_____. State Engineer.

BIENNIAL REPORT

PROPERTY OF DIVISION OF WATER RESOURCES STATE ENGINEER

FISCAL YEARS 1881 AND 1882.

DENVER TRIBUNE PUBLISHING COMPANY, STATE PRINTERS,



BIENNIAL REPORT

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STATE ENGINEER

FISCAL YEARS 1881 AND 1882,

DENVER: TRIBUNE PUBLISHING COMPANY, STATE PRINTERS, 1882.

Office of State Engineer, DENVER, December 15th, 1882.

To His Excellency, FREDERICK W. PITKIN,

Governor of Colorado:

SIR:—In accordance with the provisions of Section 10 of "An act to provide for the appointment of a State Engineer," etc., session laws 1881, I have the honor to present the following as my biennial report, containing history of operations in my department and suggestions on matters pertaining to irrigation in Colorado.

Very respectfully,

Eugene K. Stimson, State Engineer.

NECESSITY FOR IRRIGATION.

It is a well known fact that the rain-fall in Colorado during the season when it is most needed for the promotion * of agriculture has not (except in isolated instances) been sufficient for the necessities of growing crops. There is a theory advanced by teachers of natural science that the practice of irrigation increases the humidity of the atmosphere so as to increase rainfall in localities irrigated. An eminent writer on this subject says: "Irrigation affects the *humidity* of the atmosphere by increased evaporation from the surface and its temperature by the refrigeration which accompanies evaporation. Scientific observation has been very little directed to this subject, and the measure of the former effect (humidity) is embarrassed by the constant mobility of the air, which not only may remove from a given locality but may bring to it a supply of atmospheric moisture so rapidly as to render the determination of the local effect in this respect very difficult, if not impossible. But the atmospheric temperature of artificially watered districts is at certain times sensibly lower than that in unwatered regions, while at other times vapor thrown off from an irrigated surface may check radiation from the soil and thus prevent or compensate the lowering of the temperature by evaporation."

In Egypt a system of irrigation has been carried on from an early period in the history of the world to the present; in Italy, Spain and India irrigation has been practiced for very many years, yet the records of these countries do not show any material increase in rainfall in their irrigation districts. We cannot, of course, compare the limited expe-

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rience of our new country with these older ones. However, twenty-three years of irrigation in Colorado have made no noticeable changes in regard to rainfall, so it may with safety be assumed that for all time agricultural operations in our State must be maintained by an artificial system of irrigation.

The policy of the State in regard to the water supply furnished by her natural water courses is set forth in Art. XVI, Secs. 5 and 6, Constitution of the State of Colorado:

"ARTICLE XVI.

"SEC. 5. The water of every natural stream, not heretofore appropriated, within the State of Colorado, is hereby declared to be the property of the public, and the same is dedicated to the use of the people of the State, subject to appropriation as hereinafter provided.

"SEC. 6. The right to divert the unappropriated waters of any natural stream to beneficial uses shall never be denied. Priority of appropriation shall give the better right as between those using water for the same purpose; but when the waters of any natural stream are not sufficient for the service of all those desiring the use of the same, those using the water for domestic purposes shall have preference over those claiming for any other purpose, and those using the water for agricultural purposes shall have preference over those using the same for manufacturing purposes."

From proofs furnished the courts it appears that the construction of irrigating works in Colorado was commenced as far back as 1859. Agriculture as an industry has increased each successive year, most extensively, however, in the regions watered by the Cache La Poudre, Big Thompson, St. Vrain, Boulder Creek, Clear Creek and South Platte.

In Southern Colorado the Arkansas river and its tributaries comprise the largest portion of the agricultural operations in that section.

The waters of the State having been turned over to the public with very few restrictions, and no power having been heretofore exercised on the part of the State to compel an economical use, priority of right being the basis of settlement of controversies between claimants, a tendency to set up extravagant claims has become prevalent in some localities, serious conflicts have arisen between rival appropriators causing expensive litigation, and at last, legislation has been sought to adjust present complications, and to avoid more serious difficulties which might sooner or later lead to bloodshed and loss of life.

In California, where the conditions under which agricultural operations are carried on are similar to those in Colorado, a department of engineering was established in 1878, to which (among other questions which do not arise in our State) was submitted the problem of irrigation. The conflicts of interest occurring in that State are set forth in the following extract from the report of Hon. Wm. Ham Hall, State Engineer a

"THE CONFLICTING INTERESTS.

"As it is, conflicts of interest, for whose adjustment the present laws afford no adequate method, without inflicting grave injury upon one or the other, keep matters connected with water rights for irrigation in such an unsettled condition that there is no basis of credit upon which to raise money for the construction of irrigation works, and no certainty in farming with irrigation, except in cases where practically all rights can be monopolized or brought under one control, and these instances are few."

"Two general classes of conflicts have made themselves known throughout the counties where irrigation is practiced, namely:

"(1.) Conflicts between rival appropriators of water or claimants by prescription; and,

"(2.) Conflicts between appropriators or claimants by prescription and riparian owners.

"In the San Joaquin Valley not only are these conflicting interests present, but another element will soon make

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its appearance, (indeed it has already,) and we will have, inevitably, unless the State controls and directs the diversion of waters from the San Joaquin River and its tributaries.

"(3.) The worst conflict of all, namely: that between the appropriators of water for irrigation and the navigation interests on the main river.

"Conflicts of the first class are the most common of occurrence, and were the first to attract attention. There are sometimes from twenty to thirty claimants of water for purposes of diversion from the same stream. The claims have grown up from a variety of sources, and by steps quite gradual and indistinct in their character. In many instances there is no record whatever of the origin of the claim, very few have any record of their progress, except what may be embodied in testimony in the archives of some court."

In Colorado the chief controversy is between parties who appropriate water for the irrigation of crops. The conflict between claimants of water for irrigating purposes and claimants for domestic and manufacturing use exists, but not in such great proportions.

The office of State Hydraulic Engineer was created by the Legislature of 1881. Its scope was intended to assist in carrying out the provisions of certain portions of the irrigation laws passed at the same session, and to obtain important information by means of surveys and observations.

(1.) As to the capabilities of natural water courses drawn on for irrigation.

(2.) Concerning a system of storage reservoirs, their location and cost.

(3.) As to the actual capacities of irrigating works now in existence.

The following is the draft of the original bill introduced by Mr. Freeman:

SENATE BILL NO. 24.

A BILL FOR AN ACT TO PROVIDE FOR THE APPOINTMENT OF A STATE ENGINEER, AND TO DEFINE HIS DUTIES AND REGU-LATE HIS PAY, AND FOR THE APPOINTMENT OF HIS ASSIST-ANTS, AND THE ESTABLISHMENT OF WATER DIVISIONS.

" Be it enacted by the General Assembly of the State of Colorado:

"SECTION I. That for the better regulation of the distribution of water for irrigation, among the several ditches, canals, and reservoirs, into which such water may be lawfully taken, in time of scarcity thereof, the water districts now, or to be hereafter established by law, shall be constituted into water divisions, as follows:

"SEC. 2. All water districts now, or hereafter to be formed, consisting of lands watered from the South Platte river and its tributaries, shall constitute water division No. I, and named the South Platte division.

"SEC. 3. All water districts now, or hereafter to be formed, consisting of lands watered from the Arkansas river and its tributaries, shall constitute water division No. 2, and named the Arkansas division.

"SEC. 4. All water districts now, or hereafter to be formed, consisting of lands watered from the Rio Grande river and its tributaries, shall constitute water division No. 3, and named the Rio Grande division.

"SEC. 5. Other water divisions may be constituted, from time to time, of water districts, consisting of lands watered from other principal rivers and their tributaries, by act of the governor, when it shall appear to him expedient so to do upon petition of citizens interested.

"SEC. 6. The governor shall appoint a State hydraulic engineer, who shall have general supervision of the distribution of water for irrigation throughout the State. He shall have his office at the State capital, and shall be furnished with a suitable office, furniture, stationery, instruments and postage by the secretary of State. He shall be

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paid a salary of —— thousand dollars per annum, payable by the State treasurer out of officers' salary fund, on warrants drawn by the State auditor. No person shall be appointed as such hydraulic engineer, who is not known to have such theoretical knowledge, and practical skill and experience, as shall fit him for the position.

"SEC. 7. The State engineer shall appoint a water commissioner, to act in each water district; said water commissioner to be selected from persons recommended to him by the board or boards of county commissioners of the county or counties in which such water district may lie, which board or boards of county commissioners may severally recommend one or more persons.

"SEC. 8. Said water commissioners shall be paid at the rate, and in the manner now provided by law, and may be employed in the duties of his office not to exceed seventy-five days in any one year.

"SEC. 9. Said State engineer shall have general supervision over the work of the water commissioners, and shall have power to interfere, to prevent or redress any act of non-feasance, misfeasance, or malfeasance, on the part of any such water commissioner, and on good cause to him appearing, shall remove him from office, and appoint another person in his stead. He shall also have power to direct the mode of making division of water between any two or more water districts, lying on and watered from the main stream of any river.

"SEC. 10. Said State engineer shall make, or cause to be made, so far as the money appropriated for such purposes will admit, careful measurements and calculations of the maximum and minimum flow of water in cubic feet per second in each stream from which water shall be drawn for irrigation, also the average flow thereof during such irrigating season, at such points on the course thereof as may be best for affording information for making such stream most available for irrigating purposes; commencing with those streams most used for irrigation, and extending the work as rapidly as practicable, and he shall keep proper and full records of his work, observations and calculations.

"SEC. 11. Said State engineer shall also, as far as practicable, adopt measures to ascertain, as near as may be, during the season of snow falling in the mountains, the quantity and extent thereof over the water shed drained by each stream used for irrigation, and on the several localities of the tributaries thereof; and from the facts which can be ascertained with reasonable certainty, he shall, from and after the first day of February in each year, from time to time, until snow falls cease, make public the condition of snow, and probable amount of water to be expected in each considerable irrigating streams, compared with former years.

"SEC. 12. Said State engineer shall, before entering on the discharge of his duties, take and subscribe an oath before some officer authorized by law to administer oaths, to faithfully perform the duties of his office, and file with the secretary of State said oath and his official bond, in the penal sum of two thousand dollars, with sureties, to be approved by the secretary of State, and conditioned for the faithful discharge of the duties of his office, and for delivering to his successor, or other officer authorized to receive the same, at the expiration of his term of office, all moneys, implements, books, and other property belonging to the State then in his hands, or under his control, or with which he may be legally chargeable as such officer.

"SEC. 13. Said State engineer shall have power to appoint assistants, at an expense not to exceed — in any one year, at times when their services may be required, and administer to them severally an oath for the faithful discharge of their duties, which oath shall be taken by every such asststant before entering on his duties.

"SEC. 14. Said State engineer shall prepare and render to the Governor, biennially, and oftener, if required, full and true reports of his work, touching all the matters and duties devolving upon him, by virtue of his office, which report shall be delivered at the time the reports of other State

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officers are required by law to be made, in order that they may be laid before the General Assembly at each regular session thereof.

"SEC. 15. Said State engineer shall, in case of any proceeding in any water district, before any court, or referee, under any law providing for the adjudicating of priorities of right to use of water for irrigation, be notified by the clerk of the court, or referee, as the case may be, of the pendency of such proceedings; and thereupon said State engineer shall proceed without delay to measure and determine the carrying capacity of every canal or ditch in such water district, and shall procure such measurements and data as may be necessary for the purpose, and appear before such court or referee at a proper time for giving evidence, and testify to the same, and said court or referee shall take his testimony in every such matter, and may compel his appearance for that purpose on request of the party interested.

"SEC. 18. Section number twenty-nine of an act entitled an act to regulate the use of water for irrigation, and providing for settling the priority of right thereto, and prepayment of the expenses thereof, and for payment of all costs and expenses incident to said regulation of use, approved February 19, 1879, as is inconsistent with the provisions of this act, be and the same are hereby repealed."

This bill, if it had passed without mutilation and a proper appropriation had been made for assistance, its provisions would have been very useful in securing the intentions of the irrigation laws passed at the same session.

The first section of these laws requires every person, association or corporation owning or claiming any interest in any ditch, canal or reservoir, within any water district, to file, on or before June, A. D. 1881, a statement of capacity and amount claimed for such ditch or reservoir, and on proofs or evidence furnished by claimants decrees are to be made. Section 15 of the original Engineer Bill refers directly to the first section of irrigation law, and provides for the competent testimony of a party not interested.

The following is the shape in which the bill passed, after being altered and amended :

BILL AS PASSED.

"AN ACT TO PROVIDE FOR THE APPOINTMENT OF A STATE ENGI-NEER AND TO DEFINE HIS DUTIES AND REGULATE HIS PAY, AND FOR THE APPOINTMENT OF HIS ASSISTANTS, AND THE ESTABLISHMENT OF WATER DIVISIONS.

"Be it enacted by the General Assembly of the State of Colorado:

"SECTION I. That for the better regulation of the distribution of water for irrigation, among the several ditches, canals, and reservoirs, into which such water may be lawfully taken, in times of scarcity thereof, the water districts now, or to be hereafter established by law, shall be constituted into water divisions, as follows:

"SEC. 2. All water districts now, or hereafter to be formed, consisting of lands watered from the South Platte river and its tributaries, shall constitute water division No. I, and be named the South Platte division.

"SEC. 3. All water districts now, or hereafter to be formed, consisting of lands watered from the Arkansas river and its tributaries, shall constitute water division No. 2, and be named the Arkansas division.

"SEC. 4. All water districts now, or hereafter to be formed, consisting of lands watered from the Rio Grande river and its tributaries, shall constitute water division No. 3, and be named the Rio Grande division.

"SEC. 5. Other water divisions may be constituted from time to time, of water districts, consisting of lands watered from other principal rivers and their tributaries, by act of the Governor, when it shall appear to him expedient so to do, upon petition of citizens interested.

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"SEC. 6. The Governor shall appoint a State Hydraulic Engineer, who shall hold his office for the term of two years or until his successor may be appointed and qualified.

"The Governor may at any time, upon good cause shown, remove said State Engineer. Said State Engineer shall have general supervision over the water companies of the different water districts in the State; he shall have his office at the State capitol, in an office to be provided for him by the Secretary of State, and be subject to his direction and control; who shall also furnish him with suitable furniture, postage, and such proper and necessary books and instruments as will best enable him to discharge the duties of his office. He shall be paid a salary of two thousand dollars per annum, payable quarterly by the State Treasurer, on warrants drawn by the State Auditor. No person shall be appointed as such Hydraulic Engineer, who is not known to have such theoretical knowledge and practical skill and experience as shall fit him for the position.

"SEC. 7. Said State Engineer shall make, or cause to be made, careful measurements and calculations of the maximum and minimum flow in cubic feet per second, of water in each stream from which water shall be drawn for irrigation, as may be best for affording information for irrigating purposes; commencing with those streams most used for irrigation; also to collect facts and make report as to a system of reservoirs for the storage of water, their location, capacity and cost; and he shall keep proper and full records of his work, observations and calculations.

"SEC. 8. Said State Engineer shall, before entering on the discharge of his duties, take and subscribe an oath before some officer authorized by law to administer oaths, to faithfully perform the duties of his office, and file with the Secretary of State said oath and his official bond, in the penal sum of two thousand dollars, with sureties, to be approved by the Secretary of State, and conditioned for the faithful discharge of the duties of his office, and for delivering to his successor, or other officer authorized to receive the same, all moneys, implements, books, and other property belonging to the State then in his hands, or under his control, or with which he may be legally chargeable as such officer.

"SEC. 9. Said State Engineer shall have power to employ assistants at an expense not to exceed one thousand dollars in any one year, who shall be paid out of any moneys appropriated for that purpose, on certificate of said State Engineer, showing the services rendered and the amount due therefor, and on presentation of such certificate to the State Auditor by the person entitled thereto, he shall issue his warrant on the State Treasurer for the amount thereof, to be paid out of any appropriation as aforesaid, and not otherwise.

"SEC. 10. Said State Engineer shall prepare and render to the Government [Governor], yearly, and oftener if required, full and true reports of his work, touching all the matters and duties devolving upon him, by virtue of his office, which report shall be delivered at the time when the reports of other State officers are required by law to be made, in order that they may be laid before the General Assembly at each regular session thereof.

"SEC. 11. Said State Engineer shall, on request of any party interested, on payment of his per diem, charges, and reasonable expenses, measure and ascertain the carrying capacity of any ditch, canal or feeder, or any reservoir, hereafter constructed or enlarged, and give to the party or parties requiring his services an official certificate of the size and carrying capacity of such ditch, canal, or feeder, in cubic feet per second, as he shall find it to be at the time of measuring the same.

"SEC. 12. For the more accurate and convenient measurement of any water appropriated pursuant to any judgment or decree rendered by any court establishing the claims of priority of any ditch, canal, or reservoir, the owners thereof shall construct and maintain, under the

supervision of the State Engineer, a measuring wier or other device for measuring the flow, in cubic feet per second, the water at the head of such ditch, canal or reservoir, or as near thereto as practicable. The State Engineer shall compute and arrange in tabular form the amount of water that will pass such wier or measuring device, in cubic feet per second, at the different stages thereof, and he shall furnish a copy of a statement thereof to any water commissioners having control of such ditch, canal or reservoir.

"Approved March 5, 1881."

This bill, while being defective, still contains important provisions in regard to the gauging of the natural water courses, and if this work could have been promoted properly, the results would have been more valuable than I have been able to obtain.

There was no emergency clause attached to the bill, so that it did not become law until ninety days after its final passage, which made it operative June 3d, 1881. The accumulation of proper instruments and establishment of stations, delayed the work of gauging until June 20th, 1881.

Acting under the provisions of Sec. 9 of the Act, I secured the services of Mr. J. S. Greene, a competent engineer, as assistant. A gauging station was established on the Cache La Poudre, in Marsh Canon, and Mr. Greene was placed in charge of measurements and observations at this point. I also established a station on the Big Thompson, at Smith's mill, making measurements in person.

The results of these observations in 1881 are as follows:

TABLE OF DAILY AVERAGE DISCHARGES OF CACHE LA POUDRE, 1881.

Date.	Average discharge in cubic feet per second.	Total discharge in cubic feet for 24 hours.	Date.	Average discharge in cubic feet per second.	Total discharge in cubic feet for 24 hours.
June.			July.		•
20	1104	95,385,600	21	714.8	61,758,720
21	1053	90,797,200	22	585.3	50,569,920
22	1053	90,797,200	23	522	45,100,800
23	1037	89,596,800	24	546.5	47,217,600
24	1077.5	. 93,096,000	25	480.5	41,515,200
25	1095	94,641,200	26	564.25	48,752,800
26	1092	94,348,800	27	528.4	45,653,760
27	1074	92,793,600	28	483.7	41,791,640
28	1727.3	149,240,800	29	396.0	34,214,400
29	1681	145,240,000	30	376.4	32,520,960
30	1640	142,300,000	31	361.4	31,224,960
July.			August.		
I	1622	140,140,800	I- 1	343.2	29,652,480
2	1600	138,240,000	2	350.I	29,773,440
3	1600	138,240,000	3	336.8	29,099,520
4	1582	136,684,800	4	319.2	27,604,800
5	1510	132,606,720	5	301.5	26,049,600
6	1507	130,239,360			
7	1393	120,355,200			
8	1203	101,468,160			
9	1084	93,657,600			
. 10	963	83,142,720			
11	853	73,664,640			
12	785.7	67,884,480			
13	739.6	63,905,120			
14	680.3	58,777,920			
1.5	635	54,864,000			
16	673.2	58,164,480	1		
17	845.2	62,153,360			
18	823	71,107,200			
19	813.6	70,297,040			
20	713	61,603,200			

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TABLE OF DAILY AVERAGE DISCHARGES OF BIG THOMPson, 1881.

Date.	Discharge in cubic feet per second.	REMARKS. Average of all measurements in August, water not being at highest stage.		
August.	840			
Sept. 1	220			
2	220			
3	218	*		
4	214			
5	215			
6	213	· · · · · · · · · · · · · · · · · · ·		
7	208			
8	210			
9	211	4		
10	211	· · · · · · · · · · · · · · · · · · ·		
11	201			
12	200			
13	185			
14	176			
15	173			
16	166			
17	152			
18	148			
19.	148			
20	143			

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In July, 1881, a voucher was made out for salary of Mr. Greene, as assistant engineer; it was by him presented to the Auditor of State, and by him referred to the Attorney General for his opinion as to what fund warrant should be drawn on for its payment. His opinion was in effect that there was no authority in the act creating the office of State Engineer for the employment of an assistant engineer, and that no appropriation had been made by the Legislature for the payment for services of such officer. This opinion barred the employment of assistants competent to measure water as it flows, as none could be found who were willing to wait until the Legislature should convene and make appropriation for their compensation. Mr. Greene retired, and I was therefore occupying the position of State Engineer, charged with duty of gauging the water courses of the State, making surveys for a system of storage reservoirs, and while required by the provisions of the Act to perform only certain duties, yet it might be expected (the conditions being favorable) that the bienial report should be not only full and complete on the subjects mentioned, but that it should also be exhaustive on the agricultural capabilities of the State, the duty of water in irrigating agricultural lands and on the problem of irrigation generally. Other governments appropriate large sums of money and furnish their engineering departments every facility for making kindred examinations for accumulation of material for such a report. Owing to the crippled condition of my office I am unable to supply all the information desirable.

During the summer of 1882 my time has been occupied on the Cache La Poudre and St. Vrain. In that portion of water district No. 1 watered by Cache La Poudre decrees were rendered by the court on evidence taken by referee. Acting under provisions of Section 12 of Act creating office of State Engineer, I caused flumes twenty-five feet in length and occupying full width of water way to be placed in each ditch receiving decrees. Measurements were then made

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of the full capacity of each ditch with the water flowing in it, then each separate appropriation claimed by reason of enlargements was measured as decreed, and for the convenience of water commissioner, marks were placed in each flume. This district is now in shape so that a division of water can be made in seasons when river is low, and the conflicts between claimants adjusted.

The irrigating season for cereals extends from May 10th to July 20th. When the supply is sufficient of course there is no difficulty, but when this supply begins to fall off, as it generally does in June and July, it must be portioned out among the different claimants. With a permanent gauging station in the cañon where the stage of water is observed every hour in the day, and a telephone line extending the entire length of stream, the water commissioner may direct the regulation of head-gates at any time. This district is now further advanced than any other in the State toward a settlement of difficulties.

The decrees in this district are based on evidence taken by a referee appointed by the judge of district court.

The area of cross sections of water way in square feet multiplied by mean velocity of current in feet per second gives the mean discharge in cubic feet per second.

This mean velocity of current has been given in evidence in this district as being calculated from formulæ whose known factors are the grade of ditch in lineal feet per mile and the hydraulic radius or the quotient arising from dividing the area of cross section of water way in square feet by the wet perimeter in lineal feet. The result thus obtained differs from the actual velocity of current measured as it flows. In most instances that have come under my observation, the calculated velocity by formula is in excess, and in some cases as much as one half.

There has not been any standard of measurement heretofore adopted and used by the entire farming community. In different localities different methods have been employed to indicate capacities of ditches and for division of water isold from irrigating canals. Some companies deliver water to lands along the line of their ditches under pressure; others by the reliable method of passing it naturally over weirs.

In that portion of District No. I supplied from the St-Vrain, decrees have also been rendered by the Court, but differing entirely from those in the Poudre district. Here the capacity of a ditch is represented in what is termed "customary inches." Thus, when a canal or natural watercourse is said to carry 3,000 inches, these figures do not indicate cubic inches per second, but simply the superficial area of the water way in square inches, the velocity of current not being considered. It has been estimated that one "customary inch" per acre is sufficient as a water right, so that a ditch having a capacity of 3,000 inches is considered capable of supplying 3,000 acres of land. The utter unreliability of this method is apparent when we consider the fact that in the case of two ditches showing the same crosssectional area, or "customary inches," one could be capable of discharging twice as much water as the other on account of having a greater slope or grade per mile. Here is a case in hand: In June, 1882, at a time when the St. Vrain was at its highest without being in extraordinary flood, the cross-sectional area of its volume was 21,715 square inches. At this time all ditches diverting water from the stream were running full, and their combined cross-sectional area, as footed up^s from the decrees, is 38,023 square inches. Yet the St. Vrain, showing an area of 16,308 square inches less than the combined area of all these ditches, was supplying them to their full capability, and at the same time a large volume of water was passing the town of Longmont, eight miles below the head-gates of a majority of these ditches.

A study of the situation during the last two years leads me to the opinion that the most important work for the present is the settlement of existing conflicts between claimants. To accomplish this the State will be compelled

to exercise its authority. The State Constitution provides that: "The right to divert the unappropriated waters of any natural stream to beneficial uses shall never be denied." The question then arises what are the unappropriated waters of a natural stream? When the State causes measurements to be made of any natural water course, and determine its powers of supplying, and having also found that the irrigation works already constructed are sufficient to exhaust this supply, it occurs to me that the waters of this natural stream are fully appropriated, and the construction of other works should be prohibited. In all other countries the water courses are under Government control, and the diversion of water therefrom is supervised and regulated by Government officials. There should be established here a State Board of Water Commissioners, to which the State Engineer should report all the information he collects by means of measurement of natural streams and irrigation works. This Board should decide when the waters of a stream are appropriated fully, and no diversion of water should be allowed without its permission. If this be done, the great region of agricultural country now available by reason of the late Ute Reservation being thrown open to entry and settlement will never be disturbed by conflicts over water rights which appear in the older portions of the State, and many of the issues now in existence will be simplified. A State Constitution having been adopted which declares the right of the people to divert the unappropriated waters of any natural stream, it seems to me" that the State has the right and ought fo decide what waters are appropriated and what are not. There can be no injustice done by the establishment of such a tribunal. The agricultural resources of our State are measured by the water supply afforded by her streams, and since priority of appropriation is to indicate the better right, those who establish the earliest claims should be secured and protected. This Board should appoint Water Commissioners in the different districts, and be clothed with powers to

compel an economical use of water in irrigating, and to make an equitable division between appropriators in times of scarcity.

No permanent settlement of any existing controversies can be made without first ascertaining the average discharge in cubic feet per second of the streams on which these conflicts occur. Knowing the supply that is available and the quantity appropriated, the waters of the State may be apportioned. When this is done and the decrees enforced litigation will cease.

If the State desires to maintain the office of State Engineer for the purpose of making examinations on the flow of water and for obtaining other useful data relating to irrigation, the law now in force creating the office should be amended so that this officer may be able to attain valuable results. In the present condition of the law not enough can be accomplished during the proper season to warrant a continuance of the office. With proper provisions for prosecuting inquiry in this field information may be collected that will be of incalculable value to an industry of our State which it is important to encourage. Statistics collected from the transportation records of the different railway lines entering Colorado show that an enormous sum of money goes out of the State every year for the purchase of agricultural products.

TABLE OF SHIPMENTS INTO COLORADO FOR 1881.

Wheat (bushels),	1,917,823 @	\$1.20 . ;	\$2,301,387 60
Oats "	1,464,650 @	.70 .	1,025,255 00
Barley "	163,186 @	1.50 .	244,779 00
Hay (tons),	20,980 @	15.00.	329,400 00
Corn (bushels),	602,880 @	1.20.	723,456 00
Potatoes "	730,411 @	1.00.	730,411 00
Vegetables (car le	oads), 445 @	800.00 .	366,000 00

Total \$5,720,688 60

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Nearly six millions of dollars sent out of the State yearly to purchase commodities which our soil is peculiarly adapted to raise. A large portion of this vast expenditure could be retained in circulation in our State by encouraging agricultural enterprises and protecting the rights of those engaging in these pursuits. While in the northern portion of Colorado the waters of natural streams, in localities where farming is carried on extensively, is about all appropriated, in the southern portion there are vast regions of fertile land as yet unimproved, and the natural water supply is probably greater than in Northern Colorado.

In California, \$25,000 was appropriated by the Legislature for 1880 to enable State engineer to collect data relating to the irrigation question, and for the settlement of conflicts between rival appropriators. In the countries of the Old World, governmental appropriations for this purpose are much greater every year.

I have not been able, on account of no appropriation being made for assistance, to make examinations and surveys for location of storage reservoirs. Their proper location will be in the mountains, as near the head waters of streams as possible, and to ascertain the practicability of their construction and a comparison of their cost with their usefulness, will occupy considerable time and involve a thorough examination of different mountain regions.

RECAPITULATION.

For the settlement of existing conflicts between appropriators of water for beneficial uses from the public streams, it must be ascertained what average quantity of water in cubic feet, per second, these streams can be relied on to supply.

This information must be obtained by a system of daily gauging.

The actual capacity of each irrigating ditch diverting water from these public streams must be found by measuring the velocity of current as it flows in each ditch when filled.

If the State desires to maintain the office of State Engineer, the Act creating the office should be amended so that it shall be the duty of State Engineer to ascertain the carrying capacity of all irrigating works in every water district, without waiting to be called in to do this by the owners thereof; and he should also be required to furnish all this information to the Judge of any district in which decrees are to be issued.

Appropriations should be made for the maintenance of gauging stations and for the employment of necessary assistance.

The State should control the further diversion of waters from public streams, and decide when the waters thereof are fully appropriated, through the establishment of a State board of water commissioners, to whom the State Engineer shall report the results of his investigations.

When all this is done, we may compare the power of the natural water courses of the State to meet the demands made on them by appropriations. Decrees may be rendered, based on actual measurements, present conflicts adjusted, and complications avoided in the future.

PROPERTY ON HAND.

I have in my possession the following property of the State pertaining to this office :

One engineer's transit. Heller & Brightley, manufac-One level. turers. Two leveling rods. One 100-ft. steel chain. One 100-ft. Chesterman steel tape. One draughting table. Set of draughting instruments. Two tents, with three extra flys. Six circular tin floats, with screw joints.

One Eagle ¼-second timer. Stationery, office furniture, etc. One map of Colorado.

Respectfully submitted,

EUGENE K. STIMSON,

State Engineer.

To His Excellency

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FREDERICK W. PITKIN, Governor of Colorado.

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