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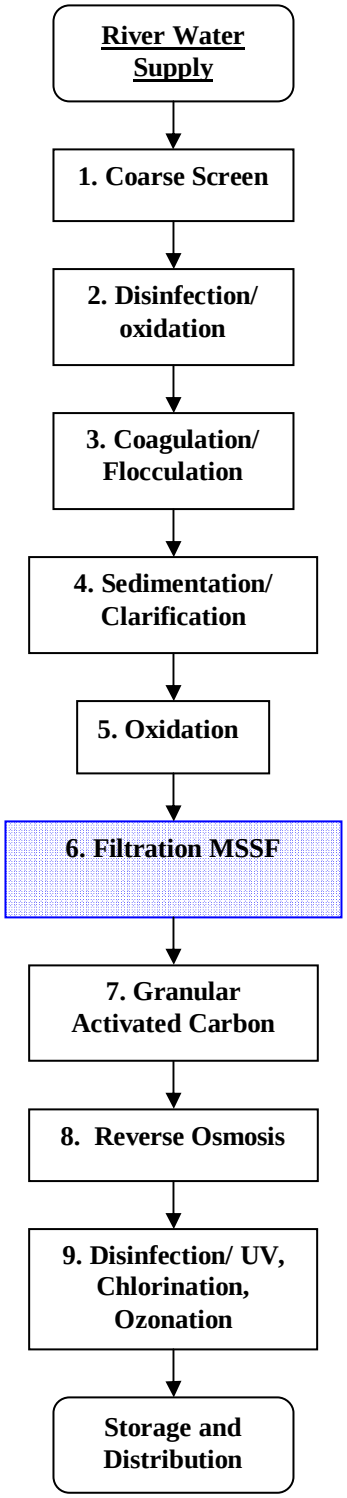
## Examples of Application in Treatment of Complex Surface Water

### Illustrative Example of the Potential Role of Manz Slow Sand Filter™ (MSSF) in Treatment of Complex Surface Water Treatment




## Treatment Examples

**See Water Quality Report in following Table.**

**A. Water from upstream of the River A**

**Use processes 1, 3, 4, 5, 6, and 9. (Process 2 may be required if there are biological growth problems prior to process 3. It is likely that process 7 will not be necessary. Post filtration disinfection will eliminate any remaining bacteria, virus or parasites.)**

**B. Water from River B**

**Use processes 1, 3, 4, 5, 6, and 9. (Process 2 may be required if there are biological growth problems prior to process 3. It is likely that process 7 will not be necessary. Post filtration disinfection will eliminate any remaining bacteria, virus or parasites.)**

**C. Treated water**

**Use processes 2, 3, 6, and 9. (The dissolved organics or other substances contributing to the elevated COD, which includes the ammonia, must be oxidized. Addition of very small amounts of flocculant followed by the polishing filters will remove any particulate material. Post filtration disinfection will eliminate any remaining bacteria, virus or parasites.)**

## Examples of Untreated or Inadequately Treated Water Water Quality Reports

(MM/DD): The date of Data

| Water source | River A | | | River B | | | Treated water | | |
|---|---|---|---|---|---|---|---|---|---|
| | Highest | Lowest | Average | Highest | Lowest | Average | Highest | Lowest | Average |
| Temperature (C) | 31.5(7.4) | 2.5(1.1) | 18 | 31.5(7.4) | 3.0(1.2) | 17.9 | 31.5(7.6) | 4.0(1.1) | 18.1 |
| Turbidity NTU | 131(2.26) | 118(4.12) | 53 | 613(10.17) | 14(7.13) | 97 | 0.46(12.24) | 0.11(10.2) | 0.21 |
| Color (CU) | 118(4.12) | 15(12.19) | 19 | 26(2.7) | 12(9.7) | 18 | 12(2.7) | 5(8.3) | 7 |
| PH | 7.8(4.5) | 7.1(5.6) | 7.4 | 7.7(8.26) | 7.3(8.3) | 7.5 | 7.3(5.30) | 6.7(8.14) | 7 |
| Total Alkalinity (mg/L) | 116(12.21) | 82(9.14) | 98 | 130(12.31) | 88(9.13) | 111 | 99(8.1) | 66(8.18) | 84 |
| Chloride (mg/L) | 136(8.5) | 63(12.7) | 88 | 144(8.5) | 55(9.7) | 93 | 143(8.5) | 67(9.13) | 90 |
| Total Hardness (mg/L) | 190(6.27) | 128(8.16) | 161 | 201(5.30) | 133(9.13) | 171 | 190(6.27) | 125(8.16) | 162 |
| Temporary Hardness (mg/L) | 116(12.21) | 80(9.20) | 98 | 130(12.31) | 88(9.13) | 111 | 111(5.30) | 66(8.18) | 84 |
| Permanent hardness (mg/L) | 86(6.27) | 33(8.2) | 63 | 94(6.2) | 32(9.20) | 60 | 102(2.17) | 50(9.1) | 78 |
| Ammonia—Nitrogen (mg/L) | 2.60(2.19) | 0.02(9.5) | 0.62 | 4.00(5.2) | 0.18(8.14) | 1.67 | 2.00(2.7) | 0.02(7.1) | 0.58 |
| Nitrite Nitrogen (mg/L) | 0.30(7.15) | 0.002(9.5) | 0.059 | 1.00(9.20) | 0.043(1.19) | 0.26 | 0.028(3.24) | 0.001(1.11) | 0.003 |
| COD (mg/L) | 8.9(7.18) | 4.5(11.25) | 6.4 | 9.8(5.23) | 4.1(8.5) | 6.9 | 5.4(8.1) | 3.0(11.25) | 3.9 |
| Dissolved Oxygen (mg/L) | 12.4(12.28) | 2.0(4.18) | 6.5 | 11.6(1.5) | 0.80(7.5) | 4.1 | | | |
| Iron (mg/L) | 3.5(1.18) | 0.48(5.30) | 1.6 | 9.1(5.23) | 0.37(5.30) | 2.4 | 0.10(11.25) | 0.05(1.1) | 0.05 |
| Manganese (mg/L) | 0.43(1.18) | 0.05(5.30) | 0.22 | 1.4(7.8) | 0.12(11.23) | 0.32 | 0.15(11.20) | 0.05(1.1) | 0.06 |
| Non-pollution index(PI) | 2.4(2.19) | 0.0(9.5) | 0.6 | 7.2(5.2) | 0.2(8.14) | 2.1 | | | |
| Residual Chlorine (mg/L) | | | | | | | 3.3(1.26) | 1.3(4.25) | 2 |
| Bacteria | | | | | | | 11(7.16) | 0(1.1) | 0 |
| Coliforms | | | | | | | <3(1.1) | <3(1.1) | <3 |

*River A and River B Water Sources*

The raw water in both cases has a very high turbidity. It is practical to remove as much of this as possible prior to filtration. Coagulation, flocculation and sedimentation are very useful for this purpose. If space is very limiting dissolved air flotation (DAF) technology may be used. If the natural occurring organic carbon in the water interferes with the coagulation process it may be necessary to add process 2, disinfection/ oxidation, to eliminate the problems.

The advantages of using the MSSF technology in this application is the significant reduction in capital cost. The use of the stacked arrangement of filters to reduce surface area (similar to a multi-storey building) more than compensates for any cost increase compared to rapid sand filters. The stacked arrangement is possible because the filters do not require significant vertical space to install (3 to 4 meters) and are not very heavy because they do not use very deep beds of filtering media. Very little treated backwash water is used, which eliminates the need for large special elevated storage reservoirs to feed a backwash process and allows the direct use of pressurized water from the treated water storage system. The MSSF's may be

manually or automatically operated using relatively unskilled operators. The use of the MSSF not only guarantees elimination of any particulate material but also the complete removal of any encysted parasites including those of giardia and cryptosporidium.

If process 2 is not used, the addition of an oxidation step immediately before the filtration process will insure that the iron and manganese in the water are oxidized and removable prior to filtration. Inclusion of an oxidation step will also insure that any residual ammonia or COD will also be removed. If chlorine is used for this purpose it is not wasted as the filtered water is usually chlorinated after filtration prior to storage and distribution.

It is unlikely that process 7, granular activated carbon (GAC), needs to be used to reduce COD or ammonia. If a GAC process was required, the MSSF would insure that water with minimum turbidity would be treated and GAC life would be greatly extended.

Similarly, if the total dissolved solids in the water were so high that membrane filtration was required, process 8 would be required. The water presented to the nanofiltration process is very well conditioned and membrane life would be significantly extended.

*Treated Water Source*

This water is actually very good but may not meet national standards for ammonia, COD, occasionally manganese, and bacteria. The treatment process described is a form of what is known as 'direct filtration' with the addition of the oxidation step that insures the ammonia and COD are oxidized and bacteria killed. As well the use of the MSSF will insure that all parasites are removed from the water.

There are many applications for the MSSF technology that can be adapted as required to consider the quality of the water to be treated and the standard to which it must be treated, volume of treated water required, availability of electrical supplies, operating environment, skill of operators and budget.