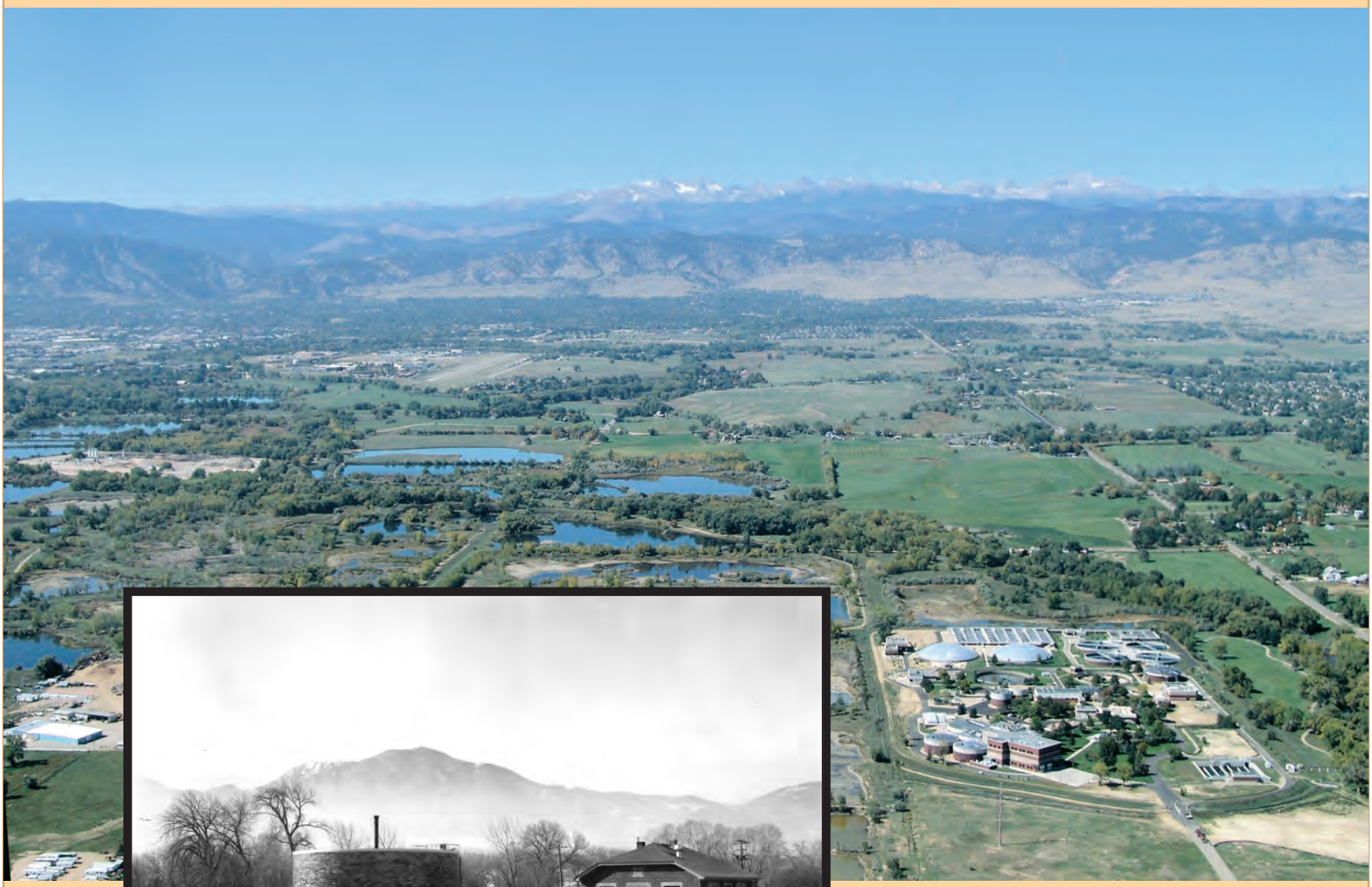
Boulder's Wastewater Past & Present



Silvia Pettem

Many people contributed to the research and writing of *Boulder's Wastewater Past & Present.* At the top of the list is Bob Harberg (Principal Engineer—Utilities, City of Boulder), who initiated the effort and coordinated the input on the recent history.

When I started this project, I found that the early history only took a little digging. As the chronology approached modern times, however, I drew on the technical knowledge of individuals who made, and continue to make, wastewater management their life work. Bob's contributions were invaluable, as were those of Chris Douville (Wastewater Treatment Manager, City of Boulder). Chris gave me a personal tour of Boulder's Wastewater Treatment Facility, then graciously answered my many questions and, like Bob, continued to correspond with me on this project through to completion.

I also wish to acknowledge and thank several other individuals who gave generously of their time and expertise to read various drafts, offer helpful comments and suggestions, and supply photographs. These include:

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Silvia Pettem
2015

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The color cover photo shows the 75th Street Wastewater Treatment Facility from the air, in 2008. The black and white inset is a photo of Boulder's first sewage disposal facility (on the site of Scott Carpenter Park) in 1936.

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Introduction

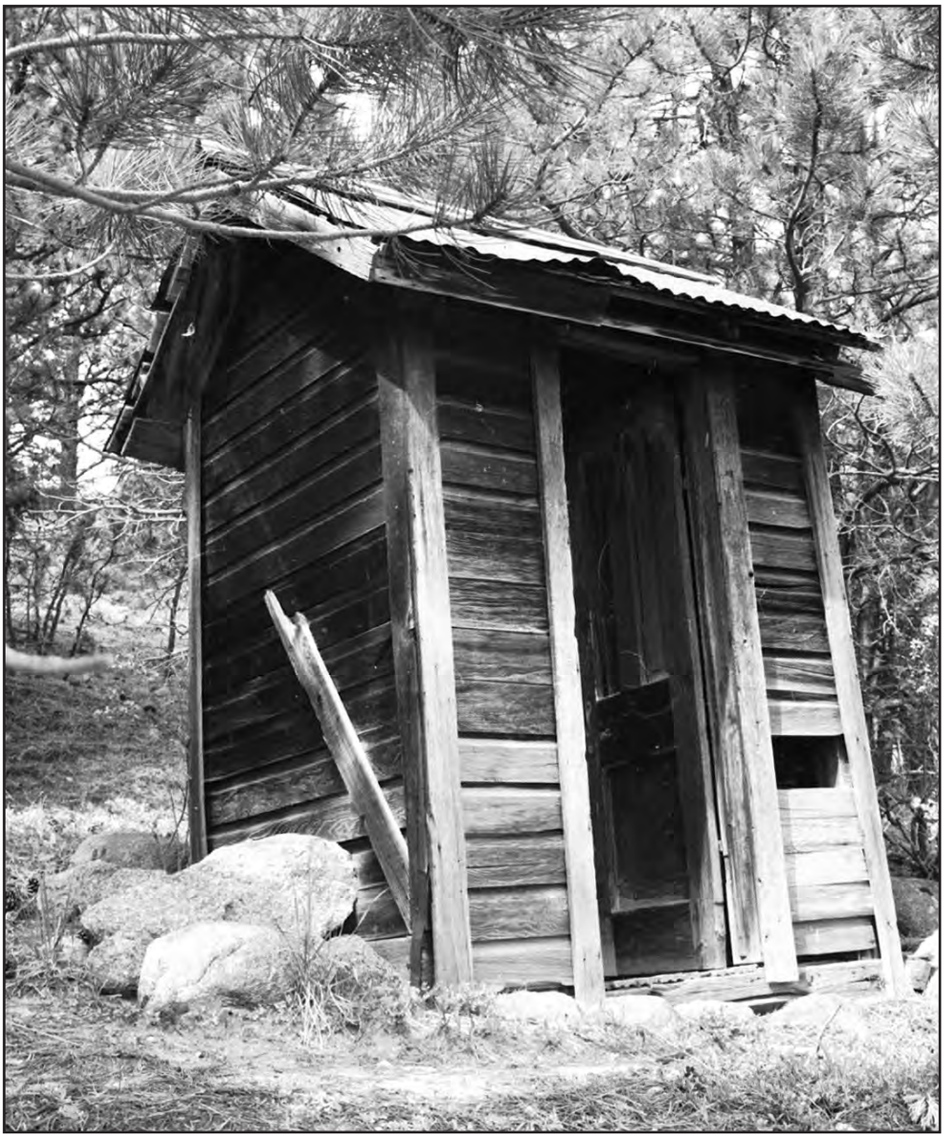
One hot summer day, in June 1893, *Daily Camera* Editor L.C. Paddock sat at his desk in the Camera building at 11th and Pearl streets and wrote a scathing article titled, "A Rotten Death Hole." The subject of his indignation was the foul odor coming from the cesspool under the three-hole-outhouse of the Brainard Hotel, across the street.

"The rear of the Brainard Hotel is a stench that cries to Heaven," Paddock wrote, "and it must be converted from its death-dealing nastiness into some sort of sanitary decency." According to the editor's story, hotel owner Anthony Arnett had recently installed a water closet (toilet) inside the building. But, after years of refusing to clean out the hotel's outhouse waste, he merely filled in his cesspool with dirt. Paddock claimed that a "wealth of odors" continued to escape "through seams in the ground."[1]

Lack of sanitation in the Brainard Hotel, on Pearl Street, stimulated a discussion on the need for sewers in Boulder. The hotel's outhouse was in back of the building.
Carnegie Branch Library for Local History, Boulder Historical Society collection, 207-9-12

The waste from the water closet would have flowed into the same, or another, cesspool, as there was no other place for it to go. Cesspools (forerunners of septic tanks) were only one step above open sewers, and grey water often was poured directly into ditches. In 1895, the City's lack of sanitation was summarized by Dr. Dean W. King[2] — a physician, Civil War veteran, and, at the time, Boulder's "health officer."[3]

> I see no relief from the present condition until we can have sewers. Mass meetings should be held, and the whole matter fully explained, and when the voters understand it, I believe they will vote for sewers. Ditches in many streets become a nuisance by slops running in them, and where there are no cesspools, what are people to do with slops, wash water, etc.? Sewerage is the only remedy in sight for the future.[4]



This outhouse is typical of those built in the late 19th-century. It's still standing behind the stone Sunshine Schoolhouse, in western Boulder County.
Pettem photo, 1994

Boulder's pre-sewer years

When Boulder City was founded in 1859, residents built privies, or outhouses, positioned over open pits or even along Boulder Creek. They also kept chamber pots under their beds or in their nightstands for use at night or in stormy weather. The contents of the chamber pots then were emptied into the outhouses.

A few rudimentary "wash-down closets," also called water closets (toilets), were patented around this same time, but Boulder residents would have kept their outhouses at least into the mid-1870s, as that's when the first pipes connected some of the City's residences and downtown businesses with its municipal water supply.

Homes and businesses continued to rely on individual cesspools for their wastewater disposal. Specific directions were written in books for homemakers, such as a popular one titled *Household Discoveries*. After a discussion on the disposal of wastewater by piping it "to any running stream where the water is not used afterwards," the next best solution (stated the author) was a cesspool or pit latrine. Its recommended size was "6 feet across and 8 or 10 feet deep, and at least 100 feet from any buildings."

The author continued:

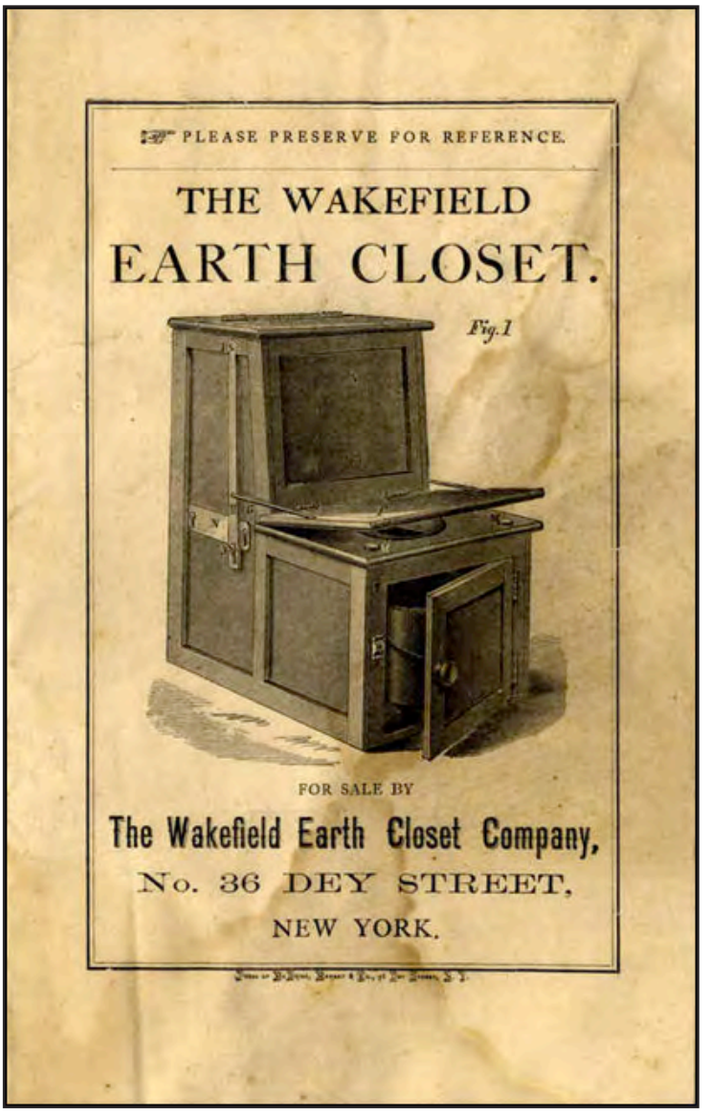
> Wall this up with stones, but do not cement it. The liquids will leach away into the soil, and the solids can be cleaned out two or three times a year. Care must be taken to locate the cesspool far enough from the well, so that drainage from it will not contaminate drinking water.[5]

Meanwhile, ditches filled up with everything from garbage and debris to dead animals. Municipal water, however, did allow the installation of fire hydrants. A Boulder newspaper item from 1879 noted that every Friday afternoon from 2:00 to 3:30 p.m.—for several months—the hydrants would be turned on for the purpose of "cleaning out the ditches."[6]

Boulder's use of the newly invented water closets was criticized, in 1875, by physician Dr. Charles Ambrook, who called them "the greatest evil of civilized life."

The Boulder doctor had recently read the "U.S. Surgeon General's Report on Sanitary Reform" and was inspired to discuss the water-closet topic in an article for the *Boulder County News*. Stated Ambrook, "Very many [are] full-to-overflowing, a festering mass of putrefactions, serving out death germs to all who inhale their filthy odors."[7] For those who chose to use them, Ambrook's remedy was to locate water closets next to ash pits (from stoves or fireplaces) and combine ashes with the human waste.

More reliable at the time was another alternative and new invention—the dry earth closet (toilet). This wooden box-like commode was comprised of a covered seat over a galvanized iron pail, along with a reservoir on the back that held dirt and/or coal ashes. After each use, the user pulled a lever on the side that controlled the amount of dirt or ashes to be dropped onto the excrement. As with water closets, the earth closets were used indoors. For the average home, the manufacturer recommended that the pail should be emptied once a week and the contents used as fertilizer.



Wakefield Earth Closets were sold and used in Boulder, beginning in the 1870s. This pamphlet dates from circa 1878. *www.southalabama.edu/mccallarchives/*

A Boulder agent for the New York-based Wakefield Earth Closet Company advertised in the B*oulder County News*, in 1876. The ad stated that earth closets were good for hotels and prisons and suggested that every family should have one or more as well. The earth closets were particularly recommended for the ill and infirm.[8]

Meanwhile, the company promoted its product with testimonials such as this one:

> I have used one of your best Wakefield Closets for three or four years at my residence and it is every way satisfactory. I consider your system equal to the Water Closet system, and in some respects superior. It saved me the expense of a water closet, with trouble of bursting and obstructed pipes, and my friends in the country were glad to keep me supplied with dry earth, on condition of receiving in exchange the product of the closet from time to time.[9]

Another happy customer stated, "It has been a great convenience to my children, day and night, during the severe winter especially. I keep it handy for use in one of the upper bed-chambers."[10]

PRELIMINARY PLANS FOR "SEWERAGE"

Two years before Editor Paddock specifically named the Brainard Hotel as the main culprit of downtown Boulder's cesspool smell, he wrote, "The time has come when a sewer on Pearl Street is a necessity. It is, perhaps, an expensive necessity, but one death from nauseous vapors is more expensive than ten sewers. A plan should be formulated at once."[11] Others in Boulder, however, didn't share Paddock's urgency.

A half a year later, in December 1892, the City Council members (then called aldermen) invited the City Engineer of Colorado Springs to address their meeting in Boulder. The Colorado Springs engineer explained that his city's sewage is not directed into a river or stream but, instead, is "used to irrigate a tract of land, where it seeps away and bothers no one."[12] He urged Boulder to do the same with its wastewater.

The topic was brought up for debate in January 1893, when the City Council added to its agenda, "Shall we have sewers?" Their answer was that "the matter deserves the most enlightened and frank consideration and discussion of our citizens."[13] Col. Ivers Phillips, one of Boulder's most prominent and wealthy residents (and, most likely, the owner of the then-socially acceptable water closet) told the *Daily Camera* that he was "strongly in favor of sewerage." Phillips explained that in other cities, sewer lines were constructed at public expense, and then the private property owners were compelled to connect their water closets at their own expense.[14]

A big announcement came in March 1893, after Mayor Isaac L. Bond and four aldermen formed the "Committee on Sewers" and visited Greeley, Fort Collins, and Colorado Springs to see how those cities handled their wastewater. When the men returned, they presented the council with a report, which follows, in part:

> If sewers are constructed in Boulder, we recommend that they be made for the use of the principal part of Pine, Spruce, Pearl, Walnut, Water,[15] and Arapahoe streets, and be so constructed as to permit their extension to other localities at a later date. Under this plan, Boulder would require, at present, about six miles of sewers. The material used is earthen sewer pipe, which is made in Colorado, as well as in other states.
>
> We will require a pipe varying in size from 8-to-12 inches in diameter. This pipe should be laid at a depth varying from 4-to-12 feet. The sewer should be constructed in the alleys, so far as practicable. A manhole should be made at the street corner of each block. Between the manholes, the pipe should be laid perfectly straight so that obstructions can be removed by means of a jointed rod made for the purpose.
>
> At each manhole, connection with the water system is necessary to permit flushing. In most localities, a connection with the ditch will afford water for this purpose during the summer season. The cost must vary with the size of the pipe and the depth to which it is placed. A competent engineer, after viewing the ground, estimated this cost from $5,000 to $6,000 per mile.
>
> The discharge may be made directly into the creek, as in Greeley and Fort Collins, or it may be made into settling reservoirs, and the water be permitted to reach the creek after filtering through sand and soil, as in Colorado Springs. In the latter place, the discharge is used for irrigating purposes during the summer season.[16]

In April 1893, a bond issue for up to $33,000 to build the sewers was voted down, 149 to 92.[17]

Three months later, and keeping in mind the comments of Col. Phillips, the City Council adopted an ordinance that required owners of water closets and earth closets to "connect with some system of sewage." Stated the Camera, "The time-honored system of easy-going and stinking receptacles is done away with, and the citizen will hereafter be required to build a place so constructed as to admit of the filth being carted away upon the filling of the receptacle provided."[18]

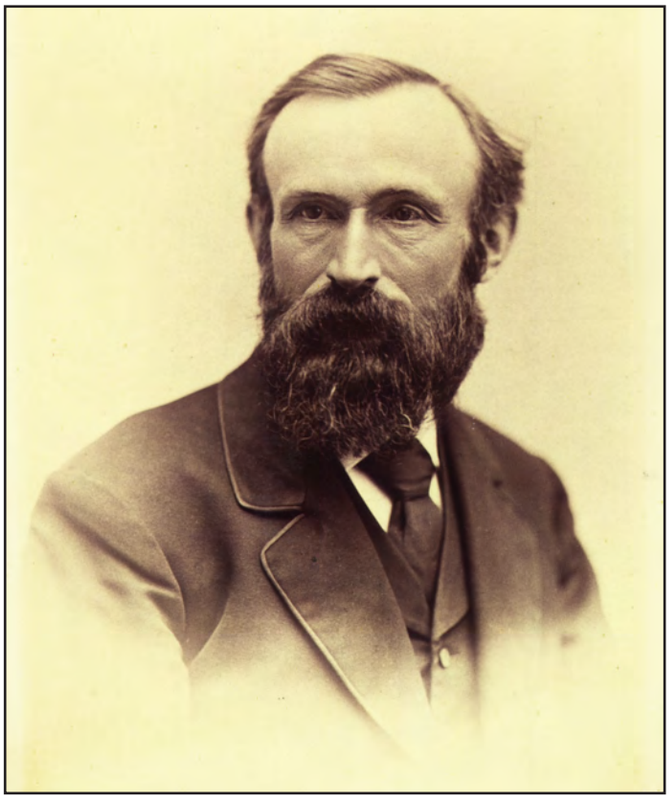
No doubt Editor Paddock (whose wife and son had recently contracted diphtheria[19]) remained fed up with the stench from the nearby Brainard Hotel, and he must have enjoyed writing that the removal of the contents of the hotel's cesspool would immediately be enforced.[20]

The writer failed to explain, however, where the carted-off contents would go. The earliest-known city dump was on the south side of Boulder Creek at 9th Street, near today's Boulder Public Library.[21] But, it's not likely that sewage would have been buried that close to downtown Boulder.

City Council minutes state that, beginning in 1892, sewage was taken to the Tyler estate, north of Boulder. Then, in 1895, the location was changed to the "dumping ground," south of Valley Road (Arapahoe Road) and north of Boulder Creek.[22] The title to the land was held by Hannah Corson,[23] wife of Boulder's first sheriff, William A. Corson. (Prior to this time, the Corsons had relocated to Colorado Springs, where the former sheriff worked as a carpenter and miner.)

At some point, the Arapahoe Road site was named Valverdan Park, possibly a combination of the words "valley" and "verdant" to give the illusion of a "green valley." Now, the former dump and sewage facility has been landscaped into a playground and popular sledding hill that covers Scott Carpenter Park.

Shortly after the sewer bond's first defeat, Mayor Bond was replaced by Mayor James Cowie who served his two-year term without any progress on sewer installation at all, other than being given a petition, submitted to the City Council, by Boulder's leading businessmen, citizens, and tax payers. Boulder Publishing (owner of the *Daily Camera*), Co. Ivers Phillips, and even Brainard Hotel owner Anthony Arnett all signed the document, but it, too, was voted down.[24] Another defeat at the polls came in April 1895.[25]



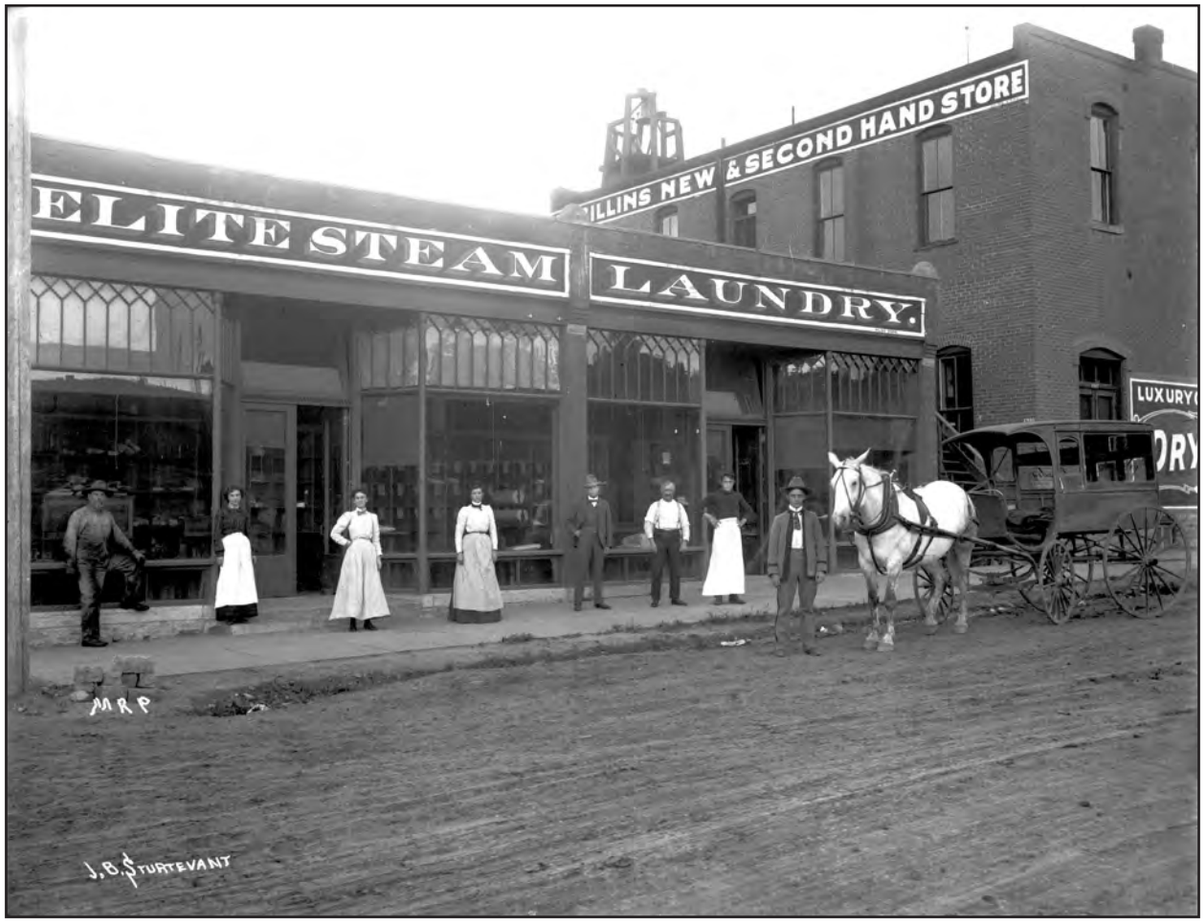
The first serious discussion of a municipal sewer system was in 1893, during the administration of Mayor Isaac L. Bond.
Carnegie Branch Library for Local History, Boulder Historical Society collection, 420-Bond-Isaac

Dr. King, then age 63, was still on the job as health officer. In 1895, he told a newspaper reporter that his position included the examination of "water closets." However, the reporter only published King's comments on earth closets—what he called "dry earth boxes."

Of those, King was less than enthusiastic. He personally examined more than 700 and stated, "Very few showed any absorbent being used. Some were running over and in a general worse condition than pits; in fact they were a general failure, although a few were kept in good shape. All needing cleaning were so ordered."[26]

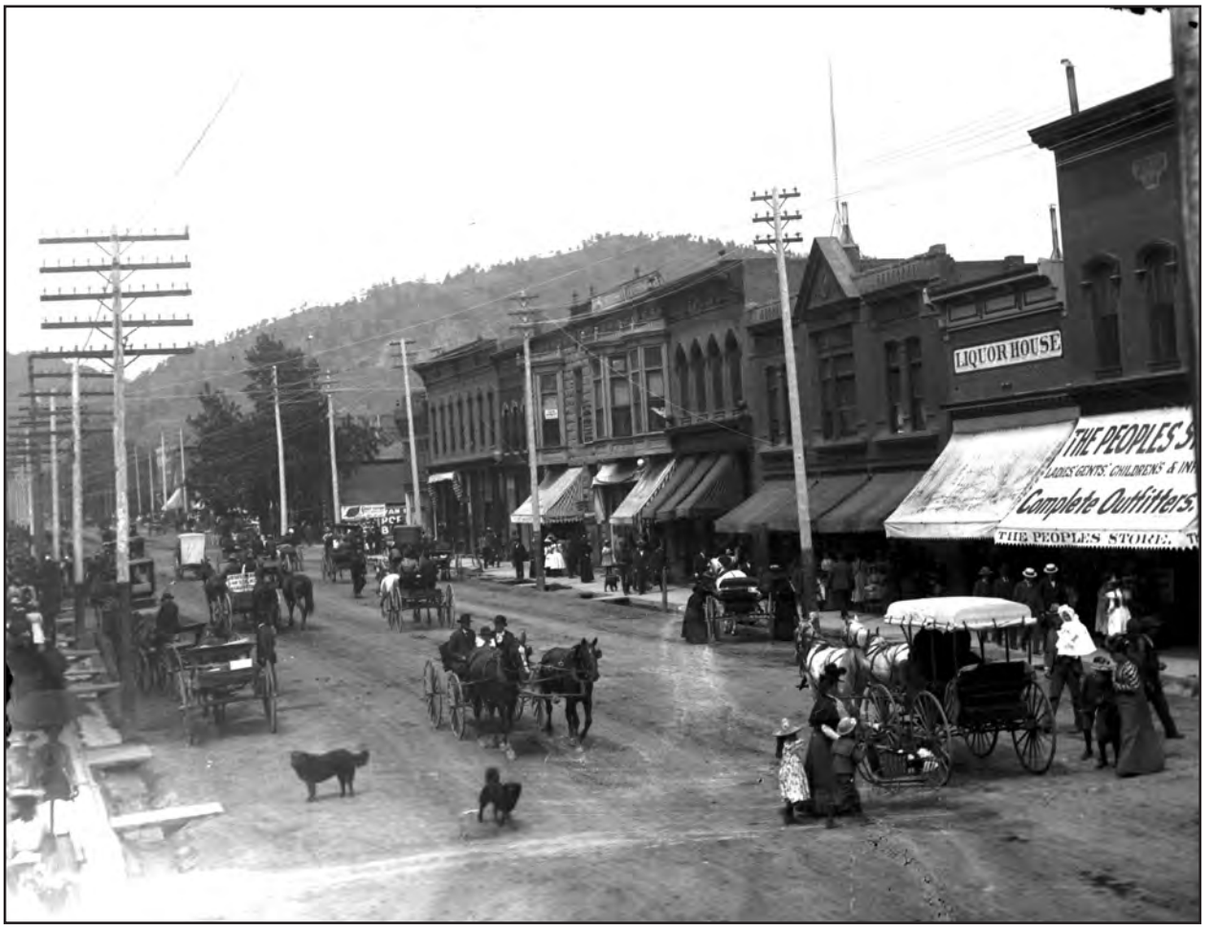
Earth closets, obviously, were on their way out. Realtors advertising houses for sale, such as a small fruit farm for $850 at 1613 Marine Street, listed the water closet among the home's noteworthy features.[27]

Below, the Elite Steam Laundry was fined for dumping grey water in a ditch , but the owner claimed he had no alternative. *Carnegie Branch Library for Local History, Boulder Historical Society collection, S-38*



According to King, the lack of sanitation in the City's alleys had continued to be a problem. The alleys, he said, were in "a horrible condition" and he ordered them thoroughly cleaned (presumably with water from the fire hydrants). Then King declared that property owners could not dump any more "slops, swill, or rubbish" into their ditches. But, residents had no choice, as evidenced by large quantities of wash water reportedly poured out by the Elite Steam Laundry, on 11th Street.

Some sanitation ordinances were in place, as the City had fined the laundry for dumping its grey water. But what was its owner to do? He had no other alternative. Another flagrant violator was the Belvidere House, a hotel on Walnut Street. King described the business as "a case of nobody responsible" and said that it required "something radical to be done."[28]



An open ditch lateral is visible on the south (left) side of the street in this 1899 photo of Pearl Street, between 12th Street (now Broadway) and 13th Street.
Carnegie Branch Library for Local History, Boulder Historical Society collection, S-800

Above is a tinted postcard of the Boulder County Courthouse, built in 1882. A decade later, its "filth" was said to have been overflowing. (The building burned in 1932 and was replaced, on the same foundation, with the current courthouse building.) *Pettem collection.*

Below, Charles Turner's plumbing shop, at 1043 Pearl Street, had a variety of water closets, bathtubs, and plumbing supplies when this photo was taken in 1899.
Carnegie Branch Library for Local History, Boulder Historical Society collection, 207-9-63-1

Cleaning up the town

By the mid-1890s, Boulder's population was approximately 3,500. The frontier town was evolving into a small, but sophisticated, city. The Boulder-Colorado Sanitarium was built by John Harvey Kellogg (of cereal fame), in 1895, and attracted health-seekers from all over the country. Meanwhile, the large Masonic Lodge was under construction at Pearl and 14th streets. Already known for the University of Colorado, the City soon would soon be home to the Boulder Chautauqua, an educational and cultural summer resort. Merchants and investors had replaced Pearl Street's hastily built wooden buildings with permanent buildings of brick and stone. It was time to clean up the town.

The Boulder-Colorado Sanitarium put Boulder on the map as a health center.
Carnegie Branch Library for Local History, Boulder Historical Society collection, 223-1-21-2

The 1894 "100-year-flood" had washed out the red-light district, located between today's Municipal Building and the original section of the current Boulder Public Library that faces Canyon Boulevard. Some of the prostitutes moved to upstairs buildings on Pearl Street, but their days were numbered. Both the Women's Christian Temperance Union and the Prohibition Party were active and prominent. Within a decade, these two organizations would even outlaw saloons within the City limits. Big changes would be occurring underground, as well.

The comments of Health Officer King and others on Boulder's lack of sanitation moved forward the discussion on the installation of a sewer system. When the City Council met in July 1895, its aldermen declared that "an emergency exists, and the work should go ahead at once." The talk of an emergency most likely reflected the residents' rising concerns that diphtheria could be spread in human waste. A November 1895 *Daily Camera* article discussed the possibility, adding, "This matter has not been determined with scientific accuracy, but the presumption in its favor is strong."[29]

Meanwhile, property owners were canvassed to see if—this time—they would agree to voluntary subscription. Only one business owner, on three blocks of Pearl Street between 11th and 14th streets, was said to have hesitated. The following day's headline read, "SEWARAGE ASSURED."[30]

On August 5, 1895, the "plans for sewerage" were unanimously adopted by the City Council, then under the administration of Mayor Crockett Ricketts. For $2,000, the City agreed to purchase the Corsons' twenty-two acre "dumping ground" and use it for a settling basin. Then, the City's wastewater would, simply, drain into Boulder Creek.

City Engineer and Civil War veteran Jason Lee Frankeberger had prepared a survey of the proposed line. After studying the construction of Denver's sewer system, he came up with a succession of increasing diameter sizes (eight-inch, then twelve-inch, then fifteen-inch) for Boulder, calculating that it would have a velocity of 2 1/4 – to - 6 1/2 feet per second. (Two years later, as chief engineer for the Colorado and Northwestern Railway, Frankeberger, would lay out the narrow gauge railroad grade between the Boulder County mountain towns of Sunset and Ward.)

The City Council immediately authorized the sale of warrants up to $18,000 and obtained $6,500 from private property owners.[31] Plans released in August 1895 indicated that the main pipe for Boulder's sewer line would start at 10th Street, in the alley between Pearl and Walnut streets (conveniently located near the Elite Steam Laundry). Another line would run from 8th to 13th streets, beginning in the alley between Pearl and Spruce streets. The two lines would then intersect and join one larger pipeline, prior to reaching the dumping ground site.

The estimated increase in taxes, for a person owning property assessed at $1,000, was estimated at 75 cents per year. The Council added, "We confidently believe that the increased rents obtained by the City for connections from water closets, cesspools, etc.

would be $500 to $1,000 per year and would naturally increase year by year."[32]

Boulder's initial sewer lines were laid during the winter of 1895-1896. The *Daily Camera* ran an article, with a map, in January 1896, to educate residents on the latest developments. The writer started out by stating that not only did he and his readers not know much about sewers, but "three or four months ago, no member of the City Council could distinguish a sewer from a blind horse."[33]

In a push for securing the bonds to pay for the work being done, the newspaper emphasized that Boulder had to remain "in the vanguard of progressive Colorado towns" and stated:

> It will not do for it to be said that Fort Collins and Greeley--towns half the size of Boulder--have sewers and Boulder has not. Nor will the citizens of this place be justified in their own minds and consciences if another visitation of children's diseases, such as Boulder has just passed through, should afflict the community, when all realize to what degree these contagions and infectious diseases are directly traceable to lack of proper sewage [disposal].[34]

SEWER ORDINANCES

The City Council got to work right away. On February 19, 1896, they passed thirty-six ordinances relating to sewers. One of the ordinances created the office of Superintendent of Sewers. Among his duties were was to keep the sewer system "properly flushed and cleaned and in proper working order." He also was to personally superintend all connections between private sewers and the public sewer.[35]

Permits were required for hook-ups to residential and business properties. Residents paid sixty-five cents per running foot for each lot. Business owners paid one dollar per running foot, unless they were on Pearl Street between 10th and 16th streets. There, the cost was one dollar and fifty cents per running foot. Connections could only be made by licensed plumbers.[36]

Ordinance 557 was titled, "What thrown into sewer," and stated:

Sec. 13. It shall be unlawful to throw or deposit, or cause or permit to be thrown or deposited, in any vessel or receptacle connected with a public sewer, any garbage, hair, ashes, fruit or vegetables, peelings or refuse, rags, cotton, cinders or any other matter or thing whatever, except faeces [feces], urine, the necessary tissue closet paper, and liquid house slops."[37]

Along with specific language on waste pipes from kitchen sinks, were requirements on grease traps, of particular importance for hotels and restaurants. Wastewater had to flow through these receptacles before entering the sewer lines. If the traps couldn't be placed in yards (with covers of iron or stone) of homes and businesses, they had to be placed below each kitchen sink, "and shall have a water jacket to keep grease in grease trap chilled." All of these traps had to be cleaned out at least once every six months.[38]

On November 11, 1898, the City Council added one more ordinance, requiring residents to connect with the municipal sewer system. In one very long sentence, the law stated:

"Every vault or privy in, upon, or belonging to any residence, factory, mill, warehouse, out house, store, office, or other building, together will all drainage from bath tubs, sinks, or basins therein located on any lot or lots or land adjoining to or abutting upon or near any street or alley or other place through which there is a public or private or district sewer connected with the sanitary sewer of said city shall be connected by the owner or owners of the property by his or their agents or other person having charge or receiving the rents of or being tenants of the same with such public or private or district sewer when required to do so by order of and notice from the Mayor of the city, which order and notice shall be served upon the owner or owners of said property by the Marshal or any policeman of the city, and if said owner or owners or his or their agent or other person having charge of said property who shall have been served with said order and notice shall fail within the time indicated in such notice to comply with the requirements of such order or fail to show good cause to the said Mayor or why he or they cannot or ought not to comply with such order, he shall upon conviction be fined not less than $5 nor more than $100."

Each day of non-compliance became a separate offense.

Three years later, the city council revised the ordinance, giving it the title of "An ordinance regulating the use of privies, water closets, urinals, sinks, and drains." In sum, all of the above had to be connected with the municipal sewer system, the fine remained the same, and not doing so was "hereby declared to be a nuisance and a menace to the public health."[39]

"A PROBLEM TO BE FACED"

After the laying of the original sewer lines, the City hired laborers to build extensions. For some, the work resulted in tragedy. On April 9, 1908, three men were killed when the sides of an unbraced trench, eight-to-eleven-feet deep, collapsed on top of them. The cave-in occurred on 13th Street, between Pearl and Spruce streets. Two of the men died immediately. One was 58 years old, leaving behind a wife and six children.

A third man, seriously injured, begged his rescuers to kill him and leave him half-buried in clay. Merchants and people on the street, however, managed to dig him out, but he died of his injuries on the way to the University Hospital. Two other workers were slightly injured.

"The faces of the dead men were terrible to behold," wrote a *Daily Camera* reporter. "They had been battered almost out of the semblance of form, and death had, in each instance, undoubtedly been instantaneous." The writer stated his opinion that the City had been "incompetent and indifferent" to the danger, and would be held responsible.[40]

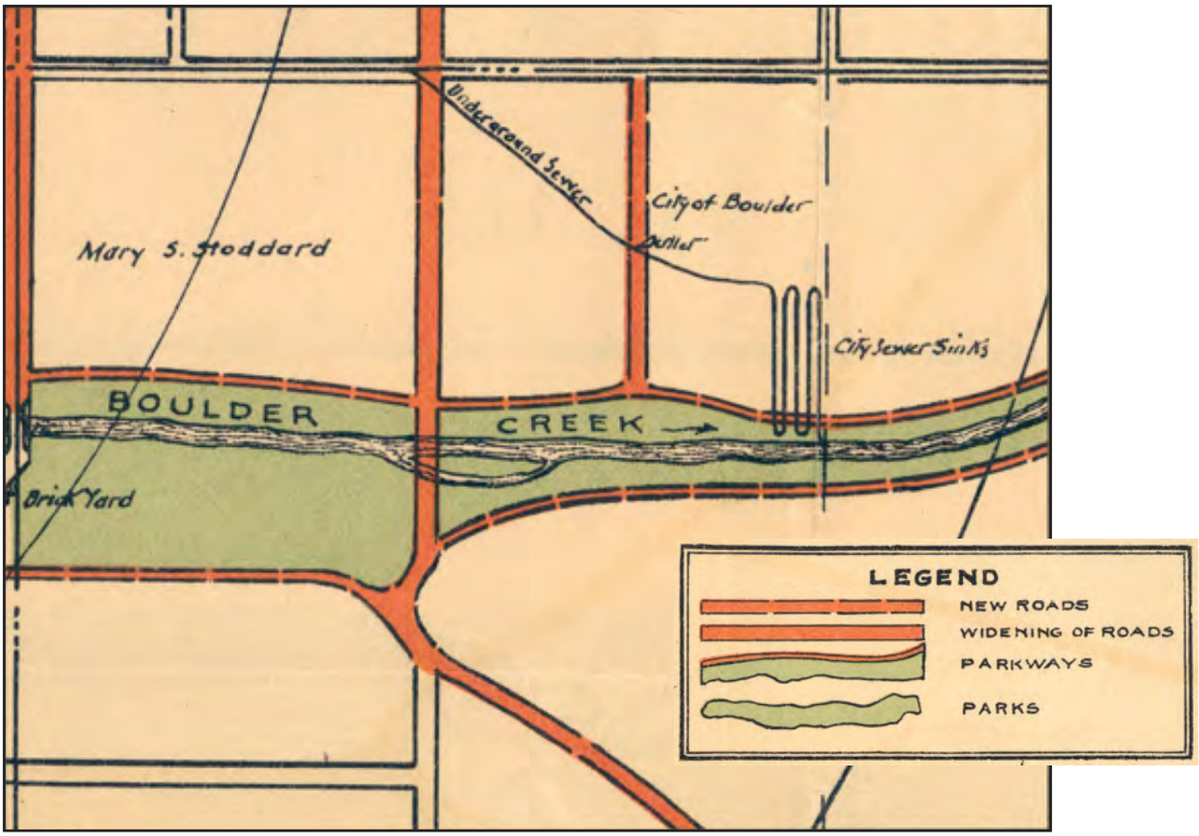
Meanwhile, in 1903, four civic leaders had banded together to form the Boulder City Improvement Association. Its purpose was the "improvement of Boulder in health, growth, cleanliness, prosperity, and attractiveness." The four leaders were judge-turned-professor Junius Henderson, pathology professor Dr. William Baird, pharmacist Eben Fine, and mining investor and Boulder Realtor Fred White. Of their joint accomplishments, then *Daily Camera* editor L.C. Paddock wrote, "Civic interest is a splendid thing to have, and those who have it are rare."[41]

In 1908, the year of the sewer-trench cave-in, the Boulder City Improvement Association arranged to bring to Boulder a nationally known city planner, Frederick Law Olmsted, Jr. As the first professional consultant to take a critical look at Boulder's features and future needs, he rode around the city on his bicycle and prepared extensive recommendations for the development of city parks, the improvement of city streets, the beautification of the banks along Boulder Creek, and—better sewage disposal.

In Olmsted's published report, "The Improvement of Boulder," he stated, "Just what to do in the neighborhood of the sewer outfall is a complicated question about which we have only certain general considerations to put before you. The problem of a permanently suitable method of sewage disposal is one which the City of Boulder will sooner or later have to face."[42]

In his report, Olmsted continued:

> At present, the sewage is discharged with all its dangerous impurities into Boulder Creek, a short distance below the town, and passes in a somewhat diluted condition into the several intakes that supply water to various localities further down the stream. Experience elsewhere indicates that considerations of public health will require these conditions to be remedied and that either voluntarily or under legal compulsion, Boulder will have to assume the burden of disposing of its sewage without menace to the health of other communities.[43]



Above is a detail from Olmsted's map that accompanies his 1910 report. Although he included suggestions for new roads and parks, he also drew in the "Underground Sewer" to show the line as it left the intersection of 28th Street and Arapahoe Road and extended to the "City Sewer Sinks." *Pettem collection*

Olmsted went on to state that a generally adopted treatment method for the purification of municipal sewage was the use of "bacterial filtration beds" to transform dangerous organic matter into harmless compounds, particularly when applied to "cultivated and productive sewage farms." In the East, where Olmsted and his father (Frederick Law Olmsted, Sr., landscape architect for New York's Central Park, as well as the Chicago World's Fair grounds) did most of their work, water was "something to get rid of."

In addition, Olmsted noted that the reverse was true in the West, i.e., in Boulder, and that economic reasons pointed toward the utilization of Boulder's sewage for irrigation purposes. Apparently, an offer had been made to pay the City for the right to use the outflow from the sewer lines in order to irrigate private land. But, Olmsted raised two objections to private ownership of the City's sewage disposal.

These included sanitation and the protection of public health, as well as the City's need to have control in current and future dealings with land owners. On the issue of sanitation, Olmsted stated, "It would be very unwise for the City to turn over the handling of this dangerous, though useful, material to a private party whose main object would

not be to make sure of it purification, but to use it in the handiest way for irrigation."[44] Lettuce, he noted, was one crop that should not be irrigated with sewage.

As to possible dealings with land owners, Olmsted said that this would be complicated by the "difficulty and cost of frequently changing the point of discharge." It would be better, by far, he stated to apply the sewage to land already owned by the City of Boulder and then lease it to the highest bidder.

Olmsted also explained that as the City grew to the east, it would need to acquire a new "sewage farm" and then dispose of the old one. Most likely, he was the first to recommend the sewage disposal site's future use as a park. But even when it was still in use, the celebrated city planner waxed eloquent on the location's "park value."

He concluded his discussion of the Arapahoe Road disposal site by stating, "Even while in use for its original purpose, a sewage farm would have some park value, for, if property conducted, it is in no way an unsightly or disagreeable spot, and though the general public could not be permitted to walk about in the irrigated area, there might very well be a public drive and promenade along the border, overlooking the fields and commanding the mountain views beyond them."[45]

Some Boulder County residents found the discharge into Boulder Creek unacceptable. Even before Olmsted had written his report, downstream farmers and ranchers complained that sewage from the outlet was polluting Boulder Creek. The City consulted engineers in 1908, 1909, and 1921, but little, if anything, was done prior to 1926.[46]

That year, a *Daily Camera* headline read, "New device has taken out of sewage the substance that contaminated the stream to the detriment of farmers." Although the writer noted that there were 2.75 million gallons of sewage emptying out of the outlet pipe every day, an improved settling basin at the outlet of the sewer pipes was removing "practically all solids and turning water back into Boulder Creek that is purer than any flow has been in years."[47]

This major achievement was credited to the City's new administrators—City Manager Frank L. Moorhead and City Engineer Earl Devalon. The change that they made was to run the sewage through a half-mile of open channels before allowing it to spill into Boulder Creek. A newspaper writer explained:

> There are five channels--ten feet wide at the base--and the water runs slowly thru them permitting the solids to settle to the bottom and on the side walls. Oil and salt on the sides and banks prevent the growing of bushes and grasses, and expose the channel to the sun and air. Board controls at various places check the flow of the water.[48]

Another basin, to the east, was being made into a duplicate set of channels, so that the two basins could be alternated yearly. The settled-out solids would then dry out and be burned.

A brief description of the sewage-disposal system was written in 1933 by consulting engineers Ernest B. Black and Nathan T. Veatch, Jr. They stated that it was operated "entirely by gravity" and was tributary to sewer mains that converged at 28th Street and Arapahoe Road. "The sewage was treated by settling and skimming in a duplicate system of earthen channels located a quarter-mile east and a quarter-mile south of the 28th Street-Arapahoe Road intersection."[49]

More years would pass, however, before the City undertook the "permanently suitable method of sewage disposal," which Olmsted had only hinted at in 1910.

In 1927, Boulder photographer Edwin Tangen documented the improved settling basin. The above photo shows the basin with water and sewage.
Carnegie Branch Library for Local History, Boulder Historical Society collection, 141-4-89

This photo shows the same basin (as on the previous page) after its contents had dried. *Carnegie Branch Library for Local History, Boulder Historical Society collection,141-4-88*

In the pre-Boulder-Denver Turnpike days, Arapahoe Road was the main route into Boulder, as shown in this postcard mailed in 1929. *Pettem collection.*

The intersection of U.S. 287 and Arapahoe Road was known as the Gateway to Boulder. It included two stone pillars and a cannon. The cannon was later damaged and removed, but the pillars (moved apart to facilitate road-widening) are still standing.
Carnegie Branch Library for Local History, Boulder Historical Society collection, 214-2-6

Depression years bring changes

In Olmsted's 1910 report, he had failed to mention that the sewage disposal site (now Scott Carpenter Park) was also the city dump, used to dispose of everything from bedsprings to dead cattle. The City Council, on January 15, 1933, voted on removing "one of the eye-sores from the entrance to Boulder." In addition, they favored consideration of "a new sewage disposal plant, also located near the highway entrance to Boulder."[50]

A few months later, Boulder parks commission chair Mrs. Charles Cheney explained, "When the dump ground and sewage plant were placed [in 1895], Arapahoe was not a main artery into town. We now realize the mistake of having the entrance to Boulder pass the sewage plant and dump ground. It is a beautiful location for future development."[51] The City Council agreed that both the dump and the old sewage plant had to go.

GATEWAY TO BOULDER

Arapahoe Road (Arapahoe Avenue within the city limits) not only was the "main artery," but it was, at the time, the only paved route into Boulder. Motorists coming north from Denver, or south from Fort Collins, drove U.S. 287 to Nine Mile Corner, then turned west on Arapahoe Road. In 1928, the American Legion and the Lions Club erected two stone pillars at the intersection, to mark the gateway to what they called the "Road of Remembrance."

The veterans and civic groups planned a beautification project for the entire length of Arapahoe Road, from U.S. 287 to Boulder, to honor veterans of World War I. The pillars are still there, but the proposed 1,000 trees and the small parks at each of the crossroads never materialized.

Beginning in the 1920s, Boulder had begun welcoming a new breed of tourists—those who traveled by automobile. Many of these motorists camped in their cars or sought overnight accommodations that catered to their new way of traveling. Because Arapahoe Avenue was *the* entrance to Boulder, the community wanted to make sure that it was amenable to tourists.

The Roxwood Auto Park (later the Roxwood Cottages) had opened in 1929, offering a ten-acre camping site at Arapahoe Road and 55th Street. Tourists paid fifty-cents per night, and in addition to a site, they got picnic tables, stone fireplaces, and radio broadcasts.

The next decade brought the El Rancho Hansen Motel and the Three Birches Lodge, both in the 3000 block of Arapahoe Avenue, as well as the Glacier View Motor Court in Arapahoe Avenue's 2800 block.

The Three Birches Lodge was located on the southeast corner of Arapahoe Road and 30th Street. Part of the building later was moved to the 9600 block of Arapahoe Road (near U.S. 287) and is still in use today as a private residence. *Postcard, Hotel Boulderado*

As a result of the City Council's January 1933 meeting, consulting engineers Ernest B. Black and Nathan T. Veatch, Jr., from Kansas City, Missouri, were invited by the City to give their proposal for a modern-day sewage disposal system. As Boulder settled into the Great Depression, it had grown into a college town of 11,000 residents and 3,000 University of Colorado students.

The time had come for Boulder to face its disposal of wastewater.

Consulting engineers Ernest B. Black and Nathan T. Veatch, Jr. were asked, by the City of Boulder, to design a sewage disposal plant.

1933 was also the year for another major Depression-era construction project—the new Boulder County Courthouse. The former courthouse, built in 1882, had been destroyed by fire in 1932 and was torn down. The new courthouse was erected on the same foundation. This photo was taken at the cornerstone-laying ceremony, on July 4, 1933.
Carnegie Branch Library for Local History, Boulder Historical Society collection, 207-12-7

BOULDER'S FIRST SEWAGE DISPOSAL PLANT

In 1933, when the "new" courthouse and other Depression-era projects were getting underway, engineers from the Black and Veatch consulting firm (perhaps Black and Veatch themselves) came to Boulder. In their subsequent report to City Manager H.C. McClintock, the engineers made the following three findings:

1. "The sanitary sewage of Boulder is typical of municipalities of this size and nature, but is extremely dilute and, since it reaches the outfall in an unusually fresh condition, it is extremely favorable to odorless plant operation."

(Additional comments also mentioned that due to the low temperature of the sewage and its rapid flow through the system, decomposition of organic matter did not progress, to any great extent, by the time the outlet was reached. The sewage was described as "normal municipal sewage," with the exception that it was carried by 2-1/2-to-4 times the normal amount of water.)

2. "Boulder Creek has sufficient flow to care for the sewage of Boulder after treatment by settling, provided coagulating chemicals are used at periods of low flow."

3. "The existing disposal site is suitable for development but has no particular advantage other than that of economy over other sites lower down the stream."[52]

Black and Veatch added that the treatment made possible by the existing system was inadequate due to the lack of facilities for handling solids, as well as the fact that sewage continued to become contaminated when it passed over decomposing solids previously deposited in the channels.

The logical solution, the men concluded, lay in primary treatment, aided by chemical treatment at times when the stream flow was low. They recommended construction—on the existing site—of a disposal works of the preliminary clarification type, equipped for chemical treatment and designed to treat a sewage flow of 5.0 millions of gallons per day (MGD) from a contributing population of 15,000.

Costs would include a capital expenditure of $70,290, as well as annual operating costs of $10,541.[53] The consultants stated, however, that various plant units would be made unusually large to accommodate seasonal fluctuations, and that their design could easily serve a population of 18,000-to-20,000 without enlargement and without an appreciable difference in operating costs.

Black and Veatch also stated that if the sewage disposal effluent was inoffensive and free from solids, and if its bio-chemical oxygen demand did not exceed 30 parts per million, the discharge would "cause no nuisance at any time." The absorption of oxygen from the air would be more than adequate to supply the demand, even during periods of no stream flow.[54]

In their report, Black and Veatch referred to the then-existing sewage treatment site as the "West Site," giving the option of an "East Site," as well. Their recommendations of the Preliminary Settling/ Clarification Plant (to be built on the West Site) included:

1. An inlet flume of concrete to intercept the sewage from the two existing outfall lines.

2. A settling tank equipped with mechanical devices for the concentration of sludge and the removal of scum. A capacity equal to two hours flow at an average daily rate of 5 MGD is provided.

3. A machinery and office building to house the following:

- *A mechanically cleaned sewage screen with incorporated or auxiliary equipment for pulverizing the screenings and returning them to the sewage.*
- *A venture [venturi] flume and a device for indicating, recording, and totalizing the sewage flow.*
- *Equipment for feeding lime, chlorine, and ferrous sulphate to the sewage.*
- *An automatically operated sludge pump to deliver the solids from the settling tank to the digester.*
- *A gas-fired hot water boiler, together with the flame trap, relief trap, condensation trap, meter, circulation pump, and other appurtenances needed to utilize the sewage gas for maintaining the proper temperature in the digester.*
- *Office space for record keeping and laboratory equipment, including table and sink. (This also includes a toilet, as well as storage space for chemicals. The building will be of fireproof construction throughout, with exterior walls of face-brick and interior walls of glazed-brick.)*

4. A sludge digester tank equipped with stirring and scum-breaking devices, as well as heating coils and a dome for gas collection. A capacity of 30,000 cubic feet will be provided.
5. A leveled and under-drained area of the natural soil will be provided for air drying the digested sludge. This area will be divided into five beds each, with an area of 3,000 square feet.
6. A 2-inch water line leading from the City system and terminating at the plant is contemplated. Outside hydrants will be placed at convenient points for use in cleaning the plant units and for lawn irrigation, and inside connections will be provided in the machinery house.

In addition:

- *The estimates include the cost of a power line from the nearest primary line.*

- *The estimates include an allowance of $3,500 for a gas holder for use in equalizing the gas pressure and improving the quality of the gas. This feature is not an essential item at the present time, although it forms an added convenience in plant operation. Within a*

short time, however, the utilization of sewage gas for power production, which is now impractical due to the lack of suitable engines in small capacities, will undoubtedly be a routine procedure, and the gas holder will be a very important part of the system.

• *The estimates include the grading and leveling of the plant grounds, but exclude fencing, planting and driveway construction. The cost of fencing is indeterminate until the plant site is selected, and the landscaping can best be done after the construction is complete, and the fills have had time to settle.*

• *The necessary yard piping—which includes the connecting sewers, the bypass lines, the sludge lines, the heating lines, the outfall line, etc.—has been provided.*[55]

CONSTRUCTION BEGUN AND COMPLETED, 1934

Construction of the sewage disposal plant began on May 25, 1934. A short article in the *Daily Camera* stated:

> Richard Dunn, who will be superintendent of construction work on the Boulder sewage disposal plant arrived today and said the equipment of his company, the Koss Construction Company of Des Moines [Iowa] is expected to be here tomorrow. Ray Oothout, construction engineer, will arrive Sunday. Paul Diehl, representative of Black & Veatch, consulting engineers, came yesterday.[56]

Three days later, the *Daily Camera* noted that forty men were employed at the sewage disposal plant site, and that nearly all of the workers were Boulder residents. A $21,000 federal grant from the Public Works Administration ("Federal Public Works Project No. 1978") funded part of the construction job, while municipal bonds paid for the rest.[57]

Unfortunately, finding information on the Federal Public Works Project has been elusive, and correspondence with a researcher at the National Archives—the repository whose mission it is to preserve federal documents—wasn't much help. The researcher wrote to the author, in an email:

"We took a look the indexes to the project files of the PWA, and we did find a reference to a disposal plant project in Boulder Colorado with the Docket Number 1978. However, we could not find a file for it. The file appears to be one of many that were improperly disposed of in 1943. Somewhere between 50 and 75 percent of the PWA's project files were destroyed in this improper disposal. To our knowledge, no additional copies of these files exist and the information is considered lost."[58]

Although the grant was part of newly elected U.S. President Franklin Roosevelt's "New Deal," it was not a Works Progress Administration (WPA) project, as the WPA would not be inaugurated until 1935. And, neither was it a project of the Civilian Conservation

Corps (CCC), started in March 1933. Boulder had two CCC camps, and its laborers, at the time, worked mostly in Boulder's mountain parks.

Meanwhile, the City found a new location for its dump, on North 26th Street. (The dump remained in that location until 1965, when a new landfill was opened near Marshall, in southern Boulder County between Eldorado Springs and Superior.)[59]

The City Council accepted the sewage disposal plant as completed at its meeting on December 18, 1934, and it was placed into operation in early 1935. Harold C. McClintock, who supervised the plant's construction, stated in its description at the time, "The daily sewage flows vary from about 2 MGD, in the winter, to about 5 MGD in the summer. Hourly peak flows in excess of 7 MGD have been recorded."[60]

Even though the construction of Boulder's Sewage Disposal Plant was funded by the Federal Public Works Project (not the Works Progress Administration), local residents employed by the WPA did contribute to its completion. Beginning in 1935, WPA projects in Boulder County included:

Project #93—This Boulder City Parks Project included grading the grounds at the sewage disposal plant. In other parts of Boulder, laborers improved parks, built playgrounds, trimmed trees, cut wood, and constructed three concrete tennis courts.

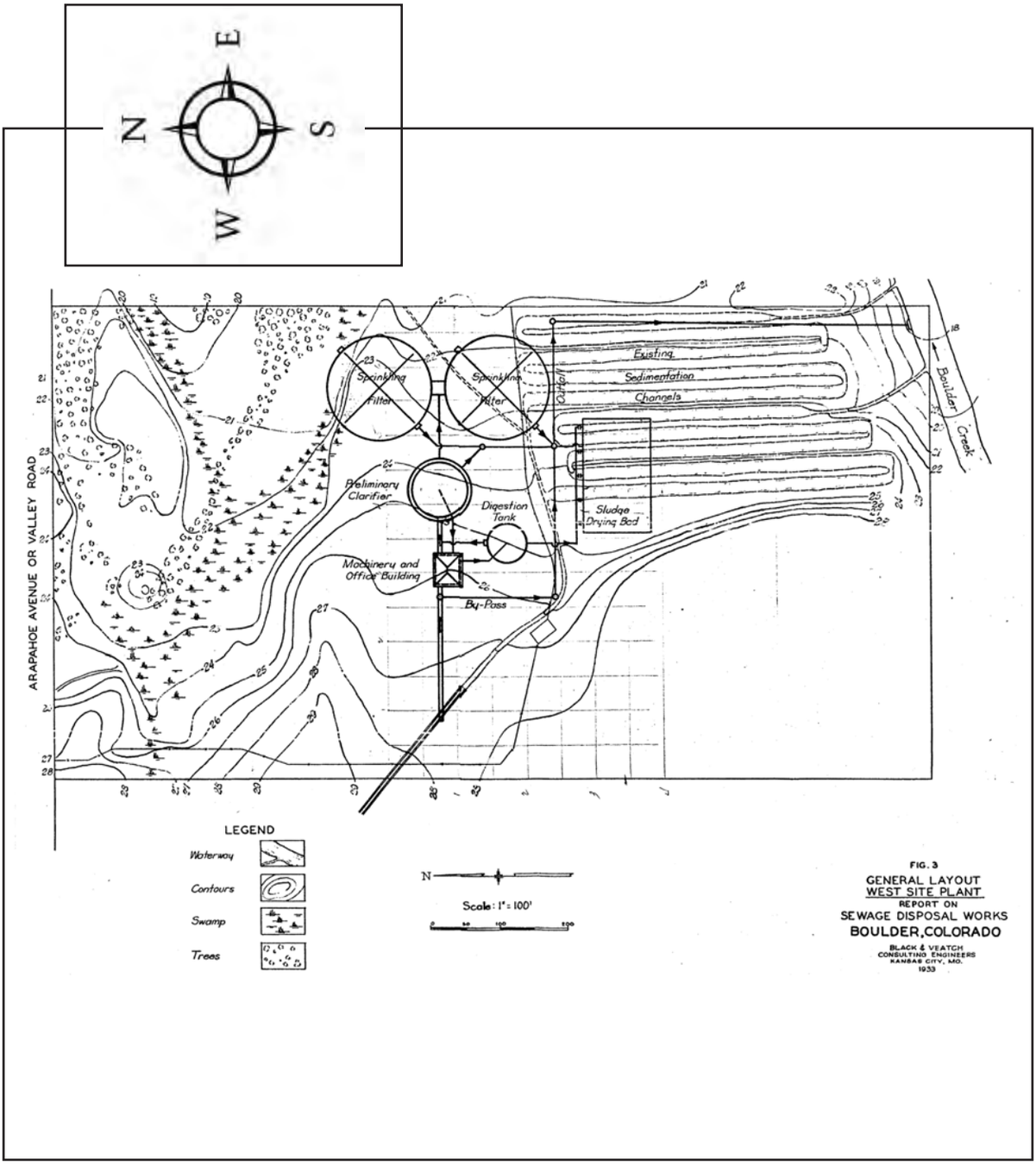
Project #135—The Boulder Sewer System Project included the re-mapping of the distribution system, excavating 13,700 feet of trench, and the laying of 13,700 feet of sewer pipe, to replace the then-present system.[61]

Project #154—With fifteen relief workers, the Sanitation Project built 634 sanitary privies in rural areas of Boulder County.

Construction of Boulder's first sewage disposal plant began in the summer of 1934. Above, the floor level of the machinery/office building is taking shape. *Carnegie Branch Library for Local History, 511-2-15*

The drawing, below, is of the sewage disposal plant, as proposed by Black & Veatch, in 1933. For the purposes of the proposal, it was designated the West Site Plant and shows the general layout of the facilities to be built southwest of Arapahoe Road and 30th Street, now Scott Carpenter Park.

Arapahoe Road (also called Valley Road at the time) is on the left, and Boulder Creek is on the right. *City of Boulder*

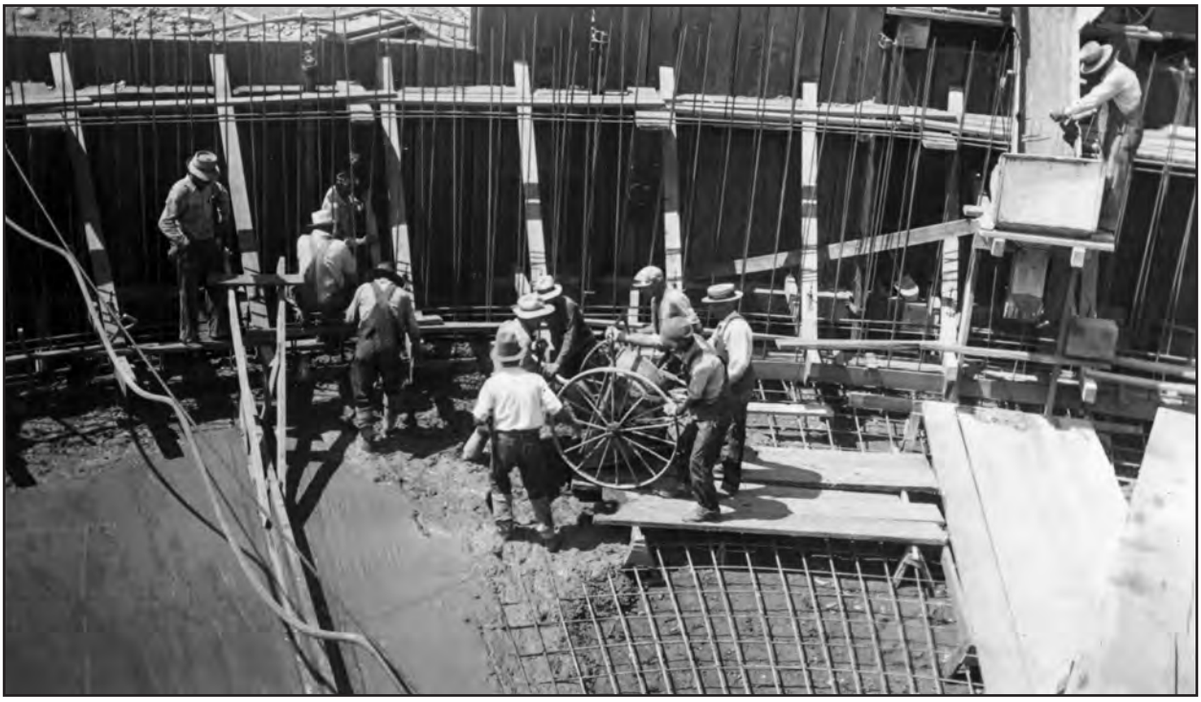


Above, left to right, are Paul A. Diehl (Black & Veatch), Ray M. Oothout (Koss Construction Company), George R. Hibberd (Boulder County Building Inspector), and Russel Palmer (Public Works Administration Inspector).

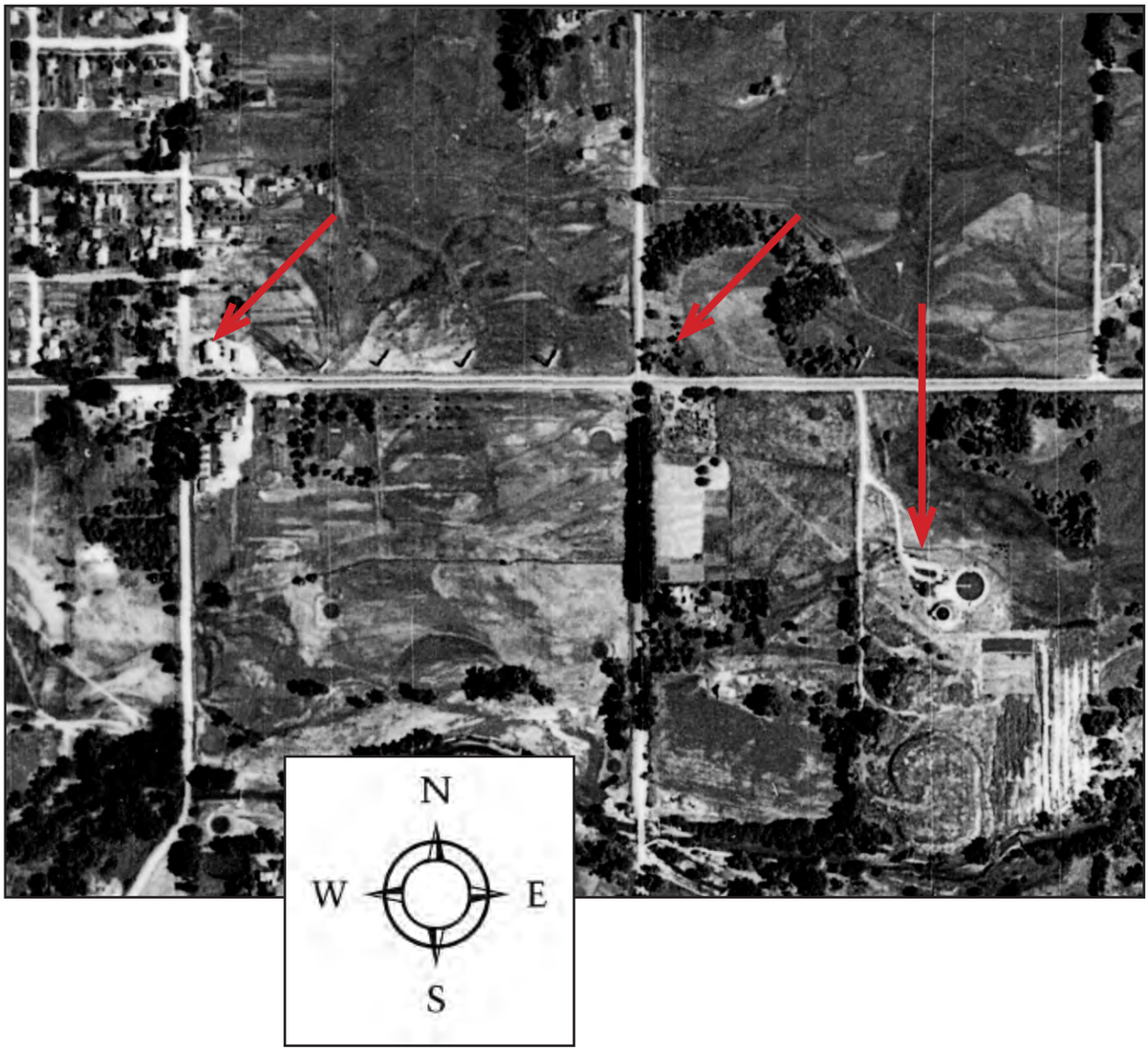
Below, the concrete floor is being poured for the machinery/office building. The site was accessed by a dirt road extending south from Arapahoe Road.
Both photos, Carnegie Branch Library for Local History, 511-2-15

These photos, also taken in 1934, show progress on the construction of the preliminary [primary] clarifier and the digester tank.
Both photos, Carnegie Branch Library for Local History, 511-2-15

Additional construction photos were taken inside the preliminary [primary] clarifier.
Both photos, Carnegie Branch Library for Local History, 511-2-15



Above, the digester tank is shown under construction. The photo below shows the digester tank, preliminary [primary] clarifier, and machinery/office building in 1936. The sign on the right reads, "Federal Public Works Project No. 1978."
Both photos, Carnegie Branch Library for Local History, 511-2-15



The aerial photo, above, was taken in 1937.

The red arrow on the right marks the City's sewage disposal facility, built in 1934 off of Arapahoe Road. The preliminary [primary] clarifier and the digester tank are easily visible. Southeast of the new building and tanks are the channels of the settling basins. In the oval area directly south of the building and tanks is the City Dump.

The other arrows show Arapahoe Road's intersections with 24th Street (now Folsom Avenue) and with 28th Street. There still was plenty of undeveloped land. *City of Boulder*

The former machinery/office building still stands today, at 1505 30th Street, as the Outdoor Adventure Camp building in Scott Carpenter Park. Below is the footprint at the site of the digester tank, between the above building and the pool. *Pettem photos, 2014*

Boulder's post-WWII years

The above photo of Arapahoe Avenue (west of 24th Street, now Folsom Avenue), was taken shortly after World War II and shows Quonset huts, on the left, used as married-student housing. At the time, Arapahoe Road (Arapahoe Avenue in the city limits) still was the main route into Boulder.
Carnegie Branch Library for Local History, Boulder Historical Society collection, 207-1-36-1

Prior to the end of World War II, Boulder was considered a "sleepy college town," but after the war, growth became inevitable. Veterans took advantage of the GI-Bill and inundated the University of Colorado. Many of the new students brought their brides and started families in tiny trailers, cramped barracks, and Quonset huts, collectively

known as Vetsville. During the following years, Boulder's population would boom. But, even before that happened, the City's sewer system was deemed inadequate.

In September 1945, the City Council received a recommendation from the Colorado State Board of Health asking that Boulder expand its sewage disposal plant. The Board reported that a study of the City's sewage disposal revealed that "the treatment was insufficient and that public health was endangered, especially when Boulder Creek, into which sewage water is run after treatment at the plant, ran low toward the end of the summer and fall."[62]

The Council then instructed City Manager H.C. McClintock to acknowledge receipt of the letter and to ask the board on what grounds it lodged its complaint, noting that the sewage disposal plant had been approved by the Colorado State Board of Health at the time it was built, in 1934.[63] Recent research, however, has not found any record of a response.

PHILLIPS-CARTER-OSBORN REPORT

In August 1949, a new group of consultants, the Denver engineering firm of Phillips-Carter-Osborn, was hired to study Boulder's sewage treatment plant. That same year, Ernest B. Black had died, after the company had been working for the U.S. Atomic Energy Commission at Los Alamos, New Mexico. (For the next few years, the firm of Black & Veatch would continue under the directorship of Nathan T. Veatch, Jr.)

Specifically, the engineers of Phillips-Carter-Osborn were to investigate and report on the adequacy of the existing plant (on Arapahoe Road), as well as to make recommendations for improvements under a long-range development plan.

Their rather simplistic description of primary treatment stated: "The raw sewage flows thru a tank wherein the liquid becomes relatively quiescent. Solids in suspension settle out; the settled sludge is mechanically collected and pumped to the digester and digested. Provisions were installed for the use of chemicals to aid the efficiency of sedimentation, and to stabilize the plant effluent during the times that conditions in Boulder Creek required improved treatment."[64]

At the time, the plant units consisted of the following major items:

1. Grit Chamber, added in 1949: Conventional channel 60 feet in length, providing reduced velocities for a period of approximately one minute. Raw sewage passed through this chamber, and the grit then settled out.

2. Comminutor, rehabilitated in 1949: Chicago Pump Company equipment, capacity 6 MGD plus. As the sewage flows through this mechanism, the solids are cut up in order to prevent clogging the sludge-lines or pumps. The continuous comminution (i.e., the

reduction of solid materials from one average particle size to a smaller average particle size) of sewage, by inducing some coagulation, also increases the efficiency of sedimentation.

3. Sedimentation Tank [preliminary/primary clarifier], rehabilitated in 1949: diameter 80 feet, depth 11.33 feet, volumetric capacity 62.75 cubic feet, with Dorr sludge removal mechanism. The float that accumulates on the surface of this tank is deposited mechanically in a hopper at the side of the tank. The material is then carted away for burial. The settled sludge is continuously plowed, by the clarifier mechanism, to a sump in the center of the tank.

4. Measuring Devices: Four-foot Cippoletti (trapezoidal in shape) Weir, Staff gauge, and Bristol recorder, which records the height of the liquid flowing over the crest of the weir.

5. Digester (Rehabilitated in 1949; An access door and a heat exchanger were added, and sand was removed from the bottom of the tank.):

Type: P.F.T. Floating Cover
Size: Diameter 42-feet, depth 23.33 feet
Capacity: 32,317 cubic feet

The P*hillips-Carter-Osborn Report* stated: "A plunger-type sludge pump located in the control house automatically operates 12 minutes out of each hour and pumps the sludge collected in the settling tank, through the heat exchanger, to the digester where the sludge is digested. This process reduces the volume of the sludge and renders it harmless and inoffensive. The digested sludge is withdrawn, by gravity, from the bottom of the digester, through a pipeline and is deposited upon the sludge drying beds."

"Supernatant liquor from the digester is returned by gravity to the influent line of the sedimentation tank. The process is manually controlled, and the operator can select any one of three elevations within the digester from which to withdraw the liquor. The proper selection is facilitated by sampling from cocks connected to each level. The elevation of the ground water at the digester site is a few feet above the digester floor."

6. Sludge drying beds:

Type: Open with natural drainage
Size: Four beds, each 6,000 square feet

"When the sludge becomes dry, it is hauled away by agriculturalists and is used as a soil conditioner."

7. Control building: Housing
Sludge pump
Gas utilization equipment
Gas-fired boiler, equipped

Gas meter
Flame trap
Heat exchanger
Chlorinator
W & T Visual vacuum feed
Capacity 400 pounds per day
Chemical feed equipment
2 Infilco dry feeders
Laboratory (not fully equipped)

8. General: "The plant, excepting the sludge drying beds, is fenced with mesh fencing and is landscaped. The plant is supplied with electrical energy by the Public Service Company of Colorado and with city water piped from the city water distribution system."[65]

The *Phillips-Carter-Osborn Report* concluded that, with the exception of the gas utilization equipment, Boulder's sewage treatment plant was in "first-class operating condition," adding:

• The designed capacity of the plant (5.6 MGD) is not at present, from a practical standpoint, being exceeded; however, it is estimated that such capacity will be exceeded during 1953.

• During low water periods of the irrigation season, the degree of treatment performed by the plant should preferably be increased by dosing the effluent with chlorine.

• Any increase of plant capacity must include provisions for final treatment because the capacity of the present plant utilizes all of the dilution afforded by Boulder Creek.

• Future extensions to Boulder, east of 28th Street, cannot be economically served by a sewage treatment plant at the present plant site. Ultimately, another plant must be constructed to serve this district.

• It would be better to construct the ultimately required plant rather than increase the capacity of the present plant.[66]

In addition, the *Phillips-Carter-Osborn Report* made the following short-term recommendations:

• That immediate steps be taken to modernize the gas-utilization equipment of the present plant. Estimated cost $3,450.

• That very serious consideration be given to the construction of a chlorination detention basin within the near future, and that the application of chlorine to the plant effluent be adopted as a standard practice during low water periods of the irrigating season. Estimated cost of required construction $12,500.

Under the long-range plan for future development, the firm recommended:

• Steps be taken to provide for an additional sewage treatment plant having a capacity of 3 MGD prior to 1953, and that such plant be located on Boulder Creek adjacent to the Union Pacific Railroad crossing. Estimated cost $260,000.

• That coincident with the construction of the plant mentioned above, an intercepting outfall sewer, probably 21 inches in diameter and having a capacity of 6 MGD, be constructed to carry sewage to the plant. This sewer would intercept the present 24-inch sewer south of the Union Pacific Railroad tracks on 28th Street and thence run parallel to the tracks to the plant. Estimated cost $70,000.[67]

By 1950, when the engineers had made their report, they reported that the two outfall sewers that converged immediately above the sewage treatment plant were each 24-inches in diameter. Main sewers and laterals, varying in size from six to 18 inches, collected the sewage from the service connections.

The average daily sewage discharge for January 1950 was at the rate of 2.075 MGD, although an estimated 5 per cent of the flow represented ground water infiltration. And, ground water infiltration, it was noted, increased the cost of the sewerage system because sewer sizes and provisions for sewage treatment must be larger than for a system that only handles sanitary waste.

Two gauging stations were maintained on Boulder Creek—one in the canyon below the Boulder Canyon Hydro plant (above all diversions) and the other at the mouth of Boulder Creek where the stream discharges into the St. Vrain Creek. The records from the mouth of Boulder Creek was useful in indicating periods of the irrigation season when the stream offers considerable dilution. The most critical months were August and September of each year.[68]

The *Phillips-Carter-Osborn Report* also outlined the need for improved treatment. It was noted that during the irrigation season, water from Boulder Creek (downstream from the sewage treatment plant) was applied directly to the land. No definite standards, however, had been established, to date, by Public Health authorities relative to the quality of water suitable for irrigation. The report stated:

"The quality of water suitable for irrigation depends upon the nature of the crops irrigated, and that sewage discharged into a stream which is used for irrigation shall have been subjected to at least primary treatment. Oxygen depletion or suspended solids as such are not detrimental to the use of water for irrigation. In fact, sugar factory wastes, which have phenomenally high concentrations of [Biochemical Oxygen Demand] BOD and suspended solids have been proven to increase crop production."[69]

"Water used for irrigating vegetables should preferably be substantially free from sewage solids which contain pathogenic organisms. Otherwise, the application of sewage

to land is the most effective mans of final treatment of sewage devised to date."

It was also noted that "the [Arapahoe Road] plant at present is not particularly efficient in the removal of bacteria." It was therefore recommended that serious consideration be given to improving the degree offered by the present plant by applying chlorine to the plant effluent during the low water periods of the irrigation season.

In the report's predictions for the future, the engineers noted that the years 1935-1947 represented the Great Depression years, World War II years, and the period immediately following the war. During the Depression, expansion was slowed due to lack of capital. During the war years and immediately afterwards, expansion was slowed due to scarcity of materials.

The years 1948 through 1954 were predicted to be a period of expansion and caught-up construction. However, the engineers also expected the normal capacity of 5.6 MGD at the present plant to be exceeded in the year 1952, necessitating immediate planning for the future. They also stated that they expected normal growth for the years 1955 through 1974. What they didn't predict, however, was Boulder's sustained population boom, continuing into the 1960s and 1970s.

RECOMMENDATION FOR A NEW PLANT TO THE EAST

Boulder's sewage treatment plant, off of Arapahoe Road (site of Scott Carpenter Park) was downstream and east of the City. Even without a huge increase in population, Boulder's eastward expansion required that any future plant needed to move to the east, as well. Instead of enlarging the facilities at the current plant, the *Phillips-Carter-Osborn Report* recommended the construction of a new plant on East Pearl Street.

In 1950, the arguments in favor of a new plant were:

1. The location of the new plant would be relatively isolated.

2. The present plant would still have the capacity to serve increased flows ultimately produced from the area south of Walnut Street.

3. Eventually, the proposed new plant could be enlarged to handle all of Boulder's sewage.

4. The proposed plant would cost less to operate, since it would be designed to operate by gravity instead of pumping.[70]

The only disadvantage of a new plant was its upfront cost—approximately $330,000.

The 1950s and 1960s

As described in detail in *BOULDER'S WATERWORKS: PAST & PRESENT* (Pettem and Ellinghouse, 2014), Boulder's sudden leap in population in the 1950s created an immediate need for all city services.

Beginning in January 1952, tourists and others driving into Boulder no longer turned west at the Gateway pillars, at the intersection of U.S. 287 and Arapahoe Road. The Arapahoe Avenue motels still took in motorists, but visitors to the City (along with residents commuting to Denver) bypassed City's former entrance and arrived in Boulder in half the time on the new Boulder-Denver Turnpike (now U.S. 36).

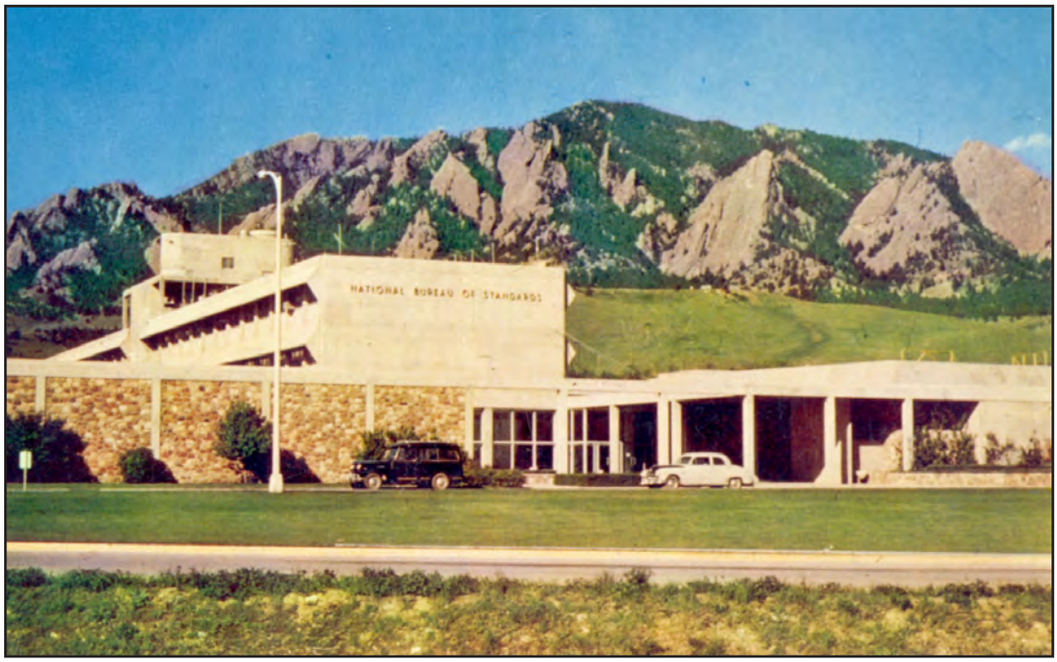
Beginning in 1952, motorists arrived in Boulder on the Turnpike. In order to direct the traffic through downtown, the City extended Broadway from Baseline Road (and the brand-new Basemar Shopping Center) to its intersection at 20th Street. In this photo, the Turnpike is visible in the background.
Carnegie Branch Library for Local History, Boulder Historical Society collection, 207-3-1-4

While Broadway was being extended, the City installed new sewer lines in the section of Broadway between College Avenue and 20th Street.
Carnegie Branch Library for Local History, Boulder Historical Society collection, 207-3-1-9

RAPID GROWTH

In April 1953, regular operations began at the Rocky Flats plant of the Atomic Energy Commission, between Boulder and Golden. By November 1953, the plant employed 1,200 people. The employees' housing needs quickly stimulated Boulder's real estate market and increased demand for schools, water, and sewer lines.

City services were taxed even more when the National Bureau of Standards (now National Institute of Standards and Technology) opened in 1954. That federal agency was followed in the mid-1960s with the National Center for Atmospheric Research (NCAR). The Highland Park and Martin Acres subdivisions popped up overnight, with Table Mesa to follow.



The photo for this postcard of the National Bureau of Standards was taken shortly after the federal agency opened in 1954. *Pettem collection*

Boulder grew so quickly during the 1950s than an organization called PLAN-Boulder formed in 1959, with a goal to slow down and direct growth in order to preserve what it saw as the City's special qualities. When the City proposed burying water transmission lines in the foothills above Boulder, PLAN Boulder drew up a proposed Charter amendment, establishing a "Blue Line."

The "Blue Line" charter amendment stated that no city water would be extended west of an imaginary boundary drawn through Boulder's mountain backdrop at approximately 5,750 feet in elevation. The charter amendment was passed by Boulder voters overwhelmingly in 1959. Later, an ordinance was adopted by City Council that restricted sewer service to the same area where water service was restricted.

Meanwhile, the consulting firm of Black and Veatch, which had begun its long relationship with the City of Boulder in 1934, remained involved. In 1956, Veatch (as sole surviving founder) formed a partnership with 29 other engineers. Retaining the company name, the Black & Veatch firm opened the company's first offices outside of Kansas City—in Orlando, Florida, and in Denver, Colorado.

According to the 1950 census, Boulder's mid-century population had been 19,999. By 1960, it exploded to 37,718. Then, by 1970, it nearly doubled to 66,870. The cold war had ushered in an economic boom. When the press predicted "a disruption of Boulder's traditionally placid existence," they weren't far off.

EAST PEARL PLANT, 1957

Following the previous years' advice of the engineers in the *Phillips-Carter-Osborn Report,* the City built the East Pearl Plant where the Municipal Services Center is now located at 5050 Pearl Street. The plant was placed in service in December 1957.[71]

When the East Pearl Plant was built in 1957, it was well east of any new Boulder development. This photo shows the trickling filter with the primary and secondary anaerobic digester tanks in the background.
Carnegie Branch Library for Local History, 511-2-15-11

The East Pearl Plant was a secondary treatment plant with grit removal, bar screen and disintegrator, a primary clarifier, a trickling filter, a final clarifier, chlorination, a primary anaerobic digester, a secondary anaerobic digester, and sludge drying beds. In the mid seventies—when it operated simultaneously with the 75th Street Plant—a vacuum filter and a chlorine contact chamber were added. (Prior to this, chlorination had been done in the outfall line.)[72]

The City again hired the firm of Black and Veatch as consulting engineers. In their *Sewage System Report* of 1964, the firm described the then-current operation of the East Pearl Plant as follows:

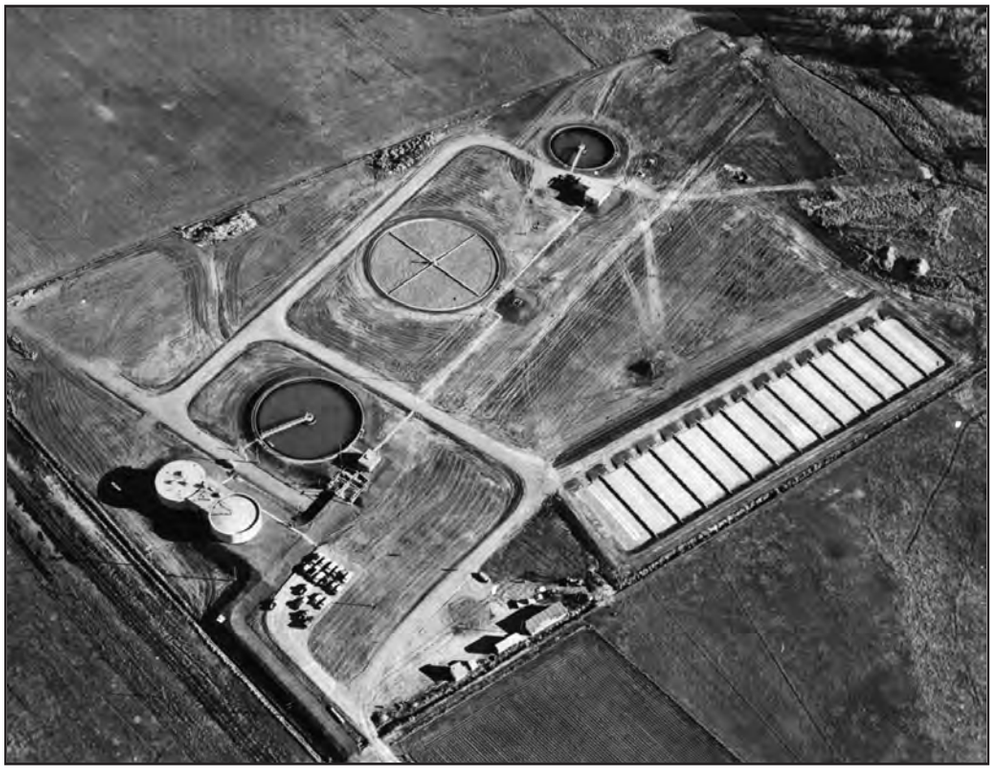
"The sewage enters the plant through a Parshall flume where the flow is metered. The

Parshall flume also controls the recirculating pumps which take suction from the final basin and return flow to the head end of the plant."

"The sewage then flows to the grit chamber which is equipped for mechanical grit removal and on to a screen house where it passes through mechanically cleaned screens. The screenings are run through a grinder and returned to the sewage which moves on to a distribution manhole. Here the flow may be split between the present and future works."

"The sewage now enters the single primary settling basin which is 110 feet in diameter and is equipped with sludge collecting and skimming equipment. The effluent from the primary basin flows to a high-rate trickling filter that is 175 feet in diameter and has a 3'-3" rock depth. Flows in excess of 9.5 million gallons daily by-pass the filter."

This aerial view of the East Pearl Plant clearly shows (from left to right) the primary and secondary anaerobic digester tanks, the primary clarifier, the trickling filter, and the final clarifier, as well as the sludge drying beds. The Union Pacific Railroad tracks are on the left, and Boulder Creek is just out of the photo, on the right. *City of Boulder*



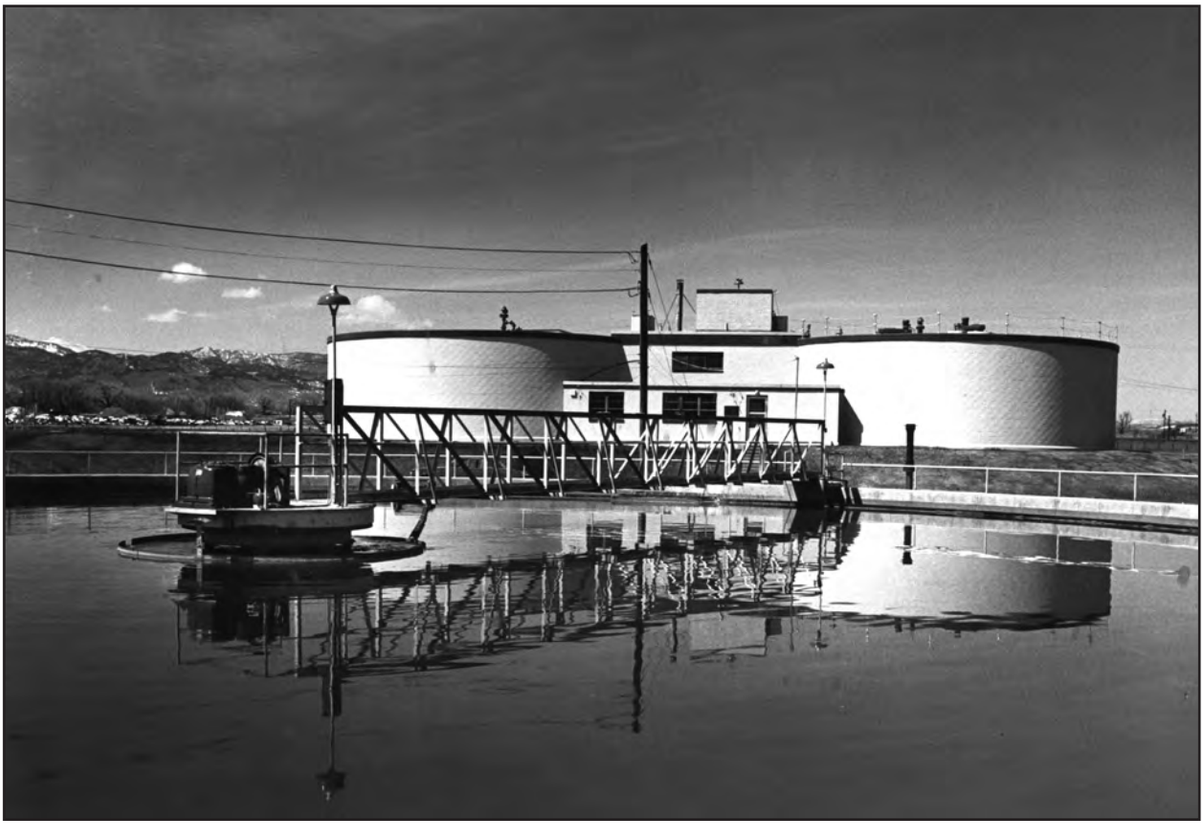
"The effluent from the trickling filter flows to the final basin which is 100 feet in diameter. The effluent from the final basin is chlorinated in the outfall sewer which carries the treated sewage to Boulder Creek."

The *Black and Veatch Report* continued: "The chlorine feed machines and chlorine storage are located in a building close to the final basin. This building also houses the three 900-gpm vertical turbine recirculating pumps which take suction from a sump under the structure."

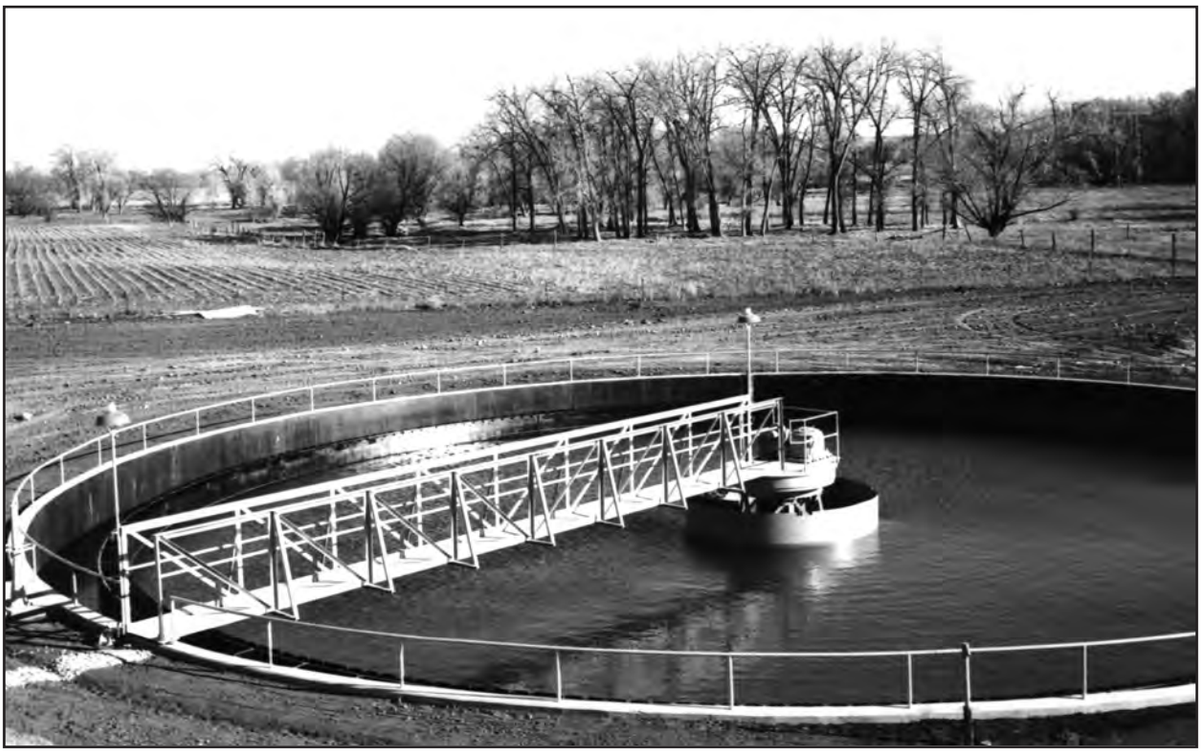
"A primary and secondary digester and a control house are located near the primary basin. The two digester tanks are each 55-feet in diameter, and both are 28-feet deep. Three draft tube mixers are located in the primary digester and a steel gas holder floating cover is located on the secondary digester. A heat exchanger is located in the control house."

"Sludge pumps in the basement of the control house pump the sludge from the primary basin to the primary digester. Offices, laboratories, and wash rooms are located in the control building. Two corrugated metal Quonset-type buildings are located on the site and are used for storage shop space."

Below is the primary settling basin and the primary and secondary anaerobic digester tanks.
Carnegie Branch Library for Local History, 511-2-15-12



Above is the trickling filter. Barely visible in the background, on the right, is the Public Service Coal Plant. Below is the final basin. *Carnegie Branch Library for Local History, 511-2-15-15 (above) and 511-2-15-14 (below)*



The 1964 *Black & Veatch Report* also gave the consultants' recommendation for the future:

"The existing sewer system and the sewage treatment plant [at the East Pearl Plant] are overloaded. Sewers have been extended about as far south, north, and east as practicable with the present system of trunk sewers. Major improvements are necessary if the sewer utility is to provide adequate service to the City of Boulder and adjacent areas. It is essential that a definite program of improvements be established and implemented at this time."[73]

Black & Veatch contracts in the early 1960s included:

- Contract #1, 1964: Interceptor sewer, Walnut Street to Skunk Creek-Empsom Ditch intersection
- Contract #1d, 1964: 75th Street STP and outfall sewer to plant
- Contract #2, 1965: Pearl Street STP, sludge dewatering equipment
- Contract #3, 1966: Pearl Street STP, vacuum filter building

At the time of this writing (2014) Boulder's most recent census figure, in 2010, gave the City's population as 97,385.[74] Now it's more than 100,000. However, when Black & Veatch prepared their report a half century ago, the City was growing so quickly that the consulting firm predicted Boulder's population would soar to 125,000 by 1985!

Black and Veatch stated the obvious—"The further down the stream the treatment works is located, the further east the limits of a reasonable service area can be extended."

The City wasted no time building a yet another new plant (the 75th Street Wastewater Treatment Plant) approximately 3.5 miles downstream on Boulder Creek.

Early years of the 75th Street Plant

Boulder's third sewage treatment plant—the 75th Street Wastewater Treatment Plant—was constructed in 1968 at its present location at 4049 North 75th Street, near Jay Road. The original plant had grit removal, comminuter (grinder), two primary clarifiers, a secondary pumping station, two trickling filters, two final clarifiers, a chlorine contact basin, a sludge holding tank and two vacuum filters. At the time, all sludge was vacuum filtered raw and hauled to the landfill, southeast of Boulder, at Marshall.

Arthur J. Dike had started working at the East Pearl Plant as a Maintenance Person I, in 1964. He saw, first-hand, the transition between the Pearl Street and the 75th Street plants. In 1985, Dike retired as Wastewater Superintendent for the City of Boulder. Before he left, he wrote a report titled *City of Boulder Wastewater Treatment Plant: History, Operations, Maintenance 1964-1985*.

Initially, the City had planned—when opening the 75th Street Plant—to take the East Pearl Plant out of service in order to expand and upgrade it, but the growth of the 1960s came too quickly, and the 75th Street Plant could not handle the whole flow.

The 75th Street Plant had some other problems, too. Its original pumps were rated at 3.5 MGD, giving a total capacity of 14 MGD, but they actually pumped much less, and the primary clarifiers often flooded out when the flow got over 11 MGD. One of the pumps was consequently replaced with a larger pump.

As Dike noted, in 1985:

> The 75th Street Plant had a design flow of 5.5 MGD and was put in operation on April 16, 1968. Then, in 1972, the plant was expanded to its present [1985] capacity of 15.5 MGD. The treatment plant has always been a trickling filter plant. The plant has generally been easy to operate, with a few exceptions, and a challenge. The secondary portion of the plant is dependent on the pumping capacity of the secondary pump stations. If the flow exceeds the capacity of the secondary pumps, the primary clarifiers will overflow to the effluent. As the history of the 75th Street Wastewater Treatment Plant shows, the secondary pump stations have been one of the most vulnerable areas.[75]

The following contracts with Black & Veatch document the engineering firm's work with the City of Boulder's 75th Street Plant between 1965 and 1968:

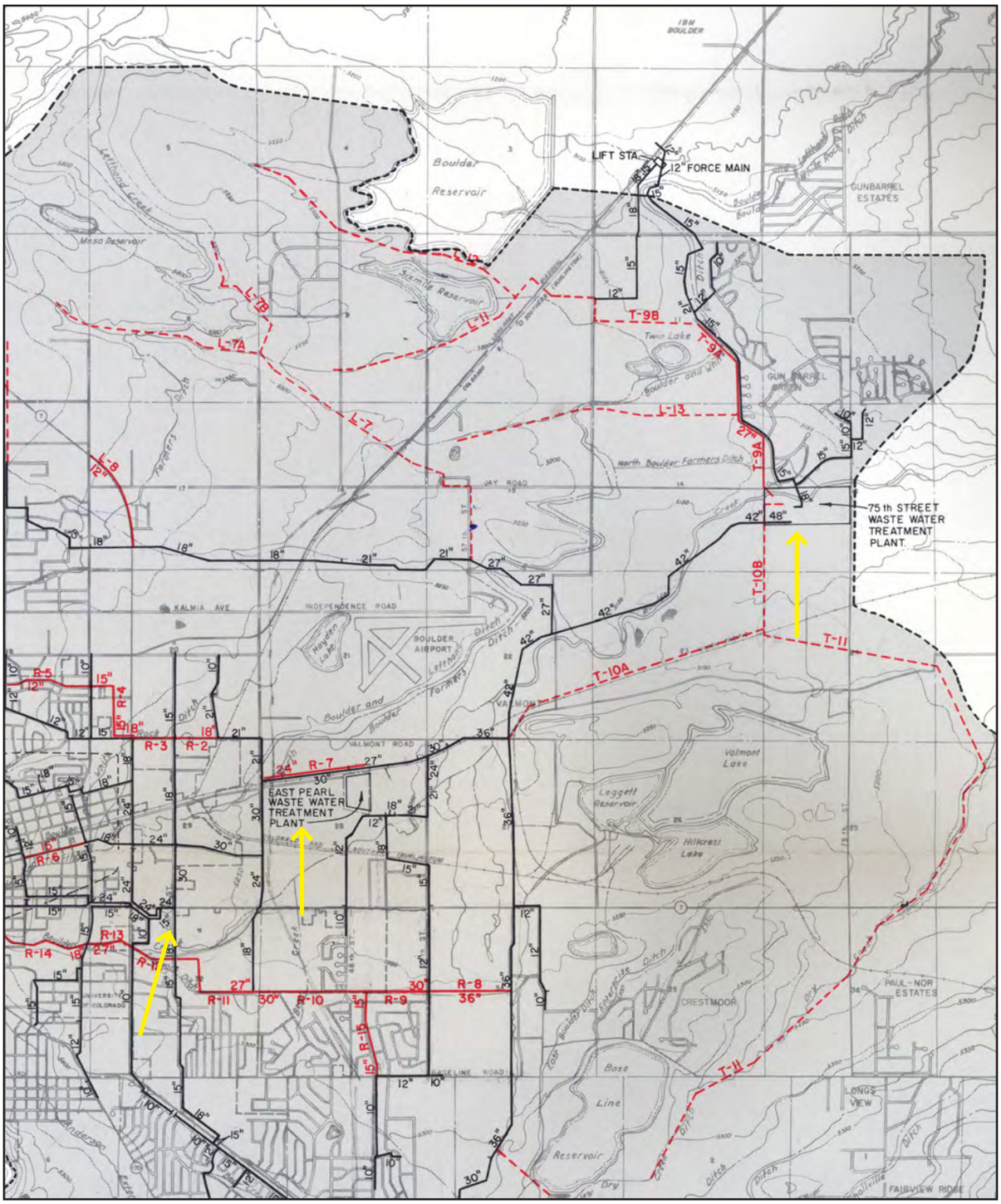
- Contract #4, 1965: IBM Force main sewer, gravity sewer, and pumping station
- Contract #5, 1966: This was THE PROJECT that constructed the 75th Street Plant and included a filter building, grit basin, primary basins, sludge pump station, secondary pump station, trickling filters, final basins, and a chlorine contact basin.
- Contract #6, 1966: Outfall sewer, Pearl Street STP to 75th Street STP, interceptor sewer, Arapahoe Road to outfall sewer
- Contract #7, 1967: Sanitary sewer, 47th Street and Pearl Street to Iris Street
- Contract #8, 1968: Sanitary trunk sewer (Section II), 19th Street and Upland to 26th Street and Norwood
- Contract #9, 1968: Walnut Street relief sewer
- Contract #10, 1968: Pearl Street STP, chlorine contact basin
- Contract #11, 1968: Cherryvale Road sanitary sewer, Baseline Road to Arapahoe Road

According to Dike, unknown substances coming into the sewer had always been a problem in the early days of the 75th Street Plant. In his report, he stated:

> A few weeks after the 75th Street Plant was put into operation, an explosion under the floor damaged the headworks building to the extent it had to be rebuilt. There was also a second explosion in the sewer line in the vicinity of Valmont Road and 61st Street. The explosive substance evidently came from a local chemical company. The headworks building was rebuilt with some modification, the incoming line was changed to an open channel next to the building, and the gas heater to the building was replaced with a furnace on the roof, not in the building.
>
> Explosions are always a hazard in sewer lines and treatment plants. Before there were good regulations on industry we frequently got batches of unknown chemicals that often had lots of color, generally black or brown, with very low or high pH. Needless to say, this was hard on our trickling filter operation.[76]

In Dike's history of the years 1964-1985, he explained that, by the mid-1970s, the East Pearl Plant was converted to primary treatment only, and the effluent was piped to the 75th Street Plant for further treatment. The East Pearl Plant continued in operation in this way until September 1980, when it was taken out of service.

Also during this time, the engineering firm of Black & Veatch was well on its way to becoming the global company that it is today, specializing in infrastructure development in energy, water, telecommunications, management consulting, and federal and environmental markets. Veatch, however, retired in 1973, and he died two years later.[77]



Shown above is part of the 1970 Sewer System Improvements map from the *Report on Sewerage and Treatment Facilities for Boulder Colorado* (Black & Veatch, 1970). Black indicates then-existing sewer lines. Red indicates then-proposed sewer lines. Yellow (added by author), from left to right: Site of the first sewage disposal plant (now Scott Carpenter Park), site of the Pearl Street Wastewater Treatment Plant, and the location of the current 75th Street Wastewater Treatment Plant. *City of Boulder*

The aerial photo, above, shows the 75th Street Wastewater Treatment Plant in 1969—shortly after it was built. 75th Street runs north-south, on the right. Note the two trickling filters on the left, as well as the two primary clarifiers and the two final clarifiers. *City of Boulder* Below is a view (looking north from the sludge holding tank) of three of the clarifiers. *Carnegie Branch Library for Local History, 511-2-15*

IMPROVEMENTS & SLUDGE TREATMENT/DISPOSAL IN THE 1970s and 1980s

Because of Boulder's continued and rapid population growth in the 1970s, the City again needed to upgrade its services, including its sewer system. Newly installed in 1969 at the East Pearl Plant were digester revisions (Black & Veatch Contract #13) and grit building repairs (Black & Veatch Contract #14).

At the 75th Street Plant, expansion (Black & Veatch Contract #16) included a new primary clarifier, new secondary pumping station, two new trickling filters, a new final clarifier, a new chlorine contact chamber, and a new standby generator. As Dike noted in his report, the 75th Street Plant was upgraded to 15.5 MGD capacity in 1972.

1972 also was the year that the Federal Water Pollution Control Act of 1948 was amended as the Clean Water Act (CWA). Specifically, these amendments:

- Established the basic structure for regulating pollutants discharged into the waters of the United States.
- Gave EPA the authority to implement pollution control programs such as setting wastewater standards for industry.
- Maintained existing requirements to set water quality standards for all contaminants in surface waters.
- Made it unlawful for any person to discharge any pollutant from a point source into navigable waters, unless a permit was obtained under its provisions.
- Funded the construction of sewage treatment plants under the construction grants program.
- Recognized the need for planning to address the critical problems posed by non-point source pollution.[78]

In addition, the Clean Water Act initiated a new challenge for the disposal of municipal sludge by creating a major increase in the volume of sludge to be handled and disposed of by cities across the United States. It also created the need for investigating new and innovative ideas of cost-effective methods of disposal, as well as utilizing the valuable properties of digested sludge that included nutrients and soils conditioning.

The use of drying beds had already become obsolete. Those in use at the East Pearl Plant had limited capacity to handle the anticipated increase in sludge volumes, plus the open system attracted vectors and emitted obnoxious odors and was not very efficient in rainy or snowy conditions.

In the 1970s, both the East Pearl Plant and the 75th Street Plant were in operation. Their post-1972 processes of handling sludge, however, were quite different.

EAST PEARL PLANT — SLUDGE

At the time, Sam Maphis was Boulder's City Engineer, and Andy Briscoe was Boulder's Director of Public Works. Together, the men formed Briscoe/Maphis and developed a subsurface injection disposal system that took liquid digested sludge out of a digester tank and applied it directly to the land, i.e. into the soil.

In a recent interview, Sam Maphis (who still lives in Boulder) stated, "It not only provided a more cost-effective method of sludge disposal, but it utilized the beneficial qualities of digested municipal sludge." After development of the subsurface injection system, in coordination with the City, Briscoe/Maphis provided more than 50 of the systems at other sites all over the country.[79]

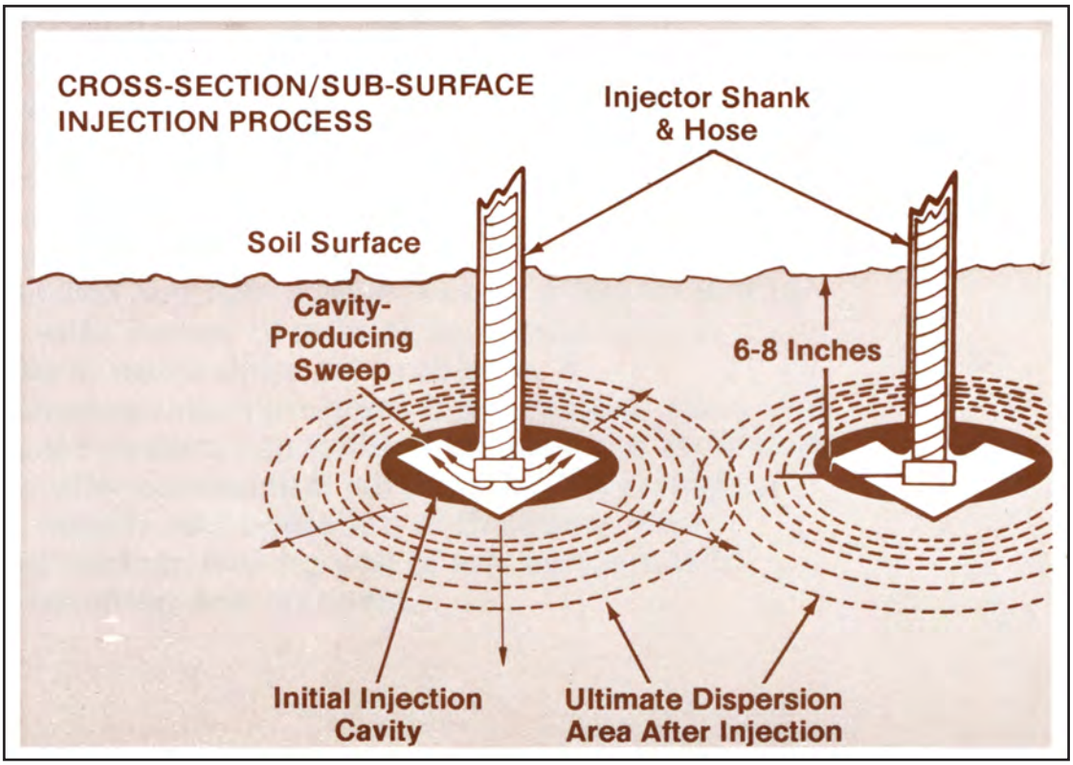
Boulder led the way, as the City was one of the first, if not the first, municipality to utilize land application via subsurface injection. The engineering firm of Black and Veatch also was directly involved in promoting and designing many of these land application system/sites via subsurface injection within Colorado, as well as in the other locations.

CONCEPT: The system concept of subsurface injection involves taking the liquid sludge directly from the digester and applying it to the land for disposal and utilization. This process eliminates the need for dewatering—along with its necessary equipment, hardware, chemicals, and support structure.

The first step in disposing of the liquid sludge is to inject the material approximately six-to-eight-inches under the soil. Then, the material is continually mixed with the soil and covered. A seven-sweep unit working six hours can dispose of 250,000 gallons of digested sludge per day. Since no sludge material is exposed to the surface, the problems associated with drying beds are eliminated.

The injection hardware, constructed in a manner similar to standard agricultural equipment, is powered by small crawler-type tractors, with three to nine sweeps/injectors depending on system requirements, sludge quantities, soil conditions, and available power. Each sweep/injector is capable of a flow of approximately 100 GPM.

SYSTEM: The system requires pumping/piping hardware to transport the liquid sludge to the sub-surface injection unit in the field, with site-specific designs based on sludge characteristics, loading rates, ground water, crops to be grown, and other environment considerations. Boulder's Pearl Street site included all of these design considerations and was permitted by the State. Monitoring of the ground water was required at all sites to ensure that the disposal operations did not negatively affect existing properties.



Above, the subsurface injection process begins with injecting liquid sludge six-to-eight inches under the soil. In the below photo (not in Boulder County), a tractor pulls an injector. The hose containing the liquid sludge is attached in the middle. *Both photos, Sam Maphis*

The East Pearl Plant was ideally situated for the development and utilization of this system, as the site included a 20-acre land parcel adjacent to the digester units. The sludge solid content was approximately one-to-two per cent and could vary up to four per cent and was pumped from the digester (using a standard portable diesel centrifugal pump) thru aluminum pipe to the injection unit that utilized a 660-foot rubber hose.

The hose gave the injection unit the flexibility to continually dispose of the material without stopping the sludge flow. And, a single connection could cover an area of 10-to-20 acres. The site used a loading rate based on the sludge characteristics, ground water conditions, and the need of the crops—primarily corn—which utilized the nutrient qualities of the sludge and at the same time removed potential contaminates to the local ground water.

Basically, the site design loading rate for sludge disposal and utilization is a balance, i.e. sludge material placed in the soil was utilized by the crops and, thus, had no negative effect on the local environment.

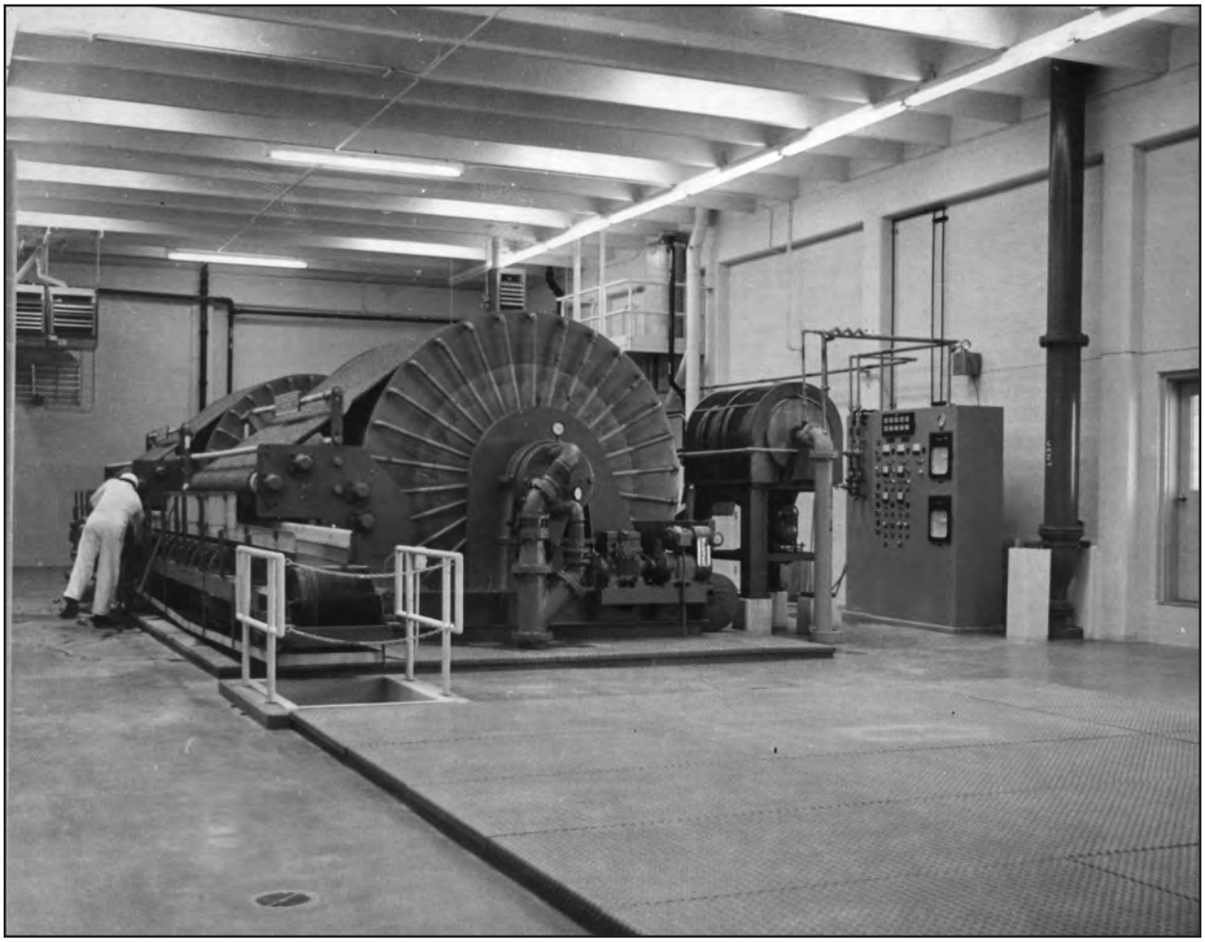
Sections of aluminum pipe are shown next to the injection unit when subsurface injection was used in the 1970s at Boulder's East Pearl Plant. *Sam Maphis*

The above photo of land adjacent to Boulder's East Pearl Plant gives a good overview of the subsurface injection disposal system. *Sam Maphis*

"The utilization of digested sludge for positive properties saved many farmers (with fields adjacent to waste treatment plants) hundreds of thousands of dollars in not having to buy commercial fertilizers," said Sam Maphis. "We are proud of Boulder's involvement in developing this cutting-edge system and utilizing its valuable properties in a cost-effective and environmentally safe manner. I had predicted, and still feel, that someday municipalities would charge users for their sludge material rather than paying users for its disposal."[80]

75th STREET PLANT — SLUDGE

Unlike the East Pearl Plant, the 75th Street Plant had no adjacent land suitable for subsurface injection. From 1968 (when the plant opened) until January 1981, sludge at the 75th Street Plant was vacuum filtered raw and hauled to the Marshall landfill. The use of the landfill, however, came to a halt in 1982 when the Environmental Protection Agency (EPA) declared the landfill a Superfund Site due to local surface water and groundwater contamination. (See following pages.) This was partly because of the sewage sludge, as well as other municipal/industrial waste.



A vacuum filter was used to remove excess water from sludge during the early days of the 75th Street wastewater treatment plant. *Carnegie Branch Library for Local History, 511-2-15*

While the sludge from the 75th Street Plant was still going to the landfill, however, the Boulder County Health Department required the City to reduce the pathogenic bacteria to zero in the landfill sludge filter cake. Dike wrote about this in his report, stating that "a system was developed using lime in the holding tank." He stated that the procedure worked very well to kill the pathogenic bacteria as long as a pH of over 11 was maintained, with a minimum detention time of 30 minutes.

The County was satisfied with the results of the tests of the filtered sludge, but the high lime sludge would not filter well with the polymer Dike had been using. "Very few polymers will work at a pH above 9," he wrote, "however we did find a polymer that worked (America Cyanimid l563C), and we used it until we quit filtering sludge in January 1981." At the time, the sludge tank at the 75th Street Plant was emptied and cleaned out every Friday. Dike made it clear that one of the most important parts of the successful operation of any wastewater treatment plant is having control of the sludge.

In September 1980, the City installed two anaerobic digesters—1.25 million gallons each (Black & Veatch Contract #19). Dike explained that a start-up procedure used was to fill both digesters half full of water from the primary clarifiers. Then, the natural gas boiler was used to bring the digester temperature up to 95.0 F, and the gas compressor was used to mix the digester continuously.

Lime was added with the sludge to keep the pH balance at a neutral level. Initially the skimmings (grease) were not added to the digester, but, instead, were filtered with a small amount of raw sludge. Dike noted that the procedure didn't work well, and the decision was reluctantly made to add the skimmings to the digester.

When the digested solids began to be produced, a new method of disposal had to be developed. A truck loading station was designed by the superintendent and installed by the plant mechanics utilizing existing sludge lines at a minimum of expense. A contractor was hired to start hauling sludge to farm land where cake material was spread and then disked it into the soil.

In the fall of 1981 the City obtained a sludge hauling truck of its own, a replacement for one of the sludge dump trucks. According to Dike, sludge was initially hauled to the East Pearl Plant either to lagoons (originally referred to as drying beds) or to the established injection site and top spread. Other sites belonging to the area farmers have been approved by the State over the years since 1981. Today there are approximately 2,500 acres that have been approved under the State guidelines.

In 1984, a used 2,500 gallon tank was purchased and mounted in place of the dump box on a treatment plant truck, making a total of two trucks for sludge hauling. More than 50 per cent of the sludge was hauled between the two trucks and the equivalent of two drivers. Dike noted that he believed the most feasible and beneficial plan for sludge disposal would be to continue land utilization of the sludge, adding, "There should not be any problem staying ahead of the sludge with good operational control."[81]

Additional Black & Veatch projects from 1970 through the mid-1980s included:

- Contract #15, 1970: South Boulder Road relief sewer
- Contract #12, 1970: Marshall trunk sewer, survey, and drawings
- Contract #16, 1971: 75th Street STP, additions, inlet structure, primary basin, secondary basin, secondary pump station, trickling filters, final basin, chlorine contact basin
- Contract #17, 1970: Sewerage pumps, IBM lift station and 75th Street STP secondary

pump station modifications

- Contract #18, 1975: Boulder Creek relief sewer
- Contract #19, 1978: 75th Street facility improvements, administration building, maintenance building, filter building, sludge thickener, headworks, anaerobic digesters, scrubber building, sludge pump station
- Contract #19A, 1977: 75th Street facility improvements, trickling filter covers
- Contract #20, 1981: 75th Street facility improvements, design only
- Contract #20A, 1981: 75th Street facility improvements, AST (advanced secondary treatment), design only
- Contract #21, 1982: 75th Street facility improvements, sulfur dioxide building, headworks modifications
- Contract #22, 1985: 75th Street facility improvements, mechanical building, chlorine contact basin, septage handling facility, flood-proofing dike, cogeneration project[82]

Also in 1985, Richard P. Arber & Associates initiated a sludge study on the future of the land application program. This was followed by Requests for Proposals (RFPs) for solids handling improvements—a big change in the way that the plant improvements were conducted. Consultants issued proposals, then plant staff, in conjunction with Utilities Engineering, reviewed the proposals and invited three-to-five firms to give their presentations. The best firm was chosen based on the consensus of the review group.[83]

The secondary digester (with a floating cover) has approximately 64,000 cubic feet of gas storage capacity. *Pettem photo, 2014*

Meanwhile, the sludge holding tank was changed to a sludge thickener. New buildings at the 75th Street Plant included an administration building, a laboratory, and a maintenance shop, and the trickling filters were covered.

The Sludge Processing Improvements (SPI) Project, in 1987-1989, included headworks modifications, with new bar screens, pneumatic grit and rag conveyance, rag dewatering, and a dumpster storage room. Solids processing improvements consisted of a second gravity thickener, upgrades of the sludge transfer pump station, sludge processing building, thickened sludge storage tanks and a centrate equalization tank. A Terragator sludge injector and a tractor trailer sludge tanker also were part of this contract. Richard P. Arber & Associates was the design engineering consultant, and Terry Kenyen was the City's Project Manager.

The Cogeneration Facility—to generate electricity from digester gas—was part of Black & Veatch's 1985-1986 contract (#22). A new mechanical building housed two 300 kW engine generators, along with a new electrical equipment, a load management system (LMS) with programmable logic controllers (PLC), and a septage receiving station. The project also included the addition of the flood protection berm/levee surrounding the 75th Street Wastewater Treatment Plant.[84] Bob Harberg, currently Principal Engineer—Utilities, was employed, at the time, by Black & Veatch and served as the resident project representative. This project was promoted by Bob Wheeler who was then the City's Coordinator of Treatment Operations. June Busse was the City's Project Manager.

The two trickling filters were covered in 1980. They are no longer in use, but the space they occupy may, one day, be used for expansion or new treatment processes. *Pettem photo, 2014*

Many of the improvement projects in the 1970s and 1980s were partially funded by the Environmental Protection Agency's Construction Grants Program.[85] Several of the projects — including cogeneration, the trickling filter/solids contact/nitrifying trickling filter, and the solids processing improvements — received additional funding because they qualified as innovative and alternative technologies.[86]

After Arthur Dike's retirement, he was honored in an unusual way. In August 1986, the 75th Street Wastewater Plant had a visitor—an alligator.

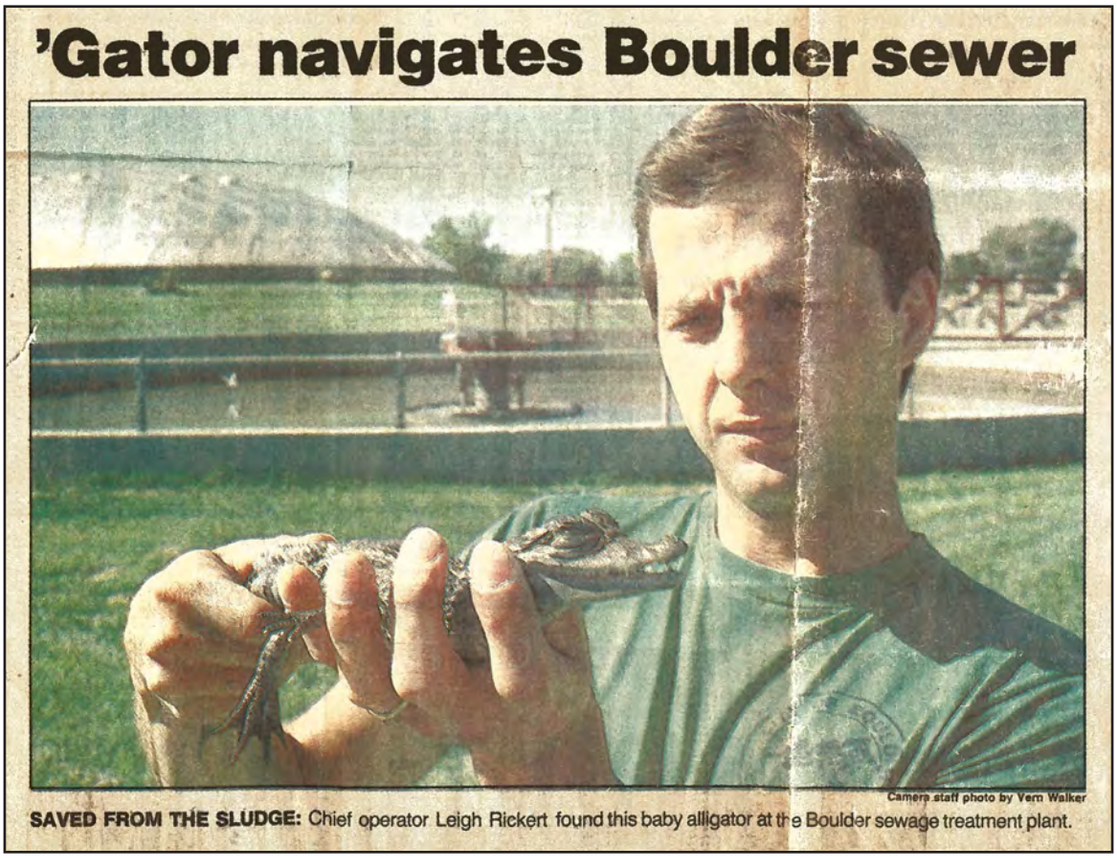
> TREK STARTS WITH FLUSH, ENDS IN SLUDGE
>
> by Sally McGrath (Boulder Daily Camera, September 12, 1986)
>
> Arthur S. Alligator is recovering from what Boulder sewage plant operators believe was one rough ride through miles of sewer pipes that started with a flush down a toilet.
>
> The 18-inch baby alligator, who is recovering at the Boulder County Humane Society, was discovered in a deep grease pit at the sewage plant.
>
> Leigh Rickert and Harry Watson found the reptile peeking at them while they were pumping grease out of a collection area at the plant at 75th Street and Jay Road.
>
> "He was very feisty at first," said Rickert. They tried unsuccessfully to rake him out of the grease, then called the Humane Society for assistance. Although tales of alligators living in sewer pipes are common in New York City, it was a first for Boulder.
>
> "It was the weirdest call I ever made," Rickert said.
>
> Animal control officers lassoed the gray and white alligator from the deep pit August 24 and gave him a temporary home at the Humane Society.
>
> They washed the grease off him with dish soap, lodged him in a heated aquarium and placed him on a diet of goldfish, crickets, and worms. They are looking for a foster family to keep him until he is older, and they expect he will end up in a zoo.
>
> "He's going to be a big guy," said Society director Jan Glick.
>
> Knox said the alligator may have come from a University of Colorado dormitory. The Humane Society had heard that a CU student was keeping a pet alligator in a dorm room and a maid there had refused to clean the room.

When a dorm inspector checked for the reptile, it wasn't there. Knox theorized that the student might have flushed the alligator down the toilet.

Humane Society officials and sewage plant operators doubt that he entered the sewage system any other way. "I can't imagine how else he'd come up where he came up," said Glick. The plant operators dubbed the alligator Arthur in honor of retired plant superintendent Art Dike.

The Humane Society gave him another name--Stan, short for Standard, a common brand of toilets. Glick said the reptile would have perished if he had been left alone among the sludge.

"If we hadn't gotten him out of that sewer plant," he wouldn't have survived this winter," she said.[87]



'Gator navigates Boulder sewer

Camera staff photo by Vern Walker

SAVED FROM THE SLUDGE: Chief operator Leigh Rickert found this baby alligator at the Boulder sewage treatment plant.

This previously folded newspaper clipping, from September 12, 1986, is all that survives in memory of Arthur the alligator. (Art Dike died at the age of 76, on June 5, 2004, and in buried in Longmont's Mountain View Cemetery.) *Leigh Rickert*

CITY'S ROLE IN MARSHALL/BOULDER LANDFILL CLEANUP

In September 1983, the Marshall/Boulder Landfill was listed on the National Priorities List (NPL) due to the release of contamination to irrigation and drinking water. A major concern was the contamination of water flowing in Community Ditch because it serves as a source of drinking water for the City of Louisville. In response to this concern, a 60-inch pressurized pipeline was installed to convey the water across the inactive landfill.

Several sources of contamination were identified during the Remedial Investigation/Feasibility Study (RI/FS), which was conducted in 1986. Of significant concern was contamination of onsite groundwater within the shallow alluvial aquifer which included volatile organic compounds (VOCs) such as benzene, trichloroethene (TCE) and tetrachloroethene (PCE), as well as heavy metal such as barium, iron, manganese and zinc and major ions that included chloride, nitrate and sulfate. Fortunately, no contamination was identified in the deeper bedrock aquifer.

Then, in September 1986, the United States Environmental Protection Agency (EPA) issued a Record of Decision (ROD) which selected a remedial alternative (Remedy) for the cleanup of the Marshall/Boulder Landfill. The following Remedy objectives were stated as follows:

- Assure that all surface water discharge from the landfills do not adversely impact the current or planned future beneficial uses of the surface waters in this area or any other waters that it may contact.
- Control the generation of contaminated groundwater at the Site.
- Assure that any offsite contaminated groundwater originating at the Site does not adversely impact the possible beneficial uses of the groundwaters in this area or any other surface waters and groundwaters it may contact.
- Eliminate or control the impacts resulting from leachate seepage in the landfills.

The major components of the Remedy selected by the ROD include:

- Elimination of offsite transport of contaminants emanating from the Site by constructing a drain or series of drains to capture shallow groundwater along the entire southern and eastern site boundaries.
- Treatment of contaminated groundwater in a facility consisting of equalization/sedimentation basins, an air stripper, and carbon adsorption of air stripper off gas (vapor-phase granular activated carbon, or VGAC).
- Implementation of an environmental monitoring program to verify the effectiveness of the remedial action and to assure protection of public health.
- Completion of landfill improvements, including regrading, revegetation, perimeter ditches and fences to minimize future environmental and public health impacts from the Site.
- Drainage of existing leachate lagoons and transfer of the liquid to the treatment system.
- Redirection of the discharge of the existing French drain (installed to collect seepage

during landfill operations) to the treatment facility.

In March, 1989, the City and Landfill Inc. (LI), a wholly owned subsidiary of Browning Ferris Industries (BFI), entered into a Consent Decree (CD) with the EPA whereby the City and LI agreed to design, construct, and operate the Remedy specified in the ROD. The City and LI retained Harding Lawson Associates (HLA) to design the Remedy. Additional site investigations were performed during 1989 and 1990 in order to provide information needed to design the collection and treatment systems specified in the ROD and determine the remediation standards.

Based on the findings of these investigations, EPA, in 1992, issued an Explanation of Significant Differences (ESD) to the 1986 ROD Remedy. Significant modifications to the Remedy as originally selected included:

- The groundwater collection system was changed to consist of a well array along most of the eastern site boundary and a collection trench along part of the southern and eastern site boundaries instead of the series of drains specified by the ROD.
- Breakpoint chlorination/dechlorination was added to the treatment system to remove ammonia from collected groundwater prior to its discharge.
- In addition to the air stripper and air stripper off-gas carbon adsorption system specified in the ROD, a liquid-phase carbon adsorption system (liquid-phase granular activated carbon, or LGAC) was added to remove VOCs.
- The effluent limitation for chloride was changed from 280 mg/L to 320 mg/L, after the Colorado Water Quality Control Commission modified the numeric water quality stream standard for chloride to 320 mg/L.

A final remedial design was submitted and approved by the EPA in May 1992, and construction commenced during the summer of 1992. Construction of the remedial facilities was completed in the summer of 1993, and operation of the collection and treatment systems was initiated.

Progress during the late 1980s and 1990s

The alligator found in a preliminary [primary] classifier, in 1986, was the most unusual item to surface in any of Boulder's wastewater treatment facilities. But, other oddities have been retrieved or are known to have passed through, as well. Employees have found jail clothing, likely flushed by disgruntled inmates at the Boulder County Jail. Occasionally, the plant gets calls from people who report lost rings, but none have reportedly been recovered.

Jail clothing passes through the wastewater facility from time to time. These items date from circa 2011. *City of Boulder*

Many changes had been made during the early days of the 75th Street Wastewater Plant, and more were to come. During the years 1989 and 1990, the main treatment process was officially converted from a Trickling Filter process to a Trickling Filter / Solids Contact (TF/SC) process. The treatment capacity was also increased to 20.5 MGD (maximum month flow).

One of the reasons for modifying the treatment process was to comply with new ammonia removal requirements. Boulder Creek had been identified as impaired for ammonia and, to gain compliance, the wastewater treatment plant needed to comply with new Environmental Protection Agency ammonia water quality criteria. The conversion was part of Brown and Caldwell's Phase 1A Project that spanned the years 1987-1990.

Additional improvements at that time included the following:
- Relocation of the IBM/Gunbarrel influent sewer
- By-pass junction structure
- Influent junction structure
- Conversion of old secondary clarifier #3 to primary sedimentation tank #4 (PST4)
- PST4 sludge pump station
- New secondary pump station
- 4 solids contact aeration tanks (SCT)
- 3 secondary clarifiers
- Nitrification trickling filter (NTF) and associated pump station.

Brown and Caldwell's Phase 1B Project officially moved the plant's outfall downstream (east) approximately 500 feet. Other changes during the years 1988-1990, included:
- Headworks by-pass channel
- PST4 lift pump station with screw pumps
- Primary sludge pump station modifications with new sludge pumps
- New plastic weirs to PSTs 1, 2, 3 & 4
- New chlorine contact basin
- New chlorination system
- New sulfur dioxide system
- New effluent structure
- Operations control center and SCADA
- New water quality lab attached to the Administration Building.[88]

LOWER BOULDER CREEK ENHANCEMENT PROJECT

Numerous studies have been undertaken to assess the stability of Boulder Creek's ecosystem and its ability to meet warm water aquatic life criteria. A Use Attainability study completed in 1987 evaluated physical, chemical, and biological indicators for aquatic life in lower Boulder Creek (that section of segment 9 between the wastewater treatment facility and Coal Creek). The study—named the Lower Boulder Creek Enhancement Project—concluded that degradation of the creek's riparian zone was the most significant factor affecting fish, and that ammonia removal at the facility alone would not achieve warm water 1 fishery conditions.

The enhancement project combined existing and new stream restoration techniques to address a fundamental problem of surface water pollution.

Brown and Caldwell's Wastewater Facilities Plan recommended that the City pursue the feasibility of an alternative process (stream enhancement) to address future Ammonia concerns. The concept of stream enhancement is based on the impact which the stream itself has on ammonia released from the wastewater treatment facility. Under current Division models, the City is held primarily responsible for the maintenance of water quality standards throughout the 8.5 mile reach below its facility.

The City's Use Attainability study showed the lower section of Boulder Creek to be adversely affected by land use practices resulting in loss of riparian vegetation, loss of stream-bank stability, channelization, erosion and hydraulic modification. These practices had created conditions promoting the conversion of ammonia to its un-ionized form, and reducing the quality of aquatic habitat for both fish and food chain organisms. To counteract these conditions, the City proposed a demonstration project to evaluate best management practices (BMPs) for riparian enhancement. A phase I project received grant support from the State's Non-Point Source Pollution Control Program in 1989-90, followed by a second phase in 1990-91. The total length of Boulder Creek proposed for enhancement (75th Street to Coal Creek) is 8.5 miles. Cost estimates for this total project were $1.3-1.4 million.[89]

According to Bob Harberg, the approach improved the health of the stream and effectively delayed the need for construction and operation of new costly treatment processes at the wastewater treatment facility for more than a decade.[90] Chris Rudkin, then the City's Coordinator of Water Quality and Environmental Services was influential in promoting this project.

MORE ON SLUDGE

In 1991, after the U.S. Congress banned the ocean dumping of sludge, the U.S. Environmental Protection Agency (EPA) instituted a policy of spreading digested sludge on agricultural land, as spelled out in a 20,431-word federal regulation—40 CFR Part 503, STANDARDS FOR THE USE OR DISPOSAL OF SEWAGE SLUDGE. During this same time, the Water Environment Federation (a wastewater industry organization) made a push to substitute the word "biosolids" for sewage sludge and promoted the policy by presenting the land application as "recycling."

The City of Boulder had been recycling biosolids through application to farm land on Gunbarrel Hill for many years, but the process was largely unknown by the public. Development pressures in the area suggested that if the City was to continue to utilize this land that was in such close proximity to the Wastewater Treatment Facility, it would need to acquire the land or buy out the development rights.

In 1992, the Boulder Utilities and Open Space departments studied the use of digested sludge/biosolids for land application on the city's 25,000 acres of Open Space. However, none of the properties were deemed appropriate. Then, in 1994, the City (in coopera-

tion with Boulder County Open Space) did purchase land for digested sludge/biosolids application on sites within 10 miles of the 75th Street plant. For most people, though, the name changes didn't change their negative opinions. Neighborhood opposition was strong, with more than 500 people turning out for one meeting in October 1994.

Members of the public even formed a group called "Neighbors Opposed to Biosolids" (NO BS.) In the mid-1990s, the recycling/disposal of sludge had become a big controversy in the Boulder community. When a landowner between Lafayette and Erie offered the use of his land, Erie's town leaders blasted the Boulder City Council. The Rocky Mountain News reported on the controversy in a January 4, 1996 article titled, "Boulder Sludge Proposal Really Stinks." Because of public outcry, the land application of biosolids in Boulder County was abandoned.

In the end, the City's biosolids program (which had operated entirely within Boulder County) was forced to move its operation into eastern Adams County, farther from urban sprawl. The change required all processed biosolids to be trucked 130 miles round trip from the 75th Street plant to the new land application sites.[91]

The above equipment was used for land application of sludge in the 1990s. *City of Boulder*

BOULDER'S BIO-TECHNOLOGY INDUSTRY

During the early 1990s, Boulder's bio-technology industry exploded with several new or large bio-technology companies either moving to or expanding within Boulder. These included Synergen (currently Amgen) and Somatogen.

In 1991, Somatogen approached the City requesting expanded water and wastewater service for a planned production facility for a new genetically engineered red-blood-cell substitute. In addition to large amounts of water, the planning production facility was expected to increase wastewater loads by 100 per cent, if it wasn't pretreated. Even with pretreatment, the wastewater load would be large and require significant improvements to the wastewater treatment plant.

At this time, Boulder did not have a rate structure that properly accounted for the impact of large water demand or wastewater loads. As a result, new plant investment fees were established to better account for large water demands and wastewater loading based on parameters such as flow, suspended solids, biochemical oxygen demand and ammonia.

An agreement between the City and Somatogen was executed to account for the proposed impact on Boulder's utility systems. Somatogen completed the construction of a pilot scale facility in 1993. However, the clinical trials for the red-blood-cell substitute product were a failure, and Somatogen never proceeded with the production scale facility.

Bob Harberg managed the analysis of this issue and worked with Ned Williams (then Assistance Director of Public Works for Utilities) and Dave Rhodes (then Director of Public Works) to obtain City Council approval of the new plant investment fee and rate structure approach.

Dave Rhodes was Director of Public Works from 1985 to 2000

ADDITIONAL CHANGES IN THE 1990s

The above aerial view shows the 75th Street Wastewater Plant circa 1990. *City of Boulder*

A study was conducted in 1990 for the effects of water plant ferric chloride residuals on the anaerobic digesters. No adverse effects were found from the residuals addition; in fact the opposite was noticed because it reduced struvite (magnesium ammonium phosphate) which builds up in piping systems and blocks the flow of liquids.

In 1991 a direct sewer line was put in from the 63rd Street Water Treatment Plant to the IBM lift station. Also in 1991, as a SPI Phase II Project, Richard P. Arber & Associates made centrate line modifications and line cleanouts, and installed a centrate pumping station.

Modifications were made to the solids contact drain system in 1991, to allow for removal of a large amounts of snails found in the basins during cleaning. This was a Brown and Caldwell designed modification in which plant staff managed and contracted the work by Hirschfeld Backhoe and Pipeline. The modification involved installing valves

and a tee to divert the drain line from solids contact around the secondary pump station to the scum sump at the station. The discharge piping at the secondary scum sump was diverted to the headworks upstream of the west grit chamber. A new slide gate was installed between the east and west grit chambers to allow the west to be isolated for snail removal.[92]

Also installed in 1991 was a heat exchanger that used plant effluent as the cooling water in the engine generator cooling system to remove excess heat. The heat exchanger supplier designed the installation, plant staff managed the project, and USA Construction, Inc. did the installation. The project was driven by numerous noise complaints from the roof-mounted radiator fans that were installed with the engine generators.

In 1993, additional improvements included removing the pneumatic rag conveyance system from the headworks and installing shaft-less screw conveyors. This modification was designed by the supplier, managed by plant staff, and installed by USA Construction, Inc. The pneumatic rag conveyance system was removed because of repeated concerns over safety and hygiene of airborne aerosols.

The next phase of the snail removal occurred in 1995 and involved installing valves and interconnects to tie the tank drain line into the building drain line. This was a Brown and Caldwell designed modification, which plant staff managed and contracted the work by Hirschfeld Backhoe and Pipeline. The staff also installed valves and interconnects to tie the secondary scum line into the drain line.

Also in 1995, the centrate equalization basin was modified to allow for a larger storage volume. Plant staff designed and managed this project, and the work was contracted by USA Construction, Inc., which required the catwalk to be raised and rotated. The aluminum dome was modified with an entry doorway for access.

Due to poor performance, gravity thickener #2 was modified in 1996 to match gravity thickener #1. The equipment supplier designed the modification, plant staff managed the project, and USA Construction, Inc. contracted to perform the work. The center ring was attached to the center column to allow it to rotate and the dispersion ports were also modified to match.

In 1996 upgrades were started on the LMS/PLC system in the plant. Hardware and PLCs were replaced around the plant and work began on the installation of the Intellution operator interface program. This on-going project was performed by plant staff.

A back-up dechlorination system was designed by Integra Engineering and installed in 1997. This system uses sodium bisulfite (SBS) to reduce chlorine residual.

The large trickling filter center columns were replaced in 1997. Plant staff managed the replacement and USA Construction, Inc. contracted to perform the work.
Headworks Improvements Phase I, designed by Rothberg, Tamburini & Winsor, Inc.,

were installed in 1998. This contract modified the grit chambers, replaced the bucket elevator system with grit slurry pumps and installation of a Hydro-gritter (grit classifier) over the dumpster.

In 1998, secondary digester floating cover roller guides were replaced after the cover tipped. The equipment supplier designed the modification, plant staff managed the project, and USA Construction, Inc. contracted to perform the work. The guides were replaced, due to tipping and binding, with slide guides.

Phase I of the aluminum slide gate replacement started in 1999, followed by Phase II in 2000. The aluminum gates were in need of replacement due to the corrosion possibly caused by the ferric chloride sludge that plant was receiving from the 63rd Street Water Treatment Plant. In 1999, seven of the aluminum slide gates were replaced with stainless steel slide gates.

In 2000, the remaining four aluminum slide gates in the solids contact process were replaced with stainless steel slide gates. Three aluminum slide gates for the secondary clarifiers and five aluminum slide gates at the chlorine contact basin were replaced at this time with stainless steel slide gates. Plant staff managed the replacements, and USA Construction, Inc. contracted to perform the work.[93] Plant staff including Floyd Bebler, Ernie Oram, and Leigh Rickert were instrumental in directing this work.

Twenty-first-century improvements

The 21-st-century ushered in even more improvements, including significant changes in the biosolids program, a switch from chemical to ultraviolet disinfection, and solar photovoltaics. Some of the wastewater plant improvements were driven by additional regulatory requirements which are discussed below. This chapter will highlight some of the changes and bring the reader up to date with the present-day operations at the 75th Street Wastewater Treatment Facility.

2000-2005

The City Utilities and the Fire Department purchased the Valmont Butte property in 2000, with future plans to construct a Biosolids Composting Facility and Fire Training Center. The project was later delayed, and then abandoned in 2006, due to public concerns.

Also in 2000, Rothberg, Tamburini & Winsor, Inc. conducted the **IBM Sewage Pump Station Improvements** project, which involved converting the lift station pumps from constant speed to pumps that run on variable frequency drives (VFDs). The project also included pump station controls and alarms, as well as other minor miscellaneous modifications.

In February 2001, the plant received a large slug load of water plant ferric chloride residuals, which overloaded the sludge pumps, inhibiting the growth of biofilm on the trickling filters and shocked the solids contact organisms. The plant recovered in 6-8 weeks, and, as a result, a pretreatment permit was issued to the 63rd Street Water Treatment Plant.

That same year, the secondary pump station scum pit was modified. The equipment supplier designed the modification, plant staff managed the project, and USA Construction, Inc. contracted to perform the work. A new pump replaced the existing one, a second larger pump was added, as were mixer, piping and level controls. This modification was done to accommodate the larger flows encountered during snail cleaning.

Headworks Improvements Phase II was designed by Rothberg, Tamburini & Winsor, Inc. in 2001 and completed in 2002. The contract replaced and upgraded the HVAC in the

screenings and dumpster room.

The two small trickling filter center columns were replaced in 2002. Plant staff managed the replacement and USA Construction, Inc. contracted to perform the work.

The **Effluent Pipeline Replacement Project** was designed by Brown and Caldwell and completed in 2003. The plant outfall was relocated down-stream of a new City of Lafayette raw water diversion structure, to a location east of the 75th Street roadway. This was done as a cooperative agreement (IGA – intergovernmental agreement) with Lafayette to provide them with a cleaner raw water source.

In 2003 Integra Engineers was contracted to perform a study on the secondary process, primarily for ammonia removal. The study looked at nitrification in the Nitrifying Trickling Filter (NTF) and the Solids Contact tanks. This study led to several major secondary treatment improvement projects, which are described below.

Rothberg, Tamburini & Winsor, Inc. conducted a project called the **Anaerobic Digester Building HVAC & Other Improvements**, in 2004. The project upgraded the HVAC systems for the digester complex, and other minor building modifications were completed.

With a new NPDES permit in negotiations it was found that the state was looking at much stricter effluent limits, specifically for ammonia-nitrogen (NH3-N). An RFP was sent out, and firms were interviewed for a study of the process and what would be needed to comply with the new permit limits. In early 2004, Brown and Caldwell was contracted to perform the study. The conclusion from the study was that the TF/SC followed by the NTF process should be abandoned and a new Activated Sludge with Biological Nutrient Removal (BNR) process selected.

Because of the delay in the Valmont Butte project, Rothberg, Tamburini & Winsor, Inc. Engineers worked with staff and designed the **Interim Centrifuge Facilities project** in 2005. This project replaced the two tube-in-tube sludge heat exchangers with three spiral sludge heat exchangers, and added a third centrifuge into the existing biosolids processing building. USA Construction performed the construction and installation work.

Randy Earley was the City's Project Manager in 2004, when the firm of Brown and Caldwell was contracted to do the design work consisting of a new Secondary Pump Station, demolition of the large TFs to make space for the construction of the Aeration Basins, the Fourth Secondary Clarifier, retrofitting the Gravity Thickeners as Dissolved Air Flotation Thickeners (DAFTs), dual feed electrical service with completion of the electrical loop, and conversion to UV disinfection. The design went out to bid in the fall of 2005 with bid alternates because of the limited funds available.

Nevertheless, this was the single largest construction project in the City's history.

Garney Construction was awarded the construction contract for the Aeration Basins, the fourth Secondary Clarifier, demolition of the TFs, and the dual feed electrical service. The new Secondary Pump Station, DAFT modification of the Gravity Thickeners, and UV disinfection system were not awarded due largely to budget constraints. The modifications to the existing Secondary Pump Station and a secondary sludge-only DAFT were added to the project by change order.[94]

2006-2008

Construction for the **75th Street Wastewater Treatment Plant Upgrades Project** ("Liquid Stream Upgrades") began January 2006 and the first phase, ABs 1 & 2, and 4th clarifier were completed and put on line August 1, 2007 with one of the DAFTs following 6 weeks later in early September 2007. DAFT 2 was completed in December 2007. AB3 was completed and placed online in April 2008. The Upgrades Project officially ended in October 2008. The treatment capacity of 75th Street facility was increased to 25 MGD.

In August 2007, the secondary digester cover tilted for the third time. The cause was determined to be the accumulation of condensation (water) inside the attic space. Water sensor alarm and drain piping was added to prevent another cover tipping incident.[95]

Ever since 1985, when Art Dike retired, Floyd Bebler had worked as Wastewater Treatment Superintendent/Coordinator. Bebler retired in 2008, and Chris Douville, previously employed by Brown and Caldwell (and resident project representative on the liquid stream upgrade project) was hired as the new Manager of Wastewater Treatment.

BIOSOLIDS PROGRAM

The Biosolids Program changed significantly from 2006 to 2008. The **Biosolids Dewatering Improvements Project** design started during the fall of 2006 with Rothberg, Tamburini & Winsor, Inc. Engineers as the consulting design engineers, and Douglas Sullivan as the City's Project Manager. Paul Heppler, Supervisor of Resource Recovery, represented the treatment plant operation and maintenance.

Construction began in the spring of 2007 after the City decided not to pursue the Biosolids Recycling Center and Fire Training Facility on Valmont Butte. The project involved construction of a new Biosolids Dewatering Building to house process and biosolids storage equipment and provide upgraded facilities for staff (offices, break-room, locker rooms, training room, etc.).

Two large high-torque, high-solids centrifuges were added. Also, a biosolids screen was installed to remove unwanted plastics and hair to protect biosolids processing equip-

ment, and produce a better final biosolids product. New cake pumps were installed to pump the higher solids to the cake hoppers. A new cake hopper system was installed to hold cake biosolids and expedite truck loading with the contract haulers.

Additionally, a new centrate tank and pump station was added to control return of centrate to the main plant. An odor-scrubbing process was installed on top of the centrate tanks to control odors generated from the new biosolids dewatering building. Historically, city staff hauled biosolids for land application, using city vehicles and equipment of a semi-dewatered liquid, (10 per cent solids). The new improvements included thicker biosolids as a cake type product (24 per cent solids).

Garney Construction (already working on the Liquid Stream Improvement Project) was awarded the contract for this project. The total funding for these projects exceeded $45 million. The City borrowed money to pay for the work by issuing 20-year reserve bonds that received an AA+ rating from Standard and Poor's.

Wastewater utility rates were increased by nearly 50 per cent to service the debt. Ned Williams, the City's Director of Public Works for Utilities, along with the City's Finance Director and City Manager traveled to New York to meet with the rating agencies.

Truck traffic from the Wastewater Treatment Facility was reduced by greater than half, but it was determined that the City could no longer be cost-effective in the operation of a land application program. This brought a drastic redirection in program focus, and a private contractor was chosen to provide hauling and land application of the city-produced biosolids.[96]

2008-2009

In late 2008, the digester boilers (one natural gas and one biogas) were replaced with a new dual gas boiler designed to burn either biogas or natural gas. Plant staff managed the replacement, and American Mechanical Services (AMS) was contracted to perform the installation work. In late 2008, the non-potable water (3W) strainer was replaced. Plant staff managed the project, and Fischer Construction was contracted to perform the work.

In January 2009, the centrate pump station flooded due to a failed sump pump control panel. All electrical and instrumentation within the pump dry well had to be replaced. Upgrades to the pump station included SCADA alarms sensors, tank overflow, and redirecting the scrubber effluent water away from the pump station sump, and introducing it to the centrate tank cells which aided in diluting the centrate. The diluted centrate showed significant improvements on controlling struvite, a mineral formation that builds up on the inside of centrate pipes that reduces capacity.

In early 2009, the digester gas flare was replaced. Plant staff managed the design and

replacement, and Fischer Construction was contracted to perform the work.

A study of the ultraviolet (UV) system, Anaerobic Digester system, Secondary Treatment Performance regarding nutrient removal, and Headworks facilities was initiated in the beginning of 2009 by Carollo Engineers. Requests for proposals (RFP) were sent out in October 2009 for design services related to a UV system, digester mixing improvements, and headworks modifications.[97]

2010-2011: UV SYSTEM, HEADWORKS UPGRADES & DIGESTER UPGRADES

In 2010, Brown and Caldwell was selected to perform detailed design of the improvements for the **Ultraviolet Disinfection (UV) system, Headworks upgrades, and Digester Mixing upgrades**. The UV system was designed to replace the previous gaseous chlorine and sulfur dioxide disinfection system.

The Headworks upgrades involved replacing mechanical and electrical systems from the then-30-year old facility. The Digester mixing upgrades replaced the original gas mixing system with pumped mixing. An engineering "opinion of probable cost" of $8.0M was established for the construction project. Douglas Sullivan managed this project for the City. Chris Douville, Ernie Oram, Leigh Rickert, Paul Heppler, and Scott Kennedy assisted the design team during 2010.[98]

In 2011, Brown and Caldwell completed detailed design of the improvements for the Ultraviolet Disinfection (UV) system, Headworks upgrades, and Digester Mixing upgrades. The bid was ultimately awarded to Stanek Constructors in May 2011 for a construction fee of $8.1M. Construction began the following July and was completed in 2013.[99]

SOLAR PHOTOVOLTAIC SYSTEM

The **Solar Photovoltaic (PV) System** at the 75th Street facility is a three-way partnership between XCEL Energy, the City of Boulder, and a private owner. The solar facility is part of the City's Climate Action Plan and reduces the power costs associated with the plant's operation. The system is a 1,000 kW (~1 MW) system constructed at no cost to the City. SunEdison owns, operates, and maintains the Solar PV system. The project was managed by Douglas Sullivan in Utilities.

The PV system became operational on July 23, 2010. For the first 4 years of operation, the system has produced essentially the same amount of power that was projected. The PV system is estimated to provide approximately 15 per cent of the wastewater treatment plant's annual electricity needs (approximately 1,500,000 kWh/yr). Instantaneous production has been measured at around 900kW.[100]

ONGOING RESEARCH

In 2007, The City of Boulder, the United States Geological Survey (USGS), and University of Colorado began a collaborative research project related to **Endocrine Disrupting Compounds**. The goal of the sampling and analysis project was to determine the fate of endocrine disrupting compounds through the wastewater treatment process and determine the removal rates for the various compounds. Sampling was conducted in June 2007 with the TF/SC process online, and in 2008 after placing the new biological nutrient removal (BNR) activated sludge system online. Some of the research findings were presented in June 2010 at the national conference of the Endocrine Society.[101]

Prior to the 2007 Activated Sludge upgrades, however, Boulder Creek had been heavily studied for more than a decade. In fact, in 1999 and 2000, the U.S. Geological Survey included Boulder Creek in its first nationwide reconnaissance of the occurrence of pharmaceuticals, hormones, and other organic wastewater contaminants (OWCs) in water resources.

This so-called "Millennium Study" used five newly developed analytical methods to measure concentrations of 95 OWCs in water samples from a network of 139 streams across 30 states. The selection of sampling sites was biased toward streams susceptible to contamination (i.e. downstream of intense urbanization and livestock production). OWCs were prevalent during this study, being found in 80 per cent of the streams sampled—including Boulder Creek.[102]

Following the Millennium Study, the research teams focused on the ecology in Boulder Creek, specifically impacts to fish (white suckers), because of the concern with the occurrence of OWCs in the creek. In summary, it was determined that upstream of the Wastewater Treatment Facility outfall where the OWC occurrence was low or non-detected, the fish were "normal" with respect to several physiological metrics and ratios of male-to-female were balanced. However, downstream of the Facility, outfall where the fish are exposed to varying amounts of the Facility's effluent and higher levels of OWCs, the male-to-female fish ratios were heavily skewed to predominantly female, and several physiological metrics were very abnormal (e.g. intersex fish with both male and female reproductive organs).

The 2007/2008 collaborative project among the City of Boulder, the USGS, and the University of Colorado was a fish feminization study that compared the sex ratios of white suckers in Boulder Creek above and below the 75th Street Wastewater Treatment Facility outfall. Several estrogenic compounds found in Boulder wastewater effluent included the natural estrogens estradiol and estriol, the synthetic estrogen (from birth control pills) ethynylestradiol, a synthetic estrogen breakdown product, nonylphenol, and a component of polycarbonate plastic with estrogenic effects, bisphenol A.

The results provided some good news and were published in the 2012 issue of Environmental Science & Technology in which Larry B. Barber, Alan M. Vajda, Chris Douville,

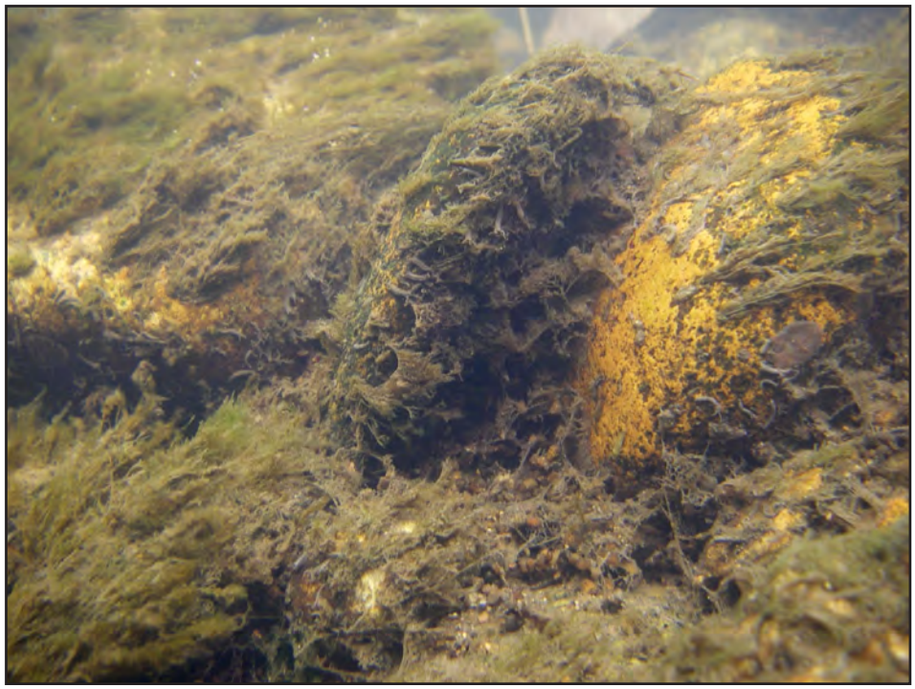
David O. Norris, and Jeffrey H. Writer wrote of the endocrine-disrupting chemicals received by Boulder Creek in an article titled, "Fish Endocrine Disruption Responses to a Major Wastewater Treatment Facility Upgrade."

As the authors stated: "Results are presented showing the effects of a full-scale upgrade of the wastewater treatment facility (that treats 0.6 m3 s−1 of sewage) from a trickling filter/solids contact process to an activated sludge process on the removal of endocrine-disrupting compounds and other contaminants (including nutrients, boron, bismuth, gadolinium, and ethylenediaminetetraacetic acid) through each major treatment unit. Corresponding impacts of pre-and-post-upgrade effluent chemistry on fish reproductive end points were evaluated using on-site, continuous-flow experiments, in which male fathead minnows (Pimephalespromelas) were exposed for 28 days to upstream Boulder Creek water and wastewater treatment facility effluent under controlled conditions."

The authors concluded, "The upgrade of the Wastewater Treatment Facility resulted in improved removal efficiency for many endocrine-disrupting chemicals, particularly 17 β-estradiol and estrone, and fish exposed to the post-upgrade effluent indicated reduction in endocrine disruption relative to pre-upgrade conditions."[103]

The City of Boulder continues to perform special regulatory and technical studies to address future water quality regulations. In 2014, the City continued its focus on evaluating total nitrogen, total phosphorus and periphyton (algae) in Boulder Creek in preparation for future regulations anticipated to be implemented around 2021. The City also continues to work on other regulatory issues such as temperature criteria, aquatic life criteria (macroinvertebrates), nutrient modeling and arsenic. The City has worked cooperatively with agencies such as Colorado Parks and Wildlife to collect biological data to evaluate potential impacts to aquatic life in Boulder Creek due to the wastewater treatment plant discharge.

Aquaria is stacked in the research trailer for the fish feminization study. *City of Boulder*



Above, periphyton (algae) growth in Boulder Creek possibly was enhanced by nutrient discharges from the wastewater treatment plant. Below, In October 2014, the City held a cooperative fish shocking effort with Colorado Parks and Wildlife to evaluate impacts of wastewater treatment plant effluent temperature. *Both photos, City of Boulder*

FLOODS AND FLOOD PROOFING

From a historical perspective, it's interesting to note that the "100-year flood" of 1894 occurred one year before Boulder's sewer system was installed. The number of outhouses washed away is unknown, but there were no sewers to be damaged.

Major floods to affect Boulder came again in 1919, 1921, 1938, and 1969. Of the 1969 flood, Arthur Dike noted that it washed out approximately 300 feet of the main sewer line entering the 75th Street Wastewater Facility. The break in the line was at the McStain gravel pits east of 61st Street. The plant was out of operation for several weeks while the section of line was rebuilt.[104]

The 2013 Boulder Flood officially occurred during the week of September 9 through 15, 2013 where most of Boulder received approximately 17 inches of rainfall during that week. Receiving the equivalent of almost a year's rainfall in one week was truly an extreme event, which has been officially recognized as a 1-in-1,000 year precipitation event (meaning, that amount of rainfall over a 7-day period has a probability of occurring only once in a thousand years).

Wastewater Treatment Facilities entrance sign, September 12, 2013. *City of Boulder*

Prior to the flood event, flow to the wastewater treatment facility was approximately 11 MGD. On the evening of September 11, 2013, flows increased dramatically over the course of several hours and exceeded 50 MGD before midnight. Flows in excess of 50 MGD continued for 6 days, after which the flow finally started slowly reducing. The significant increase in flow was due to infiltration and inflow from the extreme precipitation event that occurred that same week. Flood waters entered manholes and pipes, causing the wastewater collection system to exceed its hydraulic capacity. The facility's influent flow remained several MGDs above normal months after the flood event because of the elevated groundwater and corresponding infiltration component.

The flood berm/levee was built on the perimeter of the 75th Street plant in 1985. The berm proved its worth during the September 2013 flood , when the area around the plant was inundated with water, but the plant itself remained online and operational. Photo, September 13, 2013. *City of Boulder*

WASTEWATER SYSTEM FLOOD RECOVERY

As noted in the 2013 Annual Report, the September 2013 flood event resulted in significant damage to various facilities in the Wastewater Utility. The majority of the damage occurred in the wastewater collection system, both to the City-owned facilities and to private residences. The flooding resulted in numerous surcharged sanitary sewer and system blockages that resulted in hundreds of private homes experiencing wastewater backups in their basements. Based on the City's post-flood survey results it is estimated that up to 1,500 homes may have experienced backups of sanitary sewage, and as much as 20 per cent of the collection system experienced surcharging.

The City's primary sanitary interceptor sewer runs alongside Boulder Creek for several miles as it approaches the wastewater treatment facilities. The flood event destroyed several riverbank berms located east of the City limits resulting in the majority of the Boulder Creek flow to be diverted away from the historic drainage channel. The sanitary interceptor sewer was located in one of the berms that was breached by the flood waters and City staff worked with Redline Pipeline to reconstruct several of the riverbank berms and reinforce the sanitary interceptor sewer as shown in the following photograph.[105]

City staff worked with Redline Pipeline to reconstruct several of the riverbank berms. *City of Boulder*

The flood event heightened awareness of the vulnerability of the sewer system infrastructure to rainfall-induced infiltration and inflow resulting in surcharge of the sewer system and sewage backups into subterranean areas (basements). As a result, for the first time in many decades there is political support for increasing expenditures and utility rates to fund improvements to the city's sanitary sewer system.[106]

NEW TECHNOLOGY

The City took advantage of new technology as it became available, developing a computerized hydraulic model of the sanitary sewer system, as well as an asset management system for inventorying and tracking the ages and conditions of wastewater water system components. This led to better planning of repair and replacement needs, and also improved project scheduling and forecasting of capital improvement budgets adequate for sustaining the wastewater system in the future.

In addition, Boulder expanded its use of computer-based tools such as databases, spreadsheets, geographic information systems and remote video inspection of the sanitary sewer pipes. These tools helped to prioritize efforts under the on-going sewer lining program to identify areas most needing attention.

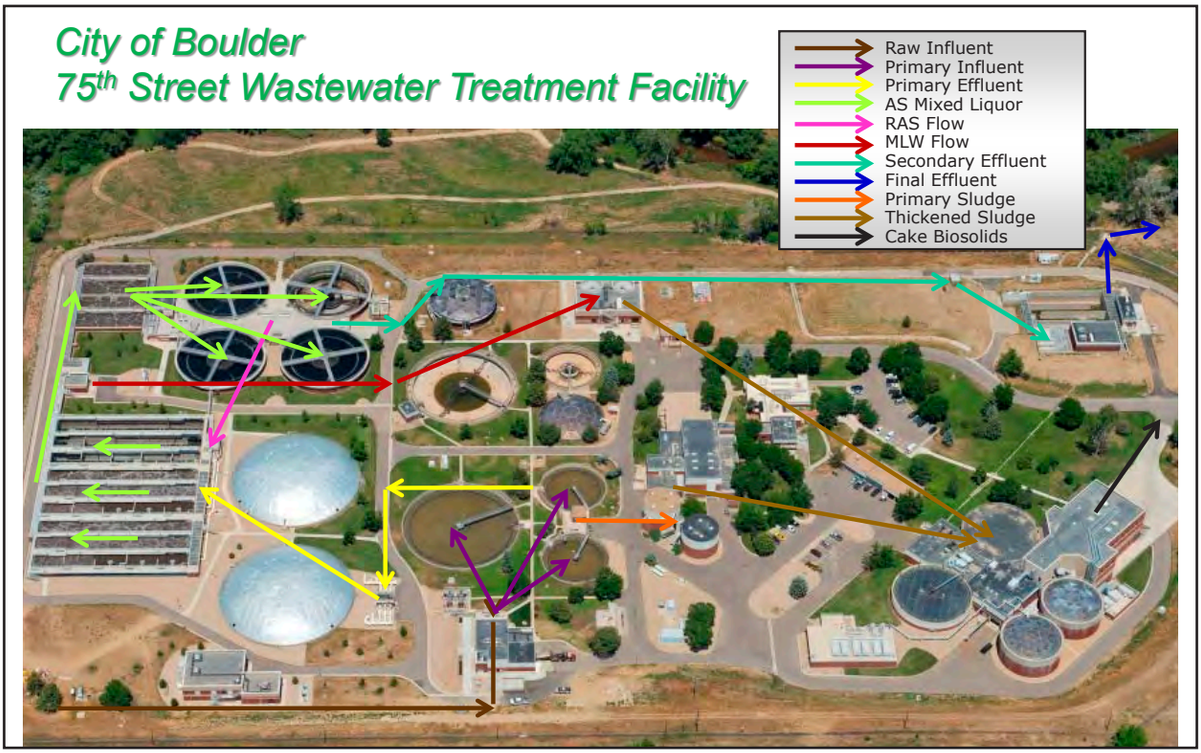
In 2010, the City developed its first enterprise level wastewater utility master plan. The Wastewater Utility master Plan (WWUMP) encompassed all elements of the utility including wastewater collection and conveyance, treatment as well as associated water quality programs and facilities such as industrial pretreatment and laboratory services and compiled information from the:

1) Wastewater Collection System (WWCS) Master Plan
2) Wastewater Treatment Plant (WWTP) Master Plan
3) Water Quality Strategic Plan (WQSP).

As part of the WWCS Master Plan, the hydraulic model was greatly expanded and improved. Based on future growth projections provided by the City's planning department and historic per capita flow contributions, projects were identified to increase the capacity of certain sewer pipes. During the intervening years, it was observed that per capita flow contributions were decreasing. This trend began after the introduction of low flow plumbing fixtures in the 1990s, but accelerated after the turn of the twenty-first century as these plumbing fixtures became more ubiquitous and high efficiency washers were introduced to the market. These factors, and the great recession of 2008-2013 which greatly limited the previous growth projections, combined to delay the implementation of these projects.

The 75th Street Facility Today

The City of Boulder's 75th Street Wastewater Treatment Facility treats an average of 15 million gallons of wastewater per day, but how that is accomplished is a mystery to the average resident. This chapter will briefly describe the facility's primary and secondary treatments, with three different end results—landfill, cake biosolids, and discharge into Boulder Creek. ("Facility," instead of "Plant," is the preferred term today.)



This aerial diagram provides a good overview of Boulder's current operation. *City of Boulder*

Screening/ Grit Removal

Wastewater treatment begins when **RAW INFLUENT** is piped to the facility's Headworks. There, debris and inorganic materials are separated from the organic material to be treated. The coarse debris, such as twigs and rags, are removed by mechanical screens. Inorganic materials, including sand and grit, are removed in treatment units known as aerated grit chambers.

On a typical day, mechanical screens, left, are filled with whatever enters the system.

Left, grit classifiers wash and clean sand and grit. All of the inorganic materials are hauled to a landfill for disposal.

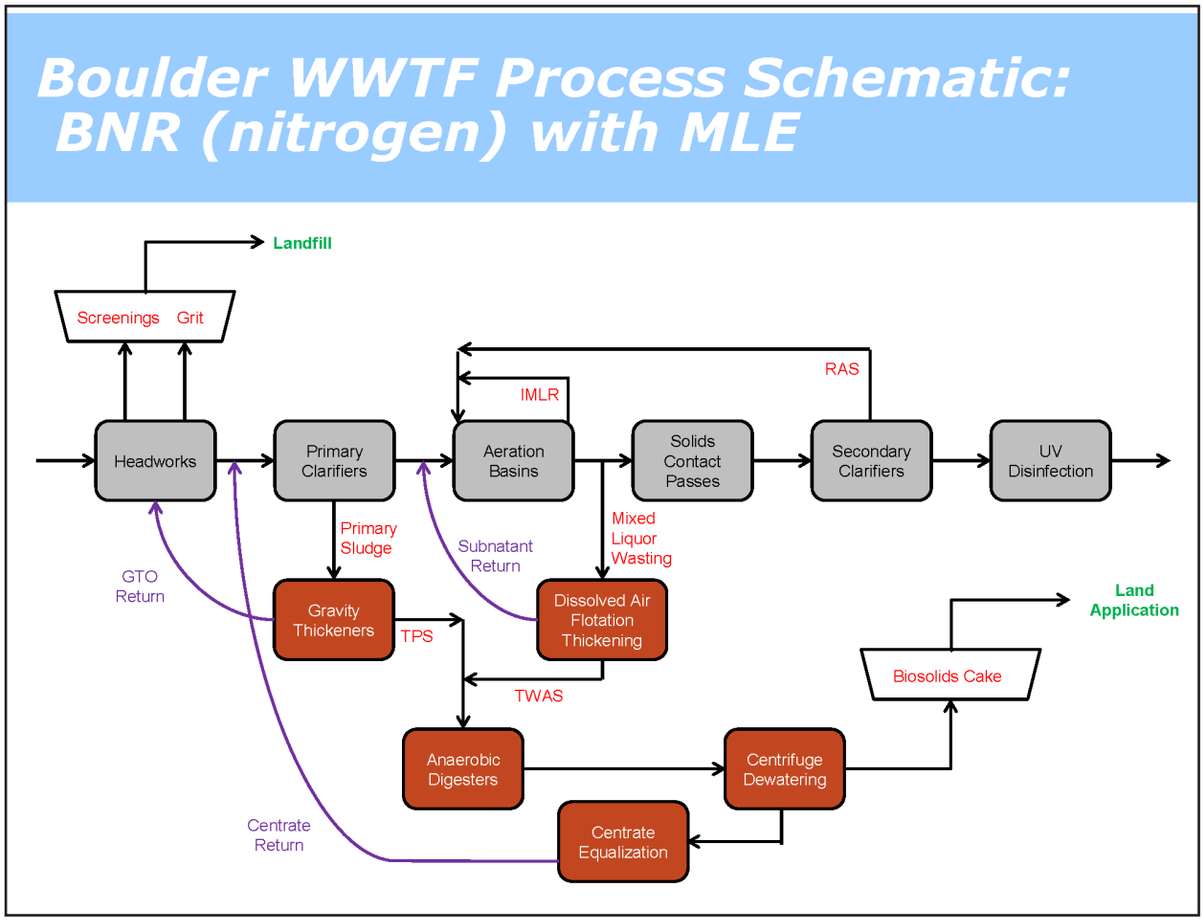
Below is a photo of one of the preliminary [primary] classifiers.

Pettem photos, 2014

PRELIMINARY [PRIMARY] CLARIFIERS

After screening has been completed and grit removed, the sewage still contains organic and inorganic matter, along with other suspended solids. The **PRIMARY INFLUENT** then goes into any of the three preliminary [primary] clarifiers (as shown on the preceding page), where the raw primary solids settle to the bottom and the clarified liquid then is pumped to aeration basins, where large populations of microorganisms are maintained.

The solids are known as total suspended solids (TSS) and are expressed in terms of biochemical oxygen demand (BOD)—the measure of organic material which serves as a food source for microorganisms. Approximately 50 per cent of the TSS and 40 per cent of the BOD contained in the wastewater are removed in the primary clarification step. (The removal will be addressed in the section on anaerobic digestion.)



The above schematic visually depicts the parallel processes of:

1. Treated wastewater as it moves from the Headworks to UV Disinfection
2. Solids as they move from the Headworks to Biosolids Cake

City of Boulder

AERATION BASINS AND SECONDARY CLARIFIERS

The clarified liquid (**PRIMARY EFFLUENT**) then moves on to secondary treatment. During the early years of the 75th Street Wastewater Treatment Facility, the process included trickling filters (basically, beds of stones), but those filters are now mothballed and the effluent is pumped directly to aeration basins. There, air is added to provide oxygen for the bacteria that biodegrade the organic materials in the wastewater.

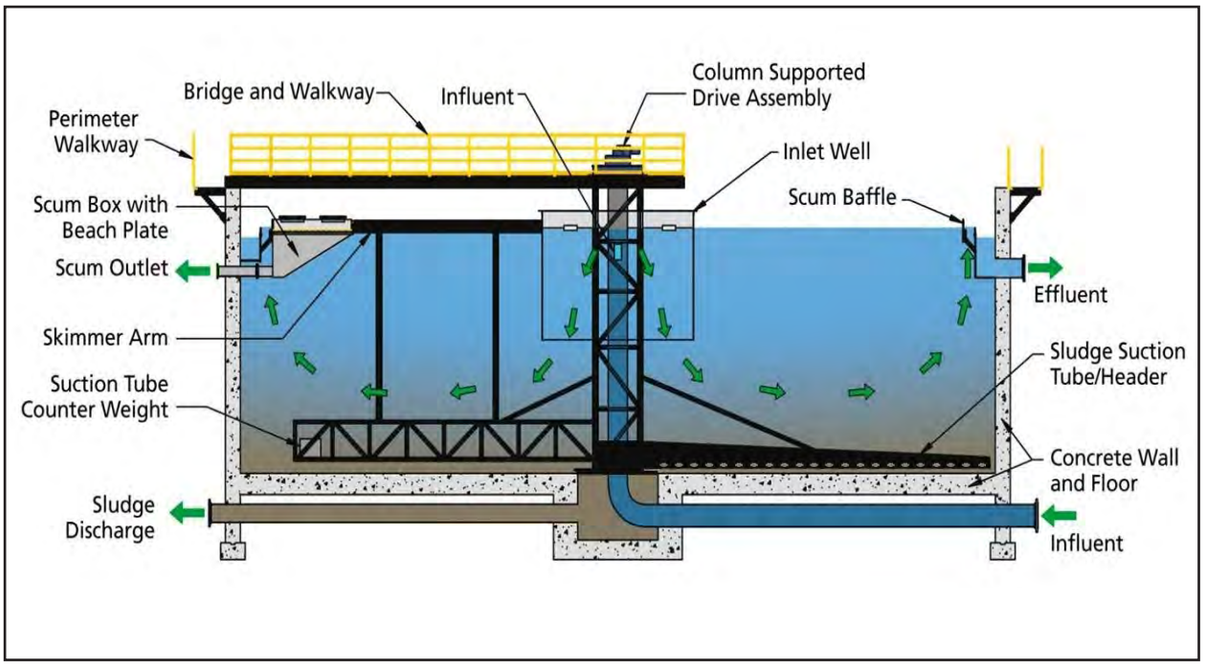
In addition to the breakdown of the organic material, various groups of bacteria convert ammonia in the wastewater to nitrite and nitrate, and then to nitrogen gas that is released into the atmosphere in a process known as Biological Nutrient Removal Activated Sludge. **A-BASIN EFFLUENT** then enters the secondary clarifiers.

In the secondary clarifiers, the biological solids produced in the activated sludge process are settled out, and the majority of the solids are recycled back into the aeration basins to maintain the desired population of microorganisms. A portion of the solids, however, is removed and thickened in a process called dissolved air flotation thickening. These thickened solids then go through anaerobic digestion.

Organic material is broken down in aeration basins.
Pettem photo, 2014

Above is one of the secondary clarifiers at the 75th Street Wastewater Treatment Facility.
Pettem photo, 2014

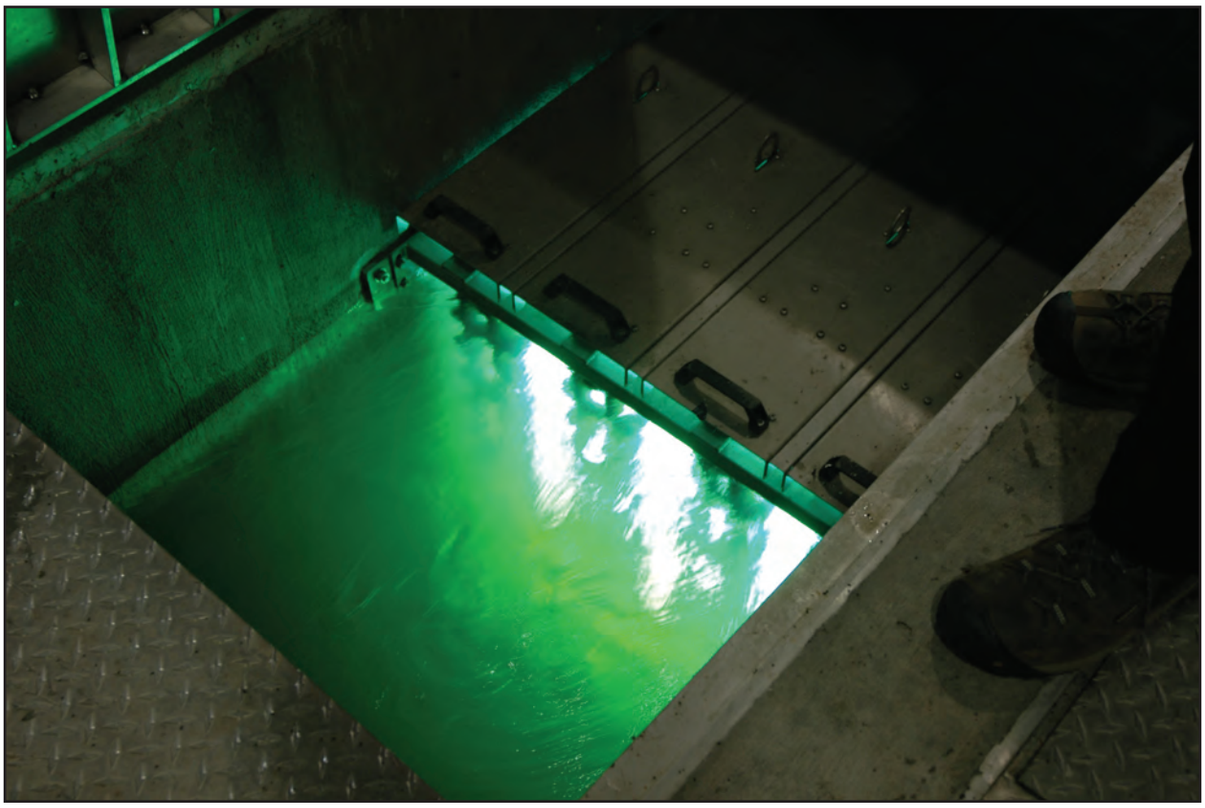
The drawing, below, is a cross-section of a secondary clarifier. *www.monroeenvironmental.com*



ULTRAVIOLET DISINFECTION AND FINAL EFFLUENT

After treatment in the secondary clarifiers, the clarified liquid known as **SECONDARY EFFLUENT** traditionally flowed to contact basins where chlorine was added to destroy pathogens. Since chlorine can be very toxic to fish, the chlorine remaining after disinfection was destroyed by the addition of sulfur dioxide. The dechlorinated water then was discharged to Boulder Creek in accordance with regulations contained in the city's discharge permit issued by the Colorado Department of Public Health & Environment (CDPHE).

The above chemical process, in place since 1990, was switched in 2013 to ultraviolet disinfection. The new technology is highly effective for bacteria, viruses and protozoa—all harmful microorganisms that could potentially contaminate the drinking water of downstream communities. Stated Wastewater Treatment Manager Chris Douville, "The new UV disinfection system is a major milestone for the facility and demonstrates the city's commitment to continuous operational improvements that meet evolving community and regulatory needs."



The secondary effluent is disinfected using ultraviolet rays. *Pettem photo 2014*

The **FINAL EFFLUENT** is then discharged into Boulder Creek, still in accordance with regulations contained in the City's discharge permit issued by the CDPHE.

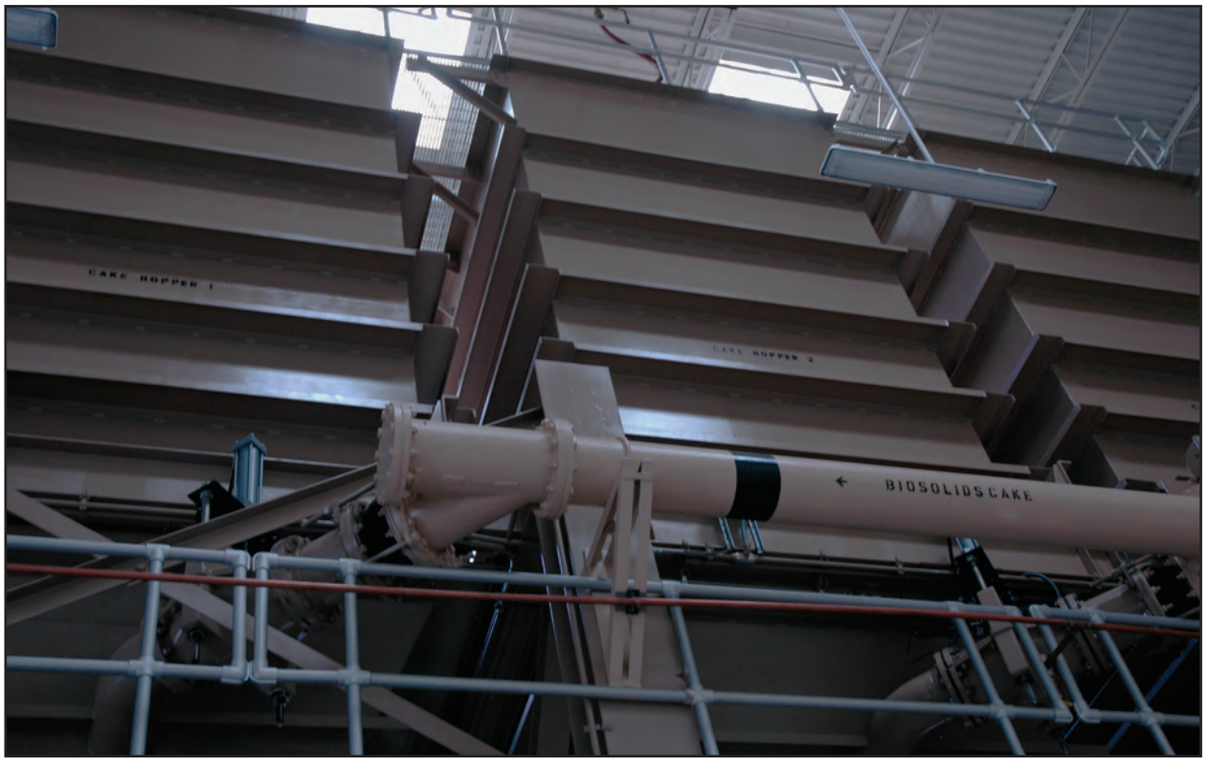
ANAEROBIC DIGESTION TO BIOCAKE SOLIDS

As described in the preceding pages, **PRIMARY INFLUENT** flows into preliminary [primary] clarifiers, then, as **PRIMARY EFFLUENT**, enters aeration basins. The **A-BASIN EFFLUENT** enters the secondary clarifiers (with solids recycled back into the aeration basins) before passing, as **SECONDARY EFFLUENT**, through ultraviolet disinfection. Meanwhile, solids (sludge) removed by primary and secondary treatment are combined with the floating materials skimmed from these same clarifiers. These combined solids and skimmings undergo a treatment process known as anaerobic digestion.

In the anaerobic process, bacteria that can live without free oxygen use the sludge organics for food. As by-products of anaerobic digestion, these bacteria produce methane, carbon dioxide and trace amounts of other gases. The resulting digester gas is used as fuel for two engine generators that produce both electricity and heat. The electricity is used by the facility and offsets the amount of grid electricity needed to be purchased from Xcel Energy Company, and the captured heat is used to heat plant buildings and keep anaerobic digestion tanks at an optimal temperature for the bacteria.

Above are the two 300 kW engines used to generate electricity from digester gas. *Pettem photo, 2014*

Centrifuges, above, have replaced vacuum filters in the dewatering process. Biosolids cake, stored in hoppers (as shown below) is similar in consistency to wet soil. *Pettem photos, 2014*



After the digestion process, centrifuges thicken the solids (sludge) into biosolids, reducing the volume of liquid from approximately 2.2 per cent solids to over 20 per cent. This dewatering step also reduces the volume that must be handled and trucked, thus reducing associated costs.

Digested and dewatered biosolids are fairly inert, have considerable value as a soil conditioner and fertilizer, and are trucked to agricultural land and applied to the fields. During parts of the year, the dewatered biosolids may be hauled to a facility for composting, and the composted material can be used for lawns and gardens. This process allows the city to beneficially reuse treated wastewater biosolids in accordance with CDPHE and U.S. Environmental Protection Agency regulations.[107]

CONCLUDING COMMENTS

Many photos from nineteenth-century Boulder show homes, businesses, and people. Unseen, and rarely discussed, however, were the overflowing ditches and cesspools. By the winter of 1895-1896, after local civic leaders had repeatedly discussed the City's lack of sanitation, Boulder installed its first sewer lines. Since then, Boulder has come a long way in its disposal and treatment of wastewater.

In 1908, visiting city planner Frederick Law Olmsted, Jr., became the first professional consultant to take a critical look at Boulder's future needs. After inspecting the City's sewer "sinks" (on the site of today's Scott Carpenter Park), he stated that a "permanently suitable method of sewage disposal" — instead of simply discharging waste into Boulder Creek — was a need that would have to be faced.

The problem finally was addressed in 1934, when the engineering firm of Black & Veatch began a long relationship with Boulder and designed a then-state-of-the-art sewage disposal plant, complete with a digester tank and preliminary [primary] clarifier. Funding came from the Federal Works Project, part of President Franklin D. Roosevelt's New Deal. The plant (still on the Scott Carpenter Park site) served Boulder well until the population boomed after World War II.

Boulder's second facility, the East Pearl Plant at 5050 Pearl Street, opened in December 1957. The City grew so quickly that the East Pearl Plant was followed, in 1968, by the first buildings of today's 75th Street Wastewater Treatment Facility at 4049 North 75th Street. Both plants operated simultaneously until 1980.

In recent years, numerous improvements were made to the City's single largest and most technically complex facility, operated and maintained to achieve consistent high levels of treatment. In addition to the core mission of achieving a high-quality effluent that surpasses all permit requirements, energy use and associated efforts to improve energy efficiency are quickly becoming a critical aspect of effective and responsible

operations. Renewable electric source power is also a high priority—to reduce dependence on grid electricity. The cogeneration system and a third-party owned/operated/maintained solar photovoltaic system also are examples of renewable source power at the 75th Street Facility.

Meanwhile, Boulder Creek and the City's wastewater treatment system have been the subject of many research projects and studies based in large part to the proximity of the University of Colorado and Federal research institutes. In addition, the September 2013 flood brought heightened awareness to the critical function of the City's wastewater conveyance system and the importance of funding ongoing rehabilitation work.

Current work is focused on treatment processes required to further reduce the discharge of nutrients (nitrogen and phosphorus), as well as the monitoring and evaluation of micro-contaminants (including natural and synthetic hormones, substances contained in personal care products, pharmaceuticals) and effluent temperature. Increasingly stringent effluent discharge regulations, as well as aging infrastructure replacement needs and capacity issues, will drive treatment modifications and priorities in the years to come.

Appendix

Recent Wastewater Utilities Work Program Staff

Executive Director of Public Works
Dave Rhodes and Mo Rait

Director of Public Works for Utilities
Ned Williams and Jeff Arthur

Finance and Analysis Manager
Carol Linn and Ken Baird

Principal Engineer—Utilities
Bob Harberg

Wastewater Treatment Manager
Floyd Bebler and Chris Douville

Water Quality and Environmental Services Manager
Chris Rudkin and Bret Linenfelser

Utilities Maintenance Manager
Don Vetterling, Felix Gallo and Joe Cowan

Water Resources Advisory Board (WRAB)

The Water Resources Advisory Board (WRAB) was first seated in 1993 and advises the City Council, Planning Board and city staff on community utilities issues. The board also:

- reviews Capital Improvement Programs for the three city-provided utilities (water, wastewater, and stormwater/flood);
- reviews utilities community and environmental assessment processes (CEAPs),
- reviews utilities master plans; and may provide recommendations concerning policy issues on operating programs.

Throughout the years, the following people have served as the board's chairs:

1993 – Peter Gowen
1994 – Peter Gowen
1995 – Peter Gowen
1996 – Peter Gowen
1997 – Peter Gowen
1998 – Robert Fiehweg
1999 – Robert Fiehweg
2000 – Robert Fiehweg
2001 – Robert Fiehweg
2002 – Robert Fiehweg
2003 – Robert Fiehweg
2004 – Jeannette Hillary
2005 – Ken Wilson
2006 – Ken Wilson
2007 – Jim Knopf
2008 – Bart Miller
2009 – Robin Beyers
2010 – Bill DeOreo
2011 – Bill DeOreo
2012 – Susan Iott
2013 – Chuck Howe
2014 – Vicki Scharnhorst

Endnotes

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10. *Herald of Health*, Volumes 25-26, New York: Wood & Holbrook Publishers, 1875, p. 191
11. *Daily Camera*, June 13, 1891
12. *Daily Camera*, December 14, 1892
13. *Daily Camera*, January 24, 1893
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BOULDER'S WASTEWATER PAST & PRESENT was published by the City of Boulder in 2015.

For related information, see BOULDER'S WATERWORKS PAST & PRESENT, published in 2014.