ARCS V

Remedial Activities at Uncontrolled Hazardous Waste Sites in Region V

United States Environmental Protection Agency

GROUNDWATER EXTRACTION AND TREATMENT PREDESIGN REPORT

ONALASKA MUNICIPAL LANDFILL
Onalaska, Wisconsin

WA No. 38-5NL5 / Contract No. 68-W8-0040

October 1991

CH2M HILL

GROUNDWATER EXTRACTION AND TREATMENT PREDESIGN REPORT

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GLT243/010.51-1

Executive Summary

Background

This preliminary design report has been prepared for the U.S. Environmental Protection Agency (EPA) as part of the design of a groundwater extraction and treatment system for the Onalaska Municipal Landfill site, in Onalaska Township, Wisconsin. The report describes the proposed groundwater extraction and treatment system, provides a preliminary design-level cost estimate, and identifies critical issues that need to be resolved with the assistance of regulatory agencies. Following review and comment on this report by the U.S. EPA and Wisconsin Department of Natural Resources (DNR), the prefinal design (95 percent) bid package will be prepared. The prefinal design will be based on the design proposed herein as modified by the review process.

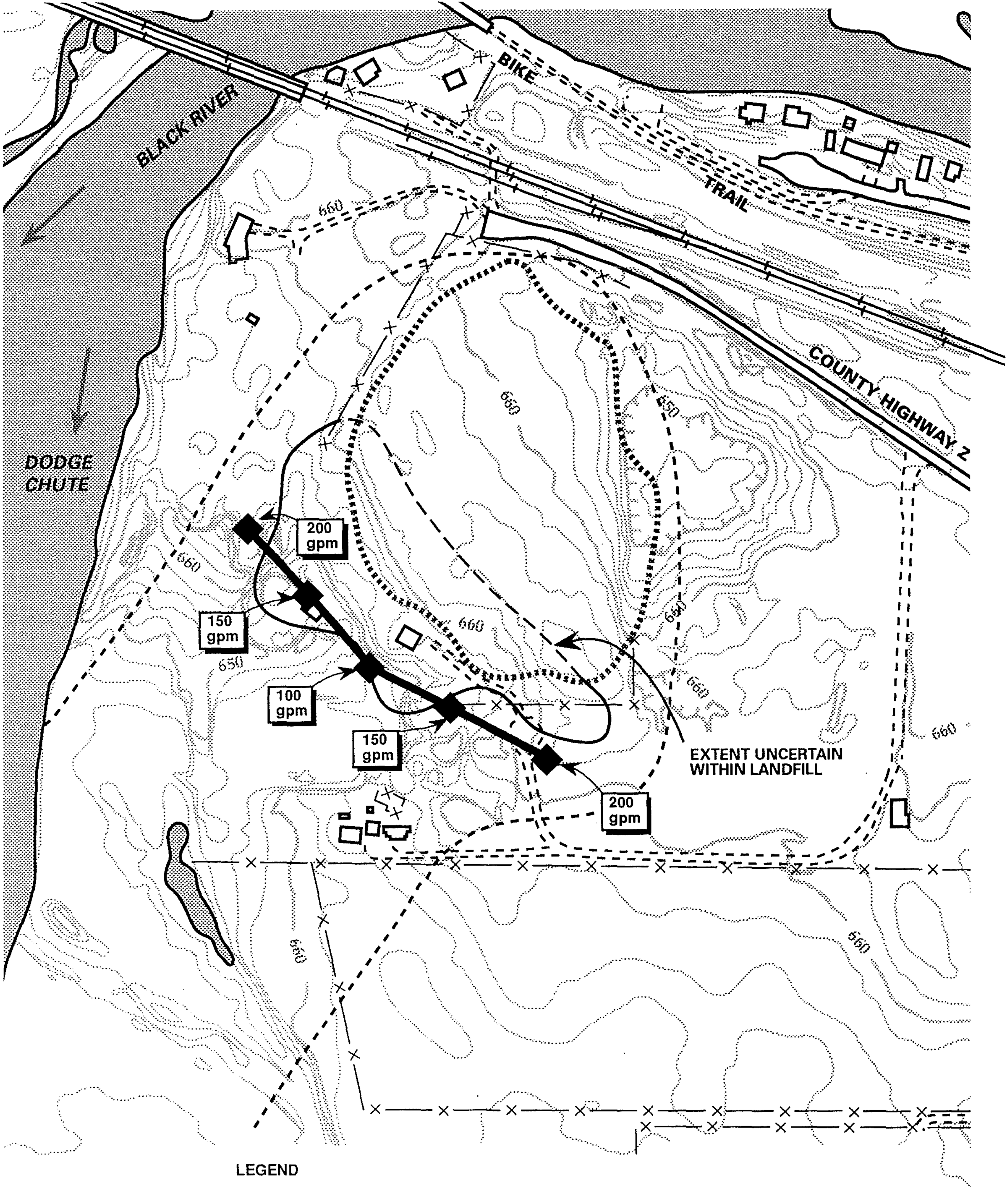
Groundwater Quality and Treatment Goals

Remedial action goals for groundwater quality and treatment are defined in the EPA's Record of Decision (ROD). The ROD requires that the groundwater extraction and treatment system be designed and constructed "to meet the designated cleanup standards and discharge requirements to be determined." The ROD has identified the preventive action limits (PALs) set forth in Chapter NR 140 of the Wisconsin Administrative Code to be the groundwater cleanup standards for the site. Water-quality based effluent limits have been developed assuming the groundwater will be discharged into the Black River. The DNR has also stated that best available technology economically achievable (BATEA) shall be used to remove iron and volatile organic compounds (VOCs) from the groundwater before it is discharged into the river. The discharge must also meet toxicity requirements as set forth by the DNR. No specific technology has been identified in the work assignment or in the ROD for treating groundwater.

Proposed Extraction and Treatment System

The proposed extraction system is designed to prevent (1) continued offsite migration of contaminants emanating from the landfill and from the zone of nonaqueous phase contamination toward the river and (2) remediate the groundwater to the extent practical. The extraction system will consist of five extraction wells located along the downgradient edge of the landfill (Figure 1). The wells will extract groundwater at a rate of 800 gallons per minute (gpm).

The proposed treatment system is designed to provide BATEA to remove iron and VOCs. The treatment system will consist of aeration (to oxidize the iron), clarification (to remove the majority of the precipitated iron and miscellaneous suspended solids), filtration (to remove unsettled solids that pass through the clarifier), and an air stripping tower (to remove VOCs). Figure 2 is a block flow diagram depicting the proposed treatment system. The treated groundwater will be discharged to an outfall located along the eastern bank of the Black River, just downstream of the railroad trestle.



LEGEND

LIMITS OF LANDFILL AS DETERMINED BY GEOPHYSICAL SURVEY

ZONE OF NONAQUEOUS PHASE CONTAMINATION

GROUNDWATER REMEDIATION TARGET AREA

N

0 250

SCALE IN FEET

FIGURE ES-1
CONCEPTUAL GROUNDWATER EXTRACTION SYSTEM
ONALASKA LANDFILL PREDESIGN

GLO65602.PD.R7 Concept GW Extract Syst 10-15-91mms

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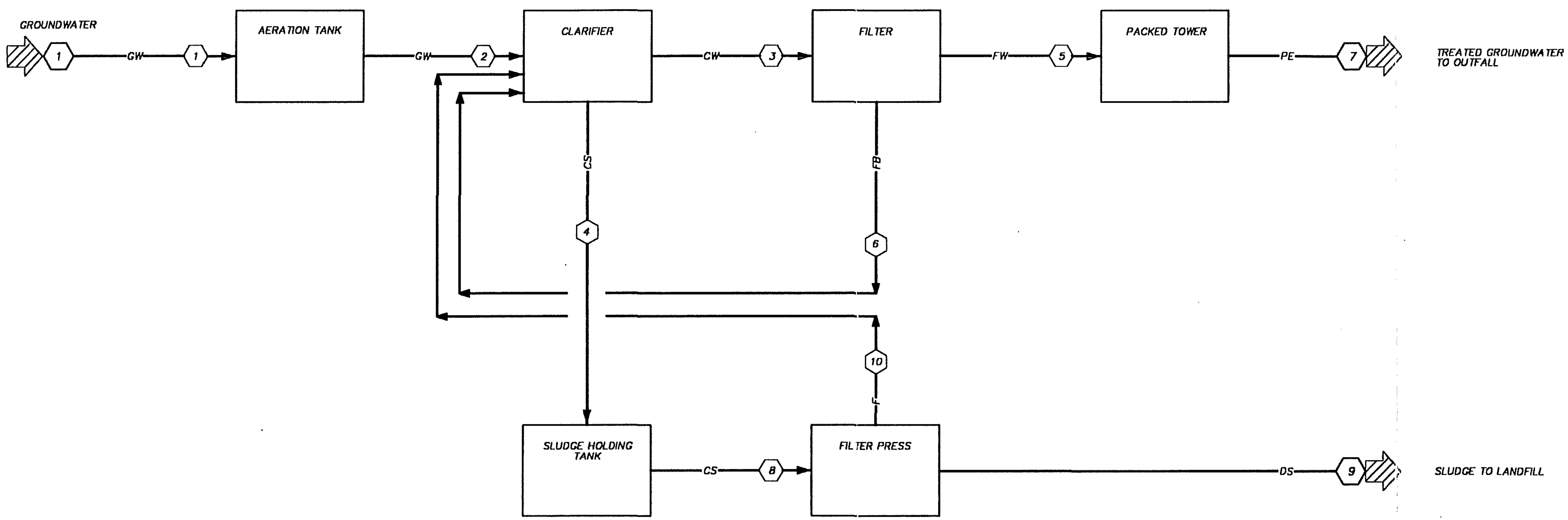

LEGEND

GW	GROUNDWATER
PE	PLANT EFFLUENT
FB	FILTER BACKWASH
CS	CLARIFIER SLUDGE
DS	DEWATERED SLUDGE
F	FILTRATE
CW	CLARIFIED WATER
FW	FILTERED WATER

FIGURE ES-2

PRELIMINARY

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DSGN S. KEITH
DR PFD-1 D. OXLEY
CHK X
APVD X

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ONALASKA LANDFILL
ONALASKA TOWNSHIP, WI.

GROUNDWATER TREATMENT SYSTEM
BLOCK FLOW DIAGRAM

SHEET 1
DWG NO. X
DATE SEPT 1991
PROJ NO. GL065602.PD.H1

1-1.0

- Can a septic tank and tile field be used to provide treatment and onsite discharge of domestic sewage? It is assumed that a septic tank would be used for this purpose.

- What level of redundancy is required? Would it be acceptable to turn off the groundwater extraction system for 1 to 2 weeks in case of operational failure, or should backup systems be included in the design? It is assumed that redundant equipment will not be provided, except for process pumps, and bypassing the treatment system to keep the extraction system functioning will not be acceptable.

GLT243/004.51

CONTENTS

Section 1
Introduction

Background

Site Description and History

The Onalaska Municipal Landfill site is located in Onalaska Township, a rural area near La Crosse, Wisconsin. It consists of a former municipal landfill, about 8 acres in area and 15 to 20 feet deep, and adjacent property where the groundwater contamination plume has migrated. The site was previously operated as a sand and gravel quarry from the 1960s to 1970s. Industrial wastes, including naphtha-based solvents, were disposed of at the site. Remedial investigations conducted at the site during 1989 found that the groundwater was contaminated, primarily with volatile organic compounds (VOCs), and the groundwater contamination is migrating toward the Black River. Appendix A to this report provides additional details on site characteristics.

Proposed Remedial Actions

The Record of Decision (ROD) signed by the U.S. Environmental Protection Agency (EPA) on August 14, 1990, documents the selection of the remedial action for the site. The ROD requires that:

- A groundwater extraction system be constructed to extract the contaminant plume to meet federal drinking water standards and state groundwater quality standards
- A groundwater treatment system treat the groundwater to meet the substantive requirements of the Wisconsin Pollution Discharge Elimination System (WPDES) and discharge the treated groundwater into the Black River.
- The landfill cap be reconstructed to comply with NR 504.07
- An in situ bioremediation system be implemented to treat the zone of nonaqueous phase contamination
- Periodic monitoring of the groundwater contaminant plume be performed
- Deed restrictions be imposed on the use of surface water and groundwater at the site

This preliminary design report was prepared for the U.S. EPA under authorization of EPA Contract Number 68-W8-0040 and Work Assignment Number WA 38-5NL5 as part of the overall remedial design for the Onalaska Landfill site. This report describes the proposed groundwater extraction and treatment system, provides a preliminary design level cost estimate, and identifies issues that need to be resolved to complete the final design. Following review and comment by the U.S. EPA and the

Section 2

Proposed Groundwater Extraction System

Remedial Action Goals for the Groundwater Extraction System

The groundwater extraction system is designed to remediate the groundwater to the extent practical over the long term and to contain the existing plume from further migration to the river in the short term.

Groundwater Remediation Goals

The groundwater extraction system for the Onalaska Landfill site has been designed to capture contaminated groundwater within the target remediation area defined in the feasibility study and illustrated in Figure 2-1. This groundwater extraction system was not designed to capture the entire downgradient extent of the contaminant plume. The groundwater cleanup standards listed in Table 2-1 are the most stringent groundwater cleanup levels published in the ROD. These standards are the remediation goals to be met when implementing the groundwater remedy at the Onalaska site.

Table 2-1
Groundwater Cleanup Standards
Onalaska Landfill

Compound	Standard (ppb)
Benzene	0.067
Toluene	68.6
Xylene	124
Ethylbenzene	272
Arsenic[1]	5
Barium[1]	200
Lead	5
Trichloroethene	0.18
1,1-Dichloroethane	0.04
1,1,1-Trichloroethane	40
1,1-Dichloroethene	0.024

[1]Naturally occurring levels for these compounds may be higher than these standards.

The standards were based on the consideration of the potential risks to consumers of the contaminated groundwater and on the consideration of federal and state groundwater protection goals and groundwater quality standards. With the exception of 1,1-DCA, the cleanup standards are the preventive action limits (PALs) for the chemicals of concern at the site. Because 1,1-DCA has no PAL, a cleanup standard was derived based on (1×10^{-7}) risk.

Section NR 140.28 provides for establishing a Wisconsin alternative concentration limit (WACL) if (1) background concentrations exceed PALs or enforcement standards (ESs) or (2) if it is determined that it is not technically or economically feasible to achieve PALs.

If it becomes apparent that it is not technically or economically feasible to achieve a state PAL, then a WACL may be considered consistent with the exemption criteria of section NR 140.28. This evaluation will be performed during the 5-year review. Except where the background concentration of a compound exceeds the state ESs, the WACL established may not exceed the ES for that compound. If WACLs are established for all chemicals of concern, the maximum levels established would be enforceable standards, and the maximum cumulative carcinogenic risk would be approximately 1×10^{-5}, which is an acceptable risk according to the NCP. See section XII(b)(1)(B)(ii) of the ROD.

Containment of Plume

The second remedial action goal for the groundwater extraction system is to contain portions of the existing plume from further migration to the south southwest towards the Black River. Groundwater will be captured approximately 200 feet downgradient of the extraction wells. The boundaries of the plume were estimated during the remedial investigation (RI) and serve as the basis for designing the flow and capture zone of the extraction system.

Achievement of Remediation Goals

The time until ESs and PALs are met may exceed 30 years because of continued contaminant loadings to groundwater from nonaqueous phase contamination in the landfill and other landfill refuse in direct contact with groundwater. Removal of VOCs in groundwater below the zone of nonaqueous phase (ZNAP) contamination may take 5 years. Continued loadings of VOCs to the groundwater from the untreated ZNAP contamination within the landfill may be sufficient to cause PALs to be exceeded for 10 years. The estimates were based on many simplifying assumptions, and actual quantities may be substantially different. Some cleanup goals may never be achieved because of the potential for the landfill to act as a continual source. The goal of preventing further migration of the existing plume, however, should be met soon after the extraction system is implemented.

Proposed Extraction Well Layout and Header Network

The proposed groundwater extraction system will consist of five wells (Figure 2-1). The wells are spaced to capture the entire estimated width of the groundwater contaminant plume near the landfill. The total design flow is 800 gpm, and each well will be piped (4-inch diameter carbon steel) to the treatment building where it will be connected to a common header.

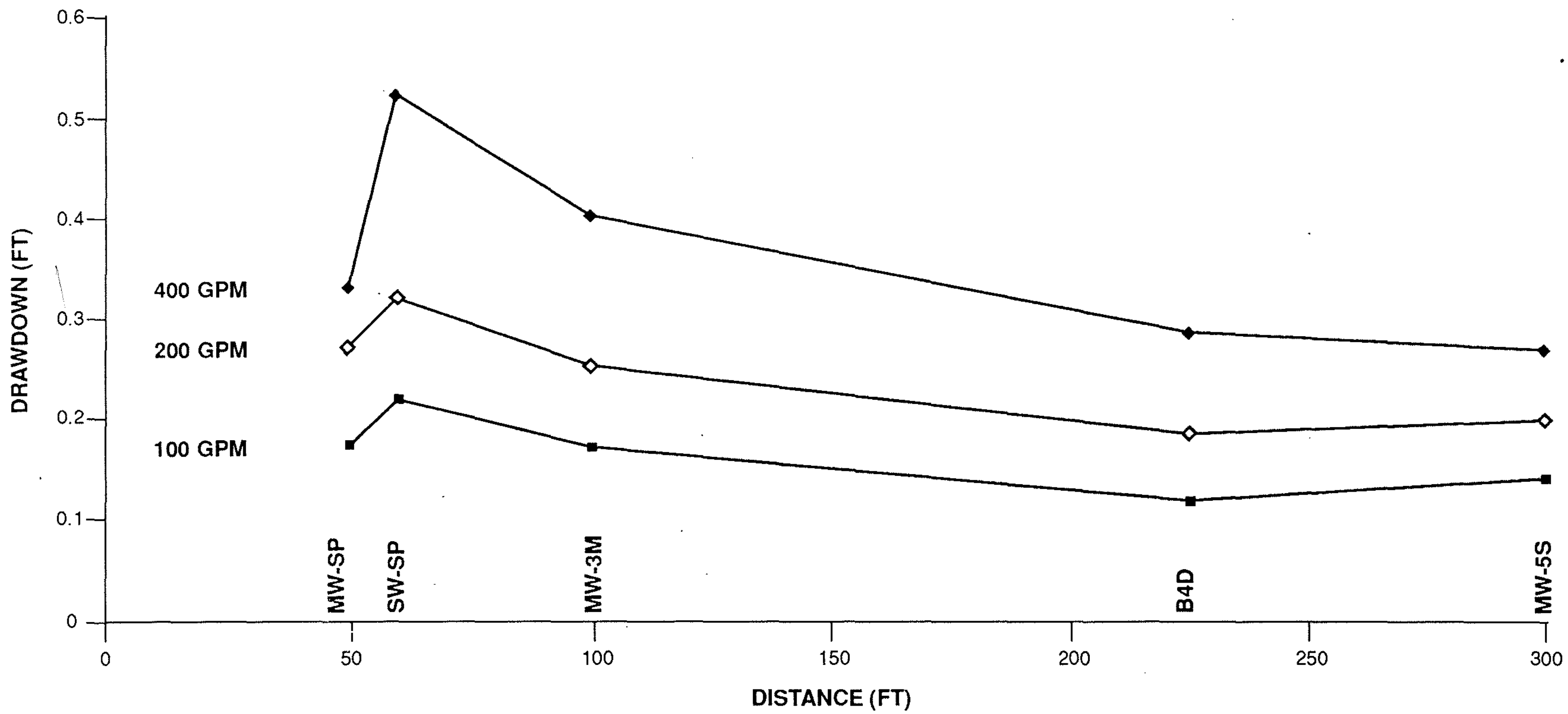
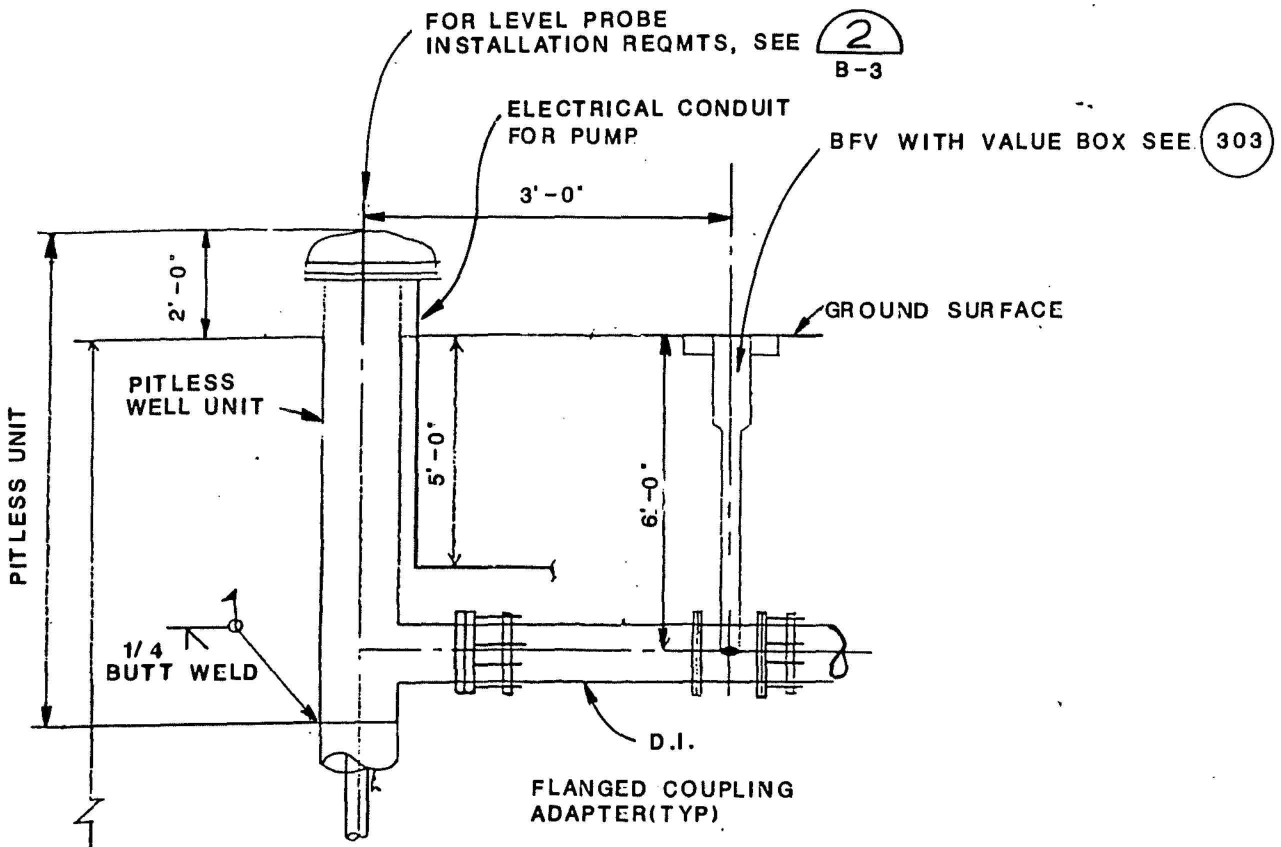
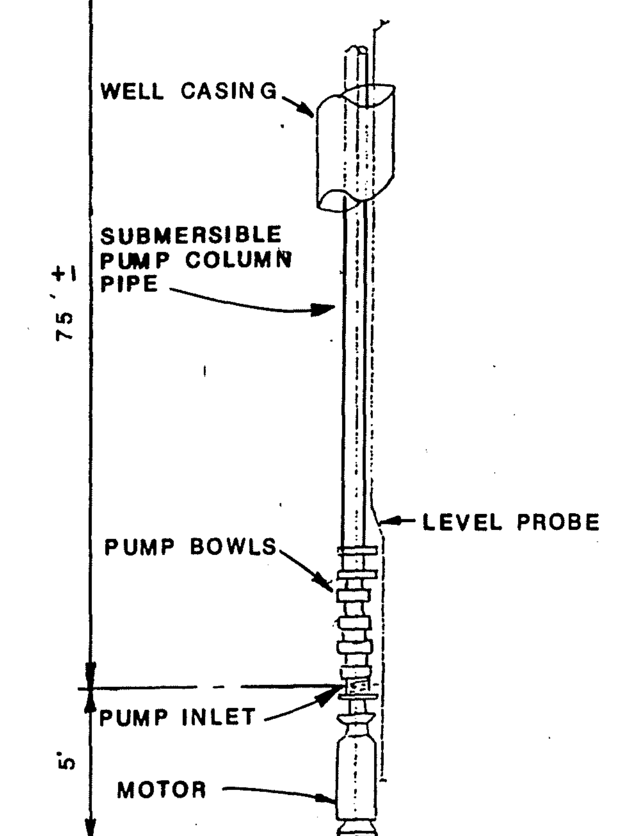
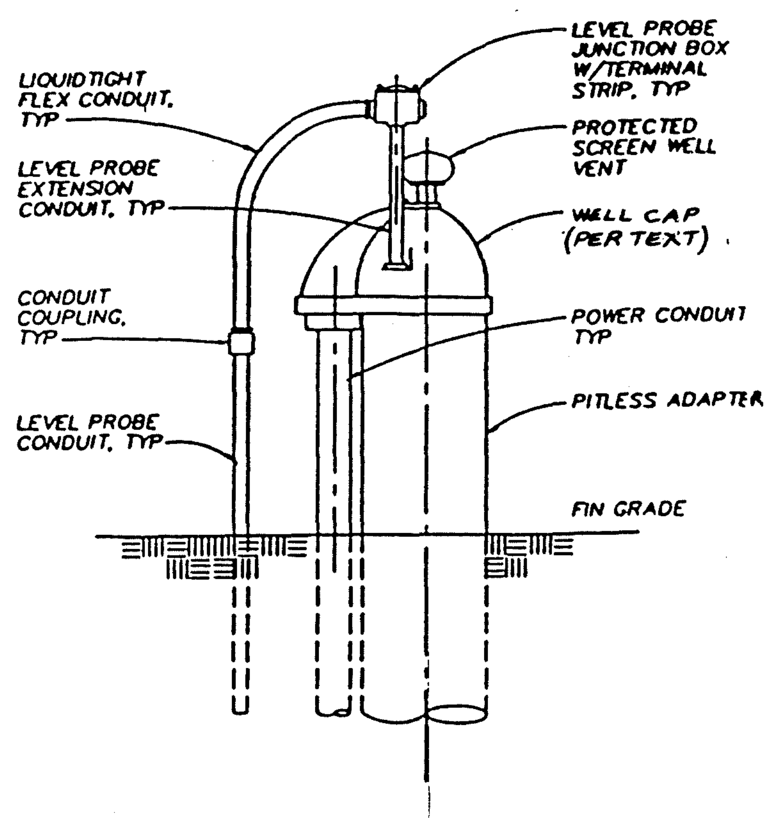


FIGURE 2-2
ONALASKA LANDFILL DRAWDOWN VS. DISTANCE FROM THE STEP DRAWDOWN TEST
ONALASKA LANDFILL PREDESIGN





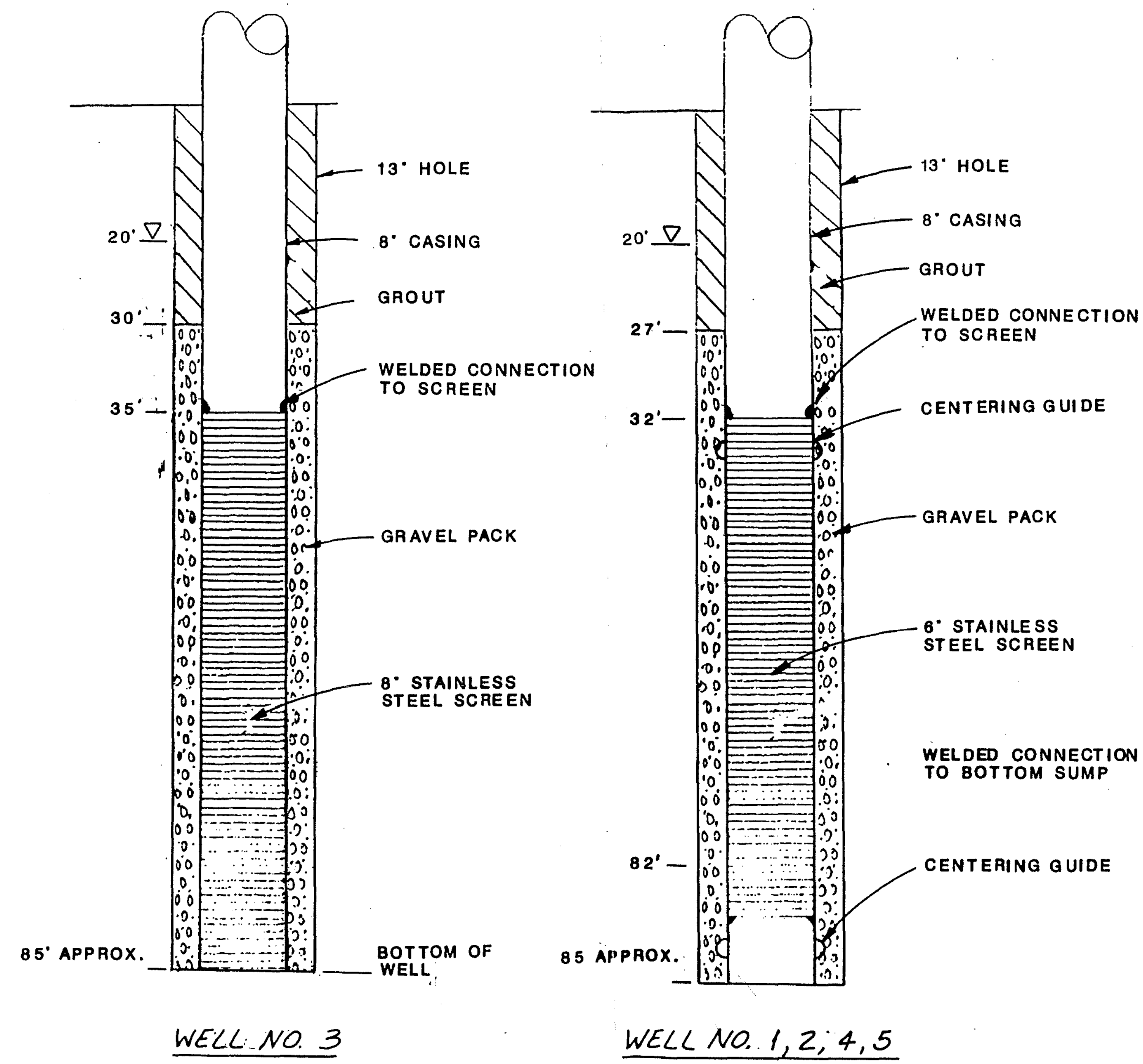
WELL AND VALVE BOX DETAIL 1
NTS



TYPICAL WELL PUMP LEVEL PROBE AND POWER - DETAIL 2
NTS

NOTES:

1. LEVEL PROBE SIGNAL CABLE, SUPPLIED BY MANUFACTURER.



WELL CONSTRUCTION DETAIL 3
NTS

FIGURE 2-3
ONALASKA LANDFILL

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but will be determined from exploratory borings drilled prior to installation. The wells will be installed to a depth of about 80 feet, again to intercept the highest groundwater contaminant concentrations.

Well Development

The new extraction wells installed at the site will be developed by either surging and bailing or hydraulic jetting.

Surging and Bailing

Well development will be completed by surging and bailing the well using a single or double valued surge block as the surging device. Surging will start at the bottom of the screen and proceed upwards. When fines have been drawn into the well screen to a depth of 10 percent of the total screen length, they will be removed by bailing or other appropriate methods before well development continues. Well development will continue until the water is free from sand, silt, and turbidity.

Hydraulic Jetting

Well development will be completed by high velocity jetting while simultaneously pumping the well at a higher rate than the jet discharge. The equipment will be assembled and operated so that jet streams of water are directed into the well screen at right angles to the axis of the screen. During jetting, the tool will be slowly rotated through 120° and back and moved up and down within the screen so that the jet streams are directed against all parts of the screen. If the well screen fills with fines to a depth of 10 percent of the total screen length before completion of jet development, the jetting equipment will be removed and the well cleaned to the bottom before resuming jetting.

Well Testing

Following installation and development of the extraction wells a well performance (step drawdown) test will be conducted. The purpose of this test is to determine if the well will produce the desired yield and to determine actual capacity/field head conditions the submersible pumps will operate under. The wells will be tested by pumping the well for a duration of 3 hours (for each step) at the rates shown in Table 2-2.

Table 2-2
Step Drawdown Pumping Rates (in gpm)

	Step 1	Step 2	Step 3	Step 4
200-gpm Design Capacity	50	100	150	200
150-gpm Design Capacity	50	100	150	——

Reduction in well yield by chemical encrustation or fouling of the well screen, pump, or the formation around the well screen is of particular concern with the high iron concentration observed at the site. Fouling of the pump, and to a certain extent the well screen, can be controlled by injecting chlorine into the well. Typical maintenance for the extraction wells may be acid treatment every 2 to 5 years, which would remove deposits of encrustation and biofouling, and pump replacement when capacity falls below 75 percent of the rated yield.

Groundwater Monitoring

Groundwater monitoring will be used to evaluate the effectiveness of the remedial actions in controlling releases from the site and the degree to which cleanup occurs. Groundwater will be monitored through the sampling of 10 monitoring wells, 6 of which will be new. The wells will be sampled quarterly and analyzed for the list of indicator parameters required for the landfill. A detailed monitoring plan will be prepared and submitted for review and approval. The plan will address the monitoring of groundwater to assess the effectiveness of the groundwater extraction system in preventing further migration of contaminated groundwater. The monitoring plan will also address monitoring of the wetlands to check that the contaminants discharging from the leading edge of the plume remain below unacceptable levels and to measure changes in water levels of the wetlands related to the groundwater pumping. This monitoring program will be reevaluated after each sampling episode and additional monitoring will be performed if necessary.

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Section 3
Estimated Influent Concentrations and Effluent Limits

Estimated Influent Concentrations

Two estimates of influent concentrations the treatment system would receive are presented in Table 3-1. One estimate is based on concentrations developed in the FS using weighted averages from monitoring wells. The other is the average influent concentrations from groundwater sampling conducted during the constant discharge pump test in March 1991. The pump test collected groundwater from within a 50-foot radius of the extraction well. It's results are not considered reflective of the entire aquifer. However, the results were included as a comparison to the FS influent estimates. Table 3-1 also includes discharge criteria and predicted influent loadings (pounds/day) based on FS concentrations at an estimated 800-gpm flow rate and compares them to discharge criteria. The following discussion highlights observed trends in the analytical sampling results from the pump test.

Volatile Organic Compounds

Nine VOCs were detected in the influent samples collected during the pump test. The VOCs and the number of times they were detected are: chloroethene (3), acetone (3), 1,1-dichloroethane (1), 2-butanone (1), benzene (3), toluene (3), chlorobenzene (2), ethylbenzene (3), and total xylenes (3). During the data validation process, acetone and 2-butanone were determined to be laboratory blank contamination and were qualified as such. Five of the seven VOCs were detected in all three samples and showed increasing concentrations as time passed. Most notable were toluene, which increased from 8 to 1,400 μg/L, and total xylenes, which increased from 84 to 320 μg/L. This may indicate the extraction well started capturing more contaminated groundwater closer to the landfill as the test neared completion.

Semivolatile Organic Compounds

Three semivolatile organic compounds (SVOCs) were detected in the samples collected during the pump test. They were naphthalene (3), 2-methylnaphthalene (3), and n-nitrosodiphenylamine (2). Naphthalene increased from 4 to 9 μg/L. Concentrations of 2-methylnaphthalene N-nitrosodiphenylamine were at concentrations too low to identify trends.

Pesticides/PCBs

No pesticides or PCBs were detected in any of the influent samples collected during the constant discharge pump test.

Metals

In general, the metals showed only a slight decrease over the 60-hour time influent samples were collected. Most important, none of the metals exceeded discharge criteria during influent sampling conducted during the constant discharge pump test. Average iron concentrations were 16,300 μg/L.

Other Groundwater Characterization Parameters

Table 3-1 also presents observed levels of biochemical oxygen demand (BOD), total suspended solids (TSS), and ammonia. BOD and TSS concentrations from samples collected during the pump test were significantly less than those observed during the RI. This is most likely the result of collecting a groundwater sample that is more vertically representative of the groundwater than that from a monitoring well. If the concentrations observed during the pump test are indicative of the full-scale extraction system, treatment will not be required for BOD or TSS to meet discharge criteria. However, ammonia concentrations observed during the pump test were nearly double those predicted during the FS. If ammonia concentrations in the influent from the full-scale extraction system are higher than 12 mg/L, ammonia removal may be required.

Table 3-2 presents the analytical results of several conventional pollutant parameters measured in samples collected from the pump test. They include alkalinity, chloride, chemical oxygen demand (COD), total organic carbon (TOC), nitrate, nitrite, total phosphorous, sulfide, sulfate, and total dissolved solids (TDS). These results generally are similar to those estimated during the FS from monitoring well data, with the exception that COD and TOC levels have decreased similarly to those for BOD. This is also attributed to the fact that samples from the pump test were collected from the entire saturated zone thickness. The lower two-thirds of the aquifer has significantly low concentrations of COD and TOC.

Summary of Influent Concentrations

Probable influent concentrations have been estimated for the treatment system based on two sets of data—concentrations observed during the RI and during the pump test. However, actual influent concentrations for groundwater extraction and treatment systems are difficult to predict. Observed contaminant levels varied widely horizontally and vertically throughout the aquifer during the RI. Furthermore, contaminant concentrations will continue to change once pumping is initiated. While these estimates have guided the selection of process equipment to achieve BATEA, it is important to recognize that the system must be designed to deal with changing concentrations with time. The adaptability of the groundwater treatment system will be discussed in the next section.

Effluent Limits

The discharge criteria for the treatment system will include:

- Meeting the requirements of the discharge criteria listed in Table 3-1
- Treating the discharge with BATEA

Surface Water Quality Criteria

Treated groundwater will be discharged to an outfall located along the east bank of the Black River, upstream of where the river divides into the Dodge Chute and Bullet Chute. Because the discharge is considered an onsite action, a Wisconsin Pollution Discharge Elimination System (WPDES) permit is not required. However, the DNR will require that the system meet the substantive requirements of a permit. The DNR has developed effluent limits for a discharge from the site based on water quality standards for the Black River (Schuettpelz 1990). A comparison of these criteria (see Table 3-1) to the estimated influent concentrations indicates that the extracted groundwater will not exceed effluent limits, and therefore treatment will not be necessary to prevent an exceedance in surface water quality standards. The concentration of TSS could possibly exceed the effluent limit if iron oxidation resulted in an increase in TSS.

The Wisconsin DNR has indicated that the "Effluent Limitations for Discharges to Surface Waters from Remediation of Groundwater Contaminated by Petroleum Products," included in the "General Permit to Discharge Under the WPDES" (February 8, 1991), will also be considered in their assessment of the performance of the treatment system. These criteria would require a daily maximum of 750 μg/L of total BETX.

Best Available Technology Economically Achievable

The DNR has also stated that best available technology economically achievable (BATEA) is required for removal of VOCs and iron. This requirement is derived from Chapter 147 of the Wisconsin Statutes, which mandates that no discharge can contain quantities of listed pollutants greater than those that would remain after the discharge had received treatment by BATEA or greater than any lesser quantity necessary to provide an ample margin of safety. The DNR has not specified what constitutes BATEA. Rather than specify what constitutes BATEA, the DNR has deferred to this report to propose BATEA.

Toxicity Testing

The DNR has also mandated that effluent from the site not be acutely toxic to test microorganisms (DNR 1990). Three toxicity tests were performed on groundwater from the site. The first test was performed on groundwater collected from the extraction well during the pump test, the second test on a composite groundwater sample from MW-3S, MW-3M, and MW-3D, and the third test on a groundwater sample from MW-3S. MW-3S has been the most contaminated well on the site.

During the first test, the groundwater was not acutely toxic to fathead minnows or *Daphnia magna* at 100 percent concentrations using the 50 percent lethality criterion. The groundwater was acutely toxic to *Ceriodaphnia dubia* at an estimated level of 78.4 percent using the 50 percent lethality criterion. During the second test, the groundwater was not acutely toxic to *Ceriodaphnia dubia* at a 100 percent concentration. During the third test, it was acutely toxic at an estimated 61 percent using the 50 percent lethality criterion.

Section 4
Proposed Groundwater Treatment System

Goals of the Treatment System

The primary goals of the groundwater treatment system are (1) to meet discharge limits for the Black River, (2) to provide the best available technology economically achievable (BATEA) for iron and VOC removal, and (3) to meet effluent toxicity requirements. During the selection of the various process options, the following goals were also considered:

- The cost-effectiveness of the process option in terms of capital and O&M costs
- The need to limit the complexity of operational control requirements
- Locating the treatment system entirely within the landfill property, but outside the areas of contaminated soil
- The concerns of nearby residents about aesthetic aspects of the treatment system
- Providing a flexible treatment system that can be easily adapted to changing influent concentrations

Overview of the Treatment System

The major components of the treatment system are:

- Aeration
- Clarification
- Filtration
- Air stripping
- Sludge dewatering

Figure 4-1 is a process flow diagram of the treatment system. Groundwater will be pumped from the five extraction wells to an aeration basin for oxidation of the ferrous iron to ferric iron. After aeration, the water will flow into the clarifier where most of the iron sludge (ferric hydroxide) is removed. The clarified water will then be filtered, passed through an air stripper for VOC removal, and discharged to an outfall along the east bank of the Black River. Sludge from the clarifier will be dewatered using a plate and frame filter press and disposed of offsite in a sanitary landfill. These processes are described in more detail in the following sections.

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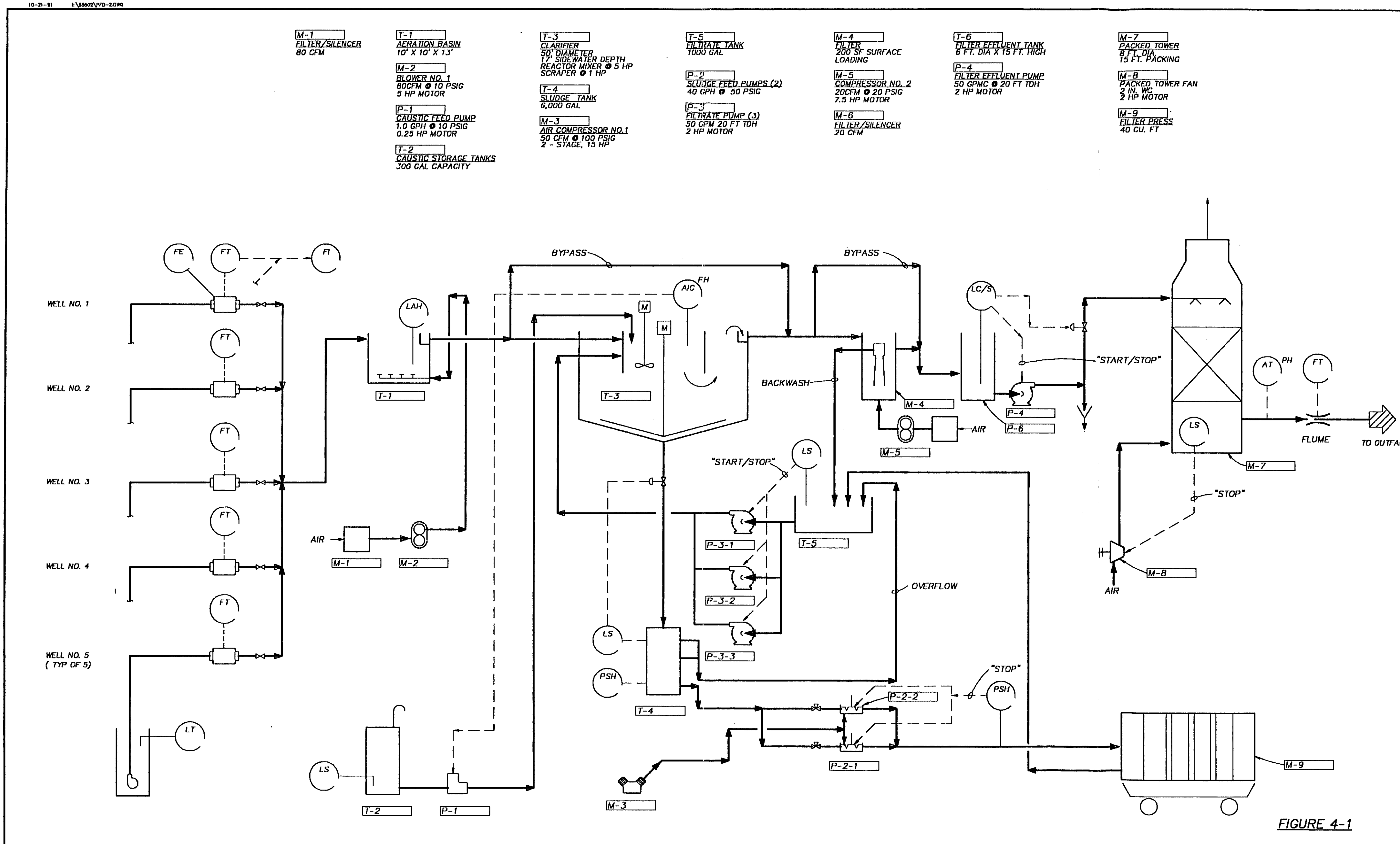

DSGN P. BOERSMA	NO.	DATE	REVISION	BY	APVD
DR D. OXLEY					
CHK S. KEITH					
APVD X					

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REUSE OF DOCUMENTS

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
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IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

ONALASKA LANDFILL
ONALASKA TOWNSHIP, WI.

GROUNDWATER TREATMENT SYSTEM
PROCESS FLOW DIAGRAM

SHEET 2
DWG NO. X
DATE SEPT 1991
PROJ NO. GL085602.PD.H1

PRELIMINARY

1-1.0

Table 4-1

PRELIMINARY DESIGN CRITERIA

DESIGN FLOW	800 gpm
AERATION BASIN	
Hydraulic Detention Time	10 min
Basin Dimensions	10'x10'x13'
Air Requirements	80 cfm
	10 psig
Aeration Method	Coarse Bubble Diffusion
CLARIFIER	
Type	Solids Contact
Construction Materials	Carbon Steel
Reactor zone detention time	30 min
Rise rate @ sludge sep. zone	0.45 gpm/sf
Overflow rate	600 gpd/sf
Sidewater depth	17 ft
Hydraulic detention time	5 hrs
Diameter	50 ft
Motor Horsepower	
Mixer	5 HP
Scraper	1 HP
FILTER	
Type	Continuous Backwash
Media	Sand
Hydraulic loading rate	4 gpm/sf
Number of filter units	1
Overall Dimensions	10'x20'x15'
Backwash rate	35 gpm
Air Requirements	20 cfm
	20 psig

Table 4-1
(Continued)

PACKED TOWER (AIR STRIPPER)

Number	1	
Packing Type	High Efficiency	
Diameter	8 ft	
Hydraulic Loading Rate	20 gpm/sf	
Packing Height	15 ft	
Air Flow Rate	4,500 cfm	
Air/Water Ratio	40:1	
Air Pressure Drop (Packing)	0.25 inches WC	
Critical Contaminant Removal	toluene	90%
Fan Motor Horsepower	2	

0.45 gpm/ft^2 in the settling zone, the diameter of the clarifier will be 50 feet with a 17-foot sidewater depth. The weir overflow rate will be less than 600 gpd/foot.

The sludge storage tank will be a steel tank inside the process building sized to hold 1 day's output of sludge from the clarifier (6,000 gallons). The clarifier itself could store another 3 days' output of sludge or more.

pH Control

Adjustment of the clarifier influent pH will be necessary before flocculation to improve the kinetics of iron precipitation. Based on observations during the bench-scale treatability study, aeration of the groundwater will raise the pH from about 6.5 to 7 or 7.5 because of carbon dioxide stripping. To increase the rate of iron oxidation reaction, the pH in the reaction zone of the clarifier will be maintained between 8 and 8.5. The pH will be adjusted by the addition of caustic (50 percent sodium hydroxide) to the center well of the SCC. A pH meter will continuously measure the pH in the reaction zone and control the addition of sodium hydroxide.

The caustic will be stored in 300-gallon containers that can be stacked with a fork lift. The containers will be stored inside in an area with secondary containment, eyewash, and emergency shower. One container should supply about a month of caustic to the clarifier. Ambient temperature around the tank will be maintained at 60°F or higher to prevent freezing of the caustic. Chemical feed piping to the clarifier will need to be heat traced to keep the caustic temperature above freezing.

Filter

Clarified groundwater will overflow the weir of the clarifier and then flow by gravity into the bottom of a continuously backwashing filter inside the process building. The continuously backwashing filter will allow water to flow upward through a filter medium moving downward. As the water flows through the filter, the solids will be trapped in the filter medium and the filtered groundwater will overflow into the filtered effluent tank to be pumped into the air stripper. As the sand reaches the bottom of the filter, an air/water scour will clean the sand and return it to the top of the filter where it will again cycle downward. The continuous backwash from the filter will be returned to a filtrate tank where it will be pumped into the clarifier. The filtrate tank will be sized to accommodate filter backwash as well as filter press filtrate. Discharge from the filtrate tank will be controlled by level to maintain a steady and continuous flow between the filter and the clarifier.

The filter will have at least 200 square feet of filter bed area to accommodate a 4 gpm/ft^2 loading rate. The backwash rate is expected to be about 35 gpm (about 4 percent of the total flow rate). Air requirements for scouring the filter medium are about 20 scfm at a 20 psi pressure. The filter will be about 15 feet high, whereas the depth of the actual filter bed will be about 40 inches.

The filter will be located inside a temperature and humidity controlled building to provide ease of maintenance and protection against freezing.

Sludge Dewatering

Sludge from the clarifier will be withdrawn into a sludge tank. From there the sludge will be pumped to a plate and frame filter press to be dewatered. The press will be sized to dewater the sludge produced daily during one 4-hour cycle. The 5,000 to 6,000 gallons of 1 percent sludge withdrawn from the clarifier each day will be pumped through the filter press and dewatered to at least a 35 percent solids filter cake. Filtrate from the dewatering process will drain to the filtrate tank where it will be pumped back to the clarifier.

The filter press has a capacity of 40 cubic feet and will operate with a compressed air supply of 100 psi at a 50 scfm flow rate. The press dimensions are 17 feet by 6 feet by 6 feet.

Based on the estimated 5,600 gallons per day of 1 percent sludge (470 pounds of solids per day), about 17 cubic feet (0.63 cubic yard) of 35 percent filter cake be produced (on average) per day. The filter cake will have a density of about 80 pounds per cubic foot. Thus, about 1,400 pounds of filter cake will be produced (on average) per day. The filter press will be elevated about 7 feet so that a rolloff container can be placed under the filter press and filter cake can drop into the container after dewatering. A 10-cubic-yard rolloff container would require emptying about every 2 weeks (i.e., about one truckload removed every week). About 250 tons of filter cake would be produced each year.

The municipal landfill near La Crosse may not accept the dewatered sludge because it may be considered an industrial waste. However, at least one landfill has been identified that would accept the sludge (in Berlin, WI) if the sludge had no free liquids and could pass the toxicity characteristic test.

Iron sludge tends to be a fine sludge that could pass through or clog the filter press fabric. In some applications, it has been necessary to precoat the filter with a slurry of diatomaceous earth to improve the performance of the filter. Provisions for precoating the filter have not been included at this time. If it appears that the filter press fabric has a problem with clogging, precoating will be implemented.

Pumps

Eight pumps will be required within the treatment system: (1) three backwash/filtrate return pumps to return backwash and press filtrate to the clarifier, (2) two sludge pumps for the filter press, (3) two air stripper feed pumps, and (4) a chemical metering pump to add sodium hydroxide to the clarifier. The pumps are shown on the process flow diagram. Table 4-3 lists the pump types and characteristics.

Table 4-4
Summary of Influent / Effluent Parameters

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Contaminant	Average Influent Concentration	Effluent Concentration
Benzene	4 μg/L	<1 μg/L
Ethylbenzene	79 μg/L	<1 μg/L
Toluene	2,800 μg/L	280 μg/L
Xylene	625 μg/L	94 μg/L
Iron	25 mg/L	1 mg/L
BOD	3 mg/L	2 mg/L
TSS	22 mg/L	10 mg/L
NH_3	10 mg/L	8 mg/L
pH	6.6	8.3

As noted in Section 3, actual influent concentrations and flows may vary from those that are predicted on Table 4-4. If ammonia should increase significantly, relatively minor adjustments in the pH of the groundwater could effect further ammonia removals. The pH of the effluent may then have to be lowered prior to discharge. Should VOC concentrations increase, the air stripper would continue to remove 90 percent of the toluene and almost 90 percent of the xylene. Additional removals could be effected by increasing the air flow through the air stripper. The clarifier and filter could easily handle a higher iron concentration and the filter press also has the capacity to dewater twice as much sludge by implementing two operating cycles per day.

Some changes in flow could also be accommodated by the system. Most of the critical sizing criteria were conservatively estimated so that a 10 to 15 percent increase in flow rates could be handled by the process equipment. Similarly, decreases in the pumping rates by up to 50 percent would not significantly affect the performance of the process equipment.

It may be feasible to operate the system with only aeration, filtration, and air stripping should iron concentrations in the groundwater decrease after pumping has started. Adjustment of the pH would then take place in the aeration basin. Clarification is required ahead of filtration to handle the current solids loading. Without clarification, filters would quickly clog from the excessive solids loading. If iron concentrations in the future drop to half their current levels, the system could be operated with only aeration, filtration, and air stripping. Filters are included in the design so that initially the system will be able to remove iron and TSS effectively and also provide the option of bypassing the clarifier should iron concentrations decrease with time.

Several other sludge handling options such as drying beds and large sludge storage tanks were considered in the design. Those options would have necessitated purchasing additional property on the west or south east side of the landfill. Because

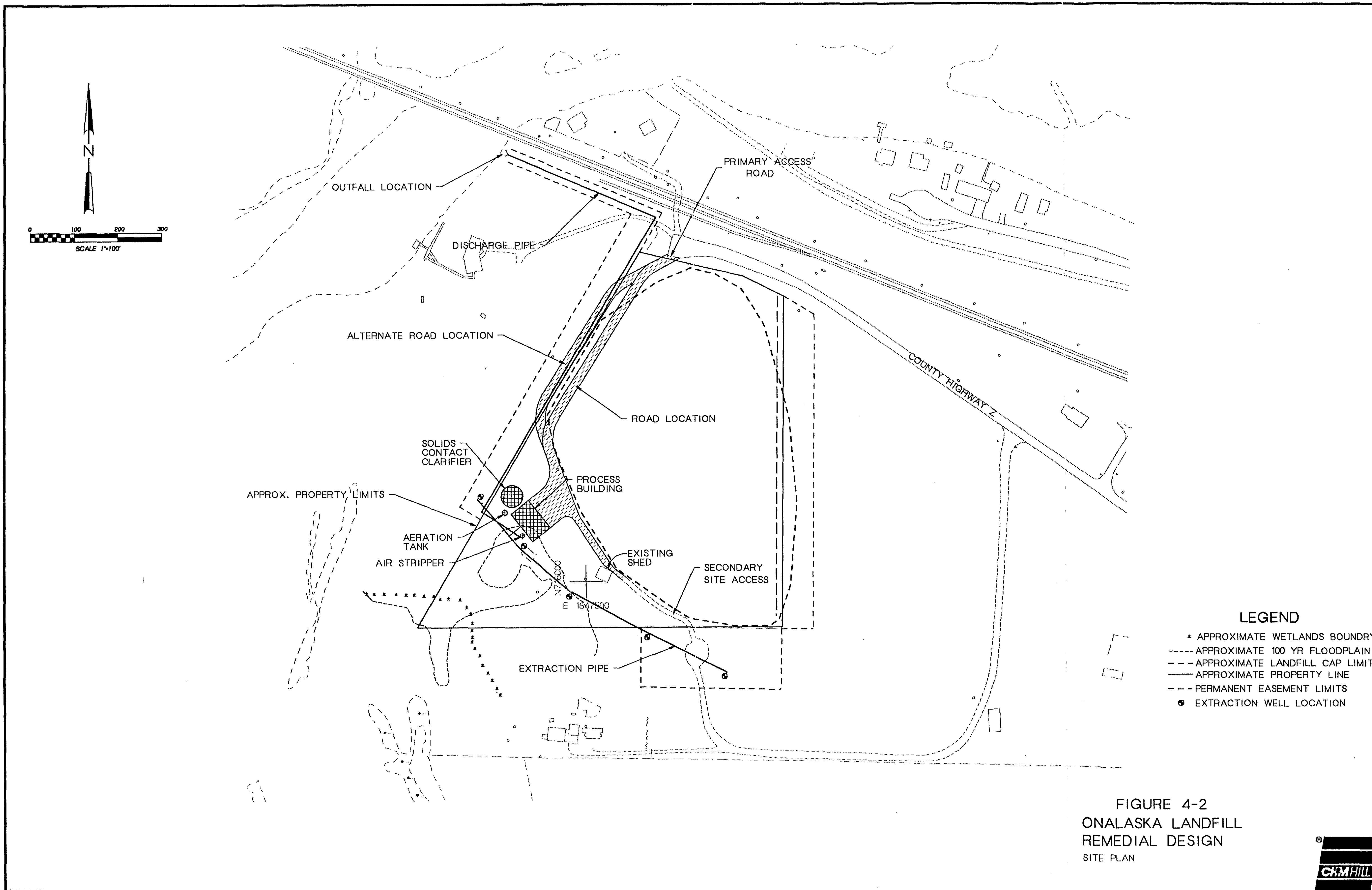
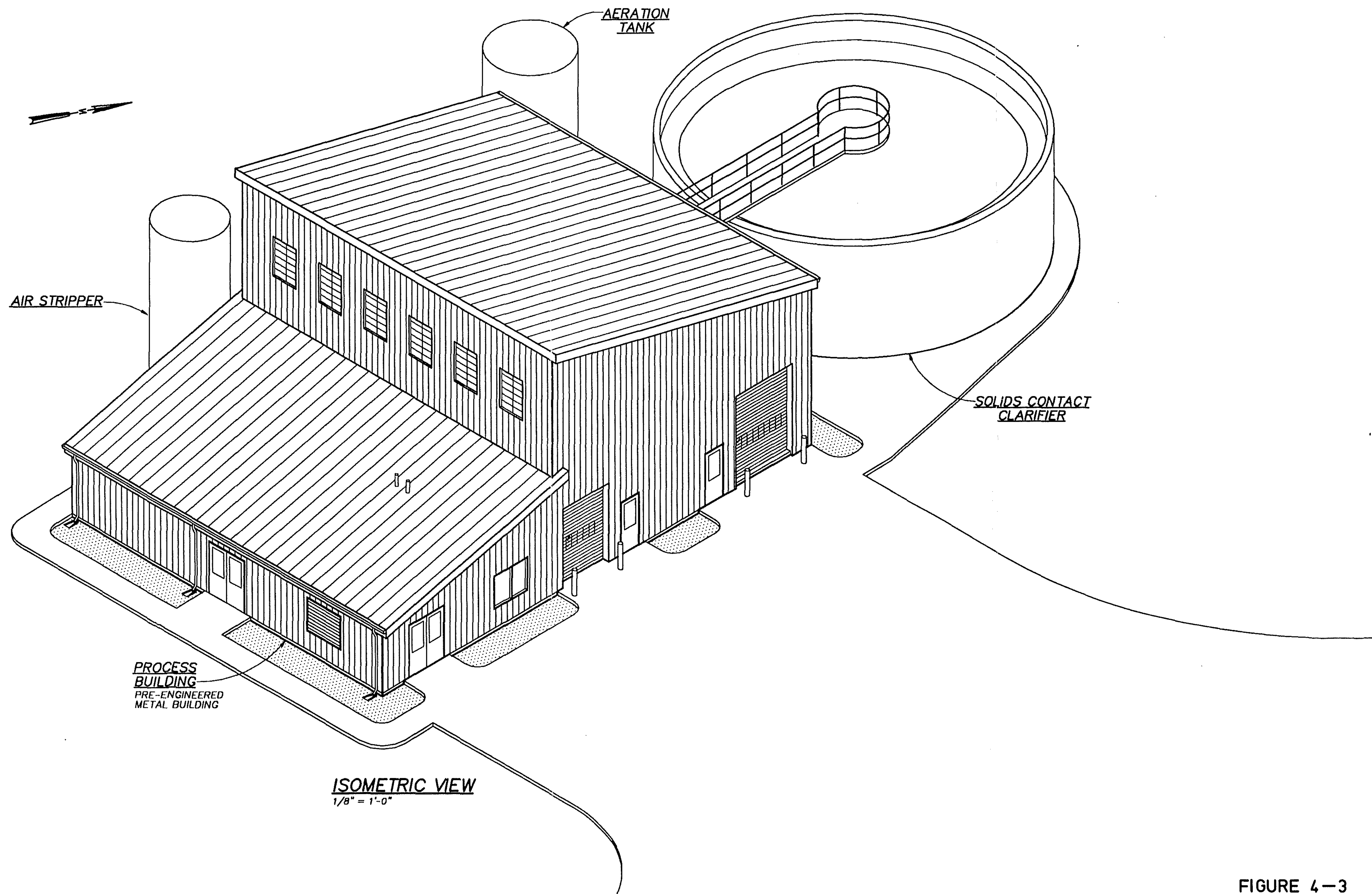


FIGURE 4-2
ONALASKA LANDFILL
REMEDIAL DESIGN
SITE PLAN

10-17-91 E:\65602\PA-2.DWG



ISOMETRIC VIEW
1/8" = 1'-0"

FIGURE 4-3

DSGN K.HARGREAVES						
DR R.G.SIEBERS						
CHK T.GLAWTSCHEW						
APVD S.M.KEITH	NO.	DATE	REVISION	BY	APVD	

CH2M HILL

REUSE OF DOCUMENTS

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

CITY OF ONALASKA, WISCONSIN
LANDFILL REMEDIAL DESIGN

GROUNDWATER EXTRACTION AND TREATMENT
PROCESS BUILDING
ARCHITECTURAL
ISOMETRIC VIEW

SHEET
DWG NO. A-2
DATE OCT 1991
PROJ NO. GL065602

1-96.0

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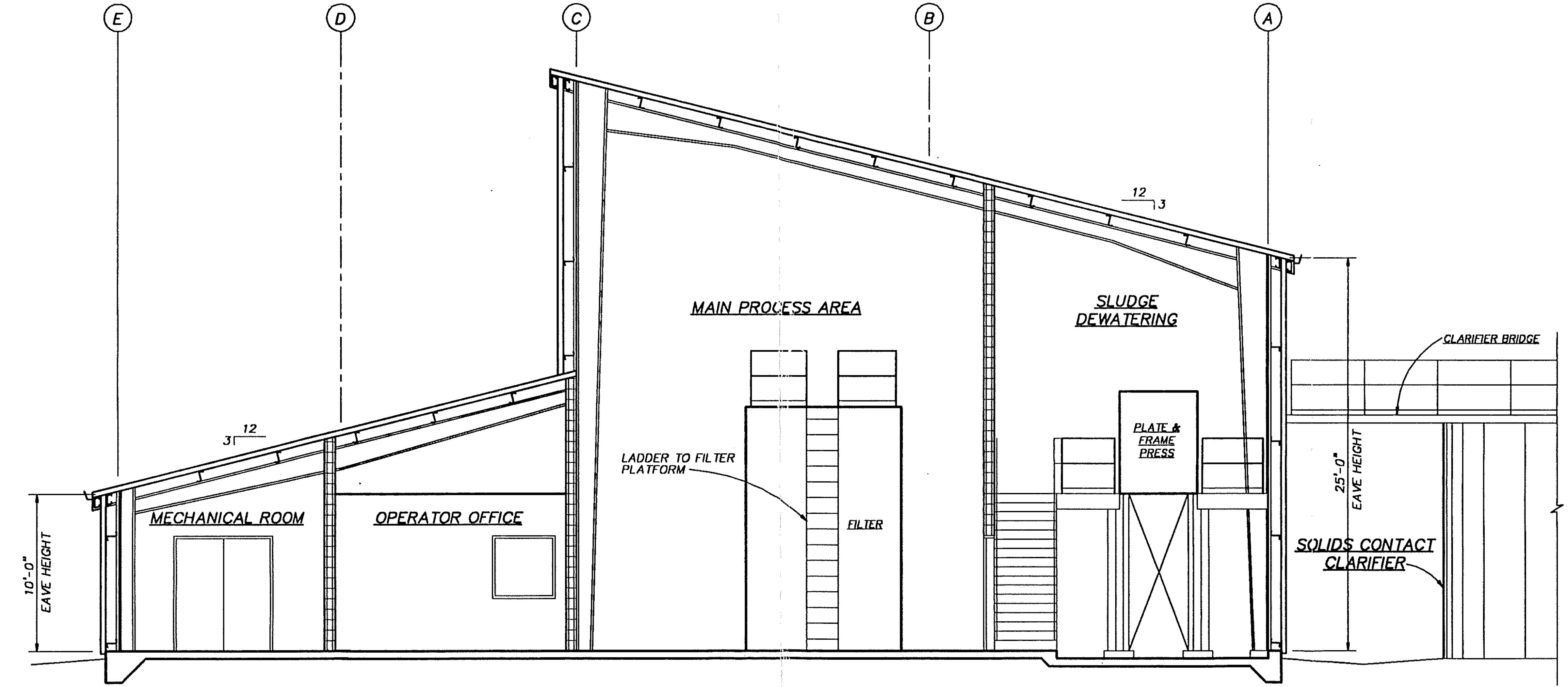

BUILDING SECTION (A) A-1
1/4" = 1'-0"

FIGURE 4—5

PRELIMINARY

CH2M HILL					
DSGN K.HARGREAVES					
DR R.G.SIEBERS					
CHK T.GLAWTSCHEW					
APVD S.M.KEITH	NO.	DATE	REVISION	BY	APVD

REUSE OF DOCUMENTS

VERIFY SCALES
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0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

CITY OF ONALASKA, WISCONSIN
LANDFILL REMEDIAL DESIGN

GROUNDWATER EXTRACTION AND TREATMENT
PROCESS BUILDING ARCHITECTURAL BUILDING SECTION

SHEET
DWG NO. A-3
DATE OCT 1991
PROJ NO. GLO65602

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The building includes two spans of varying height, one high-eave height structure, and one lower shed structure. Various standard pre-engineered metal building configurations were evaluated to determine cost tradeoffs and project applicability associated with each approach. A single structure with one eave height tall enough to accommodate all process equipment requirements was similar in cost to multiple eave height configurations, but required the construction and subsequent environmental conditioning of large volumes of unusable space over offices and other ancillary spaces. The two-span assembly depicted by the figures will provide two volumes appropriate in scale to the intended functions, will minimize operating costs, and will create the opportunity to save lighting expenses by providing daylight to the process area via clerestory windows high on the wall.

Foundation engineering requirements will be determined from a geotechnical investigation to be performed later. This report assumes that foundation work will provide a floating concrete slab floor with spread footings and separate foundations for tanks, pumps, and process equipment. Reinforced concrete foundations will support the clarifier, aeration tank, and air stripper.

The process area of the building will require an average inside height of 24 feet to provide clearance for structure, for the plate and frame press located on a mezzanine level, and for access to the top of the filter. Equipment located in the main process area of the building will include the filter, backwash sump, sludge storage tank, and air stripper sump. The plate and frame press is housed in a separate dewatering room to contain the mess associated with dewatering operations. An overhead door next to the press will allow placement and removal of a rolloff container below the mezzanine-level press. An additional overhead door on the east side of the process area will allow access for chemical delivery and for larger process equipment that may have to be moved into or out of the building. Header pipes from the five groundwater extraction wells will enter the floor of the building in the pipe area, run along the concrete masonry wall to provide operator access, and combine into a common header leading to the aeration tank.

Nonprocess facilities will be located in a smaller-scale shed structure adjacent to the process area. These facilities include a small laboratory for performing minimal effluent analysis (TSS, pH, turbidity tests), an operator office with a view of the process area, bathroom, mechanical and electrical equipment rooms, and an instrumentation and control room. The blower for the air stripper will be enclosed in a separate room to contain noise from the fan.

A galvanized steel catwalk will be built around the elevated filter press to allow operator access to the press. A steel ladder will extend up the side of the filter to allow operator access to the top. Access to the clarifier will be provided via a bridge from the Dewatering Room. This will reduce foundation and structure work otherwise required to provide an outside stair to the Clarifier and will offer the operator convenient access to the Clarifier during inclement weather.

A blacktop apron on the east side of the building will provide parking and sufficient room to back a truck up to unload the rolloff container. The Process Building will be sited to optimize use of available land and relationships with the tanks and air stripper, and to minimize adverse impacts on the flood plain, landfill cap, and wetlands.

Water flow rate from each extraction well will be measured, locally indicated on header pipes as they enter the process building and totalized. Pumps will be stopped if the water level in the well is too low or if their discharge flow rate falls below a minimum value. Low flow rate for a pump commanded to run will be alarmed.

A control panel located in the electrical room is proposed to provide a central point for operator monitoring, adjustment of process parameters, and housing of components not suited to field installation. Instrumentation and control for the treatment facilities will include:

- Level sensors for basins, tanks and pump sumps as appropriate for control of pumps or automatic adjustment of process feed rates

- ON/OFF or ON/OFF/AUTO control of pumps, blowers, fans and compressors, as appropriate

- ON/OFF status indication of pumps, blowers, fans and compressors

- Pressure switches for monitoring of the compressed air system and determining completion of a sludge pressing cycle

- Process controllers for maintaining flow rate to the treatment facility and levels in pump sumps

- An alarm annunciator for visual indication of process and equipment alarms

- Signal transducers for flow rate summation, developing alarm signals, and control of process equipment

- Control switches and status lights for manual control of equipment and status verification

- Pressure gauges or gauge taps will be provided on the discharge sides of blowers, pumps and compressor receiver tanks for visual indication of equipment operation

The flow rate signals from the well flowmeters will be summed and the total flow rate will be used for control of the feed to the aeration basin. Excessive flow rate to the aeration basin will be alarmed. Adjustment of the flow split between wells will be accomplished manually at the treatment facility.

Water level at the overflow of the aeration basin will be measured and indicated at the control panel. A high level switch will signal an alarm.

The pH of the water entering the center well of the solids contact clarifier will be measured and indicated at the control panel. The pH transmitter/controller will also control the stroke length of the caustic metering pump to maintain the pH between 8.0 and 8.5.

Control loops may be configured using hardware devices and relay logic or may be implemented with a programmable logic controller. All automatic discrete and analog control loops will be provided with manual backup control to permit operation in the event of a device failure that impedes automatic operation. Control loops will be designed to restore equipment operation following a power failure without operator intervention. Motor restarts will be staggered to prevent excessive demand on the utility power feed after power restoration.

Because the facility will not be staffed full time, it may be desirable to provide sensors and circuitry to detect and remotely alarm unauthorized entry. This would be provided by monitoring all entry doors in conjunction with time delays to allow an operator time to enter the facility and acknowledge entry via a key-operated switch. This circuitry would also be used to disable local audible alarm horns and enable an alarm autodialer or telemetry link during unstaffed periods.

Operating Requirements

Responsibility

The persons who will operate and maintain the facility have not yet been determined. It has been suggested that the Township of Onalaska may be responsible for its operation. Because of the relatively remote location of the facility, the design attempts to minimize the amount of operation and maintenance required to meet effluent limits consistently.

Requirements

The basic requirements for effective operation of the treatment system are as follows:

- Responding to emergency shutdowns or alarms
- Daily check on all pumps and compressors to see that they are functioning satisfactorily
- Daily check on level of sludge blanket in the solids contact clarifier
- Periodic adjustment of sludge withdrawal pump timer based on rate of sludge formation in clarifier bottom
- Daily check on effluent pH and TSS
- Monthly collection and delivery of effluent samples for offsite laboratory analysis
- Manual adjustment of groundwater extraction well flow rate based on piezometer readings
- Periodic activation of the sludge filter press
- Coordination of the removal of sludge for offsite disposal

Effective operation of the SCC will require daily attention from a treatment plant operator. The sludge blanket depth will need to be maintained through regular wasting of the appropriate amount of solids.

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Section 5
Estimated Capital and Operating Cost

The capital cost for the groundwater exaction system is estimated to be $180,000, and the capital costs for the groundwater treatment system is estimated to be $2 million. The estimated annual operational cost for the extraction and treatment system is $210,000. The estimated capital and operational costs for the groundwater extraction and treatment system are based on the processes described in this report. Costs associated with the landfill cap and in situ biotreatment system are not included. Appendix E presents the detailed cost estimate tables.

The current cost estimate is a preliminary design cost estimate with a +30 percent and -15 percent level of accuracy. A final design cost estimate (+15 percent, -10 percent accuracy) will be submitted with the final design.

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Section 6
Implementation

Permits and Regulatory Requirements

The remedial action selected for any given Comprehensive Environmental Response, Compensation, & Liability Act of 1980 (CERCLA) site is required to attain the standards defined by the applicable or relevant and appropriate requirements (ARARs) established for the site by the U.S. EPA and Wisconsin DNR. The ARARs apply to environmental requirements. In addition to the ARARs, permits and other administrative requirements that do not pertain to environmental regulation must be complied with. CERCLA response actions conducted entirely onsite are not required to comply with the administrative requirements of ARARs. These administrative requirements include fees, permitting, and reporting requirements. The onsite actions must meet the substantive technical requirements of the permits that would otherwise be required. The contaminated groundwater will be treated on site. Since the discharge is considered by the Wisconsin DNR to be on the site, permits will not be required for discharge to the Black River.

Groundwater

Extraction of groundwater will require the installation of groundwater wells. Construction of the wells must conform to the rules in NR 112.

Monitoring of the groundwater contamination plume requires the construction and sampling of monitoring wells. The wells must be constructed in conformance with NR 112, and sampling and analysis must conform to NR 508.

Groundwater for nonpotable use will be obtained by constructing a new groundwater well in the dolomite aquifer. Construction of this well must conform to NR 112.

Groundwater Treatment System

Requirements for plans and specifications submittals to the Wisconsin DNR are outlined in NR 108.

The treatment plant operator must meet the certification requirements of NR 114.

Construction activities that affect the floodfringe area must comply with the requirements of NR 116, and the municipal flood plain zoning ordinance.

Surface Water Discharge

Discharge to the Black River is considered an onsite discharge and therefore will not require a Wisconsin Pollution Discharge Elimination System (WPDES) permit. Monitoring requirements will be established by the DNR.

Coordination of Construction of Groundwater Extraction and Treatment with Other Portions of the Remedial Action

Construction of the groundwater extraction system must be coordinated with construction of the landfill cap and the in situ biotreatment system. The preliminary design presented herein does not fully account for the changes in site topography that will be effected by the installation of the cap. The cost estimate presented in this report assumes the cap will not extend to the area of the process building and that some filling in the process area will be necessary to develop a system that provides adequate drainage away from the area.

The in situ biotreatment system will require a structure to house the blower and controls. This report assumes that space for the in situ blower and controls will be provided in the proposed process building, although the cost of the blower and controls has not been included.

Contracting Strategy

The scope of work for the final design assumes that separate bid documents will be prepared for the groundwater extraction and treatment system, the landfill cap, and the in situ biotreatment system. Because of the potential complications associated with site grading in the process area, it may be preferable to prepare and issue the designs all under a single bid package. At this time, however, it appears feasible to let the cap construction contract and groundwater extraction/treatment construction contract separately. The landfill cap design may be complete by early spring and the cap in place by fall. The treatment facility would be constructed in the fall/winter/spring ('92/'93), and the in situ biotreatment system constructed in the summer of 1993.

Preliminary Construction Schedule

Figure 6-1 presents a preliminary construction schedule for the groundwater extraction and treatment facility. The schedule assumes that the design can be bid by May 1, 1992, and that there will be no disruptions in the schedule caused by construction of the landfill cap or the in situ bioremediation system.

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Appendix A
Site Background and Selected Alternative

GLT243/010.51-2

Appendix A
Site Background and Selected Alternative

Introduction

The Onalaska Landfill is approximately 10 miles north of the City of La Crosse near the confluence of the Mississippi and Black Rivers. The 11-acre site was mined as a sand and gravel quarry in the early 1960s. In the mid-1960s all mining ceased, and the Town of Onalaska began to use the quarry as a municipal landfill. Between 1969 and 1980 both municipal trash and chemical wastes were disposed of in the landfill.

The primary industrial wastes disposed of consisted of naphtha-based solvents, used in a metal cleaning process, and wastes from paint spray, gun cleaning, and machine shop cleaning fluids. During the period that liquid solvent wastes were delivered to the site for open burning, no specific area was used for dumping and burning of the waste. Drums containing solvent or paint residue waste were also left to be burned or buried. Later, the wastes were poured directly into prepared pits from 55-gallon drums and a 500-gallon tank truck. Small quantities of other wastes included paint and ink components, cutting oils, lubricating oils, and asphaltum. Solvent and paint residue were disposed of at a rate of 20 to 25 55-gallon drums per week at the site from 1969 to 1975, resulting in a total estimated volume of over 300,000 gallons.

In 1978 the Wisconsin Department of Natural Resources (DNR) issued an order to the town to submit an infield conditions report for the landfill because of problems with meeting Wisconsin's solid waste codes. Findings of the infield conditions report indicated that the landfill should be abandoned. By the end of the year, the town had submitted plans for phased abandonment of the landfill to the DNR. Closure started in 1980 and proceeded in phases, with the final cap being placed in July 1982.

Groundwater investigations were undertaken by the DNR and U.S. EPA in the early 1980s. In 1988, the U.S. EPA proceeded with a Remedial Investigation (RI) and Feasibility Study (FS) to assess the landfill cap and groundwater contamination and to prepare remedial alternatives for the site.

Results of the RI Investigation

Site Contamination

Results of the cap investigation reveal that there are significant problems with the existing cap at the site. The most significant problem is that the soil with the highest permeabilities across the cap are along the cap's southwestern edge, which is also the area of highest detected contamination. The materials used for construction of the cap included silty sand, silt and lean silty clay and do not meet the current DNR requirements for landfill closure. The cap investigation found the cap to be only 1 foot thick in certain areas across the site. There is visual evidence of damage to the cap along its perimeter caused by surface runoff. Also, the investigation revealed that the cap has deteriorated because of frost damage and will continue to deteriorate from freeze and thaw cycles. Erosion gullies and animal holes were observed near the perimeter of the cap.

Baseline Risk Assessment

The baseline risk assessment evaluated the potential public health and environmental risks posed by the Onalaska Landfill site under the no-action alternative (i.e., no remedial action). Risks were evaluated under both current and future site conditions.

The major risks from the Onalaska Landfill site would occur if people were exposed to contaminants through the use of contaminated groundwater as a water supply source. Currently, no residents are known to be exposed, although a contaminated residential well south of the site was replaced with a deep well. The contaminant plume does not appear to be moving in the direction of existing residences. If wells are constructed in the shallow aquifer within the plume or downgradient from the site, people could be exposed.

Contaminant concentrations in the groundwater at individual monitoring well locations within the landfill or at the landfill boundary contained contaminant concentrations that exceed one or more standards or criteria. The Safe Drinking Water Act maximum contaminant levels (MCLs) for arsenic, barium, benzene, 1,1-dichloroethene, toluene, 1,1,1-trichloroethane, trichloroethene, and xylene were exceeded at one or more monitoring well locations.

Excess lifetime cancer risks based on concentrations at individual monitoring wells where carcinogens were detected ranged from 3×10^{-3} to 3×10^{-6}. Chemicals contributing to the risks include arsenic, benzene, 1,1-dichloroethane, 1,1-dichloroethene, DDD, and trichloroethene. The excess lifetime cancer risk based on mean contaminant concentrations within the groundwater plume (sampling round 1) was 3×10^{-4}. The major contributors to risk are benzene and 1,1-dichloroethane.

Other exposure pathways such as exposure to site soils because of cap erosion, exposure to subsurface material as a result of site development, and migration of contaminants through the groundwater to the Black River were evaluated. Compared to groundwater use exposures, these pathways are less likely to occur and pose a risk of substantially lower magnitude. For example, a conservative estimate of risks from soil contact as a result of residential site development indicated an excess lifetime cancer risk of 7×10^{-8} (7 additional cancers per 1 million people).

As a way to estimate potential aquatic impacts from future groundwater discharges to the river, the highest contaminant concentrations in groundwater were compared to federal ambient water quality criteria for aquatic life and Wisconsin ambient water quality standards. Except for three inorganic chemicals (cadmium, chromium if present as hexavalent chromium and zinc), no standards or criteria were exceeded. When the dilution of groundwater into the surface water is taken into account, no criteria would be exceeded. Consequently, impacts on aquatic life would not appear to be a concern.

regulations (NR 504). This cap would consist of 2 feet of a low permeability clay, a 1 foot drainage layer, and 2.5 feet of protective soil cover, along with a passive gas collection system. Alternative 4—Multilayer Cap Over the Landfill and Zone of Nonaqueous Phase Contamination which is similar to Alternative 3, except that the new cap would be extended to the southwest to cover the zone of nonaqueous phase contamination.

All of the alternatives include provisions for long-term cap maintenance to ensure so that the performance of the new cap would continue unchanged.

Nonaqueous Phase/Groundwater Operable Unit

Alternative 1—No Action for this operable unit consists of long-term groundwater monitoring. Currently there are no detectable levels of contamination migrating from the site to the surrounding surface water. If monitoring showed that unacceptable levels of contaminants were entering the river or wetlands additional remedial actions would be implemented. Alternative 2—Source Containment consists of groundwater monitoring and containment of most of the contaminants within a subsurface vertical barrier (slurry wall) and a multilayer cap. The barrier would encircle the landfill and the zone of nonaqueous phase contamination thereby retarding the extent of migration. Alternatives 1 and 2 do not provide for any groundwater treatment.

Alternative 3—Perimeter Groundwater Collection and Alternative 4—Onsite Groundwater Collection provide for groundwater collection and treatment. Alternative 3 would collect groundwater near the perimeter of the plume. Concentrations of contaminants at the perimeter are relatively low and may remain low because of natural attenuation. As a result, the only treatment necessary to meet discharge standards would consist of cascade aeration to remove the VOCs. Alternative 4 would collect groundwater near the edge of the landfill where contaminant concentrations are much higher. Treatment would consist of aeration, clarification, filtration, and dewatering of sludges produced during treatment.

Alternative 5—Onsite Groundwater Collection and In Situ Nonaqueous Phase Treatment and Alternative 6—Onsite Groundwater Collection and Thermal Treatment of Nonaqueous Phase Contaminants would collect the groundwater onsite and treat it in the manner described for Alternative 4. These alternatives would also include treatment of the contaminated soil in the zone of nonaqueous phase contamination. Alternative 5 uses in situ biodegradation while Alternative 6 involves excavation of the contaminated soil and treatment of it at an asphalt plant. Depending on the need for asphalt, the soil could be incorporated into asphalt or returned to the site as backfill after treatment.

Evaluation of Remedial Alternatives

All of the alternatives underwent a detailed evaluation to demonstrate their fulfillment of the Superfund Law requirements and to assist decision makers in selecting a site remedy. Each of the alternatives were evaluated according to the following seven criteria:

Appendix B
Bioassay Testing and Results

Appendix B
Bioassay Testing Results

Introduction

This appendix presents the results of two laboratory acute toxicity tests conducted by CH2M HILL on groundwater samples from the Onalaska Municipal Landfill. The first bioassay tests used *Ceriodaphnia dubia*, *Daphnia magna*, and fathead minnows as the test organisms and were performed from April 8 through 12, 1991. The second set of tests was conducted August 15 through 17, 1991, and with *Ceriodaphnia* only. The bioassays were used as part of a monitoring program for the State of Wisconsin and as part of a toxicity evaluation study.

Methods

All laboratory methods, including organism culture, sample handling, test procedures, and data analyses, were in accordance with the recommendations of the United States Environmental Protection Agency (EPA) [1, 2] or the Wisconsin DNR.

Sample Collection and Handling

Two 8-hour composite groundwater samples were collected on April 5 and 7 for the first test. Groundwater from three wells of different depths was collected as grab samples and composited as follows for the second test:

Well I.D.	% of Total Volume
3S	50
3M	25
3D	25

Sample collection and delivery to the Milwaukee lab was conducted by CH2M HILL personnel. Upon arrival, the samples were logged in and physicochemical characterizations conducted. Samples not immediately prepared for testing were refrigerated (4°C) for later use.

Test Organisms

All organisms used in the bioassays were cultured at CH2M HILL's Milwaukee laboratory.

Test Procedures

Total alkalinity, hardness, and total ammonia were measured initially on each sample (100 percent concentration). Total alkalinity and hardness were measured once in the laboratory control water.

Table B-2 presents the results of the acute bioassay for the second test. No acute toxicity to *Ceriodaphnia* was demonstrated in the groundwater concentrations tested. Laboratory control data were acceptable for the bioassay.

Table B-2
Summary of Results of Acute Bioassay
Conducted for the Onalaska Municipal Landfill
August 15 to 17, 1991

Test Solution	Mean Percent Survival *Ceriodaphnia dubia*
Laboratory Control	100
6.25% Groundwater	100
12.5% Groundwater	100
25% Groundwater	100
50% Groundwater	100
100% Groundwater	95
LC_{50}	> 100%

Physicochemical Data

All physicochemical parameters measured satisfied the bioassay requirements.

Conclusions

Based on the results of the first bioassay test, the groundwater samples collected at the Onalaska landfill site failed the Wisconsin DNR's acute toxicity criteria for effluents. The results of the tests showed that:

- The groundwater samples were not acutely toxic to *Daphnia magna* or juvenile fathead minnows at 100 percent concentrations using the 50 percent lethality criteria.
- The groundwater sample was acutely toxic to *Ceriodaphnia dubia* at an estimated level of 78.4 percent (LC_{50}).

Based on the results of the second laboratory bioassay, the groundwater sample collected at the Onalaska landfill site passed the Wisconsin DNR's acute toxicity criteria for effluents. The results of this test showed that:

- The groundwater sample was not acutely toxic to *Ceriodaphnia dubia* in the 100 percent concentration using the 50 percent lethality criterion.
- Laboratory control water was acceptable for the test.

Appendix C
Bench-Scale Treatability Testing

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Appendix C

Bench-Scale Treatability Testing

Introduction

Presented here are the observations and analytical results for bench scale treatability testing of groundwater from the Onalaska Landfill. The data will be used in the design of the groundwater treatment system and will assist with the determination of best available technology economically achievable.

Sample collection for the treatability testing was done by Steve Keith and Paul Boersma on August 14, 1991. Treatability testing was performed on August 15, 16, 19, and 20 by Steve Keith, Phil Smith, and Paul Boersma.

Objectives

The objectives of the bench-scale treatability test were to:

- Verify the effectiveness of conventional aeration and clarification for the removal of iron
- Examine the effects of various polymers in the coagulation and settling of the iron floc
- Generate sufficient sludge to observe sludge thickening characteristics
- Generate sufficient sludge to complete a TCLP analysis on the sludge sample

The test was not designed to predict the amount of VOC removal that could result from the groundwater aeration because of the difficulties in extrapolating bench-scale results to full-scale applications. Furthermore, the test was not designed to determine the solids settling rate in the clarifier or to assess the affects of sludge recycle on the settling rates. These parameters are largely known throughout the literature and will be optimized during the startup of the system.

Groundwater Collection

Location

Some consideration was given to collecting a "representative" sample of groundwater. It was decided to collect the groundwater sample from MW-3S, a shallow well in the center of the observed VOC plume. Thus the concentration of VOCs and other organic contaminants used for the study were likely to be at the higher end of the observed range for organic contaminants. The iron concentration measured during the RI in MW-3S was 43 ppm, also at the higher end of measured iron concentrations. Nutrients and other groundwater parameters measured in the RI

Table C-1 VOC Analyses from MW-3S	
VOC	**Concentration (μg/L)**
1,1-Dichloroethane	280
1,1,1-Trichloroethane	530
Toluene	55,000
Ethylbenzene	350
M&P-Xylenes	2,700
O-Xylene	1,600
Methodology: EPA 601/602 Sample Collected 8/14/91	

GLT243/002.51

Table C-3
Groundwater Characterization
From MW-3S

Parameter	Concentration (mg/L)
Total Phosphate, as P	3.7
Nitrogen forms, as N Nitrate Nitrite Ammonia	 <0.5 0.161 9.68
Sulfide	0.02
Sulfate, SO_4	2.84
Fluoride, F	0.13
Oxygen Demand Biochemical Chemical	 33 87
Solids Total Suspended Total Dissolved	 77 325
Alkalinity, total as $CaCO_3$	311
Total Organic Carbon	1
Grease and Oil	<1
Sample collected August 14, 1991	

GLT243/015.51

Effects of Polymers on Clarification

After the aeration and clarification studies were completed, several studies were undertaken using a polymer. Polymers were used to increase floc size, strength, and density. The studies were completed by Bruce Mundt of Western Water Management who supplied the polymers. After initial discussions with Western about the types of polymers available, a decision was made to test only liquid cationic polymers. Anionic polymers, powdered polymers, and polymer emulsions were considered to be too difficult to handle. A polymer requiring special and highly skilled operators was not considered appropriate with the design objectives of this project. Anionic polymers will be re-considered only if they are essential to effective operation of the treatment system after full scale start-up.

Three liquid cationic polymers were tested: a medium charge/low molecular weight polymer, a high charge/medium molecular weight polymer, and a high charge/low molecular weight polymer. Tests were conducted by first raising the pH of the sample with NaOH and aerating for 10 minutes (as described before), and then making 5 ppm, 10 ppm, 15 ppm and 20 ppm solutions of each of the three polymers. After 30 seconds of rapid mix and 1 minute of slow mix, the samples were transferred to graduated cylinders and allowed to settle.

Of the 12 separate tests, the two solutions that appeared to produce the quickest settling and largest floc were the 5 ppm solution of high charge/low molecular weight polymer, and the 10 ppm solution of medium charge/low molecular weight polymer. These two mixtures were prepared again and then compared to a control column with no polymer addition. Visual comparisons were made on the rate of settling, the amount of floc formed, and the relative turbidity of each sample. After the comparisons were made, it did not appear that using the polymers provided a clear advantage in the size or strength of the floc or in the rate of sludge settling.

The capability for the use of polymers will not be included in the design. However, after the treatment system is running, it may be advantageous to again perform either full or bench scale tests with the actual influent. Therefore, it may still be advisable to design the facility with the space for polymer storage and dispensing equipment if their use is reconsidered at a later time.

Effects of Clarification on TSS

To determine the degree to which the ferric hydroxide would settle during clarification, a sample was neutralized, aerated, and then the floc was allowed to settle for 24 hours in a graduated cylinder. Samples of supernatant were collected at several time intervals and measured for TSS. The results are:

Time = 0 hours	TSS = 98 mg/L
Time = 1 hours	TSS = 24 mg/L
Time = 3 hours	TSS = 5.3 mg/L
Time = 24 hours	TSS = 0.6 mg/L

Figure 1

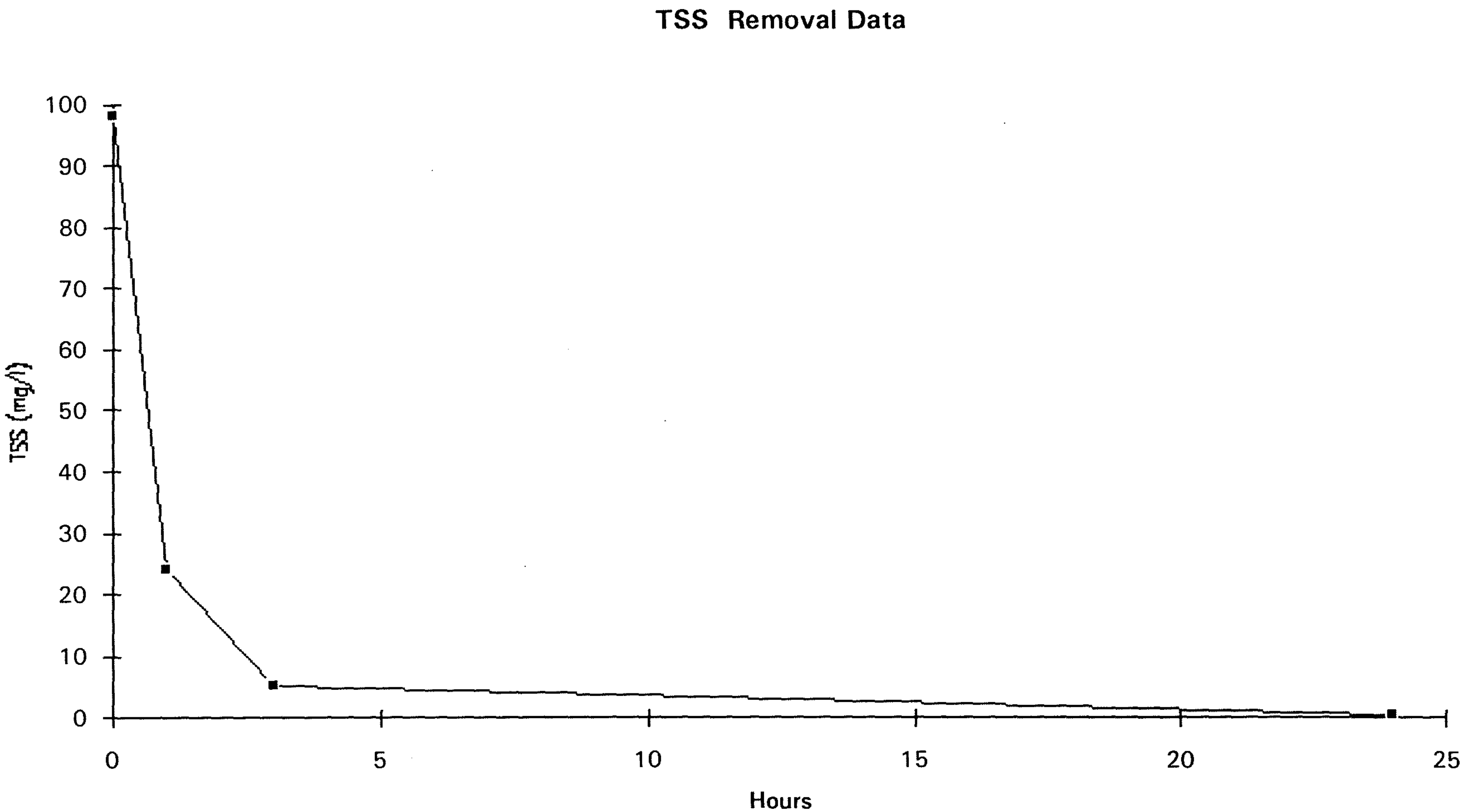
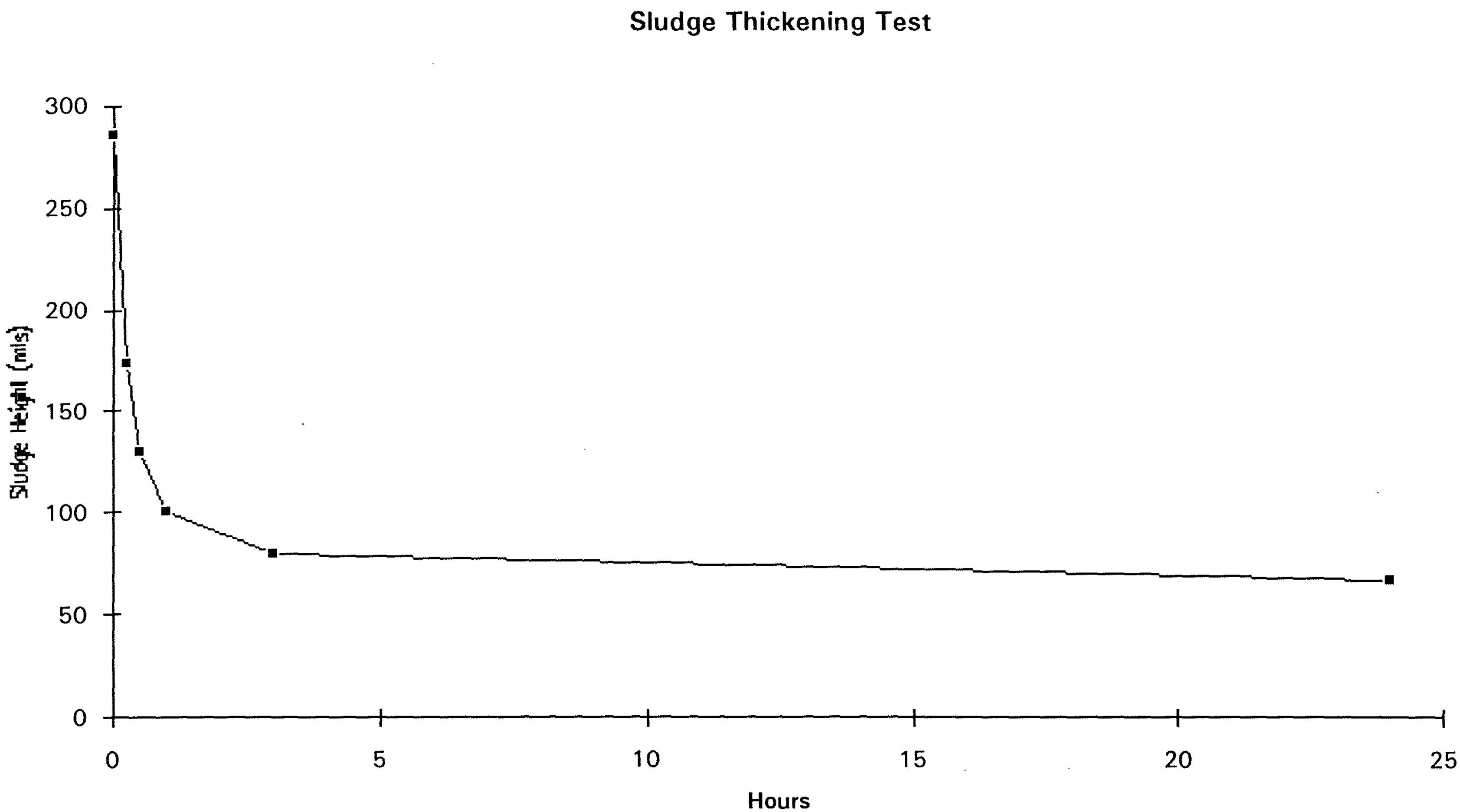

TSS Removal Data
100
90
80
70
60
50
40
30
20
10
0
TSS (mg/l)
0
5
10
15
20
25
Hours

Figure 3



Sludge Thickening Test
300
250
200
150
100
50
0
Sludge Height (mls)
0
5
10
15
20
25
Hours

APPENDIX D
EVALUATION OF PROCESS OPTIONS

Appendix D
Evaluation of Process Options

Introduction

On August 9, the Onalaska project staff and review team discussed the conceptual design of the groundwater treatment system. A conceptual design memorandum (August 2, 1991) served as the basis for the discussion. Numerous issues were discussed and some conclusions were drawn. Furthermore, more research has been completed into the various unit processes and preliminary cost data has been obtained. This appendix summarizes the issues and conclusions that where discussed during the call and present the current proposed treatment.

Note that presented costs for the process equipment are generally "off the shelf" vendor quotes. The costs do not include shipping and installation costs and are used for comparative purposes only.

Issues and Conclusions

Oil and Water Separator

There was some concern about the presence of free oil in the influent and its effect on the clarifier. The reviewers felt that if the oil was limited to just a sheen, then its effect may be negligible, but if more oil were present, it could attach to the floc in the clarifier and cause it to float. In that case, an API oil separator would be required in front of the treatment system.

After discussions with the hydrogeologists and further field observations, it was decided that it is highly unlikely that an API oil/water separator would be needed. This conclusion was based on (1) an oil sheen (described as a monolayer of product) was seen on the effluent from the pump test for 1 of 3 days, but there was no evidence of free oil in the extracted groundwater, (2) recent sampling of MW-3S, one of the most contaminated wells, showed a partial sheen in the monitoring well but no free oil, (3) there has been no evidence of an oil sheen or free oil in treatability samples, and (4) free oil was not observed during the RI.

Wet Well

The initial conceptual design included a wet well at the front of the treatment system to equalize flows into the treatment system. The wet well could also serve as a vessel for pH adjustment before aeration.

The general response of the reviewers was that a wet well would not be necessary. Groundwater flows could be combined through pipe manifolds and caustic additions needed for pH adjustment could take place in the center well of the clarifier. Thus, a wet well will not be included in the preliminary design.

Summary

The preliminary design will include an aeration tank at the front of the system to aerate the water and oxidize the iron. An aeration tank would provide more operating flexibility than a cascade aerator. For instance, should the clarifier ever be taken offline because of decreasing iron concentrations, the aeration tank could then still provide the needed residence time for pH adjustment and iron oxidation. Some VOC removal may take place in the aeration tank, but the removal would likely be less than 10 percent of the total VOCs. Thus, an air stripper will be placed at the end of the treatment system to remove the VOCs and meet BATEA.

Clarification

One reviewer suggested that if the TSS of the influent was to be less than 50 mg/L, we may want to consider direct filtration. Based on theoretical estimates and TSS measurements made during the treatability test, it is estimated that the influent could contain 70 to 100 mg/L of TSS. Therefore it was considered appropriate to use a clarifier.

There was a general agreement that a solids contact clarifier (SCC) would be preferable to a Lamella clarifier or to using separate vessels for flocculation/ clarification. A solids contact clarifier would provide more operating flexibility for variable solids loading resulting from changing influent conditions with time. In a SCC, a proper sludge blanket depth would need to be maintained through wasting the appropriate amount of solids. One of the design objectives is to minimize the need for operational control. It was suggested that sludge level detectors and sludge density detectors be used to partially automate the removal of sludge from the clarifier. The SCC is sized based on a 0.4 gpm/sq ft. rise rate, a reaction zone retention time of 40 minutes, and a hydraulic retention time of 3 hours. It is estimated that a steel tank, 50-foot diameter, solids contact clarifier, with a concrete pad built on grade would cost about $200,000 installed.

The advantages of Lamella clarifiers are that they are cheaper and more compact. A Lamella clarifier would require a 12 × 30 foot area. However, the reviewers expressed concern about the potential for the sludge to clog the inclined plates, which would necessitate removing the plates and cleaning them as well as down time for the extraction system. Past experience with Lamella clarifiers suggests that even with careful operator attention, they are still prone to clogging. The cost of a Lamella clarifier with a mixing tank and an equivalent rise rate of 0.28 gpm/sq. ft. would be $120,000 installed.

Because of the concern with the added operational control and high maintenance requirements needed for a Lamella clarifier, a traditional solids contact clarifier will be used in the preliminary design.

Filters

Standard gravity filters were proposed as part of the conceptual design for further TSS removal after clarification. It is feasible that only clarification could reduce the TSS to the 5 to 10 mg/L range. Filtration would be added if considered essential for achieving BATEA of the groundwater.

Offsite Dewatering

After further investigation it does not appear feasible to pump the sludge to a wastewater treatment plant. The City of Onalaska sends their wastewater to the City of La Crosse. Residents on the Brice Prairie use septic systems. Therefore, the nearest treatment plant is in the Village of Holman, about 6 miles away. The plant is a relatively small (rated at 0.8 mgd, currently using 0.25 mgd) and uses extended aeration for biological treatment of the wastewater. Biological sludge generated during aeration is removed by a septic hauler twice a week.

The Holman plant has no provisions or capacity to store or dewater the iron sludge from the Onalaska landfill. To handle the Onalaska sludge, the same process equipment proposed for the landfill would have to be installed at the existing Holman plant. Furthermore, the plant is within a different political entity and they would have little incentive to modify their plant. It does not appear to be cost effective to pump the iron sludge 6 miles and have to construct new sludge treatment facilities. There also would be significant regulatory and administrative problems with this approach. Therefore, offsite dewatering of the sludge will not be considered further.

Sludge Settling Basins

Sludge settling basins consist of large surface impoundments or tanks designed to provide a long term sludge storage and thickening. One to three times a year the basins or tanks would be cleaned out and either dewatered onsite with mobile belt presses or taken to an offsite treatment unit.

It is estimated the SCC clarifier could produce about 5,250 gallons of 1 percent solids sludge per day. Assuming that the sludge thickened to 5 percent solids and the holding time for the tank was 120 days (4 months), the tank would have to hold 126,000 gallons of 5 percent solids sludge. About 4,200 gallons of water per day would collected from an overflow weir around the perimeter of the tank and returned to the clarifier. A tank 65 feet in diameter with a 5-foot sludge storage depth would be required to provide the 120 days of storage. Assuming another 3 feet of depth for hydraulic retention above the maximum sludge depth, the hydraulic retention time in the tank would be about 14 days.

The cost of constructing an ongrade, covered, steel tank would be about $110,000. Adding a sludge mixing system to promote further settling of the sludge would cost another $45,000. The cost of sludge dewatering is estimated to be about 7 cents a gallon or $25,000 a year, assuming the use of mobile filter presses.

Sludge Drying Beds

Sludge drying beds have traditionally been used to dewater sludges from municipal water treatment plants. They are a low technology alternative and the beds themselves require little maintenance. However, new sludge drying beds are built less frequently. Sludge drying beds require large amount of land space, are more obvious, and less aesthetic to nearby residences.

Sludge application rates for ferric hydroxide sludge are estimated to be 5 pounds of solids per square foot per year. Based on the estimate of 470 pounds of solids

Appendix E
Preliminary Design Cost Estimates

GLT243/010.51-6

Appendix E

Predesign Cost Estimates

The estimate of cost shown, and any resulting conclusions regarding project financial feasibility or funding requirements, have been prepared for guidance from the information available at the time the estimate was prepared. The final costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, and other variable factors. As a result, the final project costs will vary from the estimate presented herein. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper project evaluation and adequate funding. Based on flowsheets, layouts, preliminary equipment descriptions and other relative information available at the time this opinion was prepared, it is anticipated that the estimate contained a +30 percent to -15 percent level of accuracy.

GLT243/017.51

Assumptions—Treatment Plant Facility

Division 1—General Requirements

- Typical percentage of facility total to be used—5 percent.

Division 2—Excavation

- Light clearing and grubbing is required—2 acres total.
- Stripping of topsoil is required for roadway.
- Roadway is asphaltic concrete—24′ wide by 800′ long.
- Parking and pavement area is 60′ by 70′.
- Effluent pipe is 10″ Reinforced Concrete Pipe—1,000′ long.
- Trench dimensions are 3′ wide by 6′ deep with 3′ depth of imported fill.
- Large foundations for buildings and equipment require 5′ depth of excavation at a layback of 2:1 and 4′ of imported structural fill.

Division 3—Concrete

- Allowance will be made for unforeseen equipment pads.

Division 4—Masonry

- Historical $/SF costs utilized for this facility.

Division 5—Metals

- Metal bridge from clarifier to building is 20′ long by 5′ wide.
- Aluminum handrail is located on both sides of the bridge.

Division 8—Doors and Windows

- Three overhead doors are required—sizes as shown in estimate.

Division 9—Painting

- Typical percentage of facility total to be used—1.5 percent.

Division 11—Equipment

- Equipment prices supplied by designer—installation and appurtenances estimated at 20 percent of material costs.

FACILITY NAME:	TREATMENT FACILITY	ESTIMATE TYPE:	Facility Plan Analysis
FILE NAME:	PLANT.XLS	ESTIMATOR:	Jim Slattery
PROJECT NAME:	ONALASAKA LANDFILL	DATE:	18-Oct-91
PROJECT NUMBER:	GLO65602.PD.FC	FACILITY TOTAL:	$1,981,000

DESCRIPTION	QTY	UNITS	UNIT COST	EXTENDED COST	RESOURCE
DIVISION 01					
GENERAL COND./BONDS/INSUR					
% OF FACILITY TOTAL	5	%	$1,981,000	$99,000	Historical/Est. Judgement
DIVISION 02					
EARTHWORK/DEMO					
YARD PIPING % OF FACILITY TOTAL	3	%	$1,981,000	$59,000	Historical/Est. Judgement
Clearing and Grubbing	2	Acre	$2,800	$5,600	Means 021-104-0200
Foundation Excavation	1,497	CY	$5.00	$7,485	Est Judgement
Imported Structural Backfill	789	CY	$14.00	$11,041	Est Judgement
Strip Topsoil/Grade Roadway	867	EA	$5.00	$4,333	Est Judgement
Asphaltic Concrete Roadway/Parking Lot	23,400	SF	$2.23	$52,205	Richardson's 2-43,5
Landscaping	1	LS	$2,500	$2,500	Est Allowance
10in Effluent Excavation	667	CY	$5.00	$3,333	Est Judgement
10in Effluent Pipe Zone	333	CY	$14.00	$4,667	Est Judgement
10in RCP Effluent Pipe	1,000	LF	$10.12	$10,120	Means 026-658-2000
10in RCP Fittings	10	EA	$430.33	$4,303	Means 026-658-9000
SUBTOTAL				$105,587	
CONTINGENCY	25	%		$26,397	
TOTAL DIVISION 02				$191,000	
DIVISION 03					
CONCRETE					
Concrete Equip Pads	149	CY	$200.00	$29,774	Historical/Est Judgement
Misc Pads	1	LS	$2,000.00	$2,000	Est Allowance
SUBTOTAL				$31,774	
CONTINGENCY	25	%		$7,944	
TOTAL DIVISION 03				$40,000	
DIVISION 04					
MASONRY					
Treatment Building	3,918	SF	$86.00	$336,948	Historical/Est Judgement
SUBTOTAL				$336,948	
CONTINGENCY	25	%		$84,237	
TOTAL DIVISION 04				$421,000	
DIVISION 05					
METALS					
Bridge	100	SF	$60.00	$6,000	Est Judgement
Handrail	40	LF	$42.00	$1,680	Historical/Thompson Fab
SUBTOTAL				$7,680	
CONTINGENCY	25	%		$1,920	
TOTAL DIVISION 05				$10,000	

ONALASKA FACILITY SUMMARY

FACILITY NAME:	TREATMENT FACILITY	ESTIMATE TYPE:	Facility Plan Analysis
FILE NAME:	PLANT.XLS	ESTIMATOR:	Jim Slattery
PROJECT NAME:	ONALASAKA LANDFILL	DATE:	18-Oct-91
PROJECT NUMBER:	GL065602.PD.FC	FACILITY TOTAL:	$1,981,000

DESCRIPTION	QTY	UNITS	UNIT COST	EXTENDED COST	RESOURCE
Clarifier	1	LS	$237,600	$237,600	Quote*1.2*1.1
SUBTOTAL				$697,326	
CONTINGENCY	15	%		$104,599	
TOTAL DIVISION 11				$802,000	
DIVISION 12					
FURNISHINGS	1	EA	$0.00	$0	
	1	EA	$0.00	$0	
SUBTOTAL				$0	
CONTINGENCY	25	%		$0	
TOTAL DIVISION 12				$0	
DIVISION 13					
I & C					
PERCENTAGE OF FACILITY TOTAL	5	%	$1,981,000	$99,000	Historical/Est. Judgement
DIVISION 14					
CONVEYORS/HOISTS					
5 Ton Overhead Crane	1	EA	$10,048.50	$10,049	Means 146-011-2500
	1	EA	$0.00	$0	
SUBTOTAL				$10,049	
CONTINGENCY	25	%		$2,512	
TOTAL DIVISION 14				$13,000	
DIVISION 15					
MECHANICAL					
HVAC and Plumbing	3,918	SF	$15.00	$58,770	Est Judgement
	1	SF	$0.00	$0	
	1	LS	$0.00	$0	
	1	EA	$0.00	$0	
SUBTOTAL				$58,770	
CONTINGENCY	25	%		$14,693	
TOTAL DIVISION 15				$73,000	
DIVISION 16					
ELECTRICAL					
PERCENTAGE OF FACILITY TOTAL	10	%	$1,981,000	$198,100	Historical/Est. Judgement
TOTAL DIVISION 16				$198,000	

FACILITY TOTAL: $1,981,000

ONALASKA FACILITY SUMMARY

FACILITY NAME:	EXTRACTION WELLS	ESTIMATE TYPE:	Facility Plan Analysis
FILE NAME:	EXTRACT.XLS	ESTIMATOR:	Jim Slattery
PROJECT NAME:	ONALASAKA LANDFILL	DATE:	18-Oct-91
PROJECT NUMBER:	GLO65602.PD.FC	FACILITY TOTAL:	$180,000

DESCRIPTION	QTY	UNITS	UNIT COST	EXTENDED COST	RESOURCE
DIVISION 01					
GENERAL COND./BONDS/INSUR					
% OF FACILITY TOTAL	10	%	$180,000	$18,000	Est. Judgement (Haz Train
DIVISION 02					
EARTHWORK/DEMO					
6in Well Casing	150	LF	$29.50	$4,425	Historical/Onalaska
6in Well Screen	250	LF	$105.00	$26,250	Historical/Onalaska
Gravel Pack	275	LF	$12.75	$3,506	Historical/Onalaska
Grout/Bentonite Seal	125	LF	$13.25	$1,656	Historical/Onalaska
Well Completion	5	EA	$375.00	$1,875	Historical/Onalaska
Well Development	5	EA	$1,480.00	$7,400	Historical/Onalaska
Pump Installation	5	EA	$3,993.00	$19,965	Means 152-480-1360
Pitless Adapter	5	EA	$330.00	$1,650	Chris Lawrence/GLO*1.2*1.
Excavation to Install Pitless	741	CY	$5.00	$3,704	Est Judgement
Backfill with Native Material	741	CY	$6.00	$4,444	Est Judgement
Manhole Excavation	52	CY	$5.00	$262	Est Judgement
Precast Manhole	5	EA	$1,411.05	$7,055	Means 027-152-1130/2000
Header Line Excavation	296	CY	$5.00	$1,481	Est Judgement
Imported Pipe Zone Fill	148	CY	$14.00	$2,074	Est Judgement
SUBTOTAL				$85,747	
CONTINGENCY	15	%		$12,862	
TOTAL DIVISION 02				$99,000	
DIVISION 03					
CONCRETE					
	0	CY	$0.00	$0	
	0	LS	$0.00	$0	
SUBTOTAL				$0	
CONTINGENCY	25	%		$0	
TOTAL DIVISION 03				$0	
DIVISION 04					
MASONRY					
	0	SF	$0.00	$0	
	0	SF	$0.00	$0	
SUBTOTAL				$0	
CONTINGENCY	25	%		$0	
TOTAL DIVISION 04				$0	
DIVISION 05					
METALS	1	EA	$0.00	$0	
	1	EA	$0.00	$0	
SUBTOTAL				$0	
CONTINGENCY	25	%		$0	

ONALASKA FACILITY SUMMARY

FACILITY NAME:	EXTRACTION WELLS	ESTIMATE TYPE:	Facility Plan Analysis
FILE NAME:	EXTRACT.XLS	ESTIMATOR:	Jim Slattery
PROJECT NAME:	ONALASAKA LANDFILL	DATE:	18-Oct-91
PROJECT NUMBER:	GL065602.PD.FC	FACILITY TOTAL:	$180,000

DESCRIPTION	QTY	UNITS	UNIT COST	EXTENDED COST	RESOURCE
TOTAL DIVISION 11				$0	
DIVISION 12					
FURNISHINGS	1	EA	$0.00	$0	
	1	EA	$0.00	$0	
SUBTOTAL				$0	
CONTINGENCY	25	%		$0	
TOTAL DIVISION 12				$0	
DIVISION 13					
I & C					
PERCENTAGE OF FACILITY TOTAL	5	%	$180,000	$9,000	Est. Judgement (Haz Train
DIVISION 14					
CONVEYORS/HOISTS					
	1	LS	$0.00	$0	
	1	EA	$0.00	$0	
SUBTOTAL				$0	
CONTINGENCY	25	%		$0	
TOTAL DIVISION 14				$0	
DIVISION 15					
MECHANICAL					
6 in CLDI Header Pipe	1,000	LF	$14.67	$14,674	Richardson's 2-39,1
6 in CLDI Tees	5	EA	$368.75	$1,844	Richardson's 2-39,4
6 in Flow Control Valves	5	EA	$2,500.00	$12,500	Est Allowance
	1	EA	$0.00	$0	
SUBTOTAL				$29,018	
CONTINGENCY	25	%		$7,255	
TOTAL DIVISION 15				$36,000	
DIVISION 16					
ELECTRICAL					
PERCENTAGE OF FACILITY TOTAL	10	%	$180,000	$18,000	Est. Judgement (Haz Train
TOTAL DIVISION 16				$18,000	

FACILITY TOTAL: $180,000

Alternative 5 - Nonaqueous Phase/Groundwater Operable Unit
Revised on 10/7/91

DESCRIPTIONS	QUANTITY	UNIT	UNIT PRICE (DOLLARS)	COST	
OPERATION AND MAINTENANCE COST					
GROUNDWATER COLLECTION					
Operation	1	ls	5000	5000	/yr
Pump Replacement/Screen Maint	1	ls	800	800	/yr
GROUNDWATER TREATMENT					
Operator	2000	hours	30	40,000	/yr
Chemicals	17000	pounds	0.14	2,380	/yr
Electric	180000	kwh	0.0717	12,906	/yr
Equipment Maint.	1	ls	40000	40,000	/yr
Analytical Costs	1	ls	10000	10,000	/yr
Sludge Disposal	250	cy	30	7,500	/yr
Sludge Transportation	25	trips	500	12500	/yr
GROUNDWATER MONITORING					
Analytical	10	wells	5000	50,000	/yr
Labor	160	hours	50	8,000	/yr
ENGINEERING/ADM					
Engineering Review of System	200	hours	75	15000	/yr
Administration	200	hours	50	10000	/yr
TOTAL				210,000	/YR
TOTAL O & M COST					