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**CONCEPTUAL DESIGN REPORT FOR THE
GROUNDWATER REMEDIATION SYSTEM
AT THE
BLACK & DECKER, INC.
MANUFACTURING FACILITY
HAMPSTEAD, MARYLAND**

JUNE 1992

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W.O. #2501-04-01

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SECTION 1

INTRODUCTION

Black & Decker, Inc. has retained Roy F. Weston, Inc. (WESTON) to provide services to support the installation and operation of a groundwater remediation system at the Hampstead, Maryland facility. These services include engineering, permitting, construction support services, start-up assistance, and performance monitoring. This report presents WESTON's conceptual design, for Black & Decker review and approval. After receiving Black & Decker's comments and approval, WESTON will proceed with detailed design activities.

1.1 BACKGROUND

The 150-acre facility has operated since 1952, originally manufacturing power hand tools. Although the current focus of plant activities is distribution rather than manufacturing, continuing operations include manufacturing gears from powdered metal, heat treatment of the gears, and cleaning and treatment of power tool accessories for rust prevention.

The detection of chlorinated hydrocarbons in the groundwater at the site has led to the need for a groundwater remediation system. The project involves pumping groundwater from ten extraction wells and treating it to remove trichloroethylene (TCE) and perchloroethylene (PCE) using a new air stripper. The objective is to develop hydraulic barriers along the east and west sides of the Hampstead plant, which will minimize the potential for off-site migration of groundwater containing volatile organic compounds (VOCs) and lead to restoration of groundwater quality.

1.2 DESIGN INVESTIGATION RESULTS

The design investigation consisted of surface geophysics to identify likely fracture zones, test well installation, and pump testing. WESTON installed a total of ten extraction wells at locations most likely to create effective hydraulic barriers. Subsequent computer modeling based on the pump testing of these wells was used to determine the pumping rates required for effective capture and the maximum sustainable pumping rate, for each extraction well.

This data is presented in Table 1-1.

The anticipated extraction rate for effective capture is shown on Table 1-1. Under these anticipated or "normal" operating conditions, the system will pump and treat groundwater at 295 gallons per minute (gpm). The performance of the system as a whole is difficult to predict based upon individual well pump test data for fractured bedrock. Accordingly, WESTON has planned for the evaluation of hydrologic performance and contingency modification of pumping rates, as necessary. In designing the treatment system, the design maximum flow will be based on the most conservative contingency that all wells could be pumped at their maximum sustainable yield, resulting in flows up to a total of 553 gpm. Accordingly, the system will be designed with the capability to treat 553 gpm, although normal operation is planned to be 295 gpm.

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BLACK & DECKER HAMPSTEAD, MD FACILITY
GROUNDWATER RECOVERY SYSTEM DESIGN BASIS

Train/ Extraction Well ID	Current Well ID	Well Casing Dia. (inch)	Well Coordinates		Maximum Sustainable Yield (gpm)	Anticipated Normal Pumping Rate (gpm)	Design TCE Conc. (μg/L)	Design PCE Conc. (μg/L)	Total Well Depth (ft)	Required Pump Installation Depth	Water Elevation (ft above MSL) Static Water Level	Water Level at Normal Pumping Rate[3]	Top of Casing Elevation (ft above MSL)
EAST													
EW-1	RFW12	4	2,184	760	35	35	6,400	130	55	50	818	795	845
EW-2	PH3A	6			55	40	4,000[2]	15[2]	117	110	818	780	849
EW-3	PH1A	6	2,413	166	90	50	1,000	15	118	110	817	778	847
EW-4	PH4A	6			30	30	1,800[2]	100[2]	107	100	819	780	858
EW-5	PH2A	6	3,205	201	75	30	2,600	50	98	90	822	786	863
SUBTOTALS					285	185							
WEST													
EW-6	PH13	6	1,466	1,796	45	20	12	87	115	110	786	760	832
EW-7	RFW5B[1]	6	1,743	2,204	70	20	20	110	78	73	795	765	818
EW-8	PH10	6	2,136	2,281	80	25	7	170	98	93	802	766	811
EW-9	PH8	6	2,126	2,265	33	20	29	1,100	141	135	794	767	811
EW-10	PW-7[1] (existing Well 7)	8			40	25	22	3,100	240	110	794	773	804
SUBTOTALS					268	110							
TOTALS					553	295							

[1]Open hole well construction (no PVC screen)
[2]Used isoconcentration contour map to estimate concentration
[3]Water level at maximum sustainable yield is approximately 5-feet above pump level

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SECTION 2

CONCEPTUAL DESIGN SCOPE

This conceptual design effort was intended to develop a preliminary design for the entire system from well pumps through discharge, including necessary modifications to existing potable water and cooling water systems. The conceptual design includes a new groundwater extraction system; a new air stripper; and connection and modifications to the existing potable water and industrial cooling water systems. The development of the extraction well locations, flows and characteristics is documented in the Groundwater Appropriation Permit Application Hydrogeologic Report, dated June 1992. The major components of the Conceptual Design include:

- Well pumps, wellhead valves, controls, and buried piping to pump groundwater from ten existing wells, to a new air stripper.

- A new air stripper, sized to treat up to 553 gpm.

- Stripper outlet connections to both the industrial cooling water loop and potable water systems, with the appropriate control devices (i.e., sensors, controllers, control valves, alarms, and switches).

- A relocated pressure control valve/bypass system for the industrial cooling water loop.

- Evaluation of an alternative water pressure booster and surge supply system (e.g. use of a pressurized tank) to potentially replace the elevated potable water tank which is scheduled to be rehabilitated, if economically justified.

- A soda ash addition system to treat water exiting the stripper prior to entering the industrial cooling water loop to reduce corrosion.

- A reduced flow pumping system at the cooling water reservoir to complement the new supply to the cooling water loop from the stripper.

- Modifications to the reservoir overflow and outfall structures to accommodate the higher discharge flows which will result from operating the new groundwater

While the existing water supply wells and air stripper has been used to provide potable water, the new extraction wells and higher capacity stripper will supply potable water and a portion of the cooling water requirements. The existing cooling water reservoir will continue to be used to supply the balance of the cooling water requirements on demand. The increased input to the cooling water reservoir will result in an increase in the average discharge to surface water.

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SECTION 3

CONCEPTUAL DESIGN BASIS

3.1 GROUNDWATER EXTRACTION AND TREATMENT

The system will be designed to handle a maximum (contingency) flow of 553 gpm, although normal operation is planned to be 295 gpm. The system will be started up in phases, first by pumping and treating only the wells comprising the east train (wells EW-1 through EW-5). This will result in a startup flow of 185 gpm. After system performance has been confirmed for the east train, the west train wells (EW-6 through EW-10) will be added, to establish the normal operating flow of 295 gpm.

Table 3-1 summarizes the critical influent design basis for the system under the three operating conditions; startup (east train only), normal operation (east and west trains at normal flows), and design maximum (all wells at maximum sustainable yield). Calculations used to develop the design basis, presented in Appendix A, were based upon the design TCE and PCE concentrations given in Table 1-1. These concentrations were selected based upon a review of the monitor well and pump test sample analysis data. The values selected were generally the highest historically observed unless the highest value was an "outlier" and not supported in repeat sample analysis results. This conservative approach was intended to ensure the adequacy of performance under all conceivable operating conditions. Actual concentrations may be lower because average concentrations are lower and because groundwater concentrations usually drop under pumping conditions. The values for EW-2 and EW-4 were estimated based upon isoconcentration diagrams because analytical data is not yet available for these wells.

Certain pumping wells were also sampled and analyzed for selected inorganic parameters which are used to evaluate the potential for iron, calcium and manganese fouling and corrosion. Table 3-2 presents these results. While iron concentrations up to 11.3 mg/l were reported, all samples which contained iron above the detection limit of 0.1 mg/l were also high in Total suspended solids (TSS). TSS values are often high during sampling but decrease rapidly in operating wells. Based upon the long history of groundwater use by Black & Decker without observing iron fouling and the high iron/TSS correlation, we have assumed that iron concentrations will be below 1 mg/l in the aggregate influent. Therefore, iron pretreatment will not be necessary.

Table 3-1

Critical Design Basis Data

Operating Condition	Total Flow (gpm)	Flow-Weighted Average Influent Concentration to the Air Stripper		Total PCE and TCE Emissions from Air Stripper[1,2] (lb/hr)
		TCE (μg/L)	PCE (μg/L)	
Startup (East train only)	185	3,059	56	0.29
Normal Operation (East and West trains)	295	1,925	400	0.34
Design Maximum (all wells at maximum sustainable yield)	553	1,424	360	0.49

Notes:

[1] Assuming 100% removal efficiency. The actual target concentration for both TCE and PCE is 5 μg/L. A design target concentration of 1 μg/l (detection limit) was used to provide a safety factor since actual performance may differ slightly from design projections.

[2] Other VOCs have been detected at low concentrations in some planned extraction wells in the 8/27/90 and 3/17/92 sampling results. Of these, however, only 1,2 dichloroethene (1,2 DCE) was ever found above the detection limits of 5 μg/l. We can conservatively take the single highest observed extraction well concentration of 18 μg/l of 1,2 DCE and use it as the maximum possible concentration of other VOCs in the aggregate flow under pumping conditions. This would result in, additional VOC emissions of 0.0017 lb/hr, 0.0027 lb/hr, and 0.0050 lb/hr for 185 gpm, 295 gpm and 553 gpm flows respectively, an insignificant change vs. TCE and PCE estimates above.

Table 3-2

Summary of Inorganic Analyses

	PH-1A	PH-2A	PH-8	PH-8D	RFW-5B	RFW-12	Pre-Stripper	Post-Stripper	Cooling Water loop
Iron, total (μg/l)	100u	100u	1440	1580	11300	1050	100u	100u	156
Manganese, total (μg/l)	50.6	44.3	55.5	55.3	182	60.4	17.6	16.7	63.6
Sodium, total (μg/l)	54,900	9980	7240	7690	25500	22700	24,100	23,700	44,700
Total Alkalinity (mg/l) (pH =4.5)	38.0	2.5	38.0	38.0	52.0	20.0	21	22	41
m-Alkalinity (mg/l) (pH =3.8)	--	--	--	--	--	--	32	34	54
Chloride (mg/l)	118.0	17.0	9.2	9.2	62.6	47.6	--	--	--
Hardness, total (mg/l)	105.0	14.0	63.0	63.0	61.0	45.0	44.9	44.2	99.7
Ca-hardness (mg/l)	34.5	5.1	50.0	50.0	29.0	20.5	28	28	76
pH	5.4	6.0	5.8	5.8	5.4	5.5	5.5	6.7	7.2
Sulfate (mg/l)	2.5u	2.5u	3.0	11.8	2.5u	3.5	--	--	--
Specific conductance (μmhos/cm)	471	78.8	113	113	265	201	175	170	395
TDS (mg/l)	310.0	62.0	107	110	255	147	125	133	254
TSS (mg/l)	5u	5u	334	194	31.0	29.0	5u	5u	8

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The overall design philosophy will be to size piping, electrical, and mechanical equipment which cannot be easily modified to accommodate the design maximum flow. Pumps and blowers in particular will be sized for the design maximum flow of 553 gpm, with the ability to be easily operated at the anticipated normal flow conditions (295 gpm). In this manner, capital costs can be minimized while providing the flexibility to operate at higher rates to meet remediation performance objectives. In certain cases where the difference in anticipated and design maximum flows is too large, it may be necessary to change out a well pump to achieve the design maximum flow to prevent excessive throttling of the well pump.

3.2   POTABLE AND COOLING WATER USE AND DISCHARGE

Treated water will be used for both potable water supply and cooling water. The design basis for the potable water supply from the new stripper is based on existing chart recordings provided by Black & Decker which show a continuous baseline flow of 25 gpm, a daytime average flow of approximately 70 gpm or less, and sudden peak flows up to 175 gpm for durations of approximately 1 minute or less each.

Whatever water is not used for potable water supply will be fed to the cooling water system to provide a baseline cooling water flow. Additional cooling water will be supplied by the existing cooling water pumps at the cooling water reservoir. Based on conversations with Black & Decker facility personnel, the existing 400 gpm pumps at the cooling water reservoir are already oversized for most time periods. Since the stripper would provide an adequate and relatively constant daytime cooling water flow of about 225 gpm (295 gpm minus an average of 70 gpm to the potable water system), the reservoir pumps can be operated as a backup only, potentially activated by cooling water low system pressure. One reservoir pump would be modified to reduce flow from 400 gpm to approximately 200 gpm, by removing one or more vertical turbine stages. This would reduce power consumption, both for baseline cooling water needs and for responding to peak demands. The remaining two pumps can remain as high capacity backups for periods of extremely high demand.

The reservoir outfall structures will be modified to accommodate the additional flow from the groundwater remediation system. According to plant personnel, the average existing outflow from the reservoir is 30 to 50 gpm. The maximum flow which can be recorded is 250 gpm. Since the outfall has reportedly overflowed during large storms, it is proposed that the weir and chart recorder be sufficiently increased in size to handle both the increase in baseline flow from the extraction wells and stormwater surges. If the design maximum extraction well flow of 553 gpm is added to the current maximum recorder capacity of 250

gpm a total flow of 800 gpm results. In order to provide additional capacity for storms as well, Black & Decker indicated that the weir should be modified to handle 1,000 gpm. Since the design capacity of 553 gpm is provided as a contingency, the additional capacity for storm surges will probably be more than adequate.

Pertinent assumptions used in the design which were provided by Black & Decker include:

- Potable water demand and use patterns would remain as depicted in representative flow charts.

- Some transient short term decreases in water pressure are tolerable.

- Manual and mechanical-only controls are preferable to automatic monitoring and control to reduce maintenance cost, where possible.

- The cooling water supply loop and return loop sizing is more than adequate to handle the new groundwater flows.

- A cooling water loop pressure of 60 to 80 psig is adequate to supply existing cooling equipment.

- The current potable water system pressure is 50 to 55 psig at maximum. A potable water target pressure of 40 to 60 psig is adequate, although slightly higher pressure may be desirable.

- The existing soda ash demand is 3.5 to 4.0 mg $Na_2 CO_3$ (dry weight basis) per liter of water to raise the pH of stripper outflow to 8.5. We assume this would apply to the future aggregate flow.

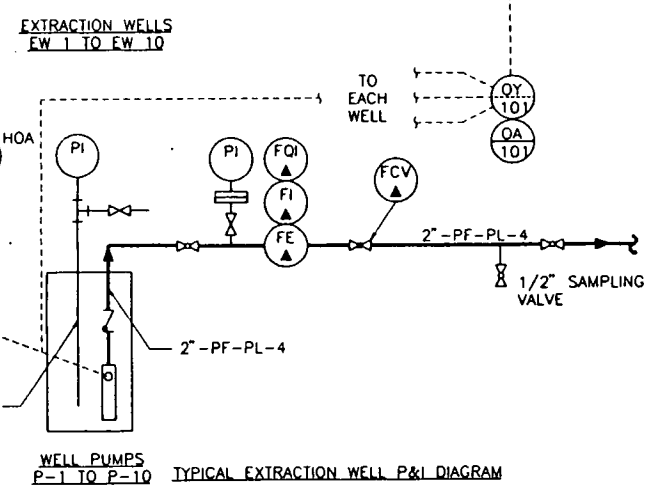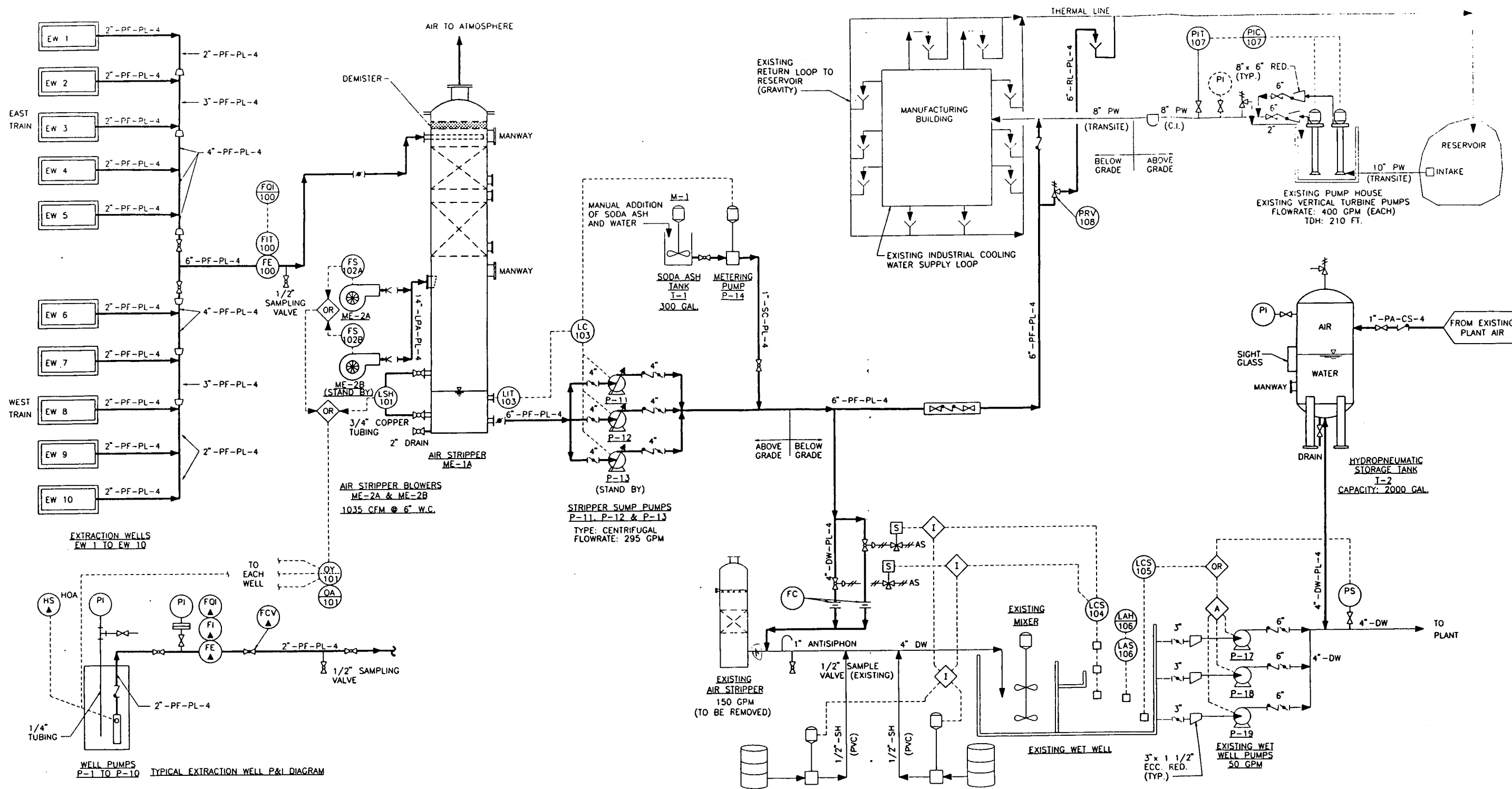Black & Decker should verify these assumptions prior to the final system design.

SECTION 4

CONCEPTUAL DESIGN

4.1 GROUNDWATER EXTRACTION SYSTEM

The groundwater extraction system will consist of the extraction wells which have already been installed and pump tested. The pump test and modeling results, presented in the Groundwater Appropriation Permit Application Hydrogeologic Report, dated June 1992, indicate that pumping these ten wells will provide sufficient hydrologic control at a total pumping rate of 295 gpm. However, higher flow rates may need to be employed, depending upon actual performance, up to the maximum well yield. Therefore, well pumps will be sized to deliver up to the maximum well yield, when feasible. Each well will be fitted with piping, instrumentation, and controls to adjust and monitor flow, including:

- An analog turbine meter with a simple local mechanical flow reading and flow totalizer.

- A self contained flow control valve that can be used easily for minor flow adjustments and can be easily modified to change flow range by changing the flow measurement orifice.

- A sampling valve.

- A simple water level measurement system consisting of a PVC riser pipe, plastic tubing, and a pressure gauge. The operator will use a portable pump (e.g. foot pump) to inject air until the pressure stabilizes and will then get the pressure reading. A simple table will be used to convert pressure to water depth for each well based upon the depth of the tube.

The piping and instrumentation for the entire system is presented in Figure 4-1. The basic pump sizing information is presented in Appendix B - Major Equipment List. The pumps will be started-up with centrally located panel mounted hand switches. Interlocks will be provided to shutdown each well pump on low water level (to protect the pumps) and to shutdown all wells on low air flow to the stripper and high stripper sump water level. A

AIR TO ATMOSPHERE

EW 1 2"-PF-PL-4
EW 2 2"-PF-PL-4
EAST TRAIN
EW 3 2"-PF-PL-4
EW 4 2"-PF-PL-4
EW 5 2"-PF-PL-4

2"-PF-PL-4
3"-PF-PL-4
4"-PF-PL-4

FQI 100
FIT 100
FE 100
6"-PF-PL-4
1/2" SAMPLING VALVE

EW 6 2"-PF-PL-4
EW 7 2"-PF-PL-4
WEST TRAIN
EW 8 2"-PF-PL-4
EW 9 2"-PF-PL-4
EW 10 2"-PF-PL-4

4"-PF-PL-4
3"-PF-PL-4
2"-PF-PL-4

EXTRACTION WELLS
EW 1 TO EW 10

DEMISTER

MANWAY
MANWAY

FS 102A
FS 102B
OR
ME-2A
ME-2B (STAND BY)
14"-PA-PL-4

AIR STRIPPER BLOWERS
ME-2A & ME-2B
1035 CFM @ 6" W.C.

LSH 101
OR
3/4" COPPER TUBING
2" DRAIN
AIR STRIPPER ME-1A

LC 103
LIT 103
6"-PF-PL-4

MANUAL ADDITION OF SODA ASH AND WATER

M-1
SODA ASH TANK T-1 300 GAL.
METERING PUMP P-14
1"-SC-PL-4

4"
P-11
4"
P-12
4"
P-13 (STAND BY)

STRIPPER SUMP PUMPS
P-11, P-12 & P-13
TYPE: CENTRIFUGAL
FLOWRATE: 295 GPM

6"-PF-PL-4
ABOVE GRADE BELOW GRADE

THERMAL LINE

MANUFACTURING BUILDING

EXISTING RETURN LOOP TO RESERVOIR (GRAVITY)

EXISTING INDUSTRIAL COOLING WATER SUPPLY LOOP

6"-RL-PL-4
8" PW (TRANSITE)
8" PW (C.I.)

PIT 107
PIC 107
PI
8" x 6" RED. (TYP.)
6"
6"
2"
PRV 108

RESERVOIR
10" PW (TRANSITE)
INTAKE

EXISTING PUMP HOUSE
EXISTING VERTICAL TURBINE PUMPS
FLOWRATE: 400 GPM (EACH)
TDH: 210 FT.

PI
AIR
1"-PA-CS-4
FROM EXISTING PLANT AIR
SIGHT GLASS
WATER
MANWAY
DRAIN

HYDROPNEUMATIC STORAGE TANK
T-2
CAPACITY: 2000 GAL.

6"-PF-PL-4
4"-DW-PL-4

HS HOA PI PI FQI FI FE FCV
2"-PF-PL-4
1/2" SAMPLING VALVE

QY 101
QA 101
TO EACH WELL

2"-PF-PL-4
1/4" TUBING

WELL PUMPS
P-1 TO P-10   TYPICAL EXTRACTION WELL P&I DIAGRAM

4"-DW-PL-4
S I AS
S I AS
FC
1" ANTISIPHON
1/2" SAMPLE VALVE (EXISTING)
EXISTING AIR STRIPPER
150 GPM
(TO BE REMOVED)

4" DW
EXISTING MIXER
I
LCS 104
LCS 105
OR
LAH 106
LAS 106
A

EXISTING WET WELL

3"
3"
3"
3" x 1 1/2" ECC. RED. (TYP.)

6"
P-17
6"
P-18
6"
P-19

EXISTING WET WELL PUMPS
50 GPM

PS
4"-DW-PL-4
6"
4"-DW
TO PLANT

1/2"-SH (PVC)
1/2"-SH (PVC)

EXISTING SODIUM HYPOCHLORITE DRUM
EXISTING METERING PUMP P-15
EXISTING METERING PUMP P-16
EXISTING SODIUM HYPOCHLORITE DRUM

Figure 4-1 P&ID

WELL	PUMP	DESIGN FLOW (GPM)	NORMAL FLOW (GPM)	▲
EW 1	P-1	35	35	001
EW 2	P-2	55	40	002
EW 3	P-3	90	50	003
EW 4	P-4	30	30	004
EW 5	P-5	75	30	005
EW 6	P-6	45	20	006
EW 7	P-7	70	20	007
EW 8	P-8	80	25	008
EW 9	P-9	33	20	009
EW 10	P-10	40	25	010

NOTES: 1.) ALL INSTRUMENTATION IS NEW EXCEPT AS NOTED.
2.) ——— EXISTING PIPING
3.) ━━━ NEW PIPING

BLACK & DECKER, INC.
HAMPSTEAD   MARYLAND

WESTON
WEST CHESTER   PENNSYLVANIA

CHECKED	DATE	CLIENT APPROVALS	DATE
DES. ENG. RG1/HFE/PSP	6/5/92		
PROJ. ENG. CWB	6/5/92		
PROJ. MGR. RLM	6/5/92		
APPROVED			
APPROVED			

GROUNDWATER REMEDIATION SYSTEM
PIPING AND INSTRUMENTATION
DIAGRAM

| DRAWN M.HANSEN | DATE 4/14/92 | DWG. NO. 101 | REV. NO. 0 |
| SCALE NONE | JOB NO. 2501-04-01 | SHT. OF |

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panel mounted strip chart recorder will be provided to continuously record the flow rate into the stripper and a totalizer will read out total cumulative flow.

4.2 AIR STRIPPER

Several process options were considered for treatment by air stripping. These included:

- Use of the existing air stripper for all flows.

- Use of the existing air stripper for potable water supply and installation of a new separate stripper for cooling water supply.

- Installation of a new stripper for all flows.

The first option was evaluated and the stripper was found to have an insufficient diameter and height of packing to meet the treatment objectives. The second option was eliminated due to the complexity of operating two strippers and little or no long-term cost advantages over the third option. Therefore, a new stripper which can meet all performance objectives and processing the maximum design flows was the selected option.

The primary compounds of concern for design are TCE and PCE. Other VOCs are present at very low levels in some of the wells. The target performance objectives for the discharge from air stripper were set at drinking water Maximum Contaminant Levels (MCLs) of 5 μg/L for both TCE and PCE. However, in order to provide a safety factor between theoretical and actual performance, a 1 μg/L design discharge criterion was set for both TCE and PCE. This safety factor is equivalent to providing a safety factor of more than 30% on the packing height necessary to achieve a concentration of 5 μg/l.

The stripper design was evaluated using the AIRSTRIP™ computer model. This model uses the Onda correlation to determine overall gas/liquid mass transfer coefficient. TCE was found to be the constituent controlling the design packing height in all cases because it is present at higher concentrations and is slightly less "strippable" than PCE. Given the design capability for removing TCE, all other VOCs will be removed to below the detection limit of 1 μg/L. Based on existing stripper performance and the inorganic analysis results presented in Section 3, inorganic constituents are not present at concentrations which will result in severe fouling. Long-term fouling will be monitored by observing blower discharge pressure trends.

Maryland air toxics emissions regulations require emission control for sources exceeding 0.5 lb/hr of air toxics. The air stripper emissions are projected to be below this level at normal, and even design maximum conditions. However, the Maryland Department of the Environment (MDE) sometimes requires temporary emission controls for groundwater treatment by air strippers with projected emissions near that limit. Alternatively, emissions could potentially be higher than estimated if unexpectedly high groundwater concentrations occur under pumping conditions. Since, in these cases, the use of air emission controls could be required by the State of Maryland, the air stripper design has been optimized to minimize the capital and O&M costs for vapor phase granular activated carbon (GAC) treatment, if required.

The contingency GAC system would consist of two GAC units placed in parallel, along with a supplemental blower to accommodate the pressure drop across the GAC units and an in-line duct heater to reduce the relative humidity to below 40%. The duct heater will raise the air temperature from 55°F to 85°F.

The air stripper design evaluation considered a range of liquid loading rates, air to water ratios and packing sizes. The optimum design was selected to minimize overall cost including contingency air emission control. The cost of air emission control is directly dependent on air flow rate. The optimum design minimized air flow rate. This resulted in a slightly larger packing height. The diameter was selected to provide reliable operation in the full range of water flows possible, 185 to 553 gpm. A 5-foot diameter provided a high enough liquid loading rate at 185 gpm to ensure complete wetting of the packing and a liquid loading rate at 553 gpm that was still well below a flooding condition.

The air stripper design parameters are summarized in Table 4-1. The air stripping tower will include a weir or orifice top distributor and a similar redistributor at the middle of the packed zone. Additional features provided will include automatic shutdown of the air stripper feed due to blower failure and level controls for the stripper sump as shown on Figure 4-1. The stripper discharge pumps and soda ash metering pump will automatically be shutdown on low level in the sump.

Table 4-1

Air Stripper Design Parameters

Maximum (Design) Water Flowrate	553 gpm
Air Flow Rate	1035 cfm
Air to Water Ratio	14
Stripping Factor	3.7
Influent Water Temperature	55° F
Packing Type	Plastic Jaeger Tripacks (2-inch diameter)
Packing Height	42 feet
Total Tower Height	52 feet (approximate)
Column Diameter	5 feet
Liquid Loading Rate	28.1 gpm/ft²
Air Pressure Drop	<2.5 inches w.c. for packing 6 inches w.c. maximum

Design Case	Influent Characteristics			Treatment Objectives
	Startup	Normal	Design Max.	
Flows	185 gpm	295 gpm	553 gpm	
Trichloroethylene (TCE)	3060 μg/l	1925 μg/l	1424 μg/l	< 5*
Perchloroethylene (PCE)	56 μg/l	400 μg/l	360 μg/l	< 5*
Total PCE and TCE	3116 μg/l	2325 μg/l	1784 μg/l	

* Effluent objectives are drinking water MCLs of 5 μg/L. The stripper was designed to achieve 1 μg/L to provide a safety factor to ensure that actual concentrations are below the MCL.

4.3 CONNECTION AND MODIFICATIONS TO THE INDUSTRIAL COOLING WATER LOOP

Figure 4-1, the piping and instrumentation diagram (P&ID), shows the planned modifications to the cooling water loop to achieve the design objectives of energy efficient reuse of water to the maximum practical extent. Each area to be modified is discussed below.

4.3.1 Stripper Sump/Cooling Water Delivery Pumps

The treated water will be conveyed from the bottom of the air stripper to both the potable and cooling water systems using up to two operating pumps. An installed spare pump will also be provided. The pumps will each be sized to individually deliver 295 gpm, the anticipated normal flow. Two pumps operating together will be designed to deliver higher flows up to the design maximum of 553 gpm. A stripper sump level controller will be used to maintain the water level between a depth of 1.5 and 3.5 feet by adjusting the pump speed. The controller will shut down these and the soda ash metering pump at low sump level. The pump discharge pressure will be at or above 80 psig, the upper end of the 60 to 80 psi cooling water loop pressure objective of Black & Decker, at design flows.

4.3.2 Soda Ash Addition System

Presently there is corrosion problem with steel pipe in the cooling water supply loop. The tendency for corrosion depends upon concentrations of calcium relative to saturation, oxygen, carbon dioxide and galvanic effects. The most easily controllable factor is calcium corrosion/scaling tendencies. Calcium scaling or corrosion depends on a variety of factors including temperature, pH, alkalinity, calcium hardness and total dissolved solids. Samples were recently taken for analysis of these parameters before and after the stripper. Based on the results presented on Table 3-2, the Langelier Saturation Index was calculated to be -3.6 and -2.5 for pre-stripper and post-stripper samples. The negative values indicate a tendency to dissolve calcium carbonate, minimizing the ability to prevent corrosion. The Ryzner's Stability Index was calculated to the 12.8 and 11.6. A value above 8.0 indicates a high probability for corrosion. With both indices for the post-stripper sample confirming the corrosion tendency, the post-stripper pH of 6.7 should be raised to approximately 8.5 so the water will have a tendency to be less corrosive. Increasing the pH to 8.5 will result in Langelier and Ryzner's Indices of approximately -0.55 and 9.6, respectively. Increase beyond this range will result in further improvement but there are drawbacks of the effect on potable water quality (e.g., sodium levels) and reductions in the effectiveness of chlorination. The pH increase can be achieved by adding soda ash downstream of the stripper.

Soda ash will be added to the total flow from the air stripper sump to raise the pH of the water and thus reduce its corrosivity. This system was designed using data from the existing soda ash addition operation in the potable water treatment system as well as inorganic water analyses of samples from selected wells and the existing water treatment system. The soda ash solution tank and metering pump were designed based on information from Black & Decker that 3.5 to 4.0 ppm of soda ash (solid weight basis) is necessary to raise the pH to 8.5. As discussed above, this is sufficient to significantly reduce the corrosivity due to calcium saturation, as indicated by the Langelier Saturation and Ryzer's Indices, but not to clearly non-corrosive levels. Residual galvanic and oxygen induced corrosion will not be addressed by the soda ash addition and corrosion should be reevaluated after the new system is in operation.

Two options for the location of soda ash addition were considered:

- Addition to total stripper outflow.
- Separate addition to the potable and cooling water flows.

Separate addition would require complex flow monitoring and controls due to the short-term variation of potable water demands. As a result, it was decided to make the soda ash addition in the line carrying the total stripper outflow to minimize system and control complexity. This will allow the use of a manually set metering pump which will have to be adjusted only when the total groundwater flow is adjusted. Soda ash powder and water will be manually added to a mixing tank as needed.

4.3.3 Connection to the Cooling Water Loop

The connection to the cooling water loop will be made inside the main facility building at a location near the new air stripper. Since no P&IDs are available for the cooling water system, Black & Decker facility personnel will provide details concerning the exact location for the tie-in and will verify the ability of the existing cooling loop piping to convey the design maximum flow of 553 gpm. The delivery piping from the air stripper will be sized for the design maximum flow of 553 gpm. A back flow preventor will be installed in the cooling water line to prevent potential back flow of process fluids to the potable water system.

4.3.4 PRV/Flow Bypass System

To provide for the case where the extraction wells are providing more flow than the combined cooling and potable water demand, a pressure regulating valve (PRV) set at 80 psi will be installed to allow flow to bypass the cooling water loop and return to the reservoir. The best location for the PRV valve to divert water to the existing "thermal return" system will also be determined by Black & Decker.

4.3.5 Reduced Flow Pumping System at the Reservoir

Since the current cooling water pumping system baseline flow is oversized at 400 gpm, it is believed that the flow of treated groundwater (295 gpm less potable water use) will satisfy baseline cooling water demand periods. The total anticipated supply of 295 gpm will be reduced intermittently by 75 gpm to supply the potable water system via a solenoid valve and flow control orifice. On a rare occasion, sustained high potable water demand will cause 150 gpm to be diverted to the potable water system. Cooling water flow from the stripper would be augmented on demand by a down rated existing reservoir pump. One of the existing 400 gpm vertical turbine pumps would be modified by removing one or more stages, to 200 gpm. This pump would operate as the automatic backup pump, to supplement the flow provided by the groundwater extraction system. A pressure switch would activate this pump when the system pressure (at the plant elevation) drops to 65 psi, and deactivate the pump at 75 psi. The target pressure for the cooling water loop will be 60 to 80 psi. The remaining two pumps would be normally inactive, and activated manually based on low system pressure and knowledge of operational needs (this is how they are currently operated). In the event that the 200 gpm pump failed, one of the 400 gpm pumps would be automatically activated instead. On the recommendation of facility personnel, the check valve on the discharge side of each pump will be replaced with new double check valves.

4.4 CONNECTION AND MODIFICATIONS TO THE POTABLE WATER SYSTEM

The P&ID shown in Figure 4-1 presents the recommended modifications to the potable water system. Each modification is discussed below.

4.4.1 Regulated Supply to the Wet Well

The air stripper discharge line will be connected to both the cooling water and potable water systems. Flow to the potable water system will be supplied on demand by a pair of solenoid valves and flow control orifices as shown on the P&ID. This design was selected to simplify the control scheme, provide stable flows to the potable water system, and to minimize interruptions in flow to the cooling water system created by sudden demands from the potable water system.

Chart recordings of the potable water system demands (recorder located after the existing elevated water tower) were analyzed to design this regulated supply system. The chart recordings show a constant, 24-hour baseline flow around 25 gpm; a daytime average flow around 70 gpm; and sudden peak flows around 175 gpm for durations around 1 minute or less each. Accordingly, the flow regulating valves would provide constant flows of either 75 gpm or 150 gpm. These valves would be activated by level control switches located in the existing wet well/chlorine contact chamber.

4.4.2 Modified Operation of Chlorine/Soda Ash Addition System

Currently two separate sets of mixers and metering pumps exist. These were initially designed for separate feed of sodium hypochlorite solution and soda ash solution. The operation was modified by Black & Decker to feed a mixture of sodium hypochlorite and soda ash via both systems to respond to changes in the number of operation wells. The soda ash and sodium hypochlorite (chlorine) solutions are mixed manually as needed, and the metering pump delivery rate is set manually. It is proposed to utilize the existing equipment to feed only sodium hypochlorite. The metering pump delivery rates will be adjusted so that each pump delivers enough solution to chlorinate the 75 gpm flow through each orifice/solenoid valve pair. The metering pumps will be turned on and off based on the same level switches operating the solenoid valves. The existing mixers can be utilized at the new soda ash feed system described in Section 4.3.2.

4.4.3 Evaluation of Replacing the Elevated Water Tank

Black & Decker would like to replace the existing elevated water tank (125,000 gal, 123 ft above grade) due to very high maintenance costs (on the order of $75,000 every 4 years).

Analysis of the chart recordings shows that the existing set of three wet well pumps would be unable to respond instantaneously to the sudden flow demands of up to 175 gpm without the water tank. The tank provides both surge capacity (on the order of 100,000 gallons) and constant head (due to the elevation). The charts indicate that these demand surges last for less than a minute and that the daytime average demand is 70 gpm or less.

There exists three basic options for replacing the water tank, although there are drawbacks to each. The first option involves continuous pumping at 100 gpm or greater and 60 psi, where water is available on demand up to 175 gpm, and a flowback system returns unused water to the wet well. Such a configuration could meet all flow demands nearly instantaneously, but would waste a tremendous amount of energy for continuously circulating the water.

The second option involves a cascading pump system (2 or 3 pumps), where the majority of system demand is provided by running the first pump continuously, and second and third pumps are activated by flow demand. This option can be purchased in the form of packaged, pre-engineered skid mounted water pressure booster systems. Some of these systems also include a small air-charged pressure surge tank (on the order of 10 gallons) to help minimize the need to activate the second and third pumps due to small variations in demand. This type of system was carefully evaluated for this application, but the existence and frequency of the large, sudden peak flows characteristic of the plant's potable water demand appear to be problematic for such a packaged system. The problem is that the bladder tank is too small to provide the surge capacity to meet the peak demands. The result is that both first and second pumps would operate almost continuously, resulting in inefficient operation and wasted energy. (The second pump would have a 5-minute run timer to prevent cycling more than 12 times each hour.)

The third option involves using the existing three wet well pumps in combination with a somewhat larger pressure surge tank (on the order of 2000 gallons), to replace the elevated tank. This is the option proposed by WESTON to be the most economical and most reliable replacement for the elevated water tank. Evaluation of the pump curves for the existing Aurora wet well pumps shows that a single pump could maintain the target system pressure of 60 psi and operate along the pump curve, based on demand, from 25 to 140 gpm. It appears that an optimum arrangement would include the pressure surge tank to provide surge capacity adequate to meet several sudden peak flows, so that cycling of the

second pump would be minimized. The second pump would be activated by a low level switch in the pressure surge tank.

The estimated installed capital cost for the pressure surge tank is approximately $35,000. Black & Decker's estimated the water tower demolition cost to be $25,000. Thus, the total initial cost of $60,000 is lower than the $75,000/4-year water tower rehabilitation cost. Maintenance and rehabilitation costs for the 2,000 gallon tank was not calculated, but will clearly be far below that of the existing water tower. Based upon this analysis, replacing the tower with a 2,000-gallon surge tank is clearly less costly. If Black & Decker proceeds with the replacement of the water tower, the reliability of potable water supply will be diminished.

The existing 125,000 gallon capacity can provide flow for several days at the current water consumption rate. Water flows by gravity even if the supply is interrupted. Sources of potential supply interruption under the proposed modification include:

- Power failure
- Air stripper blower failure
- Air stripper sump pump failure
- Simultaneous failure of both solenoid valves feeding potable water systems
- Existing wet well pump failure
- Control system malfunction

These measures can be addressed by design and maintenance measures to improve reliability. However, Black & Decker should recognize that a higher frequency of water interruption will result.

The surge tank will be supplied by compressed air to recharge the air space which may get depleted over time (by absorption into the water). Air/water levels and pressures wll be periodically manually adjusted by the operator.

4.4.4 Connection to the Potable Water System

The discharge from the pressure surge tank would be connected to the potable water system. The elevated water tank would be emptied and disconnected at that time, and eventually dismantled and scrapped.

4.5 **MODIFICATIONS TO THE RESERVOIR OUTFALL STRUCTURES**

As discussed in Section 3, the reservoir outfall structures would be modified to accommodate an additional 553 gpm flow, plus a safety factor for large storms. As discussed in Section 3, combining the existing average flow with the new flows up to 553 gpm, plus stormwater allowance, suggests designing for flows up to 1,000 gpm. Structures to be modified include the drop inlet spillway, the chart recorder, and the weir. The spillway modification will provide Black & Decker with the ability to manage reservoir water levels equal to or better than the current siphon system.

This portion of the design was based upon assumptions provided by Black & Decker. WESTON was not asked to complete a storm flow analysis to verify those assumptions.

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APPENDIX A

CALCULATIONS

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APPENDIX - A

START-UP EAST TRAIN

	WELL	FLOW (gpm)	TCE (ug/l)	PCE (ug/l)	TCE CONC. (ug/min)	PCE CONC. (ug/min)
EAST TRAIN	EW-1	35	6400	130	847840	17221.75
	EW-2	40	4000	15	605600	2271
	EW-3	50	1000	15	189250	2838.75
	EW-4	30	1800	100	204390	11355
	EW-5	30	2600	50	295230	5677.5
EAST TRAIN TOTAL		185			2142310	39364
INFLUENT CONC.(ug/l)					3059.46	56.22

ug/min = gpm * ug/l * 3.785
Influent concentration (ug/l) = Total (ug/min)/[total flow (gpm) * 3.785]

NORMAL FLOW- ALL WELLS

	WELL	MAX. FLOW (gpm)	TCE (ug/l)	PCE (ug/l)	TCE CONC. (ug/min)	PCE CONC. (ug/min)
EAST TRAIN	EW-1	35	6400	130	847840	17221.75
	EW-2	40	4000	15	605600	2271
	EW-3	50	1000	15	189250	2838.75
	EW-4	30	1800	100	204390	11355
	EW-5	30	2600	50	295230	5677.5
WEST TRAIN	EW-6	20	12	87	908.4	6585.9
	EW-7	20	20	110	1514	8327
	EW-8	25	7	170	662.375	16086.25
	EW-9	20	29	1100	2195.3	83270
	EW-10	25	22	3100	2081.75	293337.5
COMBINED TOTAL		295			2149671.82	446970.65
INFLUENT CONC.(ug/l)					1925.24	400.31

APPENDIX – A

	WELL	MAX. FLOW (gpm)	TCE (ug/l)	PCE (ug/l)	TCE CONC. (ug/min)	PCE CONC. (ug/min)
MAXIMUM FLOW CASE						
EAST TRAIN	EW–1	35	6400	130	847840	17221.75
	EW–2	55	4000	15	832700	3122.625
	EW–3	90	1000	15	340650	5109.75
	EW–4	30	1800	100	204390	11355
	EW–5	75	2600	50	738075	14193.75
WEST TRAIN	EW–6	45	12	87	2043.9	14818.275
	EW–7	70	20	110	5299	29144.5
	EW–8	80	7	170	2119.6	51476
	EW–9	33	29	1100	3622.245	137395.5
	EW–10	40	22	3100	3330.8	469340
COMBINED TOTAL		553			2980070.54	753177.15
INFLUENT CONC.(ug/l)					1423.76	359.84

APPENDIX B

MAJOR EQUIPMENT LIST FOR GROUNDWATER REMEDIATION SYSTEM

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APPENDIX B

MAJOR NEW EQUIPMENT LIST - AIR STRIPPER CONCEPTUAL DESIGN

The capacities, sizes and design features of the major equipment are given below:

1.   Well Pumps (P-1 through P-10)

   Purpose: To depress the water table sufficiently to capture and recover site-related contaminants of concern.
   Number: 10 (One at each extraction well) plus 2 shelf spares.
   Type: Submersible
   Materials: Stainless Steel
   Capacities: Static head, and rating as required.

   Flow Capacities: P-1 : 35 gpm
                     P-2 : 55 gpm
                     P-3 : 90 gpm
                     P-4 : 30 gpm
                     P-5 : 75 gpm
                     P-6 : 45 gpm
                     P-7 : 70 gpm
                     P-8 : 80 gpm
                     P-9 : 33 gpm
                     P-10 : 40 gpm

   Additional: Some pumps with low normal flows may have to be sized for lower maximum flow capacities than listed to prevent excessive flow throttling.

2.   Flow Control Valves (FCV-001 to FCV-010)

   Purpose: To control flow from each well pump at the predetermined well drawdown rate.
   Number: Ten, one per well pump
   Description: Hydraulically operated valve
   Material: Cast Iron
   Additional: Maximum capacity to match maximum well flows. Initial orifice sized for normal flows.

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MAJOR NEW EQUIPMENT LIST - AIR STRIPPER CONCEPTUAL DESIGN
(continued)

3.   <u>Flow Water Meters (FQI-001 to FQI-010)</u>

   Purpose: To provide rate indication and flow totalizing for each well
   Number: Ten, one per well pump
   Description: Standard bronze turbine water meters with pulser and rate indicator/totalizer
   Capacity: As required for each well, at the predetermined pump drawdown rate
   Materials: Standard bronze construction

4.   <u>Well Box</u>

   Purpose: To house flow control valve, flow meter and motor starter at each well.
   Number: One
   Size: 4'-0" x 4'-0 x 4'-0" high
   Material: Fiberglass

5.   <u>Stripper Inlet Flow Recorder/Totalizer</u> (FQI-100)

   Purpose: To provide rate indication and flow totalizing for water entering the air stripper.
   Number: One
   Description: Panel mounted flow rate recorder/totalizer.
   Capacity: As required to cover range 185 to 600 gpm

6.   <u>Air Stripping Tower</u> (ME-1A)

   Purpose: To remove volatile organics from groundwater.
   Number: One
   Capacity: 553 gpm at design VOC concentrations
   Type: Counter-current, groundwater downflow. 5-foot diameter column with 42-feet packing depth of 2-inch diameter polypropylene packing (No. 1 Jaeger Tri-Packs) and 52-feet high.
   Materials: FRP column with polypropylene packing
   Additional: Weir or orifice top distributor, mist eliminator, orifice/riser type redistributor, packing section loading/unloading manways and minimum 4-foot sump liquid capacity.

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MAJOR NEW EQUIPMENT LIST - AIR STRIPPER CONCEPTUAL DESIGN
(continued)

7.   Air Stripping Blowers (ME-1B, ME-2B)

Purpose: To provide requisite air flow for the stripper.
Number: Two; one operating, one standby
Capacity: 1035 cubic feet per minute (cfm) at 6 inches of static pressure.
Type: Centrifugal fan
Material: Aluminum
Additional: Low air flow switch in fan discharge to shut down feed upon blower
            failure. Evaluate use of existing blowers.

8.   Stripper Sump Pumps (P-11, P-12, P-13)

Purpose: To transfer treated groundwater from the air stripper to cooling water loop
            and potable water supply.
Number: Three, two operating, one standby.
Capacity: 295 gpm @ required TDH
Type: Centrifugal, with variable speed motor.
Material: Standard construction, bronze fitted.
Additional: Speed adjusted by level controller. Shutoff on low level.

9.   Soda Ash Feed System

Tank (T-1)

Purpose: To make soda ash solution by manual addition of soda ash and water.
Number: One
Capacity: 300 gallons
Type: Cylindrical tank
Material: Plastic or FRP tank with spill containment.

Metering Pump (P-14)

Purpose: To provide for sufficient soda ash addition to avoid corrosion downstream
Number: One
Capacity: 1 to 3 gph
Additional: Shut off on low level in stripper sump.

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MAJOR NEW EQUIPMENT LIST - AIR STRIPPER CONCEPTUAL DESIGN
(continued)

9.   Soda Ash Feed System (continued)

Mixer (M-1) (Relocate existing soda ash mixer)

10.   Pressure Surge Tank

Tank (T-2)

Purpose:	To supply water for short duration high flow surges.
Number:	One
Capacity:	2,000 gallons
Type:	Cylindrical tank elevated on legs
Pressure:	120 psig
Material:	Carbon steel, coated.

11.   Contingency Emission Control System

(Sizing assumes two 2,000 lb GAC units projected to last 23 days between changeout. Final sizing may vary depending on cost and availability of competing units.)

GAC Feed Blowers (ME-___, ME-___)

Purpose:	Boost air pressure to feed GAC units
Number:	Two; one operating, one standby
Capacity:	1,035 cfm at 19 inches of static pressure
Type:	Centrifugal fan
Material:	Aluminum

Electric Duct Heater (   )

Purpose:	Boost air temperature an average of 30°F prior to GAC
Number:	One
Capacity:	Est. 14 KW maximum for 40°F rise.
Type:	In duct electrical resistance heater.
Additional:	Integral thermostat to control temperature with a minimum 75 to 90°F set point range.

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MAJOR NEW EQUIPMENT LIST - AIR STRIPPER CONCEPTUAL DESIGN
(continued)

11.   <u>Contingency Emission Control System</u> (continued)

Vapo-Phase GAC Units

Purpose: To remove volatile organics from air stripper off-gases.
Number: Two
Capacity: Minimum 2,000 lb GAC
Material: Polyethylene or coated steel vessel
Carbon usage: Estimated at 87 lbs/day (based on projected influent concentrations to
                        stripper, 50% relative humidity, 70°F air