

Hungerford & Terry

GreensandPlus™ Filtration Systems



A Proven Filtration Method for Reliable,
Cost-effective Removal of Iron, Manganese
and Arsenic from Groundwater

Hungerford & Terry GreensandPlus™ Filtration Systems*

GreensandPlus™ Filter Media

Prior to World War II, researchers in the water-treatment field, working with well-known chemical theories of oxidation and reduction, developed the basic technology of manufacturing manganese greensand from the mineral glauconite. This medium found use in the municipal and industrial water-treatment market for the direct oxidation and removal of iron, manganese and hydrogen sulfide.

By 1965, Hungerford & Terry had perfected and patented the predecessor to the GreensandPlus Filter – the Ferrosand CR filter process, an oxidant feed prior to filtration that continuously regenerates the catalytic coating on the media. The Catalytic Oxidation process was developed using a special Catalytic Grade of the media. This system operated at higher loading rates and did not require the use of potassium permanganate, the objective being to produce a top-quality filter system that would reliably remove iron and manganese.

Today, as always, Hungerford & Terry custom designs, builds or reconfigures filtration systems to meet customers' specific requirements. Every system sold is extremely competitive in both capital and long-term operating expenses.

GreensandPlus Filtration Technology

The Hungerford & Terry team of engineers has developed GreensandPlus media which is manufactured to exact specifications. This ensures the complete oxidation of soluble iron and manganese by using stoichiometric quantities of oxidizing chemicals without the need for long reaction times or high pH levels. GreensandPlus is not one of those “magic media” that have exaggerated claims of magnetic properties for the attraction of iron and manganese. As a filter medium, it operates on the chemical principle of oxidation, reduction and the well-known catalytic effect of manganese oxide. Catalytic oxidation and filtration using a manganese dioxide coated media has demonstrated its effectiveness as the proven technology in iron and manganese removal for over a half a century.

GreensandPlus media performs optimally when combined with our unique filter system design. The GreensandPlus Filtration System is engineered to ensure the most cost-effective performance while producing outstanding water quality.

* GreensandPlus™ is a product of the Inversand Company.

The Typical External Arrangement of a GreensandPlus Filtration System

- 1 Raw Water Inlet
- 2 Backwash Outlet
- 3 Rinse
- 4 Treated Water Outlet
- 5 Backwash Inlet
- 6 Pressure Gauges
- 7 Bi-Directional Inlet/
Backwash Outlet
Flowmeter
- 8 Backwash Tell Tale
Sample



Two Methods of Design And Operation – Catalytic Oxidation (CO) for Iron and Manganese Removal and Intermittent Regeneration (IR) for Manganese Removal

These two distinct methods of operation allow for flexibility in the design of water-treating systems with specific features tailored to the raw water characteristics and specific applications.

The CO process is used primarily when removing iron and manganese is the objective and a residual oxidant in the effluent flow is preferred. This method provides long-lasting, cost-effective performance when iron predominates in the raw water. The CO method utilizes a continuous pre-feed of chlorine (Cl₂) to the raw water upstream of the GreensandPlus filter. Soluble iron and manganese are oxidized to the insoluble form and filtered out by a dual media anthracite/GreensandPlus bed.

The CO process can also be effective for treating moderate levels of arsenic. Utilizing co-precipitation with iron, arsenic is easily filtered out along with the iron. The chlorine oxidizes any arsenite to the arsenate form and up to 95% removal of total arsenic can be achieved. The USEPA's established MCL of 10 micrograms/liter, established in January 2002, can be easily met.

Due to the unique chemical and physical properties of GreensandPlus, which are attributable to the multivalent manganese oxide coating covering the grains, iron and manganese are consistently removed to desired levels.

Manganese oxide has a well-known catalytic effect in the oxidation of soluble iron and manganese and also provides a redox buffer capable of either oxidizing remaining traces of iron and manganese or reducing excess KMnO₄, if that is used as the preferred oxidant. This not only guarantees the consistent removal of iron and manganese but also maintains the GreensandPlus in a continuously regenerated state, without the need for a separate regeneration step. Periodic backwashing is all that is required.

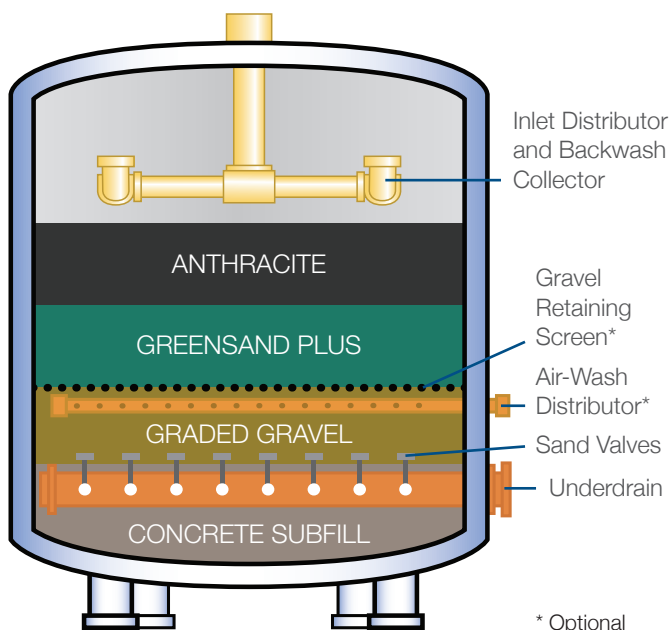
Note: Local environmental authorities generally consider the waste stream from a GreensandPlus filter more favorable than those generated by activated alumina, ion exchange or RO systems.

GreensandPlus IR for Manganese Removal

For groundwaters that contain only manganese, or manganese with small amounts of iron, as well as residential and small commercial applications, the intermittent regeneration (IR) process is recommended. It allows for extended run length, with a minimum amount of head loss experienced during the filter run. In the IR method, a filter bed of GreensandPlus is periodically regenerated (in a manner similar to sodium-cycle softening) with a solution of chlorine or KMnO₄. The frequency of regeneration is a function of raw water manganese and the volume of water treated.

During the service cycle, manganese is removed by utilizing the oxidative capacity of GreensandPlus. Oxidation of soluble manganese occurs directly on the GreensandPlus grains, becoming an integral part of the manganese oxide coating. To prevent fouling of the process by direct oxidation of soluble iron on the grains, varying amounts of accompanying iron should be oxidized by using pre-chlorination prior to contact with the IR filter's bed, consisting entirely of GreensandPlus.

Cross-Section of a Typical Hungerford & Terry GreensandPlus Filtration System



Summary

Either the CO or IR mode of operation consistently removes iron and manganese to levels that are equal to, or below, the MCL.

Proven cost-effective GreensandPlus systems, with built-in flexibility for varying operating conditions, serve municipalities and other industrial and commercial operations worldwide.

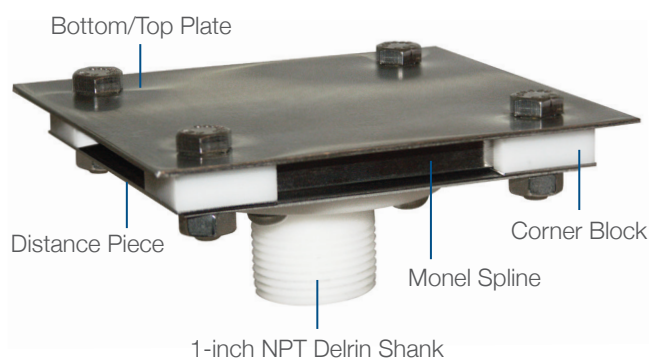
For calculating specific chemical dosages and expected run lengths, please refer to the Hungerford & Terry GreensandPlus Technical Data Sheet.

The Underdrain System

The underdrain system is critical to the operation of the filter system. It performs the following functions:

- Dual function of both filtered water collection and backwash water distribution.
- Optimum underdrain system of header-lateral design using H&T sand valve.
- An estimated 50 years life. Corrosion-proof design that cannot clog.
- Stainless steel construction, with a Delrin¹ shank and Monel² splines, provides decades of trouble-free service without the problems inherent in competitors' products.

Hungerford & Terry Sand Valve (Stainless Steel Self-Cleaning Design)



While strainers made from plastic or stainless steel incorporating fixed orifices are offered by various suppliers, Hungerford & Terry is reluctant to offer such a design. This is because the strainers may eventually become plugged and result in poor backwash distribution, which causes channeling, resulting in a premature filter rebuild. The expansive port design of the Hungerford & Terry sand valve makes it impossible to plug.

Our technology offers a precise underdrain configuration required for optimum distribution and minimal head loss.

Hungerford & Terry Air/Water Wash System

A supplemental air/water wash is often recommended where the manganese concentration is high. This helps to ensure that the filter bed is effectively cleaned of manganese precipitates.

How It Works

Air discharged with a lobe-type air blower is used in conjunction with a simultaneous upflow water wash immediately prior to the full backwash.

The simultaneous upflow water wash should be maintained at 4 to 5 gpm/sq. ft. combined with .8 to 2.0 cfm of air to provide collapse - pulse agitation for maximum scouring action between the individual filter media grains. This design has been used by H&T for over 80 years.

Hungerford & Terry Gravel Retaining Screen

The Hungerford & Terry stainless-steel gravel-retaining screen is designed to secure the gravel supporting bed without hindering the necessary service or backwash flow distribution. Securing the gravel bed prevents it from becoming upset during either air wash operations or unpredictable backwash surges. As part of the GreensandPlus CO or IR filter, the Hungerford & Terry stainless steel retaining screen has proven its effectiveness and value in over half a century of service.

¹ Delrin is a registered trademark of E.I. DuPont.

² Monel is a registered trademark of International Nickel Co.



A horizontal filter with the underdrain installed (internal view).

Hungerford & Terry, Inc.

Specializing in design, manufacture and service of custom-built water treatment systems. Our only business since 1909.

For over a century, Hungerford & Terry has designed and supplied various types of water-treatment systems for municipal, industrial and power-plant applications. Today, H&T, a US owned privately held corporation, continues to specialize in filtration systems for iron and manganese removal, turbidity removal and carbon adsorption. We are at the forefront of ion exchange technology and can design and manufacture custom-built

water-treatment systems for softening, nitrate removal, PFAS/PFOS, demineralization, as well as conventional deep bed and sodium cycle condensate polishing. We also offer forced draft and vacuum degasification.

Hungerford & Terry is known for our consistent level of excellence, competitive pricing and state-of-the-art engineering and manufacturing services that can meet or exceed any demands.



This is an example of the 1.5 MGD municipal filter installation with air/water wash, by Hungerford & Terry.



GreensandPlus Pretreatment for RO Filter System 4.2MGD

Hungerford & Terry

GreensandPlus™ Filtration Systems

Hungerford & Terry has been designing and manufacturing water-treatment systems for over a century. Contact us for your specific treatment needs. We are ready to assist your engineering staff in predesign and pilot plant studies, preliminary and final specifications development, as well as equipment start-up and training of operating personnel.

Partial List of Customers

	Capacity (MGD)		Capacity (MGD)
Longview Beacon Hill W&S District Longview, WA	21	Municipality of Halton Georgetown, Ontario, Canada	3.3
City of Zanesville Zanesville, OH	10	Town of Surf City Surf City, NC	2.6
City of Hutchinson Hutchinson, KS	8	Churchill County Planning Board Fallon, NV	2.5
Suffolk County Water Authority Bohemia, NY	6.9	Jackson Township MUA Jackson Township, NJ	2.4
Northern Area Water Authority Tipp City, OH	6.7	Boro of Paulsboro Paulsboro, NJ	2.1
Suffolk County Water Authority Oakdale, NY	5.9	South Dallas Water Authority Sardis, AL	2.1
City of New Bern New Bern, NC	5.5	City of Urbana Urbana, OH	2.0
Suffolk County Water Authority Copiague, NY	5.1	Crestwood Village Water Co Whiting, NJ	1.7
Jackson Township MUA Jackson Township, NJ	4.7	Valparaiso City Valparaiso City, IN	1.6
Lakewood Township MUA Lakewood, NJ	4.6	City of Centerville Centerville, MD	1.4
City of Yerington Yerington, NV	4.3	Ventura County Waterworks Ventura, CA	1.4
City of Lancaster Lancaster, OH	4.2	Yarra Trinidad Yarra Trinidad, WI	0.9
City of Tallahassee Tallahassee, FL	3.6	Cook Springs Water Authority Pell City, AL	0.8
Suffolk County Water Authority Smithtown, NY	3.4	Town of Hopedale Hopedale, MA	0.6



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Hungerford & Terry
“Plug & Play”
GreensandPlus™
Systems...



Pre-engineered to last a lifetime.

Water Filtration Packages for Iron, Manganese, Hydrogen Sulfide, Arsenic, and Radium Removal

New Hungerford & Terry “Plug & Play” GreensandPlus™ Systems can provide low-cost, pre-engineered solutions to handle a wide range of water filtration applications... when and where you need them

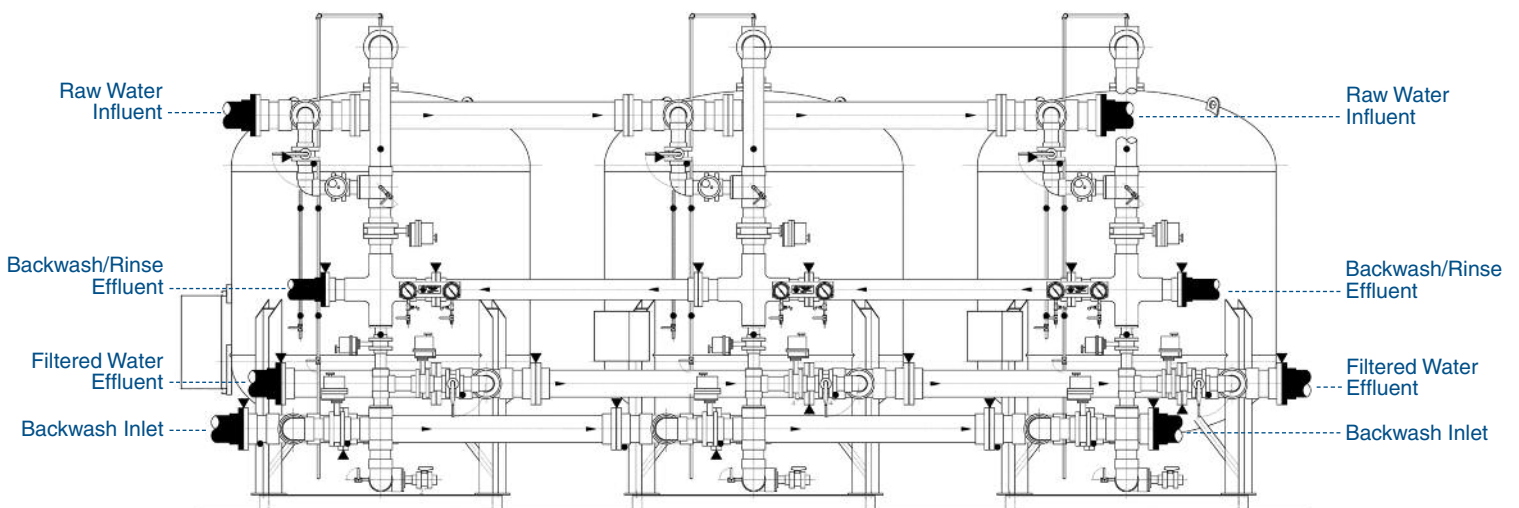
Here’s why:

Low cost because it's already pre-engineered with all the right stuff – all the value is in the components with no associated engineering cost typical of "Plans and Specs" Systems

Designed to handle flows from 14 to 2808 gpm, “Plug & Play” Water Filtration Systems are available with one to three tanks, in diameters from 36” to 120” in 6” increments, complete with piping, valves, actuators, instruments, and controls – all mounted on a rugged, durable, skid-mounted frame.

Simply set in place wherever filtration is needed, hook up water and electrical connections, load & condition media, and the system is operational for: **Iron, Manganese, Hydrogen Sulfide, Arsenic, and Radium Removal.**

A highly versatile design to accommodate a variety of treatment and flow rate demands



H&T “Plug & Play” Water Filtration Systems feature a versatile “Daisy-Chain” design that allows for coupling one to three vessels.

Common “straight-through” headers with magnetic bi-directional flowmeters allow simple and easy connections for raw water, treated water, and waste water.

Manufactured with rugged, durable components, to provide low maintenance and superior performance

All "Plug & Play" Water Filtration Systems utilize the same high quality components, controls, and filter media found on "customized" water treatment systems that are manufactured to specifications for larger scale H&T filtration applications.

Standardized system features include:



ASME Code steel pressure tanks with stamp rated for 100 psi working pressure



Genuine, State-of-the-art Allen Bradley PLC Controller



Electric actuator operated butterfly valves with integral anti-condensation heaters and manual hand wheel override



State-of-the-art touch screen operator interface terminal with no lights or switches to wear out or replace



Magnetic bi-directional flowmeter with stainless steel electrodes, 4-20 mA output, local display, NEMA 4X housing, and no moving parts to wear out



Non-ferrous, hub-curved, non-corrosive underdrain eliminates the need for concrete sub-fill with no "hide-out" beneath the distribution system



Genuine GreensandPlus™ filtration media – tried, proven, and recognized standards in ten states and AWWA B 102-04

Exceptional customer support that includes application planning, telephone support, and on-site installation supervision to ensure proper operation of your system

As a private **employee-owned** company, every employee of Hungerford & Terry takes great pride, and has a vested interest in ensuring your satisfaction with its products, systems, and services.

Backed by extensive electrical and mechanical engineering capabilities, fully equipped wet lab for sample testing and computer monitoring, pilot plant capabilities for testing, and an experienced customer service team, we work together to analyze your water problem and recommend the proper "Plug & Play" Water Filtration System to meet your exact water treatment requirements.



Equipment Selection Guide

Model No.	Number of Filters	Tank Diameter (feet)	Sq. Ft. of Surface Area	Grain Capacity		Flow Rate (in GPM)			Backwash Rate (per filter)	Valve Sizes (inches) per tank				Waste
				Min.	Max.	Min.	Opt.	Max.		Inlet	Outlet	Backwash Inlet	Backwash Outlet	
GSP36-X1	1		7	4,900	8,400	14	35	84						
GSP36-X2	2	3	14	9,800	16,800	28	70	168	84	1.5	1.5	2	2	1.5
GSP36-X3	3		21	14,700	25,200	42	105	252						
GSP42-X1	1		9	6,300	10,800	18	45	108						
GSP42-X2	2	3.5	18	12,600	21,600	36	90	216	108	2	2	3	3	2
GSP42-X3	3		27	18,900	32,400	54	135	324						
GSP48-X1	1		12	8,400	14,400	24	60	144						
GSP48-X2	2	4	24	16,800	28,800	48	120	288	144	2	2	3	3	2
GSP48-X3	3		36	25,200	43,200	72	180	432						
GSP54-X1	1		15	10,500	18,000	30	75	180						
GSP54-X2	2	4.5	30	21,000	36,000	60	150	360	180	2	2	3	3	2
GSP54-X3	3		45	31,500	54,000	90	225	540						
GSP60-X1	1		19	13,300	22,800	38	95	228						
GSP60-X2	2	5	38	26,600	45,600	76	190	456	228	3	3	4	4	3
GSP60-X3	3		57	39,900	68,400	114	285	684						
GSP66-X1	1		23	16,100	27,600	46	115	276						
GSP66-X2	2	5.5	46	32,200	55,200	92	230	552	276	3	3	4	4	3
GSP66-X3	3		69	48,300	82,800	138	345	828						
GSP72-X1	1		28	19,600	33,600	56	140	336						
GSP72-X2	2	6	56	39,200	67,200	112	280	672	336	3	3	4	4	3
GSP72-X3	3		84	58,800	100,800	168	420	1008						
GSP78-X1	1		33	23,100	39,600	66	165	396						
GSP78-X2	2	6.5	66	46,200	79,200	132	330	792	396	3	3	4	4	3
GSP78-X3	3		99	69,300	118,800	198	495	1188						
GSP84-X1	1		38	26,600	45,600	76	190	456						
GSP84-X2	2	7	76	53,200	91,200	152	380	912	456	4	4	6	6	3
GSP84-X3	3		114	79,800	136,800	228	570	1368						
GSP90-X1	1		44	30,800	52,800	88	220	528						
GSP90-X2	2	7.5	88	61,600	105,600	176	440	1056	528	4	4	6	6	3
GSP90-X3	3		132	92,400	158,400	264	660	1584						
GSP96-X1	1		50	35,000	60,000	100	250	600						
GSP96-X2	2	8	100	70,000	120,000	200	500	1200	600	4	4	6	6	3
GSP96-X3	3		150	105,000	180,000	300	750	1800						
GSP102-X1	1		56	39,200	67,200	112	280	672						
GSP102-X2	2	8.5	112	78,400	134,400	224	560	1344	672	4	4	6	6	3
GSP102-X3	3		168	117,600	201,600	336	840	2016						
GSP108-X1	1		63	44,100	75,600	126	315	756						
GSP108-X2	2	9	126	88,200	151,200	252	630	1512	756	4	4	6	6	3
GSP108-X3	3		189	132,300	226,800	378	945	2268						
GSP114-X1	1		70	49,000	84,000	140	350	840						
GSP114-X2	2	9.5	140	98,000	168,000	280	700	1680	840	4	4	6	6	3
GSP114-X3	3		210	147,000	252,000	420	1050	2520						
GSP120-X1	1		78	54,600	93,600	156	390	936						
GSP120-X2	2	10	156	109,200	187,200	312	780	1872	936	6	6	8	8	4
GSP120-X3	3		234	163,800	280,800	468	1170	2808						

Hungerford & Terry, Inc.

A Leader in Providing Custom-Built Water Treatment Systems

For more than 100 years, H&T has met the challenge of new regulations with a vast array of water treatment solutions.

H&T advanced water treatment solutions include systems that remove iron, manganese, hydrogen sulfide, arsenic, radium, nitrate, sodium, perchlorate, hardness, color, and other contaminants for municipal, industrial, and government facilities worldwide.

Hungerford & Terry, Inc. also designs and manufactures complete demineralizer systems, forced draft and vacuum degasifiers, condensate polishers, and specialized treatment systems.

In the 21st century, H&T continues to improve water treatment solutions through in-house research & development with a focus on economizing operational costs and waste generation. Through advances in science and technology, H&T is focused on one purpose – to produce pure water, our most precious resource.



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GREENSAND^{plus}TM

Performance Media for Water Filtration

Removes iron, manganese, hydrogen sulfide, arsenic and radium.

GreensandPlusTM is a black filter media used for removing soluble iron, manganese, hydrogen sulfide, arsenic and radium from groundwater supplies.

The manganese dioxide coated surface of GreensandPlus acts as a catalyst in the oxidation reduction reaction of iron and manganese.

The silica sand core of GreensandPlus allows it to withstand waters that are low in silica, TDS and hardness without breakdown.

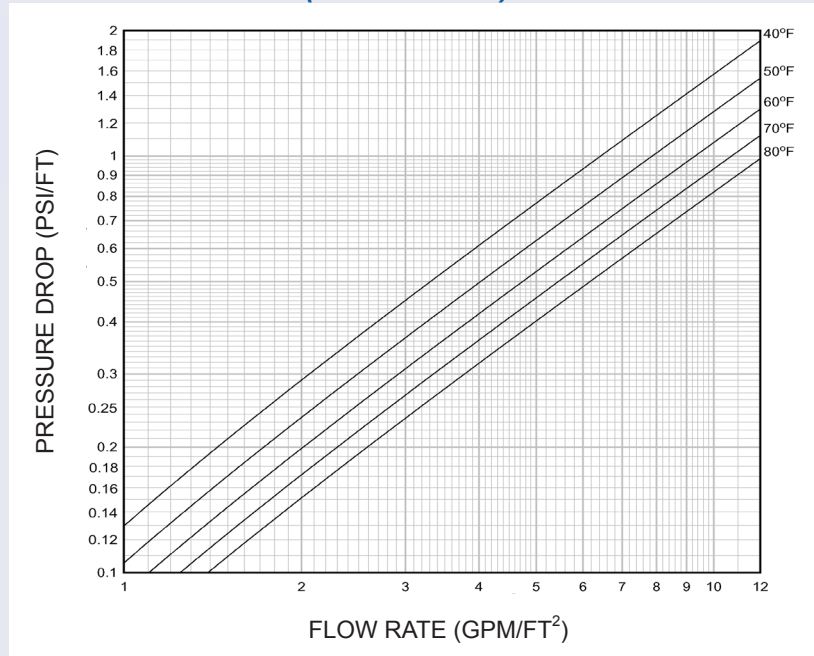
GreensandPlus is effective at higher operating temperatures and higher differential pressures than standard manganese greensand. Tolerance to higher differential pressure can provide for longer run times between backwashes and a greater margin of safety.

Systems may be designed using either vertical or horizontal pressure filters, as well as gravity filters.

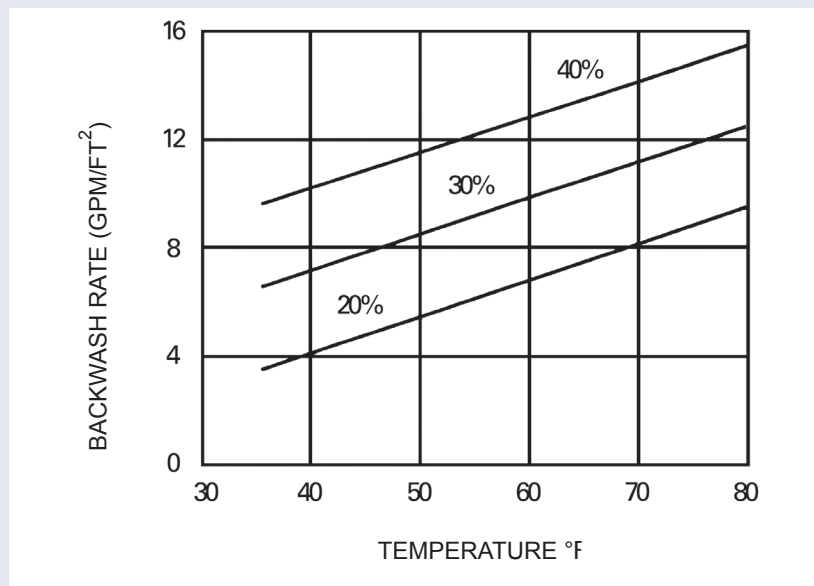
GreensandPlus is a proven technology for iron, manganese, hydrogen sulfide, arsenic and radium removal. Unlike other media, there is no need for extensive preconditioning of filter media or lengthy startup periods during which required water quality may not be met.

GREENSANDPLUSTM TECHNICAL DATA

GREENSANDPLUS PRESSURE DROP (CLEAN BED)



BED EXPANSION DURING BACKWASHING



GreensandPlus is an exact replacement for manganese greensand. It can be used in CR or IR applications and requires no changes in backwash rate or times or chemical feeds.

GreensandPlus has the WQA Gold Seal Certification for compliance with NSF/ANSI 61. Packaging is available in 1/2 cubic foot bags or 1 metric ton (2,205 lbs) bulk sacks.

PHYSICAL CHARACTERISTICS

Physical Form

Black, nodular granules shipped in a dry form

Apparent Density

88 pounds per cubic foot net

Shipping Weight

90 pounds per cubic foot gross

Specific Gravity

Approximately 2.4

Porosity

Approximately 0.45

Screen Grading (dry)

18 X 60 mesh

Effective Size

0.30 to 0.35 mm

Uniformity Coefficient

Less than 1.60

pH Range

6.2 - 8.5 (See General Notes)

Maximum Temperature

No limit

Backwash Rate

Minimum 12 gpm/sq. ft. at 55°F

Service Flow Rate

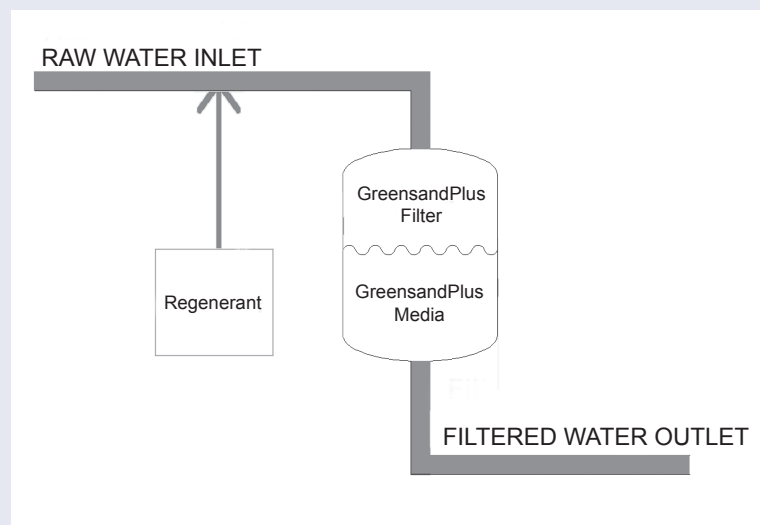
2 - 12 gpm/sq. ft.

Minimum Bed Depth

15 inches of each media for dual media beds or 30 inches of GreensandPlus alone.

METHOD OF OPERATION CO

GreensandPlus: Catalytic Oxidation (CO)



Catalytic Oxidation (CO) operation is recommended in applications where iron removal is the main objective in well waters with or without the presence of manganese. This method involves the feeding of a predetermined amount of chlorine (Cl_2) or other strong oxidant directly to the raw water before the GreensandPlus Filter.

Chlorine should be fed at least 10-20 seconds upstream of the filter, or as far upstream of the filter as possible to insure adequate contact time. A chlorine residual carried through the filter will maintain GreensandPlus in a continuously regenerated condition.

For operation using chlorine, the demand can be estimated as follows:

$$\text{mg/L Cl}_2 = (1 \times \text{mg/L Fe}) + (3 \times \text{mg/L Mn}) + (6 \times \text{mg/L H}_2\text{S}) + (8 \times \text{mg/L NH}_3)$$

SUGGESTED OPERATING CONDITIONS

Bed Type

Dual media: anthracite 15-18 in. and GreensandPlus 15-24 in.

Capacity

700-1200 grains of oxidized iron and manganese/sq. ft. of bed area based on oxidant demand and operation to iron break through or dp limitations.

Backwash

Sufficient rate using treated water to produce 40% bed expansion for 10 minutes or until waste water is clear.

Air/Water Scour

Optional using 0.8-2.0 cfm/sq. ft. with a simultaneous treated water backwash at 4.0-4.5 gpm/sq. ft.

Raw Water Rinse

At normal service flow rate for 3 minutes or until effluent is acceptable.

Flow Rate

Recommended flow rates with CO operation are 2-12 gpm/sq. ft. Extremely high concentrations of iron and manganese usually require lower flow rates for equivalent run lengths. Higher flow rates can be considered with very low concentrations of iron and manganese. For optimizing design parameters, pilot plant testing is recommended. The run length between backwashes can be estimated as follows:

What is the run length for a water containing 1.7 mg/L iron and 0.3 mg/L manganese at a 4 gpm/sq. ft. service rate:

Contaminant loading

$$\begin{aligned} &= (1 \times \text{mg/L Fe}) + (2 \times \text{mg/L Mn}) \\ &= (1 \times 1.7) + (2 \times 0.3) \\ &= 2.3 \text{ mg/L or } 2.3/17.1 = 0.13 \\ &\quad \text{grains/gal. (gpg)} \end{aligned}$$

At 1,200 grains / sq. ft. loading \div 0.13 gpg
= 9,230 gal./sq. ft.

At 4 gpm / sq. ft. service rate 9,230/4
= 2,307 min.

The backwash frequency is approximately every 32-38 hours of actual operation.

The Intermittent regeneration (IR) operation is available for certain applications. Contact your Hungerford & Terry representative for additional information.

GENERAL NOTES

pH

Raw waters having natural pH of 6.2 or above can be filtered through GreensandPlus without pH correction. Raw waters with a pH lower than 6.2 should be pH-corrected to 6.5-6.8 before filtration. Additional alkali should be added following the filters if a pH higher than 6.5-6.8 is desired in the treated water. This prevents the possible adverse reaction and formation of a colloidal precipitate that sometimes occurs with iron and alkali at a pH above 6.8.

Initial Conditioning of GreensandPlus

GreensandPlus media must be backwashed prior to adding additional media types. The GreensandPlus backwash rate must be a minimum of 12 gpm/sq. ft. @ 55°F.

This initial backwash could last for up to 60 minutes to thoroughly remove the fine dust. After backwashing is complete, the GreensandPlus must be conditioned. Mix 0.5 gal. (1.9 L) of 6% household bleach or

Initial Conditioning of GreensandPlus

0.2 gal (0.75 L) of 12% sodium hypochlorite for every 1 cu. ft. (28.3 L cu. m) of GreensandPlus into 6.5 gallons (25 L) of water.

Drain the filter enough to add the diluted chlorine mix. Apply the diluted chlorine to the filter being sure to allow the solution to contact the GreensandPlus media. Let soak for a minimum of 4 hours, then rinse to waste until the "free" chlorine residual is less than 0.2 mg/L. The GreensandPlus is now ready for service.

Radium and Arsenic Removal Using GreensandPlus

The GreensandPlus CO process has been found to be successful in removing radium and arsenic from well water. This occurs via adsorption onto the manganese and/or iron precipitates that are formed. For radium removal, soluble manganese must be present in or added to the raw water for removal to occur. Arsenic removal requires iron to be present in or added to the raw water to accomplish removal. Pilot plant testing is recommended in either case.

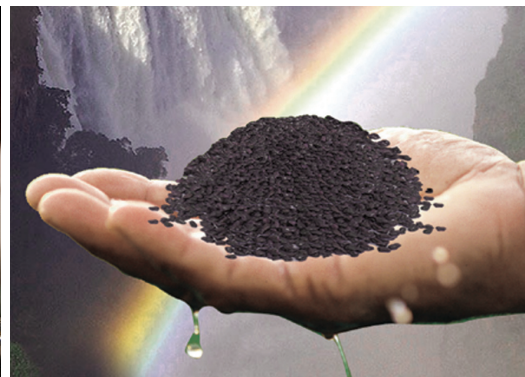
REFERENCES

USA

American Water Company, CA
San Jacinto, CA
City of Tallahassee, FL
City of Mason City, IL
City of Goshen, IN
City of Hutchinson, KS
City of Burlington, MA
Dedham Water Co., MA
Raynham Center, MA
Northbrook Farms, MD
Sykesville, MD
City of New Bern, NC
Onslow County, NC
Fort Dix, NJ
Jackson Twsp. MUA, NJ
Churchill County, NV
Suffolk County Water Authority, NY
City of Urbana, OH

International

Ozogram, Laval, Quebec, Canada
Sydney, Nova Scotia, Canada



The manufacturing of GreensandPlus is an ongoing, 24/7 process to ensure the highest quality water treatment media.

Disclaimer: The information and recommendations in this publication are true and reliable to the best of our knowledge. These recommendations are offered in good faith but without warranty or liability for consequential damage as conditions and method of use of our products are varied and beyond our control. We suggest the user determine the suitability and performance of our products before they are adopted on a commercial scale.



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www.hungerfordterry.com

GREENSAND PLUS

The GreensandPlus process for the removal of iron, manganese and hydrogen sulfide from groundwaters is an enhancement to the original Manganese Greensand process which has been used since the 1950's in the United States. Since then, GreensandPlus has been found to be effective in the removal of arsenic and radium as well. Historically, the original Manganese Greensand product was utilized through two distinct processes, the IR (intermittent regeneration) and the CR (continuous regeneration) process. Today, GreensandPlus is most commonly utilized through a more efficient and cost effective CO (catalytic oxidation) process.

GreensandPlus is processed from a special gradation and purity of silica sand to which a manganese dioxide coating is fusion bonded. This coating provides the GreensandPlus with its special chemical oxidation-reduction properties for the removal of iron and manganese as well as hydrogen sulfide.

The advantages of the GreensandPlus process over aeration and filtration are; single pumping (as the process generally employs pressure filtration), reliability, flexibility, and a high quality effluent coupled with ease of operation. Operational options including CO and IR are uncomplicated in both their design and operation, resulting in efficient and reliable methods for iron and manganese removal.

The mechanism for iron and manganese removal by GreensandPlus in the CO mode is oxidation followed by physical removal of the resulting precipitates by filtration using a GreensandPlus or GreensandPlus-&-anthracite bed. In the IR method, the manganese is removed by contact oxidation. Arsenic, when raised to the +5 state, tends to co-precipitate with ferric hydroxide, a precipitate that is commonly produced in the CO process. Similarly, both radium 226 and 228 tend to co-precipitate with manganese dioxide.

CO Process

The GreensandPlus CO process, as previously mentioned, is applicable on well waters where iron and manganese removal is the main objective. This process can remove iron from water in concentrations up to 15 mg/L or more. However, with such high concentrations, the run length between backwashings would be minimized.

The CO process involves the feeding of an oxidant (generally chlorine) or combination of oxidants to raw water prior to contact with the GreensandPlus bed. Oxidants should be injected into the raw water stream ahead of the filter(s) to insure the greatest contact time. Enough chlorine can be fed to provide the desired residual in the treated water.

The GreensandPlus bed performs a dual function to complete the removal of iron and manganese. First, correct operation of a CO filter requires that a slight residual of chlorine will insure that the oxidant demand has been met. The manganese oxides will then precipitate on the grains, maintaining them in a continually regenerated state. Conversely, a temporary underfeed of oxidant would utilize the oxidizing capacity of the regenerated GreensandPlus to complete the oxidation of iron and manganese as required. Therefore in the CO process the GreensandPlus acts as a redox buffer with capabilities of both oxidation and reduction as required by influent water conditions. Second, it is a well-known fact that in iron and manganese removal by oxidation, the presence of manganese oxide will act as a catalyst whether the oxidizing agent is oxygen, chlorine, ozone, or permanganate, insuring that the reaction goes rapidly to completion.

Extended service with an underfeed of oxidants prior to the filter will eventually exhaust the oxidative capacity of the media with resultant manganese leakage into the treated water, even if the raw water contains no manganese. The media must therefore remain in a continually regenerated form at all times. This is easily accomplished by a visual check for the "orangeish" color in the filter influent and/or the presence of chlorine in the effluent.

The closed pressure filter normally contains a gravel support bed for the proper distribution of backwash waters, and a GreensandPlus and anthracite dual media bed. Dual media beds can range from 15" to 24" GreensandPlus and 12 to 24" anthracite. Deeper anthracite beds are recommended for waters with high iron concentrations, over 2- 3 mg/L. As the run progresses, the pressure drop increases as the filter bed becomes contaminated with the insoluble oxidation products. After either a predetermined number of gallons or when the headloss reaches approximately 8-9 psi, the bed should be backwashed to remove the filtered particulates. Please note that in some instances the precipitated iron is of such a nature that it filters in depth and leaks into the effluent, even after a 2- 5 psi differential pressure increase. In this case backwashing should be initiated on a gallonage basis. In addition, in applications where there is a predominance of manganese, it is also beneficial (although not necessary) to provide some means of periodic air washing to minimize the formation of "mudballs" and/or channeling by maintaining the filter media in a loose, clean condition. Naturally, no regeneration of the media is required prior to returning the unit to service due to the continuous regeneration during service. As with conventional filtration processes such as oxidation by aeration followed by filtration, the backwash waste water can be collected for reuse and the settled precipitates sent to a sanitary sewer or drying bed.

IR Process

When the well water contains all manganese, or mostly manganese with lesser quantities of iron, the intermittent regeneration process can be considered. This process involves passage of the raw water through a GreensandPlus bed where oxidation of manganese occurs directly on the grains utilizing the oxidative capacity of the treated GreensandPlus. Although GreensandPlus will oxidize appreciable amounts of iron directly on the grains as well, iron has a tendency, proportionate to the concentration, to coat or foul the media with iron oxides which then inhibit both the oxidation properties and regeneration reactions of the GreensandPlus. For this reason, waters being treated by the IR process for manganese removal which also contain appreciable concentrations of iron, should have a pre-oxidation step, either in the form of chlorine injection or aeration to convert the iron to its insoluble form. Precipitates of iron are then filtered out and manganese is oxidized on the individual grains and becomes an integral part of the manganese oxide coating. A 12"-15" layer of anthracite is recommended for these type waters.

After treating a specified number of gallons, the oxidation capacity of the media will be consumed and regeneration is required. Prior to regeneration the media should be backwashed to remove collected precipitates and to reclassify the media. Again, with an appreciable iron concentration, a high loading of filterable material indicated by a high pressure drop across the bed will require that the filter be backwashed possibly before the oxidation capacity of the media has been utilized. In such as case as this, the filter can be backwashed without regeneration and then placed back into service.

Regeneration consists of the downflow passage of a dilute oxidant solution through the bed. Following regeneration, the filter will require rinsing until all the excess oxidant is gone. The IR method may also be very flexible with regard to regeneration, as the excess regenerant can be recycled to use for the next regeneration. In this way there are no oxidant disposal problems and chemical costs are minimized.

There are certain limitations with the use of GreensandPlus in either the CO or IR process. The minimum pH with either process is 6.2. At a raw water pH of less than 6.2, pre-pH adjustment would be required. With the CO process, however, pre-pH correction should not exceed 6.8-7.0 to prevent formation of a non-filterable iron colloid, which sometimes occurs

In any circumstance, with questionable waters, it is recommended that a pilot plant study be undertaken to determine the optimum operating parameters.

ADVANTAGES OF GREENSAND PLUS VS. OTHER PROCESSES

GreensandPlus is a specially processed medium for iron, manganese, and hydrogen sulphide removal. GreensandPlus is a premium non-proprietary filter medium which is processed from silica sand upon which a manganese dioxide coating is fusion bonded.

This material has a high buffering or oxidation- reduction capacity due to the well defined manganese oxide coating.

The grains of GreensandPlus are of both the size and shape to capture the fine precipitates of iron and manganese which pass through the upper coarse anthracite layer during normal service conditions. No expensive polymer or other filter aid is needed to prevent leakage of these oxidation products.

Greensand products have been in use for over 50 years and are unequalled in performance. Beware of claims that other medias are "just as good" or "the same as" GreensandPlus.

Other "supposedly" comparable media are formed by adding chemicals, in place, to form manganese hydroxide which is supposed to adhere to the filter media after a 24 hour contact period. Unlike GreensandPlus, there are no specifications or samples for these type media to show the similarity to GreensandPlus.

The GreensandPlus process requires no detention time, no secret expensive filter media, no high concentration of chlorine, and no sulphur dioxide. Greensand Plus catalytic by nature and is not soluble. There is no increase in the total dissolved solids of the treated water. It is not necessary to backwash GreensandPlus every time the well pump starts up.

GreensandPlus can be operated at flow rates up to 12 GPM per sq. ft. on waters with moderate concentrations of iron and manganese. As with any filtration process, the run length to a specified pressure drop is inversely proportional to the flow rate. Pilot tests are recommended, and usually specified by the various regulatory agencies, for operation at these higher rates.

ADVANTAGES OF GREENSAND PLUS

GreensandPlus has many advantages over other iron and manganese removal media.

1. Optimum grain size and shape to retain oxidation precipitation products of iron and manganese.
2. All GreensandPlus grains have the same finite uniform coating which is firmly attached.
3. All GreensandPlus is processed to exact specifications and tested prior to shipment or placement into filters.
4. Unequalled oxidation-reduction buffer capacity. Can tolerate slight over or underfeed of continuously fed oxidants.
5. Unequalled effluent water quality.
6. Adaptable for gravity, vertical, or horizontal pressure filters.
7. No on-site batch chemical preparation required to attempt to form a manganese oxide coating.
8. No "black box" chemicals are required.
9. Not a "secret" expensive filter media.
10. No media reconditioning is required because coating is firmly attached to the GreensandPlus.
11. Manganese oxide coating is not removed during backwashing.
12. No expensive polymer or filter aid is required.
13. No extended seasoning or conditioning period is required.
14. Only chlorine (no potassium permanganate) is required for the catalytic method of operation.
15. No excessive concentration of chlorine and no sulphur dioxide is ever needed.

16. No detention time is required.
17. Filter backwashes are not needed every time well pump starts up.
18. No leakage of alkaline substances which cause increased hardness and high pH under certain conditions.
19. Precipitated products rapidly settle out of backwash water, making wash water reclamation simple and economical.
20. GreensandPlus is not proprietary and samples are available on request for inspection or pilot plant testing.
21. GreensandPlus is NSF (National Sanitation Foundation) listed.
22. The AWWA (American Water Works Association) has developed a standard for greensand.

HUNGERFORD & TERRY, INC.



PREPARED FOR: PAUL LUTZKANIN, P.E.- SESI

PROJECT: FREDERICKSBURG WATER AUTHORITY WTP UPGRADE

PREPARED BY: CHRISTOPHER RALPH
TECHNICAL SALES REPRESENTATIVE



May 3, 2023

Attention: Paul Lutzkanin, P.E.- SESI

Reference: Penn Gaming Iron and Manganese Pressure Filters

Mr. Lutzkanin,

Hungerford & Terry, Inc. is pleased to submit the attached budget 23-BDJ0503 for your consideration.

This proposal is budgetary and is formulated using the available information. The design may be subject to change as more information becomes available. The specifications provided within is intended for securing funding for the project and contains contingency pricing to account for changes that may be necessary as the project progresses. Firm pricing will be available on bid day or upon request per intent to purchase. This proposal is for equipment only and does not offer treatment guarantees at this time.

We very much appreciate the opportunity to submit this proposal and look forward to working with you on this project. Should you have any questions or need for additional information, please feel free to contact our local representative at the address and telephone number listed below, or this writer at our home office in Clayton, New Jersey.

Very truly yours,

HUNGERFORD & TERRY, INC.

Christopher Ralph
Technical Sales Representative

DAVE FACKLER-
SALES REPRESENTATIVE
Hungerford and Terry Inc,
226 N. Atlantic Ave.
Clayton, NJ 08312
Ph: 856-881-3200
Fax: 856-881-6859
dfackler@hungerfordterry.com



1. SCOPE OF SUPPLY

Vertical GreensandPlus Filtration System:

Filter Tanks:

Four (4) 96 inch OD x 63 inch straight shell filter tanks designed in accordance with the following:

- 100 PSI design pressure.
- ASME code section VIII construction with stamp.
- Constructed with SA-516 70 grade steel.
- One (1) 14 inch x 18 inch manhole with spare gasket.
- Necessary flanged pad type connections.
- Four (4) lifting lugs.
- Four (4) structural steel I-beam type support legs.
- Tank interiors will not be lined.
- Tank exteriors will be commercial sandblasted (SSPC-SP6) and painted with one (1) coat (3.0 – 5.0 mils DFT) of Tnemec Hi-Build Epoxoline II N69 primer.

Notes:

1. Finish painting of the filter tank exteriors and all provided piping is to be field applied by the contractor.
2. All anchor bolts are part of the foundation equipment and shall be furnished and installed by the equipment installer or contractor.



Tank Internal Distributors:

- Four (4) H-pattern inlet distributor/waste collector with Schedule 80 PVC pipe and fittings.
- Four (4) Gravel retaining screens with stainless steel support angles and flats, 8-mesh #304 stainless steel screen, and stainless steel nelson studs as required to fasten the screen to the tank and supports.
- Four (4) Header-lateral air wash distributors of Schedule 80 PVC construction complete with 2 inch manifolds and 1/2 inch laterals.
- Four (4) Hub (polypropylene), curved radial lateral (Schedule 80 PVC) underdrain distributor. Laterals are curved to follow the contour of the tank bottom heads.

Notes:

1. The tank inlet and underdrain distributors will be shop installed prior to shipment. The airwash distributors and gravel retaining screens will be installed by the general contractor as the media is placed into the units.



Filter Media:

- Four (4) 12 inch graded gravel support bed plus head fill (129 cubic feet each).
- Four (4) 18 inch bed (75 cubic feet each) of GreensandPlus.
- Four (4) 18 inch bed (79 cubic feet each) of Anthracite.

Notes:

1. The Greensand Plus will meet the following criteria:
 - a) Specific gravity:approx. 2.4
 - b) Effective size:0.30 – 0.35 mm
 - c) Uniformity coefficient: ...less than 1.6
 - d) Screen grading: 18 x 60 mesh
2. The Anthracite will meet the following criteria:
 - a) Specific gravity:approx. 1.6
 - b) Effective size:0.6 – 0.8 mm
 - c) Uniformity coefficient: ...less than 1.6
3. All filter media is to be field installed by the contractor.
4. H&T will provide approximately 1,032 one-half cubic foot bags of gravel, 600 one-half cubic foot bags of GreensandPlus and 316 one cubic foot bags of Anthracite.
5. For every 100 cubic feet of GreensandPlus, 20 gallons of 15% bleach, or 50 gallons of 6% bleach is required for conditioning of the media and disinfecting of the tanks.
6. All start-up chemicals are to be supplied by the purchaser or contractor.



Filter Exteriors:

Four (4) Valve nest exteriors consisting of:

Bray series 30 butterfly valves with wafer style epoxy coated cast iron bodies, nylon 11 coated ductile iron discs, bonded EPDM seats, with Bray series 70 electric actuators for:

- Inlet (4 inch).
- Outlet (4 inch).
- Backwash inlet (6 inch), modulating.
- Backwash outlet (4 inch).
- Rinse outlet (2.5 inch).
- Tank draindown (3 inch).
- Air wash inlet (2 inch).
- Air pressurizing (2 inch).

Bray series 30 butterfly valves with wafer style epoxy coated cast iron bodies, nylon 11 coated ductile iron discs, bonded EPDM seats, with manual operators for:

- Inlet isolating (4 inch).
- Outlet isolating (4 inch).

Flowtek stainless steel threaded ball valve with manual lever operator for:

- Backwash tell-tale (1/2 inch).
- Tank air vent (1 inch).

Simtech PVC socket weld ball valve with manual operator for:

- Tank drain (2 inch).

Apco model 200A air release valve with cast iron body and stainless steel float for:

- Air release (1 inch).



System Face Piping:

All piping material and fittings will be Schedule 80 PVC:

- Filter face piping.

Schedule 40 Steel Air Piping:

- Air line from blower.

Notes:

1. All system face and interconnecting piping will be furnished with the required bolts, studs, nuts, and gaskets as follows:

Bolts: ASTM A307 Grade B plated carbon steel.
Studs: ASTM A307 Grade B plated carbon steel.
Nuts: ASTM A563 plated steel heavy duty hex.
Gaskets: Shore A70 or equal, 1/8 inch thick.

Filter Pressure Equipment:

- One (1) Ashcroft or equal series 400 snap acting differential pressure switch.
- Eight (8) Ashcroft model 1279SS pressure gauges for the tank inlet and outlets with 4.5 inch diameter dials and stainless steel bourdon tubes.
- Nine (9) Sets of polypropylene supply tubing.
- Nine (9) Sets of isolating valves.
- Nine (9) Sets of sampling valves.

Filter Unit Inlet Flow Equipment:

- Four (4) Rosemount 8750WD magnetic bi-directional flowmeter with 4-20mA output for:
 - Inlets (6 inch).



Air Blowers:

- Two (2) Roots model 22 RAI air blower rated 40 cfm at 6 PSI complete with flexible connections, v-belt drive with guard, inlet filter/silencer, weight type pressure relief valve, motor slide rails, pressure gauges, common steel base plate, sound enclosure and a 460 volt, 3-phase, 60 hertz, TEFC motor.
- Two (2) Allen Bradley 512 series combination motor starter with NEMA 4 steel enclosure, fusible disconnect, 480/120V control power transformer, H-O-A switch electronic overload, etc.
- One (1) Check rite or equal check valve of stainless steel construction for:
- Blower discharge (2 inch).
- One (1) Asco solenoid valve for:
- Air header drain (.5 inch).

Filter System Control Panel:

- One (1) NEMA 4 electrical control panel of painted (ANSI 61 light gray) steel construction complete with an Allen Bradley CompactLogix L33ER Ethernet programmable controller, Automation Direct #EA9-T10CL 10" diag. color touch screen Operator Interface Terminal and all required nameplates, Phoenix Contact #UT-6 terminal blocks, internal type "THHN" wire, Phoenix Contact AC surge suppressor, 24VDC power supply, C3 Controls door mounted disconnect switch, Allen Bradley #700-HK series interposing relays, Panduit Type "G" gray wire duct, Phoenix Contact heat-shrink white wire sleeves, Red Lion/Ntron #104TX unmanaged switch, GFCI duplex, UL-508 label, and etc.

Skid Mounted Junction Boxes:

- Four (4) Hoffman NEMA 4, wall-mount type electrical panel of ANSI 61 painted steel construction complete with all required nameplates, Phoenix Contact #UT series terminal blocks, internal type "THHN" wire, ground bus bars, UL-508A label, and etc.



Notes:

1. The control panel will be completely shop wired and tested prior to shipment.
2. All interconnecting wiring, conduit, and wire terminations between the Filter System Control Panel and remote located electrical equipment is to be furnished and installed by the contractor. A 120VAC-1PH-60Hz, 25A power feed is required for control panel.
3. H&T will supply one (1) spare Ethernet port for communication to future SCADA RTU (by others) via Ethernet/IP protocol. Any required interconnecting Ethernet cables and connectors shall be by others.
4. The filter system control panel shall provide I/O to control all items listed in this proposal only. All other balance of plant controls shall be by others.
5. All instrumentation not specifically listed in this proposal shall be by others.
6. H&T will submit our standard electrical drawing package, which includes ladder logic drawings, external and internal panel view drawings, electrical equipment lists, PLC system architecture drawing and electrical wiring diagrams showing both internal/external wiring.
7. All engineering and drafting required for field interconnecting conduit, cable list and sizing, conduit supports and maps of interconnecting electrical installation, conduit and trays shall be supplied by others. All engineering and drafting required for customer's ground grid system shall be by others.
8. Any required short-circuit fault analysis, protective device coordination and arc-flash hazard study shall be furnished by others.

System Software/Programming equipment:

Programming integral to the operation of the equipment supplied by Hungerford & Terry, Inc. will be performed by Hungerford & Terry, Inc. Should the customer choose to modify the original factory program, a laptop computer and a registered copy of Allen Bradley RSLOGIXS 500 PLC & Automation Direct C-More OIT software will be required. Hungerford & Terry will provide a quotation to furnish the programming software and accessory hardware defined above upon request.



**Hungerford and Terry, Inc. Standard Surface
Preparation & System Painting:**

Unlined Tanks:

The interiors of all unlined tanks will be hand cleaned removing all dirt, grease, etc. The tank interiors will not be sandblasted.

Misc. Equipment:

The exterior surface's of all misc. valves, pumps, etc. will be furnished with the manufacturer's standard prime coat painting or standard prime and finish painting.

Finish Painting:

Finish painting of all equipment furnished by Hungerford & Terry, Inc. is to be field applied by the installation contractor.

Assembly:

Skid numbers 1 thru 4 each will include one (1) filter tank complete with internal distributors, exterior face piping and valves, and a NEMA 4 junction box with THHN wiring and RGS conduit to each electrical item.



2. PRICE SUMMARY

Price:

F.O.B. Shipping Points: With full motor freight allowed to the jobsite:
Payable in US currency, plus any applicable Municipal, State or Federal Taxes.

Payment Terms:

Unless otherwise specified, 16% of the contract amount will be invoiced upon the approval of our engineering submittals. 42% will be invoiced upon start of assembly. The contract will be invoiced upon shipment of materials to the jobsite up to the 95% point (including partial shipments). 5% of the contract amount will be invoiced upon commissioning of the plant—not to exceed 180 days following shipment.

Net thirty (30) days. All invoices are due within 30 days. A service or interest charge of 1 ½% per month (18% per annum) will be assessed on all amounts which become past due.

A copy of the payment bond (if applicable) will be required as part of the credit approval process. Purchaser agrees to make pro rata payments for partial shipments and further agrees that if shipment of material is delayed by any act or omission on part of purchaser, payment shall become due within thirty (30) days after the material is ready for shipment

Shipment:

Applicable freight to location is included in the price of the contract. Logistics of shipment will be advised as project proceeds.

Acceptance by Purchaser

This proposal is hereby accepted by:

Date _____
By _____

HUNGERFORD & TERRY, INC.

Christopher Ralph
- Technical Sales Representative



3. CONDITIONS

Prices are based on present day labor and material costs and subject to revision after thirty days from date of quotation. They do not include any Federal, State, Municipal or other tax or Government charge applicable to the sale, shipment or use of equipment quoted on.

Deliveries are contingent upon strikes, accidents, delays in manufacture and other causes beyond our control.

Any typographical or clerical errors in the prices or specifications are subject to correction.

Order shall be made out to Hungerford & Terry, Inc., Clayton, NJ, and shall be subject to acceptance by us at Clayton, NJ. After acceptance, orders may be cancelled only with our written consent and on terms that will indemnify us against loss. Equipment on material cannot be returned except by special permission and when so returned will be subject to discount.

The Company will, free of charge, replace or repair, after receipt f.o.b. its factory promptly and within one year from shipment by it, any part of equipment which, under normal or proper use proves to be defective in workmanship or material. In no event shall the Company be liable for consequential damages.

The Company shall not be liable for failure to perform or delay in performing any obligation if such failure or delay shall be caused directly or indirectly by invasion, insurrection, riot, war, military authority, or by fire, flood, strike, or labor difficulty or by any other cause, whether of the same or different nature from those enumerated, beyond our reasonable control.

From the time said machinery of apparatus or any part thereof arrives on the premises, and until Hungerford & Terry, Inc., for an amount equal to the unpaid portion of the purchase price of the same; such loss or damage to be payable to Hungerford & Terry, Inc., as its interests may appear. All losses by fire or other casualties for which Hungerford & Terry, Inc., is not indemnified and paid under such policies of insurance, shall be borne by the Purchaser on and after the arrival of said machinery or apparatus, or any part thereof on Purchaser's premises.

The title and right of possession of above described articles shall remain vested in Hungerford & Terry, Inc. until Purchaser shall have made full payment thereof in cash and this right shall not be waived by attachment of said articles to the real estate. Upon Purchaser's failure to make above agreed payments or any part thereof, Hungerford & Terry, Inc. is to retain any and all partial payments which may have been made as liquidated damages, and shall be entitled to take immediate possession of said materials.

This proposal, of which the Conditions of Sale are an integral part, shall not become a contract or become binding until it has been approved and signed by a representative of Hungerford & Terry, Inc. at its home office, Clayton, NJ. Persons signing on behalf of purchaser hereby represent that they are legally authorized to enter into this contract.



4. FIELD SERVICE CHARGES

Hungerford and Terry will provide a service tech to provide the assistance required in the project for 10 days in 10 trips. If more service is necessary, Hungerford & Terry, Inc., will furnish a Field Supervisor at USD-\$1,200.00 per weekday of 8 consecutive hours or USD-\$150.00 per hour, coinciding with the Purchaser's regular business hours during the normal work week of Monday through Friday including traveling time, plus living and traveling expenses from date of departure from Clayton, NJ, to destination and return. All time in excess of 8 hours shall be charged at 1-1/2 times the daily rate and all traveling and living expenses will be charged at cost. Meal charge is USD-\$50.00 per day. All overtime will be charged at 1-1/2 times the daily rate.

PLEASE NOTE: The Purchaser will be charged for the services of the Field Supervisor at the jobsite when service cannot be rendered because of delay or conditions beyond Hungerford & Terry's control. In cases of undue delay, Hungerford & Terry reserves the right to recall the supervisor.

HUNGERFORD & TERRY, INC.

PER: _____
Christopher Ralph- Technical Sales Representative

DATE: _____

ACCEPTED: _____
PER: _____
TITLE: _____
DATE: _____

CUSTOMER: FSWA

DATA SHEET: F-22-49 G P AW

PHONE:

DATE: 28-Jul-22

FAX:

PREP. BY: H&T, INC.

SITE: Well Blend

dju

DESIGN FLOWRATE (gpm): 595

MAX SYST USAGE (gal/24hr): 856,800

WATER ANALYSIS

Fe	0.138 (mg/L)	Hardness	200 (mg/L as CaCO ₃)
Mn	1.32 (mg/L)	Alkalinity	100 (mg/L as CaCO ₃)
H ₂ S	(mg/L)	SiO ₂	(mg/L)
pH	7.7 units	NH ₃ -N	(mg/L)
Temp	60 deg. F	Other	

FILTER DATA

PROCESS TYPE: CATALYTIC OXIDATION (CO)

FILTER TYPE: VERTICAL FILTER
PRESSURE
COMP. AUTO OPERATION
FIELD INSTALLED

NUMBER OF FILTERS	4	ANTHRACITE (in)	12
DIAMETER (ft)	8	GREENSANDPLUS (in)	24
CAPACITY / UNIT (%)	33.3	GRAVEL (in)	12
FLOWRATE (gpm/sq. ft.)	3.9		

Cl₂ RX VESSEL NO
DET. TIME (min)
CAPACITY (gal)

CUSTOMER: FSWA
PHONE:
FAX:
SITE: Well Blend

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CHEMICAL FEEDS

	<u>DOSAGE (mg/L)</u>	<u>LB/24 HR</u>	<u>GAL/24 HR</u>
Cl ₂	5.1	36.4	29.1

AIR/WATER WASH & BACKWASH

WATER SOURCE: STORAGE

BACKWASH

FLOWRATE (gpm) 600
TOT/UNIT (gal) 6,000
TOT/SYST (gal) 24,000

AIR/WATER WASH

WATER RATE (gpm) 200
AIR RATE (cfm) 40
TOT WATER/UNIT (gal) 1,000
TOT WATER/SYST (gal) 4,000

TOTAL SYSTEM WASHWATER USAGE (gal) 28,000

RUN LENGTH

	<u>MINIMUM</u>	<u>MAXIMUM</u>
CAPACITY (gr/sq. ft.)	700	900
BACKWASH FREQUENCY (gal)	649,400	835,000
RUN LENGTH (hr)	18	23

CUSTOMER: FSWA
PHONE:
FAX:
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BACKWASH ONLY SEQUENCE

STEP	WATER SOURCE	FLOW (gpm)	FLOW (gpm/sq. ft.)	TIME (min)	WASTE VOL (gals)
BACKWASH	STORAGE	600	11.9	10	6,000
BED SETTLE	-	-	-	2	-
RINSE TO WASTE	RAW	198	3.9	3	595
TOTAL				15	6,595

CUSTOMER: FSWA
 PHONE:
 FAX:
 SITE: Well Blend

DATA SHEET: F-22-49 G P AW
 DATE: 28-Jul-22
 PREP. BY: H&T, INC.
 dju

AIR/WATER WASH SEQUENCE

STEP	WATER SOURCE	FLOW (gpm)	FLOW (gpm/sq. ft.)	AIR FLOW (cfm)	AIR FLOW (cfm/sq. ft.)	TIME (min)	WASTE VOL (gals)
DRAINDOWN	-	Variable		40	0.8	5	1,000
AIR WASH	-	-	-	40	0.8	2	-
AIR/WATER WASH	STORAGE	200	4.0	40	0.8	3	-
SLOW REFILL	STORAGE	200	4.0	-	-	2	-
BACKWASH	STORAGE	600	11.9	-	-	10	6,000
BED SETTLE	-	-	-	-	-	2	-
RINSE TO WASTE	RAW	198	3.9	-	-	3	595
TOTAL						27	7,595

Note: Draindown time and volume are approximate.
 Air/water wash and slow refill times are approximate.

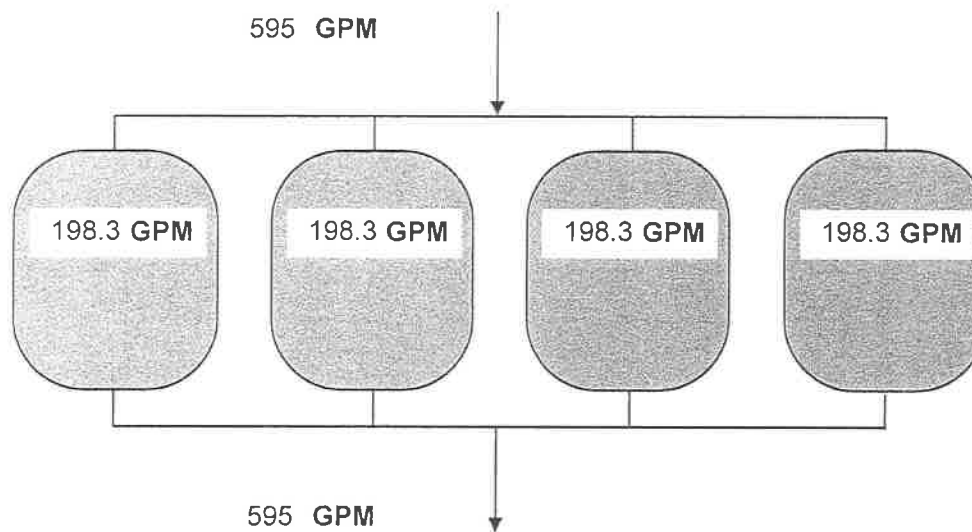
CUSTOMER: FSWA
PHONE:
FAX:
SITE: Well Blend

DATA SHEET: F-22-49 G P AW
DATE: 28-Jul-22
PREP. BY: H&T, INC.
dju

FLOW DIAGRAM

SYSTEM FLOWRATE (gpm): 595
FILTER INFO:

4 33% capacity, 8 ft. diameter
Catalytic Oxidation (CO), Vertical Filters



CUSTOMER: FSWA

PHONE:

FAX:

SITE: Well Blend

DATA SHEET: F-22-49 G P AW

DATE: 28-Jul-22

PREP. BY: H&T, INC.

dju

BACKWASH WATER RECLAIM/SETTLING TANK

BACKWASH VOLUME (gal)	3 VESSELS	18,000
DRAINDOWN VOLUME (gal)	3 VESSELS	3,000
RINSE VOLUME (gal)	3 MINS AT SERV. RATE	1,785
	TOTAL VOL (gal)	22,785
	SAFETY FACTOR	1.3
	VOL OF VESSEL REQD (gal)	29,621
	<u>FINAL VOLUME (gal)</u>	29,600
SUPERNATANT VOL TO RETURN (gal)	85% OF TOT VOL	19,367
SETTLED SLUDGE VOLUME (gal)	15% OF TOT VOL	3,418
SUPERNATANT RETURN FLOWRATE (gpm)		60
TOTAL RECYCLE TIME (hr)		5.4
SLUDGE REMOVAL FLOWRATE (gpm)		30
TOTAL SLUDGE REMOVAL TIME (hr)		1.9
SOLIDS IN SETTLED SLUDGE (lb)		12.9
PERCENTAGE SOLIDS IN SETTLED SLUDGE (%)		0.045
SETTLED SLUDGE VOL / MIL GAL TREATED (gal)		5,263
SOLIDS IN SETTLED SLUDGE / MIL GAL TREATED (lb)		19.8