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ANALYTICAL
LABORATORIES INC.
"TOMORROWS ANALYTICAL SOLUTIONS TODAY"

NYSDOH ELAP# 11693
USEPA# NY01273
CTDOH# PH-0284
NJDEP# NY012
PADEP# 68-2943

SUSPENDED SOILDS REMOVAL TEST

Of Stormwater Filtration System

Prepared For:

FABCO INDUSTRIES INC.

66 Central Avenue
Farmingdale, NY 11735

June 2015

Prepared By:
Long Island Analytical Laboratories Inc.
110 Colin Drive
Holbrook, NY 11741

Michael Veraldi, President, Director of Laboratories

1 Table of Contents

2 Introduction

Long Island Analytical Laboratories Inc. (LIAL) has been retained by Fabco Industries Inc. to conduct a sediment removal efficiency test for a storm water filtration system's cartridge; identified as Fabco Industries Inc. Standard Filter Cartridge, part number 9718-1-000. [1] The efficiency test was conducted at the Fabco Industries location in Farmingdale, N.Y., using OK-85 silica sand.

3 Overview of Test Apparatus

The testing apparatus is composed of two reinforced wooden boxes, each wrapped with a PVC liner to create two water tight vessels. The boxes are vertically stacked so that the lower box, hereafter referred to as the collection tank, will collect the effluent water from the filter test cartridge which is contained in the upper box, hereafter referred to as the testing tank. The testing tank included a standard aluminum cartridge attachment plate of which configuration is typically used in Fabco Industries standard products to securely lock and seal cartridges in place. [2] Clean water is then pumped from a 5,000 GAL holding tank through a series of control valves and through an initial (coarse) flow meter. The water is then piped to a second meter, at the testing tank inlet, where a butterfly valve is used for fine flow adjustment. The regulated influent water is immediately allowed to freefall into the testing tank, where a calibrated lead screw auger introduces the OK-85 Silica Sand. Furthermore, the testing tank incorporates a propeller style mixer to keep the tank in a turbulent state during testing, thereby preventing the silica sand from falling out of suspension. The homogeneous mixture is then filtered through the test cartridge and discharges (freefall) into the collection tank below, which in turn drains into a 2,000 GAL discharge tank. [3]

Testing Equipment	
Burks 7.5 HP Centrifugal Pump	CAT. 469-4
Blue-White Industries Digital Flow Monitoring System (2)	F-2000
Lead-Screw Auger Feeder [Calibrated by Fabco Industries]	NA
Butterfly Valves	NA
Leeson Agitator Speed: 1725 RPM	CAT. 102954.00

Table 1: Equipment used for sediment removal testing.

4 Test Sediment:

The OK-85 silica sand used for the sediment removal efficiency testing was produced by U.S. Silica Company at a plant in Mill Creek, Oklahoma. The sediment was produced by screening the crystalline silica through different sized sieves and then mixing a percentage of the silica that was retained on each sieve together (Figure 1). The OK-85 silica sand is a fairly homogeneous, inert material composed of 99.8% Silicon Dioxide (SiO_2) and has the following physical properties. [4]

pH	6.7
AFS Grain Fineness	81.8
Grain Shape	Round
Hardness	7 Mohs
Specific Gravity	2.65
Moisture Content	<0.50%
Mineral	Quartz
Color	White
Melting Point	3100°F

Table 2: Typical physical properties of OK-85 Silica sand. [4]

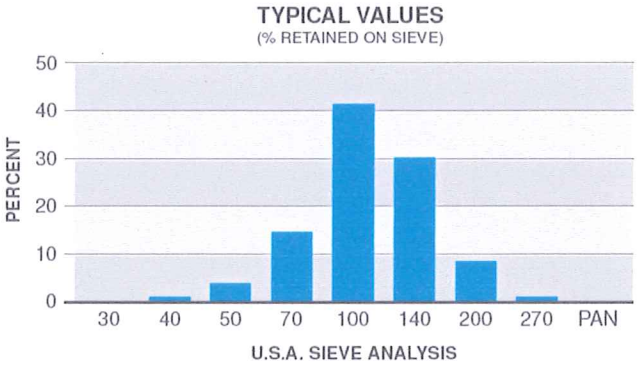
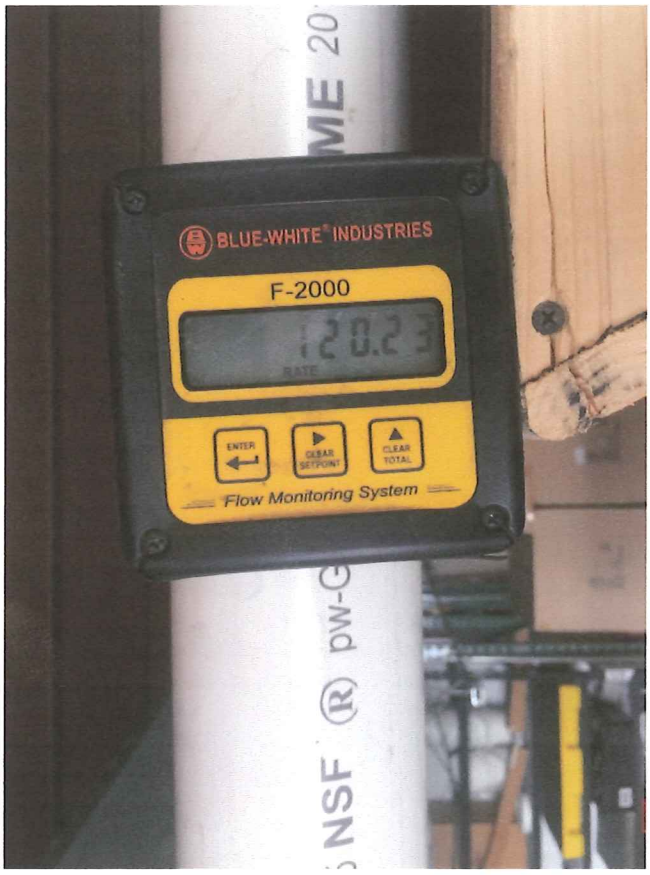


Figure 1: Sieve analysis for OK-85 Silica sand. [4]

5 Testing Procedure

Prior to sampling, Fabco Industries, Inc. conducted calibration tests on the lead screw auger and the flow meters to ensure proper functionality and accuracy. The calibration test for the "lead screw auger was conducted through timed trials of sediment expulsion and collection." [5] The calibration test for the flow meters "was conducted through a timed volume displacement trial." [5] The sampling procedure consisted of recirculating water through the pump to achieve a flow rate of 120 GPM; this was done utilizing an external piping system as diagramed in the plumbing schematic (Attachment 4). Then the water was diverted into the testing tank where it was allowed to stabilize at a constant head height and thus creating constant flow through the filter cartridge. After 60 seconds the lead screw auger and propeller mixer were activated and the testing tank was left to mix for an additional 60 to 90 seconds. A total of eight samples were then collected, four at the influent and four at the effluent of the filter cartridge, by a trained Long Island Analytical Laboratories technician. All sampling and preservation techniques were done in strict compliance with NYSDOH ELAP protocols. [5]



6 Sample Analysis Method

The eight samples, each approximately 500 mL, were analyzed at Long Island Analytical Laboratories using the Standard Test Methods for Determining Sediment Concentration in Water Samples, ASTM Designation: D3977-97. From the ASTM specification Test Method B – Filtration was found to be most suitable for analyzing the samples. Test Method B "can be used only on samples containing sand concentrations less than about 10,000 ppm and clay concentrations less than about 200 ppm. The sediment need not be settleable because filters are used to separate water from the sediment." Then "the sample consisting of water, sediment and dissolved solids were weighed and then filtered through a glass-fiber disk. The disk and sediment were dried and weighed" then the sediment concentration was calculated. [6]

7 Laboratory Results

$$P_{Removal} = \frac{S_{Before} - S_{After}}{S_{Before}}$$

Sample #	Influent [mg/L]	Effluent [mg/L]	Efficiency (%)
1	954	232	75.7
2	2060	217	89.5
3	1150	258	77.6
4	1970	266	86.5
Mean	1533.50	243.25	82.3

Table 3: Sediment Removal Efficiency Results.

8 References

[1] Fabco Industries, Inc., *Cartridge, Standard,* Farmingdale, New York, 2007.

[2] Fabco Industries, Inc, *TSS Testing Fabco Cartridge,* Farmingdale, NY, 2014.

[3] Fabco Industries, Inc., *Testing Plumbing Schematic,* Farmingdale, NY, 2014.

[4] U.S. Silica Company, "Product Data OK-85 Unground Silica," U.S. Silica Company, [Online]. Available: http://www.ussilica.com. [Accessed 18 June 2015].

[5] Fabco Industries, Inc., *Total Suspended Solids (TSS) - Outline,* Farmingville, NY, 2014.

[6] ASTM International, "Standard Test Methods for Determining Sediment Concentration in Water Samples," 2013. [Online]. Available: http://www.ASTM.org. [Accessed 2 March 2015].

9 Appendix

9.1 Attachment 1: Fabco Industries, Inc. Standard Cartridge

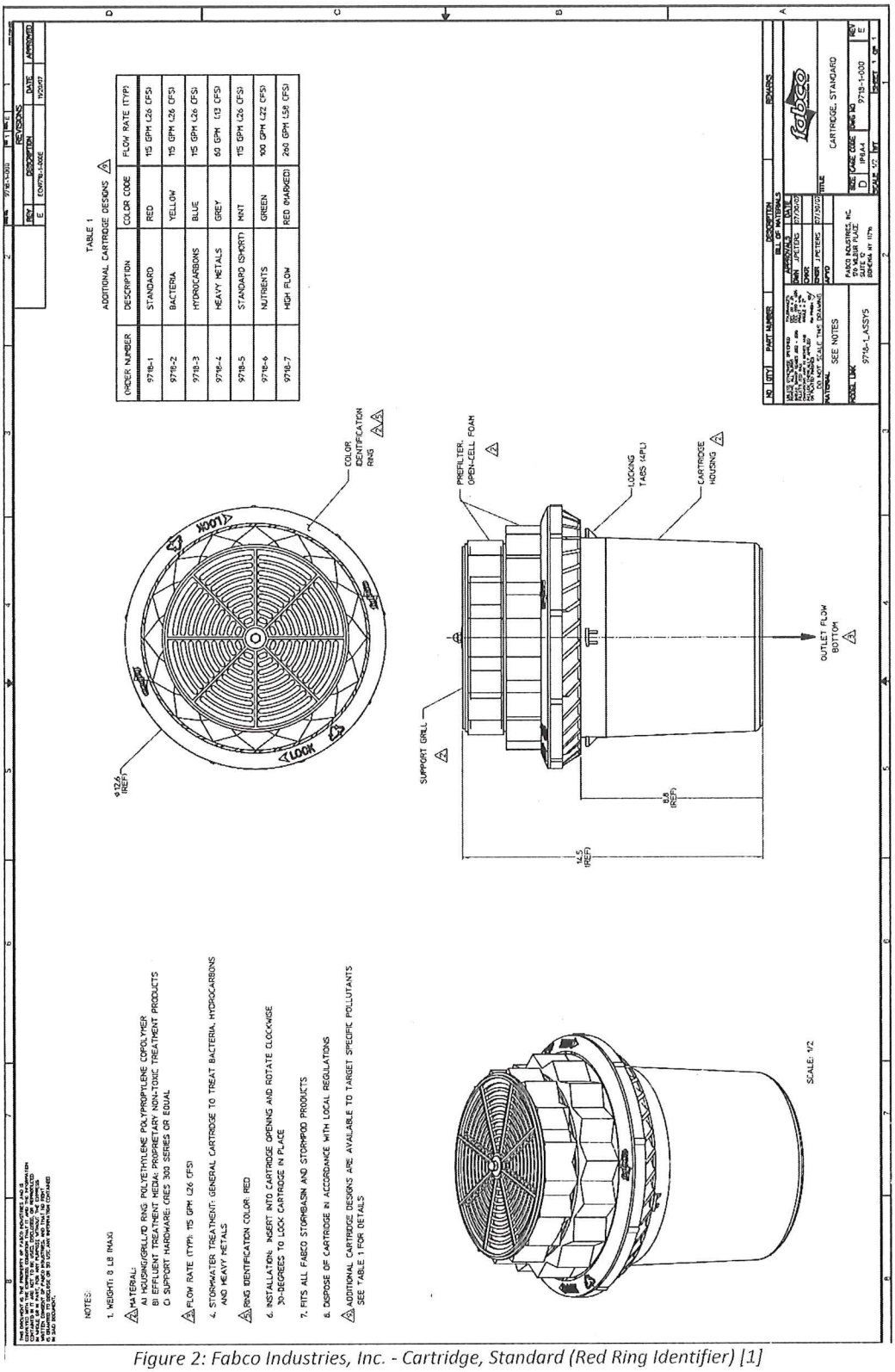


Figure 2: Fabco Industries, Inc. - Cartridge, Standard (Red Ring Identifier) [1]

9.2 Attachment 2: U.S. Silica Company: OK-85 Silica, Unground

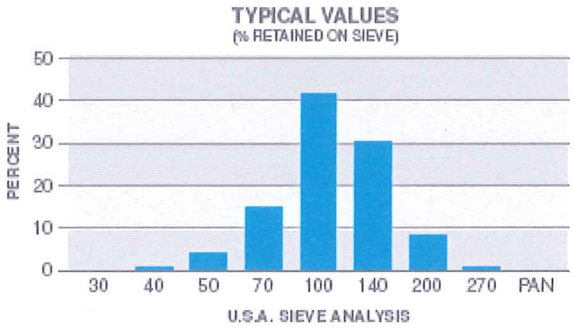
Product Data

US SILICA

OK-85

UNGROUND SILICA

PLANT: MILL CREEK, OKLAHOMA



USA STD SIEVE SIZE		TYPICAL VALUES		
		% RETAINED		% PASSING
MESH	MILLIMETERS	INDIVIDUAL	CUMULATIVE	CUMULATIVE
30	0.600	0.0	0.0	100.0
40	0.425	0.8	0.8	99.2
50	0.300	4.0	4.8	95.2
70	0.212	14.8	19.6	80.4
100	0.150	41.0	60.6	39.4
140	0.106	30.0	90.6	9.4
200	0.075	8.4	99.0	1.0
270	0.053	0.9	99.9	0.1
Pan		0.1	100.0	0.0

TYPICAL PHYSICAL PROPERTIES	
AFS[1] Acid Demand (@pH 7)	0.4
AFS[1] Grain Fineness	61.8
Color	White
Grain Shape	Round
Hardness (Mohs)	7
Melting Point (Degrees F)	3100
Mineral	Quartz
Moisture Content (%)	<0.50
pH	6.7
Specific Gravity	2.65

(1) American Foundrymen's Society

TYPICAL CHEMICAL ANALYSIS, %	
SiO_2 (Silicon Dioxide)	99.8
Fe_2O_3 (Iron Oxide)	0.017
Al_2O_3 (Aluminum Oxide)	0.09
TiO_2 (Titanium Dioxide)	<0.01
CaO (Calcium Oxide)	<0.01
MgO (Magnesium Oxide)	<0.01
Na_2O (Sodium Oxide)	<0.01
K_2O (Potassium Oxide)	0.04
LOI (Loss On Ignition)	0.1

July 1, 2008

U.S. Silica Company
8490 Progress Drive, Suite 300
Frederick, MD 21701
(301) 682-0600 (phone)
(800) 243-7500 (toll-free)
ussilica.com

Figure 3: U.S. Silica Company - MSDS for OK-85, unground [4]

9.3 Attachment 3: Fabco Industries, Inc. Cartridge Testing Fixture (P/N: 10111-1-000)

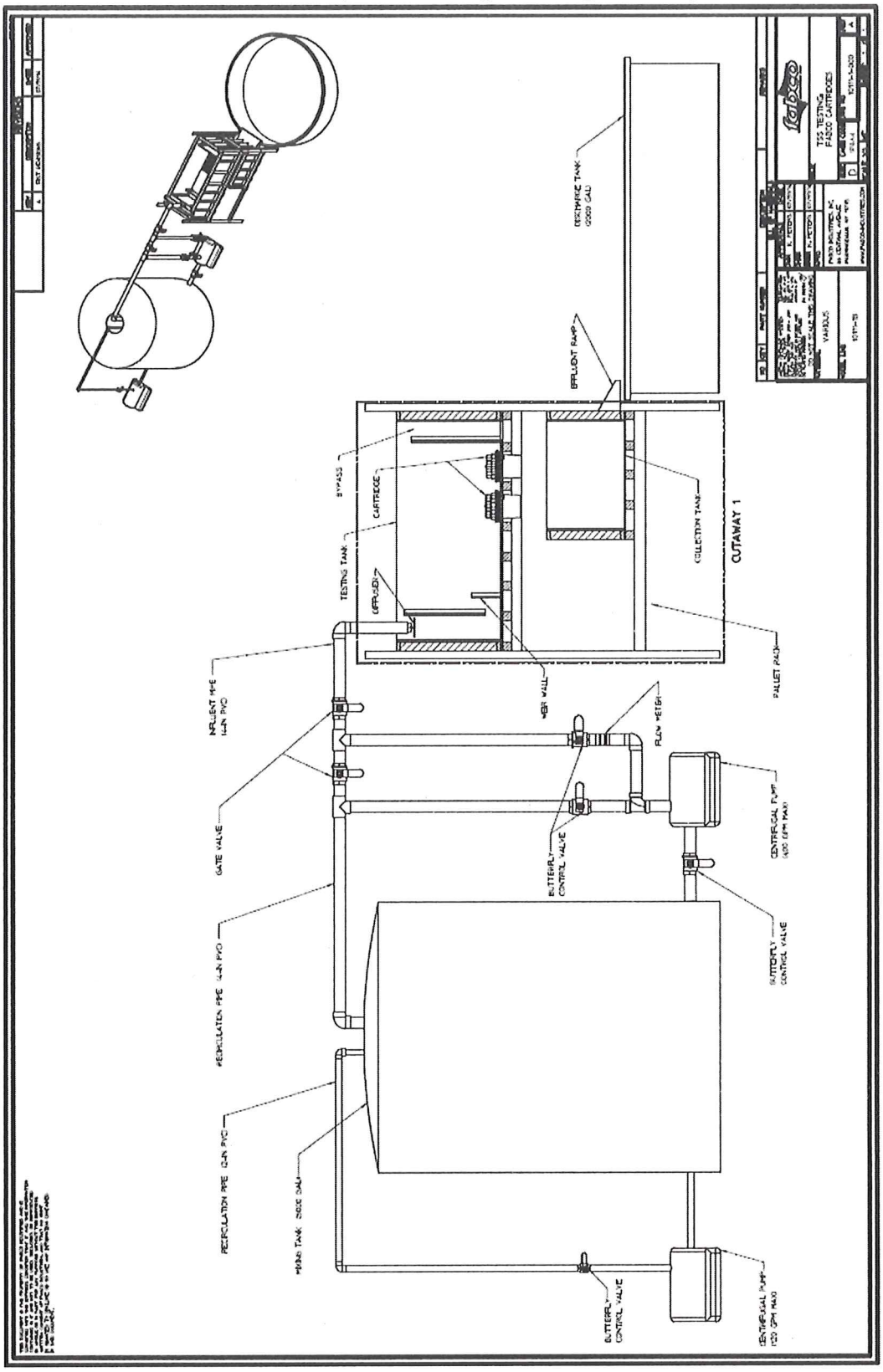
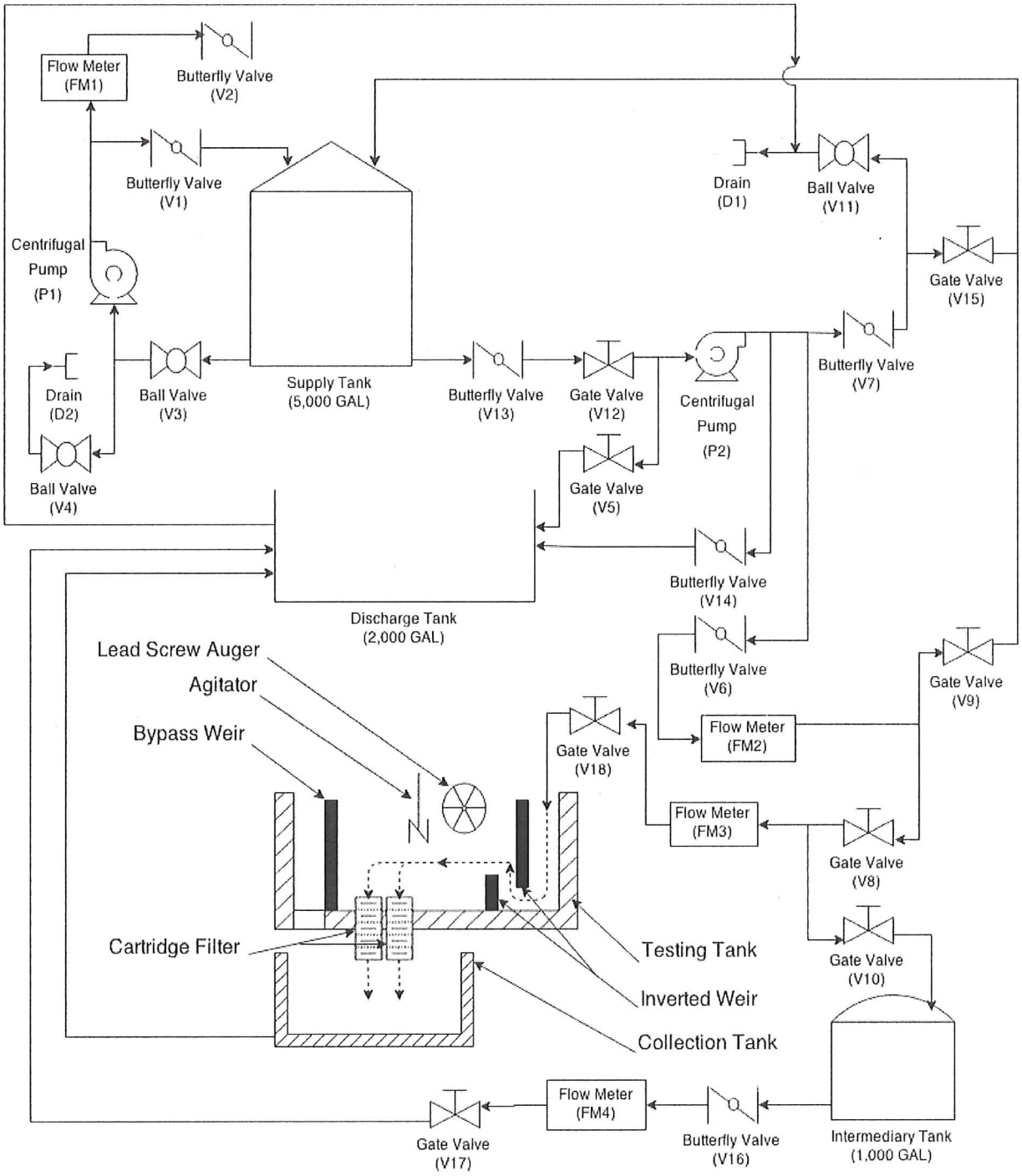


Figure 4: Fabco Industries, Inc. cartridge fixture for sediment removal testing. [2]

9.4 Attachment 4: Fabco Industries, Inc. Testing Fixture Plumbing Schematic



Notes:

- FM1: GPI, TM Series, Water Meter, Great Plains Industries, Inc. Wichita, KS.
- FM2, FM3, FM4: Blue-White Industries, F-2000, Flow Monitoring System
- P1: US Motors, SN: C55CXJZB-4757, Power: 1 HP, Speed: 3450 RPM
- P2: Burks Pumps, SN: 0305, CAT: 469-4, Power: 7.5 HP, Speed: 1760 RPM

Figure 5: Fabco Industries, Inc. Plumbing Schematic. [3]

9.5 Attachment 5: Fabco Industries, Inc. Total Suspended Solids (TSS) – Outline

Figure 6: Fabco Industries, Inc. Testing Procedure. [5]

Total Suspended Solids (TSS)- Outline

Written by:

Kevin C. Peters

Prior to Sampling:

1st.: The testing setup was constructed to the TSS Plumbing Schematic featured at the conclusion of this document. (Figure 1)

2nd.: The cartridge test fixture (Figure 1) was cleaned and rinsed of all sediment and particulates.

3rd.: The 5,000 gallon supply tank (Figure 1) was filled with clean water to the 4,500 gallon mark. (Previous sediment testing for a single cartridge assembly has been shown to use no more than 2,000 gallons)

4th.: The water level in the 2,000 gallon discharge tank (Figure 1) was drained to readily accommodate the total volume of water used during the experiment.

5th.: Calibration of the lead screw auger was conducted through timed trials of sediment expulsion and collection. The lead screw auger was run for one minute and the sediment excreted from the auger was collected in a beaker and massed using a digital balance.

6th.: Calibration of flow meter 3 (Figure 1) was conducted through a timed volume displacement trial. The flow meter was held at a constant flow rate of 60 gallons per minute for one minute to stabilize and then a 30 gallon, marked, drum was used to collect the dispensed water. A stop watch was used to measure the required time to fill the drum to the 30 gallon marker.

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Concurrent to Sampling:

1st.: A new Standard Fabco Cartridge was inserted into the Testing Tank as shown in Figure 1.

2nd.: The testing setup was configured to the valve positions specified in the table Valve Positioning – Sediment Testing, Start column (Table 1).

3rd.: The centrifugal pump, P2, (Figure 1) was started. With the valves in the Start position this allows the water to be recirculated through the 5,000 gallon Supply Tank (Figure 1).

4th.: Using flow meter FM2 (Figure 1) and butterfly valves V6 and V7, (Figure 1), here forth referred to as the control valves, the flow rate is adjusted roughly 15 to 20 gallons per minute higher than the desired flow rate. For sediment testing the desired flow rate was 120 gallons per minute, thus the flow rate obtained by the control valves was roughly 145 gallons per minute.

5th.: Once the flow rate was maintained, the valve positions were reconfigured to correspond with the Test column of the Valve Position – Sediment Testing Table (Table 1). This configuration redirects the flow of water that was passing though the flow meter, FM2, (Figure 1) away from the 5,000 gallon Supply Tank and into the Testing Tank (Figure 1).

6th.: Using flow meter FM3 and gate valve V18 (Figure 1), thus forth referred to as the regulatory valve, the flow rate was readjusted to the desired rate. For the total suspended solids (TSS) testing the desired flow rate was 120 gallons per minute.

7th.: Once the desired flow rate was obtained, the lead screw auger filled with OK-85 sand and the water agitator were turned on. The water and sediment was then allowed to mix in the testing for between 60 and 90 seconds.

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8th.: A total of ten samples were taken during testing, five inlet and five outlet. The inlet and outlet samples were taken concurrently at 20 second intervals between samples. The inlet samples were taken at the invert of a half pipe which was placed so that both the inlet water and OK-85 sediment would thoroughly mix. The outlet samples were taken at the exit of the standard cartridge filter (Figure 1) which was between the testing Tank and the Collection Tank (Figure 1).

9th.: Once all samples had been taken the centrifugal pump P2 was turned off and the valves were reconfigured to the positions specified in the End column of the Valve Positioning – Sediment Testing table (Table 1).

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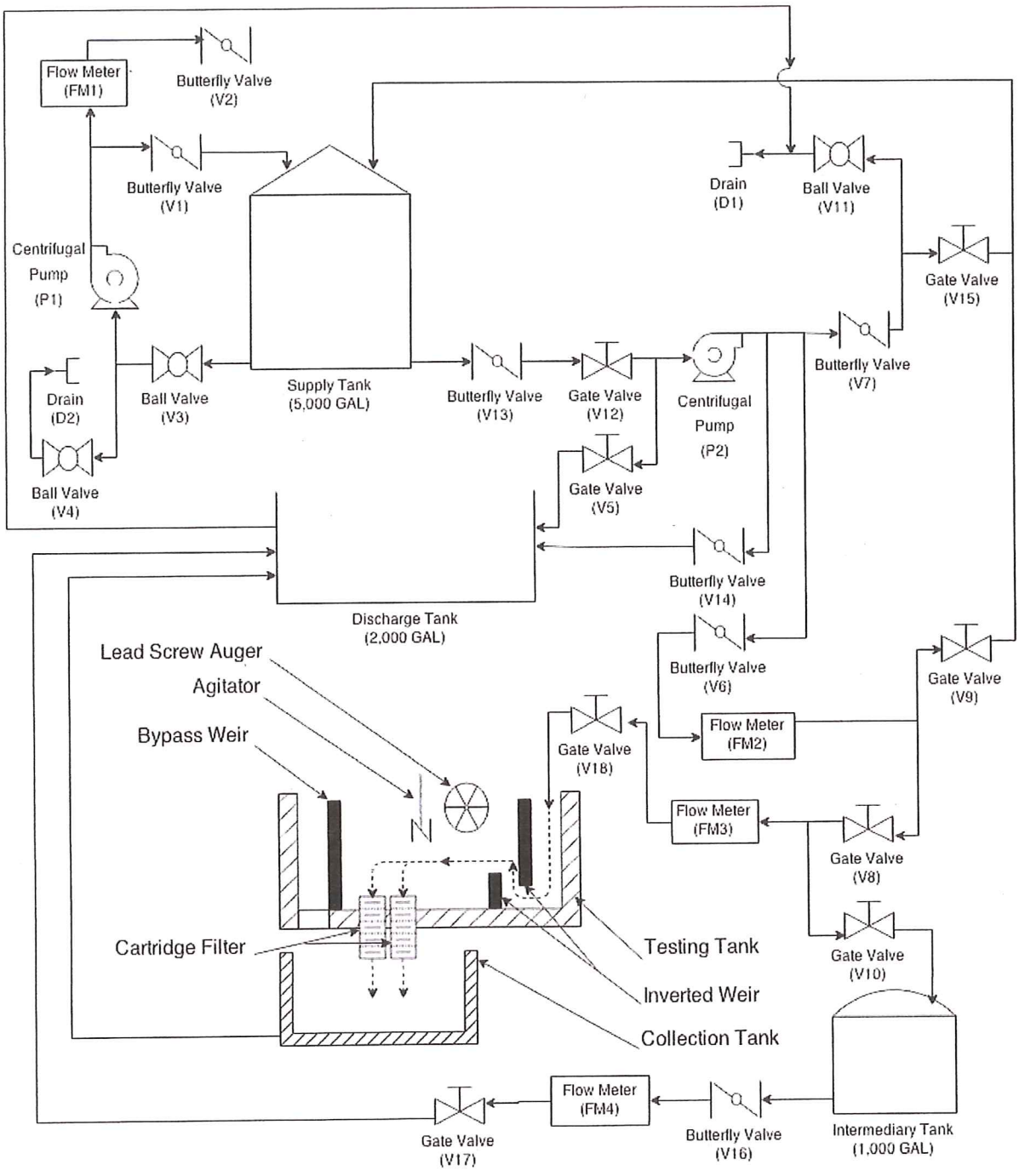
TSS Plumbing Schematic



Notes:

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- FM2, FM3, FM4: Blue-White Industries, F-2000, Flow Monitoring System
- P1: US Motors, SN: C55CXJZB-4757, Power: 1 HP, Speed: 3450 RPM
- P2: Burks Pumps, SN: 0305, CAT: 469-4, Power: 7.5 HP, Speed: 1760 RPM

Figure 1: Plumbing schematic for total suspended solids testing.

VALVE POSITION - SEDIMENT TESTING				
VALVE #	START	TEST	DRAIN	END
V1	OPEN	OPEN	N/A	N/A
V2	CLOSED	CLOSED	CLOSED	CLOSED
V3	OPEN	OPEN	CLOSED	CLOSED
V4	CLOSED	CLOSED	CLOSED	CLOSED
V5	CLOSED	CLOSED	OPEN IF DRAINING POOL	N/A
V6	CLOSED	ADJ. W/ V7 TO OBT. FL. RT.	CLOSED	CLOSED
V7	OPEN	ADJ. W/ V6 TO OBT. FL. RT.	OPEN	OPEN
V8	CLOSED	OPEN AT CORRECT FL. RT.	N/A	N/A
V9	OPEN	CLOSE AT CORRECT FL. RT.	N/A	N/A
V10	CLOSED	CLOSED	N/A	N/A
V11	CLOSED	CLOSED	OPEN	N/A
V14	CLOSED	CLOSED	OPEN	OPEN
V15	OPEN	OPEN	CLOSED	CLOSED
V12	OPEN	OPEN	OPEN IF DRAINING CIELO	N/A
V13	OPEN	OPEN	OPEN IF DRAINING CIELO	CLOSED

Table 1: Valve positioning for sediment testing to be used in cognizance with TSS Plumbing Schematic (Figure 1)

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9.6 Attachment 6: Standard Test Methods for Determining Sediment Concentration in Water Samples, ASTM Designation D3977-97

TEST METHOD B—FILTRATION

14. Scope

14.1 Test Method B can be used only on samples containing sand concentrations less than about 10 000 ppm and clay concentrations less than about 200 ppm. The sediment need not be settleable because filters are used to separate water from the sediment. Correction factors for dissolved solids are not required.

14.2 Even though a high-concentration sample may filter slowly, users should not divide the sample and use two or more filters. Instead, the entire sample should be filtered through one disk.

15. Summary of Test Method

15.1 The sample consisting of river water, sediment, and dissolved solids is weighed and then filtered through a glass-fiber disk. The disk and sediment are dried and weighed, then the sediment concentration is calculated in accordance with Section 18.

16. Apparatus

16.1 *Gooch Crucibles*—Porcelain or borosilicate glass crucibles with fritted glass bases are required for holding the filters. Capacities of the crucibles are optional; sizes in the 25 to 130-mL range work best with 1-L samples. Small crucibles have the advantage of requiring less oven space during drying and absorbing less moisture during weighing; large crucibles are needed if filtering proceeds slowly.

16.2 *Glass-fiber Filter Disks*—Filter diameter and filter retention rating, sometimes referred to as filter pore size, are critical to this analysis. The sediment that accumulates on a filter traps some particles that are smaller than the filter's retention rating. As filtration proceeds and the sediment layer thickens, the retention rating of the sediment and filter acting as a unit gradually decreases. Users should use filters with retention ratings of 1.5 µm to agree with practices in many sediment laboratories.[8] Filter diameters should equal or exceed 24 mm. Filters as large as 42 mm may be required to avoid filter plugging at high concentrations. Record filter retention rating in micrometres and filter diameter in millimetres at a convenient place on the laboratory form.

16.3 *Vacuum System*—See 10.2.

16.4 *Drying Oven*—See 10.3.

16.5 *Desiccator*—See 10.4.

16.6 *Laboratory Balances*—See 10.5 and 10.6.

17. Procedure

17.1 Wash the filter with water to remove soluble compounds; then dry the filter and its crucible at 105°C for at least 1 h.

17.2 Transfer the crucible and filter to the desiccator, then, after the parts have cooled to room temperature, weigh them to the nearest 0.0001 g and record the reading on the laboratory form under the heading Weight of Sediment—Tare.

17.3 While a vacuum is being applied to the bottom of the crucible, decant supernate from the sample into the crucible. Flush the inner surfaces of the sample bottle with water to complete the transfer.

17.4 As filtering proceeds, inspect the filtrate. If it is turbid, pour the filtrate back through the filter a second and possibly a third time. If the filtrate is still turbid, the filter may be leaking. In this case, substitute a new filter and repeat the process. If the filtrate is transparent but discolored, a natural dye is present; refiltration is not necessary.

17.5 When filtration is complete, place the crucible and its contents in the drying oven set for 105°C.

17.6 When the crucible and its contents are dry, transfer to a desiccator. After the crucible has cooled, weigh to the nearest 0.0001 g and record the reading on the laboratory form under the heading Weight of Sediment—Gross.

17.7 Refer to 11.6 for a discussion of multiple drying and weighing cycles.

18. Calculation

18.1 Subtract Weight of Sediment—Tare from Weight of Sediment—Gross and record the difference under the heading Weight of Sediment—Net. No dissolved-solids correction is required.

18.2 Refer to 12.3 and 12.4 for computations.

19. Precision and Bias for Test Method B (Filtration)

19.1 These precision and bias data meet requirements of Practice D2777.

19.2 Samples for collaborative testing were prepared by dispersing a specially prepared dry powder in approximately 350 mL of water. Mixtures were shipped in sealed glass containers to the nine participating laboratories where three Youden pairs at each of three concentrations were tested.

19.3 Bias was influenced not only by analytical procedures such as filtering, drying, and weighing but also by failure to remove all sediment from the containers and by losing particles through dissolution.

19.4 The following table shows precision and bias for Test Method B:

Concentration Added, mg/L	Concentration Recovered, mg/L	Standard Deviation of Test Method (St)	Standard Deviation of Single Operator (So)	Bias, %
10	8	2.6	2	−20
100	91	5.3	5.1	−9
1000	961	20.4	14.1	−3.9

TEST METHOD C—WET-SIEVING-FILTRATION

20. Scope

20.1 This test method covers concentration measurements of two particle-size fractions. The term fine fraction refers to

[8] The sole source of supply of the apparatus known to the committee at this time is Whatman type 934-AH, Whatman Lab Sales Inc., Hillsboro, OR. If you are aware of alternative suppliers, please provide this information to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

Figure 7: Test Method B - Filtration from ASTM Designation D3977-97. [6]