshen Hole which this canal is expected to reclaim is, however, of a character suited to irrigation.

Recently surveys have been made for a canal on the north side of the Platte with the head gate at the vicinity of Whalen Canyon (see fig. 4). This ditch is expected to reclaim a large tract of land and has been planned under the provisions of the Carey act.[a] The course which it will follow is relatively long and runs through considerable rough ground, where there will be a loss of water by seepage through the sands and gravel. This loss, however, will diminish as the canal becomes silted up. Besides small tracts along its upper course the area which it is expected to reclaim lies principally along the mouth of Rawhide Creek and east of that stream, which it will cross.

TIMBER, GRASS, AND AGRICULTURAL PRODUCTS.

Timber.—On the High Plains, to which the area here discussed belongs, timber occurs only at favored localities, and seldom in areas sufficiently large to render it a valuable resource. In the absence of coal, wood of any kind is valuable for fuel, and is hauled long distances. The trees which grow on the plains are not very good for building, although they are frequently utilized by the settlers for the construction of log houses and small buildings. Their principal use has been to furnish posts for fences. One reason why the timber does not furnish valuable lumber is because of its slow and stunted growth. Moreover, the varieties do not represent the more durable woods. On the bluffs and escarpments, and occasionally the lone hills, there is a scant growth of pine and cedar. This timber has been largely depleted, and sometimes in cutting it considerable waste has resulted from the leaving of the tops and stumps. After the trees which furnished good logs for building had been cut away and the smaller ones suitable for posts had been used up by the ranchmen, the settlers found that wood was becoming so valuable that they

[a] For the provisions of this act see Appendix.

A. BEAR CREEK MOUNTAIN, LOOKING EASTWARD; ALFALFA FIELD AND MERIDEN POST-OFFICE IN FOREGROUND.

B. EAGLE ROCK AND LONE ROCKS AT FOX CREEK GAP IN ARIKAREE FORMATION.

resorted to the hauling of the stumps and tops for fuel. The area in which the pine and cedar occurs is shown on the accompanying map, Pl. VIII. In nearly all the localities pine trees predominate over the cedar; at no place is there a dense growth. The color symbol indicates the area in which scattered trees are found, and should not be interpreted as denoting well-wooded land.

Along the streams and in the valleys in which small springs occur a growth of deciduous trees is found. The species are relatively few in number, the predominating ones being the cottonwood, willow, and box elder. Their growth is such that they do not furnish good timber, and their principal value, outside of supplying a poor quality of firewood, is in giving shade for cattle in the summer and shelter during winter storms.

The trees which have been able to maintain themselves are those which have abundant and winged seeds. The wind transports the seeds for long distances, and it is probably due to this agency that small clumps of trees are found in gulches at widely separated localities. The occurrence of the trees along the streams where seeds could be transported by water may also be observed on the Platte River, Horse Creek, Rawhide Creek, and the other streams.

The localities which seem favorable to the growth of the soft woods are places in which considerable moisture is present. The pines and cedars, on the contrary, are found on the dry and nearly barren bluffs and escarpments. It is probable that there has never been a broader distribution of timber than at the present time. Except that settlers have cut away the trees, the tendency has been toward an increase rather than a decrease, because of the fact that prairie fires are not allowed to run so widely as in former times.

Grasses.—The surface of the High Plains is largely held by the grass sod. Without this protecting covering the surface would be soon deeply channeled by the run-off water or blown into sand hills. The rock formations and the detritus which results from their weathering are largely sand or material which does not cement readily, and, being in an arid region, is rapidly reduced to small particles and dust which can be transported by the wind. Wherever for any reason the grass has been killed out one can observe the results of wind erosion or the cutting of channels by the run-off water.

The grasses which grow on the High Plains are of many varieties. Probably over 100 species occur within the area here discussed. Their value as forage is known to cattlemen, although the various kinds are not carefully distinguished. The more characteristic types are commonly denominated buffalo grass, grama grass, wheat grass, bunch grass, needle grass, prairie grass, blow-out or sand-hill grass, and nigger-wool or black-root grass. In riding across the prairie the various species may be seen to occur in patches of irregular shape, sometimes of considerable size, but usually they are mingled. Where a single

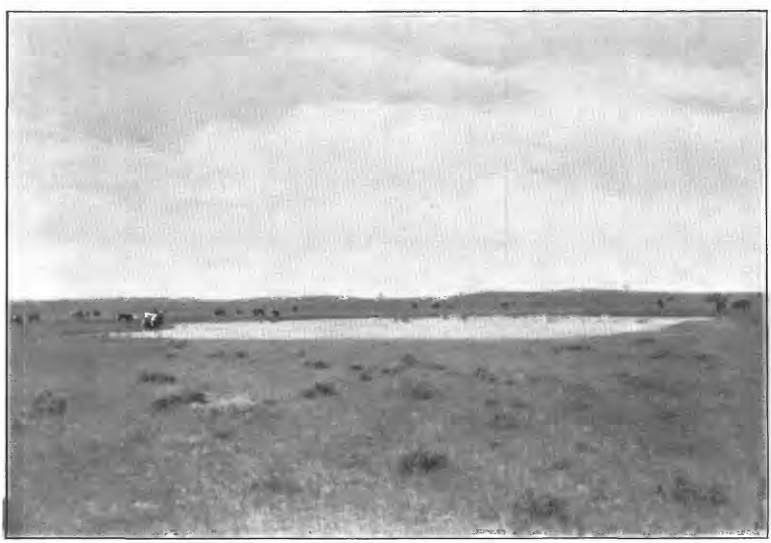
species occupies an area it may be distinguished from the surrounding grasses by the difference in color and length of stem. Not infrequently several species may be seen growing in distinctly marked patches, all embraced within the range of vision. While the natural grasses of this country, with the exception of a few kinds, are not long enough to furnish hay, they are particularly nutritious and valuable as natural pasturage. To one accustomed to the luxuriant prairie grass of the middle section of the United States the buffalo grass and similar varieties which are sometimes spoken of under the common name of "short grass" appears at first to be valueless as pasturage. As a matter of fact, according to the amount of vegetation, they are richer than the prairie grass. The area required for pasturage is necessarily great because of the small growth. Unlike the prairie grasses, the short grasses cure on the sod and maintain their nutritive value during the winter season, so that they form a natural pasture the year round. When fall rains occur the leaching of the grass lessens its value, but fortunately the seasons are usually dry.

Although the grass of the plains is short, certain species are cut for hay and are found to be of exceptional value. One of these is known as wheat grass. The valuable part of the hay consists of the seed, which somewhat resembles the head of wheat, although much smaller. The longer grasses of the sand hills are also cut, but are not esteemed so highly. In mowing, the hay is made to fall on a table behind the sickle bar, where it is held until a considerable quantity is accumulated, when it is dumped. This obviates the necessity of raking and makes it possible to gather hay which it would be difficult to collect by any other method.

Herbaceous plants.—In the more sandy portion of the country, particularly within the area of Goshen Hole, sagebrush and grease wood are found, practically excluding other plants at certain localities. These herbaceous plants serve the purpose of forage to some extent, but are not so valuable as the prairie grass. Sheep eat them much more than cattle do, and are practically the only stock which can be herded in such an area. Intermingled with the grease wood and sagebrush are large patches of cactus or prickly pear. Where both of these occur the prairie grass is choked out and the land rendered nearly valueless for grazing. The most important function of this class of vegetation is in retaining the sand, which would otherwise be blown into sand hills.

Agricultural products.—Most of the land which is cultivated is under irrigation. The seasons are not favorable for raising grain, although some of it is produced each year. Oats, wheat, and barley do well when irrigated and not attacked by rust or mildew. Inasmuch as the cattle industry requires a large amount of forage, ranchmen have found it to their advantage to raise alfalfa, since its yield is large and it requires little cultivation. The areas indicated on the

A. GOSHEN HOLE ESCARPMENT AND CHIMNEY ROCK; TRELONA POST-OFFICE IN FOREGROUND.



B. WATER HOLE AND CATTLE, GOSHEN HOLE LOWLAND.

map (Pl. VIII) as being irrigated are nearly all devoted to the raising of alfalfa. The hay commands a good price for local use. Along the valleys where it is raised the larger ranches are located, and during winter the cattle which must be fed are brought in off the range and carried through the winter storms by feeding on the alfalfa. The hardier cattle are usually left to graze on land which is reserved for winter pasture. The particular value of alfalfa to the ranchman lies in the fact that he is enabled by feeding it to prevent losses in his herd and bring his stock through in better condition for fattening in the spring, so that they go into the market early.

Forage plants other than alfalfa have not been experimented with extensively. It is not improbable that other crops could be raised which would yield a larger amount of food for cattle per acre than alfalfa. They would require more cultivation, however, and this would be against their popularity in a region where labor is relatively scarce.

In exceptional years good crops can be raised without irrigation, and there are settlers in western Nebraska, adjacent to the area here discussed, who are successful in maintaining farms on the uplands. In Wyoming few attempt to cultivate the prairie land. This difference in the agricultural industry might at first sight appear to be due to a difference in the kind of settlers. In Wyoming the country is given over to ranchmen, who enjoy the privileges of free range, while in Nebraska the herd law protects the settlers, whose crops might otherwise be overrun by cattle even if fairly good fences were built.

SETTLEMENT AND OCCUPANCY OF PUBLIC LANDS.

Early settlement relative to water for stock.—The first settlers in the plains region were cattlemen who located their home ranches with respect to stock water, natural meadow, pasture, and sheltered localities. In the beginning of the stock-raising industry the herds were widely separated and there was no crowding. With increase of the size of the herds and the establishment of ranches by men of large capital, there naturally arose conflicts concerning privileges of the range. In order to maintain themselves and obtain exclusive use of grazing lands, the first effort of the cattlemen was directed to securing the most valuable watering places. Since the streams of the area, with the exception of the larger ones, are not perennial, the first ranches were established on Sheep Creek, Rawhide Creek, Platte River, and Horse Creek and its tributaries. These are to-day the most important ranches, although many others may be found at localities where there is a sufficient supply of water. The lands which were occupied as home ranches were homesteaded, and in each case the land to which title was thus obtained was necessarily a small tract. The ranchman did not need land for agricultural purposes, and with free range his cattle were left to graze as widely as they wished, and

he counted on their return to the watering place as one means of holding his herd together.

After the most desirable locations had been secured for the herds a new ranchman coming into the country found it difficult to obtain open water at a locality where his cattle would have an independent range. The spring branches and smaller streams, and even the ponds, have become important as the crowding of herds has increased. As long as there was no inducement to settlers to homestead the land, because it was of little value for agricultural purposes, the cattlemen by mutual agreement allowed their herds to mingle to a considerable extent, and depended upon the round-ups for keeping track of them. With the passing of the law which provided for obtaining title to the lands by constructing irrigation ditches, a new element entered in the competition for possession of the grazing lands.

Entry of lands under the desert-lands act.[a]—According to the provisions of the so-called desert-lands act, a large number of irrigation ditches were constructed which were intended to utilize the supply of the larger streams. The nature of the country is such that ditches could be built with very little expense, especially if they were made to parallel the stream channels, and inasmuch as there is considerable grade to the streams at some localities, ditches were carried for a considerable distance away from the valleys. Although it was the intention that the ditches constructed under the desert act should be for the purpose of irrigation, in reality many of them simply served the purpose of obtaining title to the land. By constructing a ditch parallel to the stream the use of the water for irrigation purposes was obtained, and also the ownership of the land, which brought with it control of the stream as a watering place for cattle. Since the water supply was not adequate for irrigation purposes all the year round, the cattlemen frequently preferred to allow the water to flow on to a natural meadow or pasture land and make it more valuable for their herds, rather than to attempt the raising of crops. Some of the ditches which were constructed were practically abandoned as soon as the title to the land through which they were built was secured. Where the supply of water in the streams was really adequate for irrigation purposes the ditches which were built are of use at the present time, provided they had prior rights. The ditches, however, which were constructed with second and third rights to the water have in many cases been abandoned because the ditch having the first right takes all the flow at the season of the year when it is most essential to the crops.

As soon as the construction of irrigation ditches began, the cattlemen saw that it would be necessary for them to enter into the projects or they would be deprived of water for their stock. Accordingly, there is hardly any part of the courses of the perennial streams along

[a] For the provisions of this act see Appendix.

which ditches have not been built in order to protect the water rights and obtain titles to the lands bordering the streams. Where there was only a limited supply of water, such as could not be reasonably expected to irrigate a crop, ditches were sometimes constructed in order to obtain title to the land so as to exclude herds from the privilege of watering. Examples of such ditches will be found near springs and along the valleys in which the water flows only at flood time and at other seasons stands in water holes.

The nature of the soil and rock formations in the Patrick and Goshen Hole quadrangles is such that very little work is required in excavating the ditches. On the other hand, the loose and sandy nature of the country rendered a ditch of little value when first constructed, because the water which entered it seeped into the ground. After the flow has been maintained for some time the silting-up process made the ditches carry a larger percentage of the water, but unless they were kept up and utilized for agricultural purposes they soon fell into a poor state of repair, as a result of the breaking down of the banks, which consisted simply of sandy loam. When the water was turned to no other purpose than that of irrigating natural meadows for pasture land, and cattle were allowed to frequent the ditch, it was a matter of but a short time until the herds had destroyed its usefulness.

By reference to the accompanying map, Pl. XI, the reader will see what portion of the country was entered under the desert-lands act. The percentage of land to which title was obtained under the provisions of this act is relatively large as compared with the whole amount of land thus far entered by settlers. A considerable portion of the land entered under the desert-lands act was never proved up according to its provisions, because of certain rulings of the Land Office which required a more complete reclamation than the value of the land would warrant. In some instances the cost of constructing ditches or placing them in complete operation would have been too great, and the land, when considered valuable, was reentered under other acts.

While it was not the intention of many who promoted irrigation enterprises to simply obtain title to the land in order to control the range, this was the final result in many cases. Even where the cost of the construction of the ditches was great and fully equal to the cost of the land through other modes of entry, the final result has been the same and the lands are now used only for grazing purposes. The law under which the proposed irrigation ditches in this region will be constructed is known as the Carey act.[a] It supersedes the desert-lands act and provides for more complete reclamation. With the exception of the waters of the Platte, all the supply available for irrigation purposes was practically appropriated under the desert-lands act, and the Carey act will be operative principally along the valley of Platte River.

[a] For the provisions of this act see Appendix.

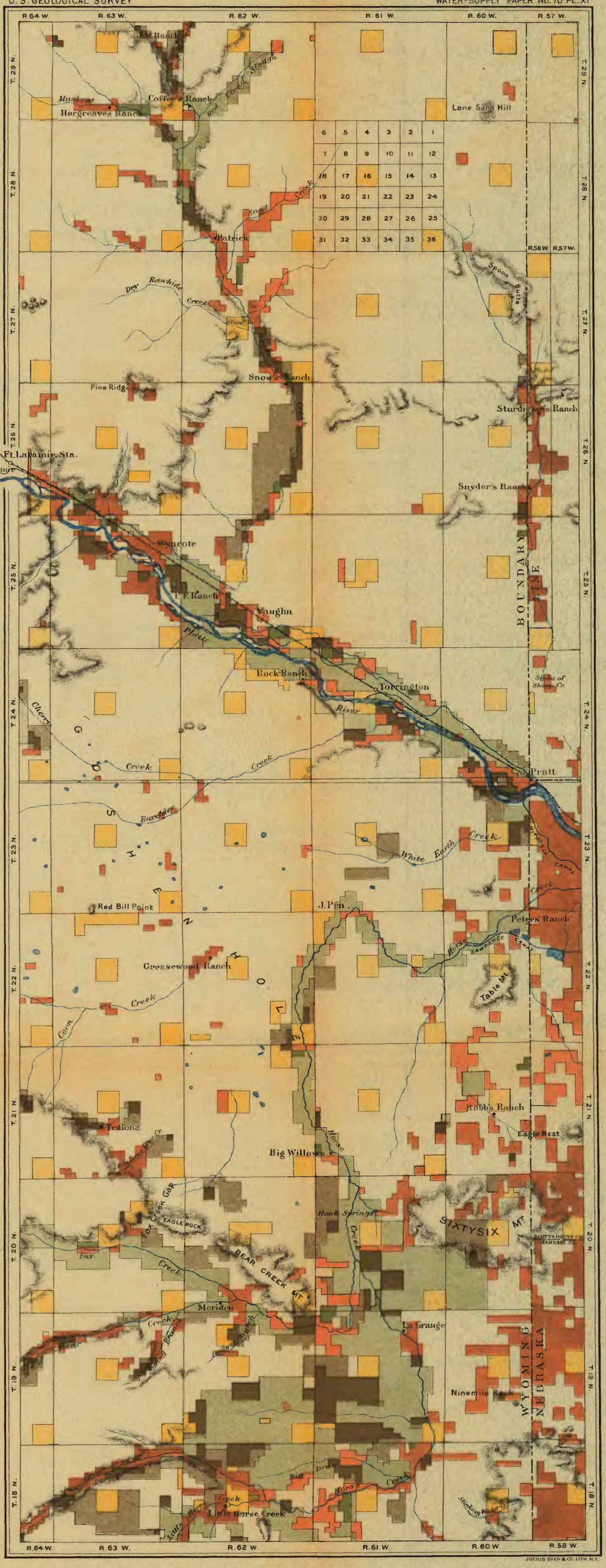
Construction of reservoirs on public lands for watering live stock.—The provisions of the act of Congress relative to the construction on the public domain of reservoirs for watering stock are set forth in the appendix to this paper. The regulations and rulings of the Land Office relative to this act are too lengthy to be set forth here. They provide that not more than 160 acres shall be reserved for a reservoir, and that no reservoir shall be made within a half mile of the boundaries of a group of 160 acres of adjoining or cornering tracts already reserved under this act. Land so reserved shall not be fenced, but shall be kept open to the free use of any person desiring to water animals of any kind. The rulings also provide that the reservoir shall be constructed within two years after the filing for the site.

As a matter of fact, the reservoirs have seldom been constructed. Ranchmen have, however, filed upon such sites as it has been of advantage to them to reserve for free range. Where there has been a probability of a portion of the public domain being included within an illegal fence, the filing of a reservoir site has been resorted to by a rival ranchman in order to protect his interests. Since the lands on which reservoir sites are located are reserved from public sale, filing on them has in some cases been resorted to as a means of preventing the occupancy by prospective settlers under the provisions of other acts.

Entry of lands under the homestead, preemption, timber-culture, timber and stone, and other acts.—Upon examination of the map, Pl. XI, which shows the classes of entry of lands, it will be seen that the portion which lies in Nebraska was practically all taken under the homestead act. During the period when it was supposed that the plains country could be utilized for agricultural purposes settlers were induced to take up the lands of western Nebraska in the more inviting localities, and titles were perfected in a large percentage of cases where the land was entered, although actual residence, cultivation, and improvement were only such as were demanded by the letter of the law. The lands which are owned by private individuals, as a result of this influx of settlers, practically all lies open and unfenced, except where there is a supply of water available for irrigation or for the support of a herd. The ranchmen have acquired simply that portion of the land which borders the streams, and by owning this are able to control the range.

The percentage of land entered under these acts in Wyoming is relatively less than in Nebraska. This is probably due to the different conditions which influenced settlers in going into the plains country, and is largely due to the fact that the law relative to herding and free range was different in the two States.

Occupancy of land not naturally watered.—Recently ranchmen have found that the tracts of land which are not occupied are the broad stretches of upland in which open water is found during only a



JULIUS BIEN & CO. LITH. N.Y.

MAP SHOWING CLASSES OF ENTRY OF PUBLIC LANDS AND STATE SELECTIONS

COMPILED FROM LAND OFFICE RECORDS, SEPTEMBER, 1901

Scale

0 1 2 3 4 5 6 7 8 9 10 11 12 miles

LEGEND

Desert entry title perfected	Desert entry no final proof	Desert entry canceled	Desert entry reentered under other acts	Entered under other acts, homestead, timber, culture etc.	State lands

part of the year. In order to utilize this type of country, wells have been drilled and windmills erected. The water obtained by pumping is stored in tanks and allowed to flow into watering troughs, so as to furnish the cattle a constant supply. The percentage of successful wells thus far has been encouraging, and there promises to be a larger number in operation in the near future. There are advantages in such a method of watering stock over the usual method of allowing them to run to ponds or streams, particularly where there is no constant flow. The water supply in watering troughs at the wells can be kept clean, and by having the wells distributed at regular intervals the distance which the cattle have to travel is practically reduced to the distance which they naturally go in grazing.

At the present time the school lands and State selections may be leased for 5 per cent per annum of their appraised value. The minimum for grazing lands is $16 for a section of 640 acres. By leasing these lands the stockmen have locations for wells which they may control, and the intermediate country being a free range, they are practically in possession of all of it for grazing purposes. This method of occupancy does not necessitate the expenditure of any large sum in permanent improvements, and at the same time it enables the ranchmen on the high prairies away from the streams to become strong competitors for the use of the range. Previous to such occupancy the cattlemen who controlled the water of the streams had, by mutual agreement, determined the amount of the range which they would use individually, and in many cases had constructed fences which embraced large tracts of the public domain. As soon as a newcomer establishes himself in the midst of this range by digging a well and constructing watering tanks, he is in a position to demand an equal share with the others. In this way the illegal fencing will soon be done away with, and the owners of the lands adjacent to the streams will no longer monopolize the range.

APPENDIX.

DESERT-LANDS ACT.

AN ACT to provide for the sale of desert lands in certain States and Territories.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That it shall be lawful for any citizen of the United States, or any person of requisite age "who may be entitled to become a citizen, and who has filed his declaration to become such," and upon payment of twenty-five cents per acre, to file a declaration, under oath, with the register and the receiver of the land district in which any desert land is situated, that he intends to reclaim a tract of desert land, not exceeding one section, by conducting water upon the same within the period of three years thereafter: *Provided, however*, That the right to the use of water by the person so conducting the same on or to any tract of desert land of six hundred and forty acres shall depend upon bona fide prior appropriation; and such right shall not exceed the amount of water actually appropriated and necessarily used for the purpose of irrigation and reclamation; and all surplus water over and above such actual appropriation and use, together with the water of all lakes, rivers, and other sources of water supply upon the public lands, and not navigable, shall remain and be held free for the appropriation and use of the public for irrigation, mining, and manufacturing purposes subject to existing rights. Said declaration shall describe particularly said section of land if surveyed, and if unsurveyed shall describe the same as nearly as possible without a survey. At any time within the period of three years after filing said declaration, upon making satisfactory proof to the register and receiver of the reclamation of said tract of land in the manner aforesaid, and upon the payment to the receiver of the additional sum of one dollar per acre for a tract of land not exceeding six hundred and forty acres to any one person, a patent for the same shall be issued to him: *Provided*, That no person shall be permitted to enter more than one tract of land, and not to exceed six hundred and forty acres, which shall be in compact form.

SEC. 2. That all lands exclusive of timber lands and mineral lands which will not, without irrigation, produce some agricultural crop, shall be deemed desert lands within the meaning of this act, which fact shall be ascertained by proof of two or more credible witnesses under oath, whose affidavits shall be filed in the land-office in which said tract of land may be situated.

SEC. 3. That this act shall only apply to and take effect in the States of California, Oregon, and Nevada, and the Territories of Washington, Idaho, Montana, Utah, Wyoming, Arizona, New Mexico, and Dakota, and the determination of what may be considered desert land shall be subject to the decision and regulation of the Commissioner of the General Land Office.

Approved, March 3, 1877. (19 Stat. L., p. 377.)

By the act approved March 3, 1891 (26 Stat. L., 1096), entitled "An act to repeal timber-culture laws, and for other purposes," the following sections were added to the desert-lands acts:

SEC. 4. That at the time of filing the declaration hereinbefore required the party shall also file a map of said land, which shall exhibit a plan showing the mode of contemplated irrigation, and which plan shall be sufficient to thoroughly irrigate and reclaim said land, and prepare it to raise ordinary agricultural crops, and shall also show the source of the water to be used for irrigation and reclamation. Persons entering or proposing to enter separate sections or fractional parts of sections, of desert lands may associate together in the construction of canals and ditches for irrigating and reclaiming all of said tracts, and may file a joint map or maps showing their plan of internal improvements.

SEC. 5. That no land shall be patented to any person under this act unless he or his assignors shall have expended in the necessary irrigation, reclamation, and cultivation thereof, by means of main canals and branch ditches, and in permanent improvements upon the land, and in the purchase of water rights for the irrigation of the same, at least three dollars per acre of whole tract reclaimed and patented in the manner following: Within one year after making entry for such tract of desert land as aforesaid, the party so entering shall expend not less than one dollar per acre for the purposes aforesaid; and he shall in like manner expend the sum of one dollar per acre during the second and also during the third year thereafter, until the full sum of three dollars per acre is so expended. Said party shall file during each year with the register, proof, by the affidavits of two or more credible witnesses, that the full sum of one dollar per acre has been expended in such necessary improvements during such year, and the manner in which expended, and at the expiration of the third year a map or plan showing the character and extent of such improvements. If any party who has made such application shall fail during any year to file the testimony aforesaid, the lands shall revert to the United States, and the twenty-five cents advanced payment shall be forfeited to the United States, and the entry shall be canceled. Nothing herein contained shall prevent a claimant from making his final entry and receiving his patent at an earlier date than hereinbefore prescribed, provided that he then makes the required proof of reclamation to the aggregate extent of three dollars per acre: *Provided*, That proof be further required of the cultivation of one-eighth of the land.

SEC. 6. That this act shall not affect any valid rights heretofore accrued under said act of March third, eighteen hundred and seventy-seven, but all bona fide claims heretofore lawfully initiated may be perfected, upon due compliance with the provisions of said act, in the same manner, upon the same terms and conditions, and subject to the same limitations, forfeitures, and contests as if this act had not been passed; or said claims, at the option of the claimant, may be perfected and patented under the provisions of said act, as amended by this act, so far as applicable; and all acts and parts of acts in conflict with this act are hereby repealed.

SEC. 7. That at any time after filing the declaration, and within the period of four years thereafter, upon making satisfactory proof to the register and the receiver of the reclamation and cultivation of said land to the extent and cost and in the manner aforesaid, and substantially in accordance with the plans herein provided for, and that he or she is a citizen of the United States, and upon payment to the receiver of the additional sum of one dollar per acre for said land, a patent shall issue therefor to the applicant or his assigns; but no person or association of persons shall hold, by assignment or otherwise prior to the issue of patent, more than three hundred and twenty acres of such arid or desert lands;

but this section shall not apply to entries made or initiated prior to the approval of this act: *Provided, however*, That additional proofs may be required at any time within the period prescribed by law, and that the claims or entries made under this or any preceding act shall be subject to contest, as provided by the law relating to homestead cases, for illegal inception, abandonment, or failure to comply with the requirements of law, and upon satisfactory proof thereof shall be canceled, and the lands and moneys paid therefor shall be forfeited to the United States.

SEC. 8. That the provisions of the act to which this is an amendment, and the amendments thereto, shall apply to and be in force in the State of Colorado, as well as the States named in the original act; and no person shall be entitled to make entry of desert land except he be a resident citizen of the State or Territory in which the land sought to be entered is located.

The Commissioner of the General Land Office interpreted this act as follows:

The act of March 3, 1877, entitled "An act to provide for the sale of desert lands in certain States and Territories" (19 Stat. L., 377; Appendix, No. 4, p. 164), contained three sections. By the act of March 3, 1891 (26 Stat. L., 1095; Appendix, No. 44, p. 221), five sections were added thereto, numbered from 4 to 8. The first section provides for the reclamation of such lands by "conducting water upon the same." The second section provides "that all lands, exclusive of timber lands and mineral lands, which will not, without artificial irrigation, produce some agricultural crop shall be deemed desert lands within the meaning of this act," and the third section provides that "this act shall only apply to and take effect in the States of California, Oregon, and Nevada, and the Territories of Washington, Idaho, Montana, Utah, Arizona, New Mexico, Wyoming, and Dakota, and the determination of what may be considered desert land shall be subject to the decision and regulation of the Commissioner of the General Land Office."

It is therefore prescribed as follows:

First. Lands bordering upon streams, lakes, or other natural bodies of water, or through or upon which there is any river, stream, arroyo, lake, pond, body of water, or living spring, are not subject to entry under the desert-land law until the clearest proof of their desert character is furnished.

Second. Lands which produce native grasses sufficient in quantity, if unfed by grazing animals, to make an ordinary crop of hay in usual seasons are not desert lands.

Third. Lands which will produce an agricultural crop of any kind in amount to make the cultivation reasonably remunerative are not desert.

Fourth. Lands containing sufficient moisture to produce a natural growth of trees are not to be classed as desert lands.

CAREY ACT.

Section 4 of the act of August 18, 1894, entitled "An act making appropriations for sundry civil expenses of the Government for the fiscal year ending June 30, 1895, and for other purposes" (28 Stat. L., 372–422), authorizes the Secretary of the Interior, with the approval of the President, to contract and agree to patent to the States of Washington, Oregon, California, Nevada, Idaho, Montana, Wyoming, Colorado, North Dakota, South Dakota, and Utah, or any other States, as provided in the act, in which may be found desert lands, not to exceed 1,000,000 acres of such lands to each State, under certain conditions.

The text of the act is as follows:

SEC. 4. That to aid the public-land States in the reclamation of the desert lands therein, and the settlement, cultivation, and sale thereof in small tracts to actual settlers, the Secretary of the Interior, with the approval of the President, be, and hereby is, authorized and empowered, upon proper application of the State, to contract and agree, from time to time, with each of the States in which there may be situated desert lands as defined by the act entitled "An act to provide for the sale of desert lands in certain States and Territories," approved March third, eighteen hundred and seventy-seven, and the act amendatory thereof, approved March third, eighteen hundred and ninety-one, binding the United States to donate, grant, and patent to the State free of cost for survey or price such desert lands, not exceeding one million acres in each State, as the State may cause to be irrigated, reclaimed, occupied, and not less than twenty acres of each one hundred and sixty-acre tract cultivated by actual settlers, within ten years next after the passage of this act, as thoroughly as is required of citizens who may enter under the said desert-land law.

Before the application of any State is allowed or any contract or agreement is executed or any segregation of any of the land from the public domain is ordered by the Secretary of the Interior, the State shall file a map of the said land proposed to be irrigated which shall exhibit a plan showing the mode of the contemplated irrigation and which plan shall be sufficient to thoroughly irrigate and reclaim said land and prepare it to raise ordinary agricultural crops and shall also show the source of the water to be used for irrigation and reclamation, and the Secretary of the Interior may make necessary regulations for the reservation of the lands applied for by the States to date from the date of the filing of the map and plan of irrigation, but such reservation shall be of no force whatever if such map and plan of irrigation shall not be approved. That any State contracting under this section is hereby authorized to make all necessary contracts to cause the said lands to be reclaimed. and to induce their settlement and cultivation in accordance with and subject to the provisions of this section; but the State shall not be authorized to lease any of said lands or to use or dispose of the same in any way whatever, except to secure their reclamation, cultivation, and settlement.

As fast as any State may furnish satisfactory proof according to such rules and regulations as may be prescribed by the Secretary of the Interior, that any of said lands are irrigated, reclaimed, and occupied by actual settlers, patents shall be issued to the State or its assigns for said lands so reclaimed and settled: *Provided*, That said States shall not sell or dispose of more than one hundred and sixty acres of said lands to any one person, and any surplus of money derived by any State from the sale of said lands in excess of the cost of their reclamation, shall be held as a trust fund for and be applied to the reclamation of other desert lands in such State. That to enable the Secretary of the Interior to examine any of the lands that may be selected under the provisions of this section, there is hereby appropriated out of any moneys in the Treasury, not otherwise appropriated, one thousand dollars.

In the act making appropriations for sundry civil expenses of the Government for the fiscal year ending June 30, 1897, and for other purposes, approved June 11, 1896 (29 Stat. L., 413–434), there is, under the head of appropriation for "Surveying public lands," the following provision:

That under any law heretofore or hereafter enacted by any State, providing for the reclamation of arid lands, in pursuance and acceptance of the terms of the grant made in section four of an act entitled "An act making appropriations

for the sundry civil expenses of the Government for the fiscal year ending June thirtieth, eighteen hundred and ninety-five," approved August eighteenth, eighteen hundred and ninety-four, a lien or liens is hereby authorized to be created by the State to which such lands are granted and by no other authority whatever, and when created shall be valid on and against the separate legal subdivisions of land reclaimed, for the actual cost and necessary expenses of reclamation and reasonable interest thereon from the date of reclamation until disposed of to actual settlers; and when an ample supply of water is actually furnished in a substantial ditch or canal, or by artesian wells or reservoirs, to reclaim a particular tract or tracts of such lands, then patents shall issue for the same to such State without regard to settlement or cultivation: *Provided*, That in no event, in no contingency, and under no circumstances shall the United States be in any manner directly or indirectly liable for any amount of any such lien or liability, in whole or in part.

The limitation of time in the above-quoted section 4 was modified by section 3 of the act entitled "An act making appropriations for sundry civil expenses of the Government for the fiscal year ending June thirtieth, nineteen hundred and two, and for other purposes," approved March 3, 1901 (31 Stat. L., 1133–1188), which provides as follows:

SEC. 3. That section 4 of the act of August eighteenth, eighteen hundred and ninety-four, entitled "An act making appropriations for sundry civil expenses of the Government for the fiscal year ending June thirtieth, eighteen hundred and ninety-five, and for other purposes," is hereby amended so that the ten years' period within which any State shall cause the lands applied for under said act to be irrigated and reclaimed, as provided in said section as amended by the act of June eleventh, eighteen hundred and ninety-six, shall begin to run from the date of approval by the Secretary of the Interior of the State's application for the segregation of such lands; and if the State fails within said ten years to cause the whole or any part of the lands so segregated to be so irrigated and reclaimed, the Secretary of the Interior may, in his discretion, continue said segregation for a period of not exceeding five years, or may, in his discretion, restore such lands to the public domain.

AN ACT PROVIDING FOR THE CONSTRUCTION OF RESERVOIRS ON PUBLIC LANDS FOR WATERING LIVE STOCK.

The act approved January 13, 1897 (29 Stat. L., 484), entitled "An act providing for the location and purchase of public lands for reservoir sites," is as follows:

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That any person, live-stock company, or transportation corporation engaged in breeding, grazing, driving, or transporting live stock may construct reservoirs upon unoccupied public lands of the United States, not mineral or otherwise reserved, for the purpose of furnishing water to such live stock, and shall have control of such reservoir, under regulations prescribed by the Secretary of the Interior, and the lands upon which the same is constructed, not exceeding one hundred and sixty acres, so long as such reservoir is maintained and water kept therein for such purposes: *Provided*, That such reservoir shall not be fenced and shall be open to the free use of any person desiring to water animals of any kind.

SEC. 2. That any person, live-stock company, or corporation desiring to avail themselves of the provisions of this act shall file a declaratory statement in the United States land office in the district where the land is situated, which statement shall describe the land where such reservoir is to be or has been constructed; shall state what business such corporation is engaged in; specify the capacity of the reservoir in gallons, and whether such company, person, or corporation has filed upon other reservoir sites within the same county; and if so, how many.

SEC. 3. That at any time after the completion of such reservoir or reservoirs which, if not completed at the date of the passage of this act shall be constructed and completed within two years after filing such declaratory statement, such person, company, or corporation shall have the same accurately surveyed, as hereinafter provided, and shall file in the United States land office in the district in which such reservoir is located a map or plat showing the location of such reservoir, which map or plat shall be transmitted by the register and receiver of said United States land office to the Secretary of the Interior and approved by him, and thereafter such land shall be reserved from sale by the Secretary of the Interior so long as such reservoir is kept in repair and water kept therein.

SEC. 4. That Congress may at any time amend, alter, or repeal this act.

Although the title indicates that lands are to be sold for reservoir sites, the act does not provide for the sale of any lands, and therefore no lands can be sold under its provisions. The act, however, directs the Secretary of the Interior to reserve the lands from sale after the approval of the map showing the location of the reservoir.

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