received
9-2-8

Final Bill

TOWN OF NAGS HEAD

NAGS HEAD, NORTH CAROLINA 27959

August 5, 2008

Dare County Water Plant, Skyco
Mr. Billy Brown
P.O. Box 1000
Manteo, NC 27954

Dear Billy:

Enclosed is the charge for water delivered from Fresh Pond for the month of July 2008.

Beginning Meter Reading	Ending Meter Reading
132811	154085

The total water pumped to the Regional system this billing is 21.274 MG. At the present rate of $1.584/1,000 gallons, this calculates to $33,698.02. This billing period is from July 1 2008 to July 29, 2008.

If I can be of further assistance, or if you have any questions, please call me.

Sincerely,

Nancy Roop Carawan

Nancy R. Carawan
Water Plant Superintendent
Town of Nags Head

NRC/nrc
Cc: Kim Kenny
Dave Clark
Andrea Paxson

ırtment of Public Works
Administration
Maintenance Garage
Public Facilities Maintenance
Sanitation
Water Distribution
Water Operations

Town of Nags Head
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Nags Head, North Carolina 27959
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www.townofnagshead.net

Dave Clark, P.E.
Public Works Director

Ralph Barile
Deputy Public Works Director

received 11-27-06 KCD

MEMORANDUM

To: Mayor and Board of Commissioners

From: Public Works Director

Date: November 22, 2006

Re: Discussion of Fresh Pond Water Treatment Plant Construction/Engineering Projects

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In September, we received the Preliminary Engineering Report from The Wooten Company covering the Filter Assessment portion of their "Disinfection and Disinfection Byproducts (D/DBP)" study. The D/DBP Regulations promulgated by the US-EPA and adopted by NC-DENR require every Public Water Supply to change the way they collect and analyze water samples for the potential carcinogenic compounds know as Trihalomethanes (THM's) and Haloacetic Acids (HAA5). The most effective way to reduce the formation of THM's and HAA5's in our distribution is to reduce, to the extent possible, the Total Organic Carbon (TOC) in the finished water being treated with chlorine.

The first part of this study involved a thorough analysis of the 20+-year old filters at the Treatment Plant. This analysis (copy attached) revealed that the filter media (the porcelain spheres, torpedo sand, sand and gravel) was in very poor shape. It has passed the estimated lifespan of 20 years for such filter media. In addition to the filters, Wooten looked at the sedimentation basin, where cypress baffles cause the treated water to rise, and coagulated solids to sink to the bottom. Several of the baffles have deteriorated to the point where they need to be replaced, and improvements can be done to increase the amount of solids retained in the basin, and reduce the amount which ends up in the filters. This will make the filters even more efficient in removing the solids which cause turbidity in the water, the main problem we have in consistently meeting the drinking standards. Due to algae problems in Fresh Pond (which result in difficult to remove solids in the water) this past summer, we ceased operation sooner than planned.

The final component of the needed plant repair/upgrade project is the replacement of the filter (butterfly) face valves beneath the filter. These valves are currently leaking, which permits the filters to drain down some overnight, and completely during the "off" season when they are not being run. The filters need to remain "wet" at all times, even when the plant is not running. This drying of the filter media accelerates its degradation. Since they are of the same vintage as the filters, they are also over 20 years old.

The total estimated cost for these three items, including the engineer's proposal for "turn key" services, is $206,124. This exceeds the $100,000 threshold for required repairs to be split three ways between Nags Head, Dare County and Kill Devil Hills. Town staff met with those entities on November 27th to initiate discussions regarding their cost-sharing on this necessary project.

FRESH POND WATER TREATMENT PLANT
DISINFECTION AND DISINFECTION BYPRODUCTS – PHASE I
FILTER ASSESSMENT
PRELIMINARY ENGINEERING REPORT

THE TOWN OF NAGS HEAD N.C.
1961

TOWN OF NAGS HEAD, NORTH CAROLINA

September 18, 2006

NORTH CAROLINA PROFESSIONAL SEAL 12925 ENGINEER C. V. BROOKS, IV

C. V. BROOKS, IV, PE
WATER RESOURCES MANAGER

THE WOOTEN COMPANY
Engineering • Planning • Architecture
120 North Boylan Avenue
Raleigh, North Carolina 27603

TWC Job No. 2977-A

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Appendix B – Filter Media Sieve Analysis Results .... 8 pp
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FRESH POND WATER TREATMENT PLANT DISINFECTION AND DISINFECTION BYPRODUCTS – PHASE I FILTER ASSESSMENT PRELIMINARY ENGINEERING REPORT

TOWN OF NAGS HEAD, NORTH CAROLINA

1.0 INTRODUCTION

Nags Head owns and operates a water system to provide potable water to its citizens and businesses. The town is located on Bodie Island on the Outer Banks of Dare County. Being a resort community, the town's water system population and demand fluctuate. From its draft 2002 local water supply plan, the permanent population was reported to be 2,847. The seasonal population was reported to be 38,353. The yearly average day demand (ADD) was 1.147 mgd. The maximum day demand (MDD) was 2.680 mgd and occurred in July. The minimum monthly average was 0.588 mgd in December. It should also be noted that the maximum day demand of record for the town was 2.718 mgd in July 2001.

The town purchases potable water in bulk from Dare County. The county in turn obtains its water from three sources. One of these sources is a conventional surface water plant (Fresh Pond WTP) on Bodie Island owned and operated by the Town of Nags Head.

The Fresh Pond WTP is typically only operated during the peak demand months of the summer. The maximum production capacity of this plant is 1.5 mgd. It is a conventional surface water plant using alum coagulation. Powdered activated carbon is fed at the flash mixer for taste and odor control. Gas chlorine is fed on the top and bottom of the multi-media filters. Caustic soda is used for post-filter pH adjustment. Fluoride is added to the finished water.

The filters consist of two parallel, open top, gravity units. The original 1984 specifications for the filters called for each filter to have 18 inches of anthracite, 10 inches of sand, 4 inches of torpedo sand, 12 inches of graded gravel, and a precast Wheeler bottom. The actual filters supplied are Clarion® stainless steel package units by Roberts Filter. Each filter has 144 sf of surface area (12 feet square). The filter face piping and filter console are contained within a custom built building.

Roberts Filter completed a filter assessment of these units in February 1997. One of several findings was that the filter sand effective size was too large due to an unknown coating on the media. Roberts recommended that the media be acid washed or replaced. Town staff does not recall this ever being done. Therefore, it is believed that the current filter media is the original media and dates back to the mid 1980's.

Town staff typically runs the facility as a peaking plant during the summer. It usually runs the plant for about 12 hours per day. It begins operation each day by first backwashing each filter. Reviewing operating data for the past two years, the plant has been able to meet the new filtered turbidity standard of 0.3 ntu most of the time. When it cannot, the plant is immediately taken off line. Filtered turbidity regularly exceeds 0.1 ntu and sometimes exceeds 0.2 ntu. Exceeding 0.1 and 0.2 ntu, though certainly acceptable, leaves the staff with little cushion for correction should process chemistry suddenly change.

With all of the above in mind, Nags Head public utility staff asked The Wooten Company to complete a new filter assessment. This investigation was to be limited to the surface sweeps and filter media in each of the filter tubs. Town staff knows of no current issues with the filter face piping, valves, and controls. Also, a field analysis of the Wheeler bottom could not be made from above without first removing all of the media in the tubs (not acceptable at this time) or from below since there is no manway access to the plenum area. Following below is a summary and analysis of the field investigation and conclusions and recommendations.

2.0 FIELD INVESTIGATION

The two filters were inspected by The Wooten Company on June 15, 2006. The plant was out of service for the season and had been so since the end of summer 2005. The filters were both drained and had been so for some time. Both filter tubs are located outside.

Pictures taken during the field inspection are included in Appendix A. A total of 62 pictures were taken. The first two pages in the appendix are an index of the pictures. The first picture is taken from the southeast corner of the filter tubs looking west towards Fresh Pond. The sedimentation basin is to the northwest (covered tank), and the filter building (housing the filter console and the filter face piping) is to the south. Filter Cell No. 1 is on the west (far) side. Filter Cell No. 2 is on the east (near) side.

Pictures 2-4 are of Cell No. 1. Pictures 5-6 are of Cell No. 2. Pictures 7-33 are of Cell No. 1. Pictures 34-62 are of Cell No. 2.

As the pictures show, each filter cell has one surface sweep and two backwash troughs. Some roofing gravel was found in some of the troughs. It was also noted that the sweeps in both filters had been repaired on-site over the years. Both sweeps rotated freely when pushed. Other general observations were as follows:

- Filter Cell No. 1:
  - There was severe alum sludge accumulation in the corners, especially on the west side.
  - Alum sludge "mud balls" in the northwest corner have caused some separation of the filter media from the filter tub wall.
- Filter Cell No. 2:
  - There was some minor alum sludge accumulation in the corners, especially in the southern corners.
  - There were sunken "sink hole" areas in the southwest corner.
  - The southeast corner contained a lot of mud balls under the surface.

Following below are summary tables of measurements taken in the field. Comparisons to the 1984 design specifications and the 1997 filter assessment are made where applicable.

Table 1
Field Measurements – Filter Cell No. 1

Item	1984 Design Specification	1997 Filter Assessment	2006 Filter Assessment
Freeboard (inches)[a]	unknown	41-41.5	40.8-42.6 (41.5 avg.)
Anthracite Depth (inches)[b]	18	16-18	15-17
Filter Sand Depth (inches)[b]	10	12-14	10-12
Sweep Nozzle Height (inches)[c]	unknown	2.5-3	2.3
Mounds?	n/a	yes	yes
Cracks?	n/a	no	yes
Depressions?	n/a	no	yes
Mud / Mudballs?	n/a	no	yes

Table 2
Field Measurements – Filter Cell No. 2

Item	1984 Design Specification	1997 Filter Assessment	2006 Filter Assessment
Freeboard (inches)[a]	unknown	41.5-42	41.5-43.1 (42.0 avg.)
Anthracite Depth (inches)[b]	18	18-19	12-18[d]
Filter Sand Depth (inches)[b]	10	10.5-12	10-18[d]
Sweep Nozzle Height (inches)[c]	unknown	0.75-3	2.3
Mounds?	n/a	no	yes
Cracks?	n/a	no	yes
Depressions?	n/a	yes	yes
Mud / Mudballs?	n/a	no	yes

Notes:

a. Freeboard is defined as the vertical distance from top of backwash trough weir to top of media. NCPWS rules require a minimum freeboard in this case of 30 inches.
b. Depth is media thickness.
c. Height is vertical distance from surface sweep nozzle to top of media.
d. Specifically, media depths were measured as follows:

Location	Anthracite (inches)	Sand (inches)
Middle	18	10-12
Southwest Corner	12	18
Southeast Corner	15-16	14-15

Reviewing the measurements in these tables, it is readily apparent that the condition of the filter media has deteriorated significantly since the 1997 assessment. The development of mud balls on the sides and corners may be the result of ineffectively low backwash or surface wash rates or durations. The improper media thickness in the southern corners of Filter Cell No. 2 may be from an abnormally high backwash or from an air bubble in the plenum that "boiled out" during a backwash, thus causing a filter upset. This may also explain the sink holes evident on the surface in Filter Cell No. 2.

3.0 LABORATORY RESULTS

Composite samples of sand and anthracite were taken from each filter cell. A sieve analysis of each of the four samples was conducted by S&ME in Raleigh. The results are included in Appendix B. Following below are summary tables of these analyses. Comparisons to the 1984 design specifications and the 1997 filter assessment are made where applicable.

Table 3
Sieve Analysis Results – Filter Cell No. 1

Item	1984 Design Specification	1997 Filter Assessment	2006 Filter Assessment
Anthracite			
Effective Size (mm)[a]	0.75-1.00	0.96	0.47
d_{60}[b]	----	1.34	1.30
Uniformity Coefficient[c]	1.25-1.70	1.40	2.77
Sand			
Effective Size (mm)[a]	0.50-0.55	0.74	0.62
d_{60}[b]	----	0.98	1.15
Uniformity Coefficient[c]	1.35-1.70	1.33	1.85

Table 4
Sieve Analysis Results – Filter Cell No. 2

Item	1984 Design Specification	1997 Filter Assessment	2006 Filter Assessment
Anthracite			
Effective Size (mm)[a]	0.75-1.00	0.93	0.50
d_{60}[b]	----	1.29	1.50
Uniformity Coefficient[c]	1.25-1.70	1.39	3.00
Sand			
Effective Size (mm)[a]	0.50-0.55	0.73	0.50
d_{60}[b]	----	0.96	1.00
Uniformity Coefficient[c]	1.35-1.70	1.32	2.00

Notes:

a. Effective size (d_{10}) is defined as the particle diameter for which 10% of the total mass of the sample is smaller than this diameter (i.e., 10% of the total sample mass will pass through a sieve with this size openings). The hydraulic resistance of the filter bed is controlled by this parameter.
b. d_{60} is defined as the particle diameter for which 60% of the total mass of the sample is smaller than this diameter (i.e., 60% of the total sample mass will pass through a sieve with this size openings).
c. Uniformity coefficient is defined as d_{60}/d_{10}. The closer the coefficient is to 1.00 the more uniform the particles are in diameter.

A review of the results above produces the following observations:

- In 1997 the anthracite was within the tolerances allowed in the original specifications. However, in 2006 the effective size had decreased to about 0.5 mm while the d_{60} remained about the same. This resulted in the uniformity coefficient increasing.
- In 1997 the sand was too big ($d_{10} > 0.7$ mm). The 1997 report suggested that this may be the result of some type of solids coating. However, in 2006 the effective size was 0.5 mm in one filter and 0.6 mm in the other. Again the d_{60} changed some but not much. The uniformity coefficient was too high.

There are a multitude of potential reasons for these differences, including:

- Dry filter media in both 1997 and 2006, making the collection of uncontaminated samples difficult
- Possible sampling technique differences between 1997 and 2006
- Possible laboratory technique differences between 1997 and 2006
- Wear and tear of the media caused by freeze/thaw conditions in the winter (since the filter tubs are outside and the media is not submerged)
- Wear and tear of the media from normal usage over the nine year period
- The great abundance of chemical mud present in 2006
- A change in coagulation water chemistry in the nine year period resulting in the removal of the solids coating referred to in 1997
- Atypical backwash rates.

Additional and more rigorous (detailed) testing is needed to eliminate some of the possibilities above before cause and effect can be stated with any degree of certainty. However, as will be detailed below, it would not be cost effective to do this at this time since it is recommended that the media be replaced.

4.0 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions are made:

- It is believed, from conversations with town staff, that the filter media is the original media and is therefore on the order of 20 to 22 years old. This being the case, it is also believed that the precast Wheeler bottom, porcelain spheres, and plenum have never been inspected. Filter media is generally replaced every 15 to 20 years if no other problems are apparent.
- The anthracite effective size is too small. This may contribute to abnormally short filter runs.
- The sand effective size is at or above the proper size of 0.5 mm. The sand uniformity coefficient is too high. This may contribute to high filter effluent turbidity.
- The media in each filter, especially in the corners and sides, contains an abnormally large accumulation of chemical mud. This indicates that the backwash rates and surface wash rates may be too low. The accumulation is enough that the media needs to be replaced.
- The accumulation of chemical mud has caused filter cracking and wall separation. This may contribute to high filter effluent turbidity.
- Some small sink holes were evident in Filter Cell No. 2 on the south side. Improper media thickness was also evident in these locations. This may be from an abnormally high backwash or from an air bubble in the plenum that "boiled out" during a backwash, thus causing a filter upset. This may indicate that the filter media support system has been disturbed in some way. Therefore, the support system needs to be inspected and possibly repaired.
- Filter media depths in Filter Cell No. 2 vary greatly across the filter. This can cause the unit filter rate to vary across the surface of the filter, resulting in "hot spots" with abnormally high rates.

Preliminary recommendations were made to the town in an email dated June 16, 2006. See Appendix C for a copy of this email.

In addition to the recommendations above, the following specific recommendations are made:

- Rebuild both filter cells before they are put back into use next summer. This work should include the following:
    - Remove the anthracite, sand, torpedo sand, gravel, and porcelain spheres from each filter cell.
    - Inspect the precast Wheeler bottom for wear and tear and damage and repair as necessary.
    - Inspect the plenum for evidence of filter media or gravel. The inspection would be accomplished by removing some of the filter face piping to gain access or using fiber optic technology to look through the Wheeler thimbles or some other method. Clean as necessary.
    - Place new media in each filter cell to include all new porcelain spheres, gravel, torpedo sand, sand, and anthracite. Skim the fines from the media after the placement of each layer.
    - Disinfect before placing back into service.

A budget estimate for this work is as follows:

Item	**Budget ($)**
Construction	88,000
Engineering / Contingency	35,000
Total	**123,000**

Note the following:

- The construction budget is based on estimates from reputable contractors for this type work and assumes that no work will be required to repair the Wheeler false floor or to clean out the plenum or to repair the surface sweeps, etc.
- The engineering / contingency is a 40% budget due to the small nature of this work and to allow room for some change orders to occur should minor repairs be needed. It does not allow enough cushion should major repairs be needed (None are anticipated at this time.).
- The cost of this work (below $300,000) will allow it to be bid informally by invitation only.
- The addition of other specialty work that may be needed to be done at the same time (such as sedimentation basin repair, valve replacement or repair, etc.) will increase the

size of this project and may make it more economically attractive to potential bidders, thus making the bid process more competitive and the project more economical.
  - The lead time for obtaining porcelain spheres and anthracite can be five to seven months. Therefore, time is of the essence.
- Verify proper wash rates and times:
  - The backwash rate should be on the order of 15 – 20 gallons per minute per square foot (gpm/sf). This translates to 2,160 to 2,880 gallons per minute (gpm) per filter.
  - The surface wash rate should be on the order of 90 gpm with a pressure of 80 psi. The release of air bubbles during surface washing should be evident.
  - Duration time of each and sequencing can be discussed if requested.
  - Check for air bubbles that may be developing in the filter face piping or in the filter tub plenum. If necessary, make improvements or repairs to minimize the possibility of such bubbles developing.

The Wooten Company trusts that this report is acceptable to the Town of Nags Head and has answered its questions concerning the performance and condition of its filters at the Fresh Pond WTP. Upon the town's review of this report, The Wooten Company stands ready to answer any questions and to provide additional assistance as needed in this worthy endeavor. The Wooten Company appreciates this opportunity to be of service to the citizens of the Town of Nags Head.

Appendix A – Pictures


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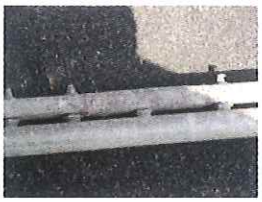
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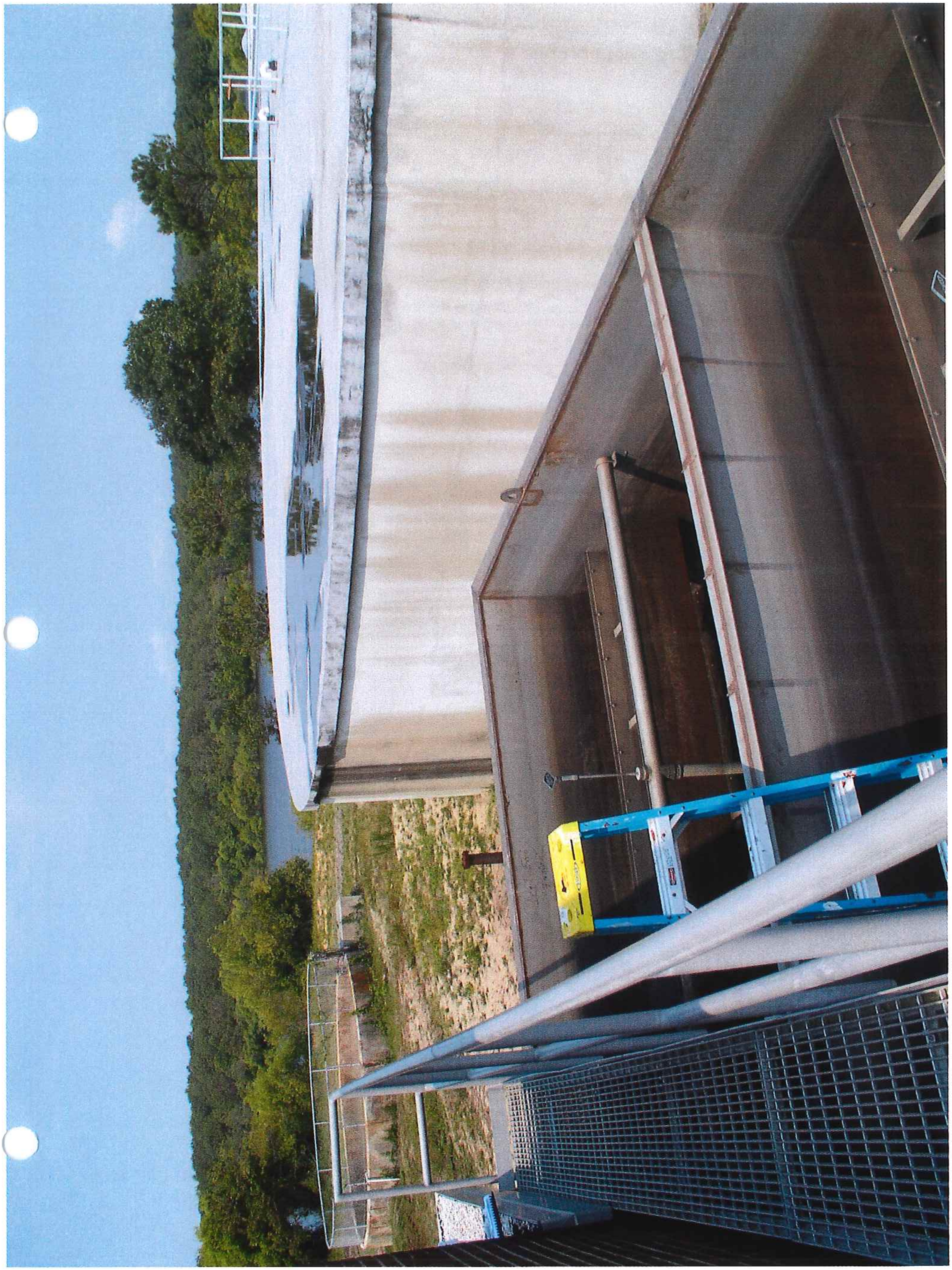

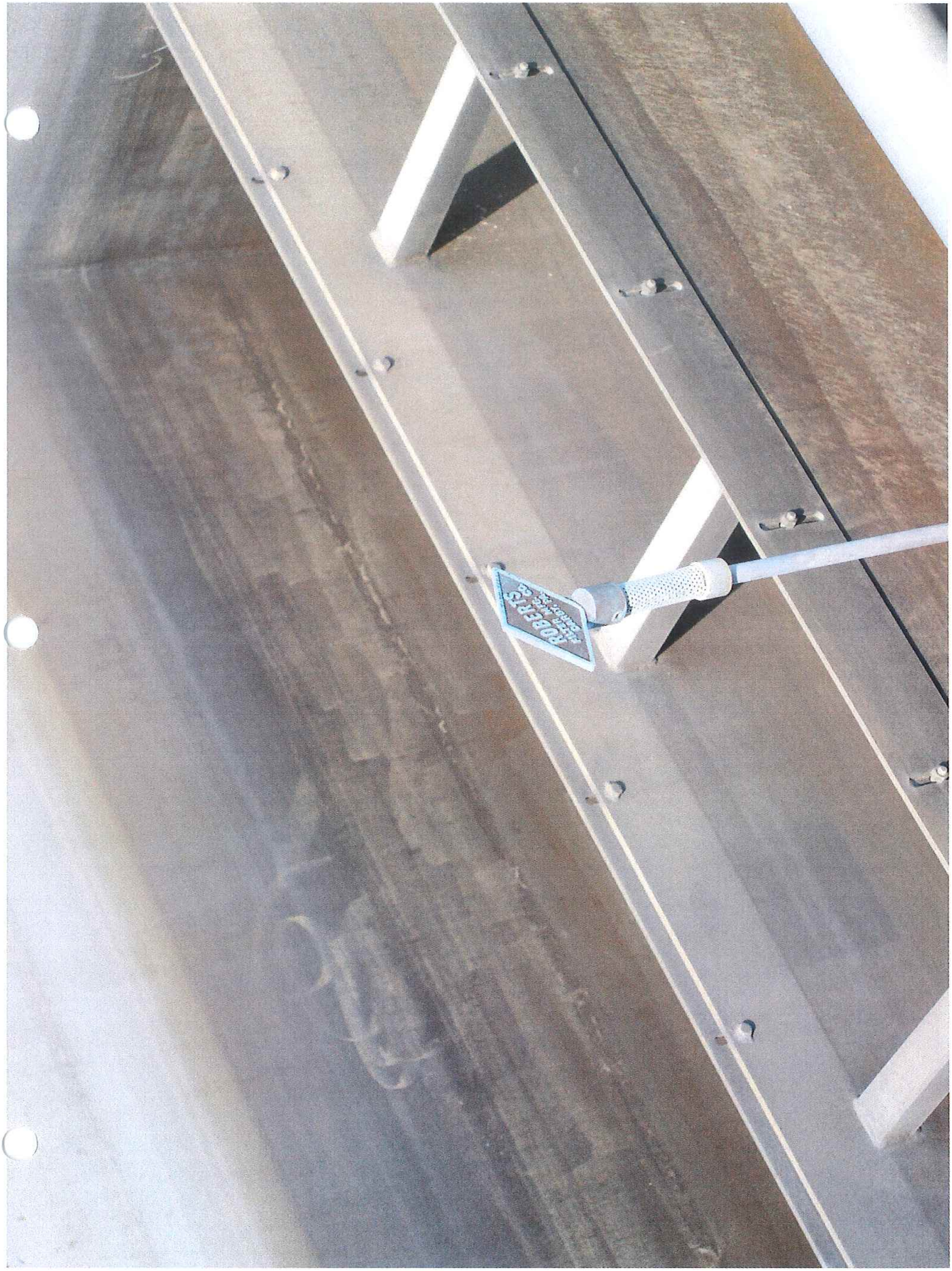
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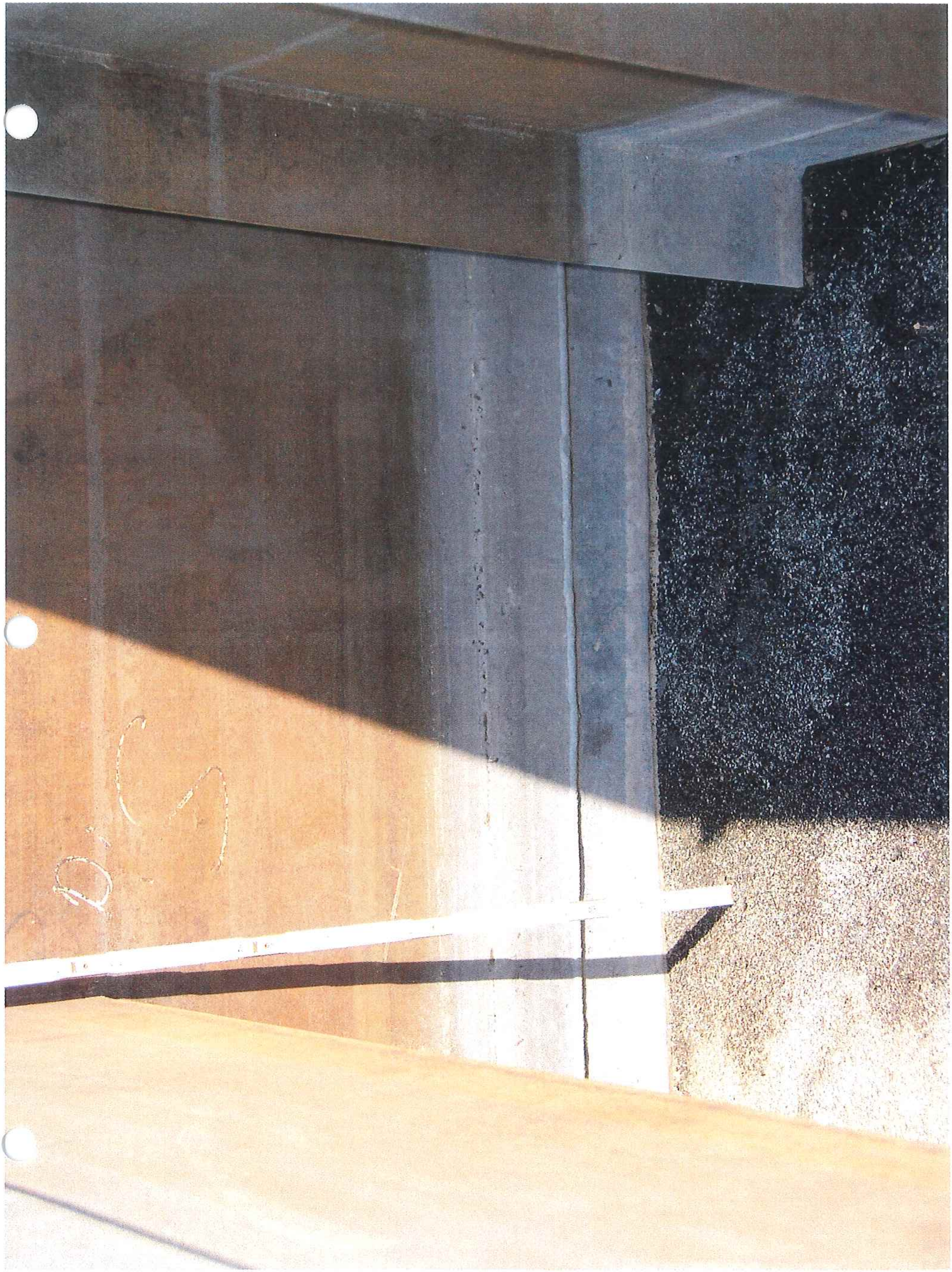

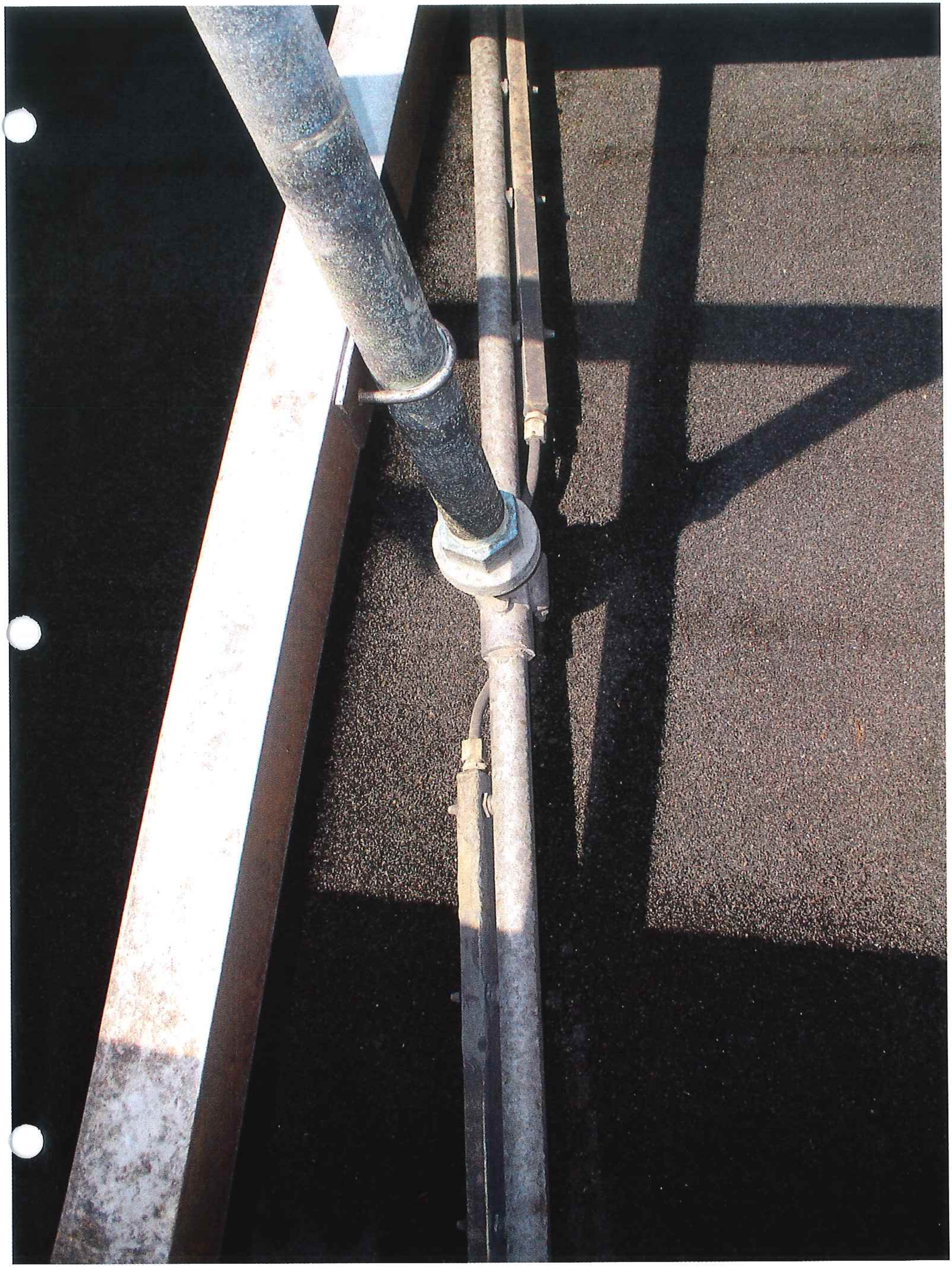

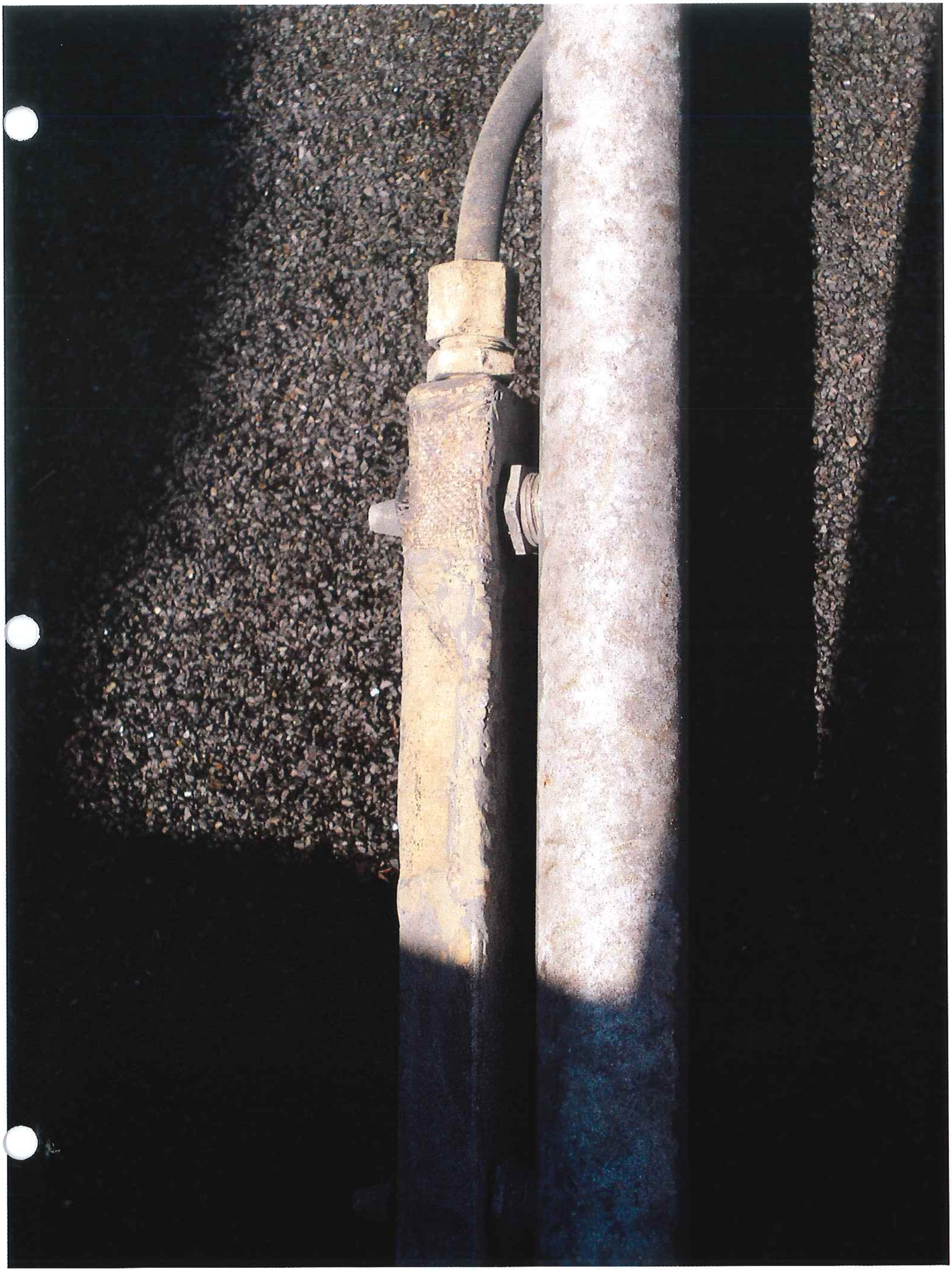


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