ATTACHMENT A1

PART A and PART B

Date revised: 10/1/2024

Part A and B

Date revised: 10/1/2024

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List of Appendices

1 Part B Attachments

This permit application follows the EGLE format and uses EGLE's attachment templates when available. This Attachment contains required information which has not been provided a EGLE template with the exception of:

- Preventive Procedures, Structures and Equipment, 40 CFR 270.14(B)(8)], which has been added to the Preparedness and Prevention plan provided in Attachment A6 as Appendix A6-1
- Prevention of Reaction of Ignitable, Reactive and Incompatible Wastes [40 CFR 270.14(b)(9) and 264.17], which has been added to the Preparedness and Prevention Plan provided in Attachment A6 as Appendix A6-2.

2 General Description [Form 5111 XIV A.1]

(40 CFR 270.14 (b) (1))

Gage Products Company, limited storage facility (Gage LSF), is a commercial solvent reclamation, blending, and distribution facility. The street and mailing address is 625 Wanda Avenue, Ferndale, Michigan 48220. A location map has been provided in Figure A1-1a, and a regional topographic map with a scale of 1:24,000 AND 5-foot contour intervals has been provided in Figure A1-1b. A site layout map of the facility showing boundaries, major buildings, and the location of the Limited Storage Facility is located in Figure A1-2. Engineering plans for the Limited Storage Facility are provided in Appendix A1-5

GAGE PRODUCTS COMPANY'S GENERATED WASTES

Recycling process wastes are accumulated in on-site storage tanks and manifested off-site, within the 90-day storage requirements for fully regulated hazardous-waste generators, to a licensed off-site disposal facility for use as an alternate fuel in cement kiln or for incineration. Other drums of process wastes are accumulated on-site and are manifested within the 90-day storage requirements for fully regulated hazardous-waste generators, to a licensed off-site disposal facility for fuel blending, recycling or incineration. Universal wastes are accumulated for no longer than one calendar year before being sent off-site for proper disposal or recycling at a licensed facility.

MATERIALS RECEIVED FOR RECYCLING

Solvent Hazardous Secondary Materials and Hazardous waste received for recycling is primarily characterized with EPA waste codes of F001, F002, F003, F005, and D001. D002 wastes are received in drums for limited storage only, pending shipment off-site to a licensed treatment/disposal facility. Spent solvent wastes are received both in bulk tankers and 55-gallon drums. The limited Storage Facility is designed to feed incoming and hazardous secondary materials directly into the processing units or into the Limited Storage Facility's container storage area or tank farm temporary storage. D002 wastes are only stored in 55-gallon drums within the container storage building in a segregated area.

Note: Throughout this document the term tank farm refers to the bulk storage tank area associated with the Limited Storage Facility only.

In keeping with the specific requirements for a Limited Storage Facility, as outlined in Michigan Hazardous Waste Act; Public Act of 1994, number 451 Section 299.9501, as amended, Gage LSF does not receive hazardous waste from other treatment, storage, or disposal facilities (TSDF).

The Limited Storage Facility has a maximum storage capacity of 25,000 gallons. This storage capacity reflects the potential total combined capacities of the container storage area plus the capacity of the storage tanks in the tank farm. The facility has been designed to contain flammable liquids, in accordance with applicable BOCA, NFPA, and NEC codes for Class I, II, and III liquids. The contained facility consists of a totally enclosed three-bay unloading and container storage area and an adjacent tank farm. Two bays are designed for unloading tankers directly into processing units or into temporary tank-farm storage. The third bay is designed to unload 55-gallon drums into the container storage area. The unloading area allows for the safe transfer of containers or tankers into the storage areas. The unloading area also allows for the safe transfer of generated recycling-process wastes to bulk tankers for off-site disposal.

All incoming wastes stored in the drum container area or in the associated tank farm are checked for compatibility prior to storage. Incoming compatible waste groups are stored in designated areas within the container storage area or in bulk tanks containing compatible wastes. Incompatible wastes are only received in 55-gallon drums and are stored in a segregated area within the container storage area. The Limited Storage Facility is designed with natural ventilation. A pressure equalization line between an offloading tanker and the receiving storage tank prevents the discharge of volatile fractions to the environment.

The container storage area is designed to have a maximum storage capacity of 2,750 gallons of hazardous-waste solvents or approximately fifty (50), 55-gallon drums. The temporary storage tank-farm area has a capacity of 22,250 gallons. Process and design information is provided in Appendix A1-5.

In summary, the regulated portion of the Gage LSF facility consists of the following:

- An unloading area, consisting of three bays with a spill collection and containment structure. The entire area is enclosed.
- Five bulk storage tanks, with a total holding capacity of 22,250 gallons, having secondary containment and covered by a roof.
- An enclosed container storage area with a maximum storage capacity of 2,750 gallons within a spill collection and containment structure.

3 Disclosure Statement

Gage LSF prepared a disclosure statement in accordance with the applicable requirements as stated in Michigan's Hazardous Waste Act; enacted by Public Act of 1994, Number 451, as amended. This disclosure statement is a component of Gage LSF's Application for a Michigan Act 451-Limited Storage Facility Operating License. The disclosure statement is provided in Appendix A1-9.

4 Topographic Map **[Form 5111 XIV.A.13]**

(40CFR 270.14 (b) (19))

The information required by 40 CFR 270.14 (b) (19) (a topographic map showing contours at 5-foot contour intervals and a distance of 1,000 feet around the facility) is provided in Figure A1-1b. The pattern of surface runoff is slow with moderately rapid on-site infiltration on unpaved areas. A regional topographic map that includes the Gage LSF and surrounding areas is contained in Figure A1-1b. Other information provided in association with the topographic map is summarized in the following sections.

4.1 100 Year Floodplain

The Gage LSF facility is not located within the boundaries of a 100-year flood plain. Army Corps of Engineers made this determination. A photocopy of a letter received from P. McCallister, P.E. in Appendix A1-1, indicates that the City of Ferndale has no special flood hazard and that a flood map for the community has not been published. The entire city, including the Gage LSF facility, is considered to be in Zone C, and area of minimal flood hazards.

4.2 Surrounding Land Uses

The facility is located within a mixed industrial and residential area. The land areas occupied by the Gage LSF are zoned M-2, general Manufacturing District. The areas immediately north and south of the facility are characterized by industrial activities. To the immediate west is a Canadian National (CN) switching yard. On the east side of Wanda are single-family residential neighborhoods. Residential land uses also border along the northeastern and southeastern edges for the property with Wanda Park located three blocks northeast of the facility (see Figure A1-3). Additional information regarding surrounding land uses is provided in the environmental assessment (Attachment B4).

4.3 Hazardous-Waste Management Facility Boundaries

The Gage Products Company occupies approximately 9.0 acres of land in the northeast quarter of the southwest quarter of Section 35, township 1 North, Range 11 East in Oakland County, Michigan. Figure A1-2 delineates the boundaries of the Gage LSF as well as the Gage Products Company as a whole. Parcels B, C D, and E, approximately 6.5 acres, are contiguous by virtue of the fact that access from one parcel to the other is by crossing the right-of-ways (Silman Avenue) and (Jewell Avenue). The Limited Storage Facility is constructed on Parcel C.

4.4 Wind Rose

Figure A1-4 contains a wind rose calculated from data collected at an Air Quality Division (ASQ) site.[1] The wind rose from Oak Park AQS ID 261250001, October 12, 2024, is approximately 4 miles northwest of the Gage LSF facility and indicates that the Predominant wind directions for this area are from the south and west.

[1] Oak Park ID 261250001 , Air Quality Division, Department of Natural Resources, P.O. Box 30028, Lansing Michigan.

4.5 Access Control

Barbed-wire-topped, 6-foot-high chain-linked fence and secured gates surround the entire Gage facility. Access to the various site parcels is controlled at the secured entrance/exit gates. All visitors to the site sign in at the office at 821 Wanda and are issued a security pass (see Appendix A1-2). Company employees when seeing visitors without security passes challenge visitors. During nights, weekends and holidays, all gates to the site are locked and security is provided by contracted security personnel. Contracted security officers make hourly clocked surveillance checks of the entire site. All guards are trained with regards to the emergency-response procedures. Office buildings are protected with an ADT intrusion/fire-alarm system in addition security cameras cover all access points for the entire facility. Access points are illustrated in the Facility Layout Map Figure A1-2 and the Evacuation Map Figure A1-6.

4.6 Injection and Withdrawal Wells

The site has no injection or withdrawal wells. The City of Detroit supplies all water used at the site and within the surrounding neighborhoods. A review of public records revealed no domestic groundwater supply wells within a two-mile radius of the Gage LSF facility. Twelve tank monitoring (TMW) and seven monitoring wells (GMW) have been installed at the facility since 1985. The tank monitoring wells were removed along with the underground storage tanks. Seven of these wells (GMW) have been used to obtain perimeter groundwater samples (see Attachment B5).

4.7 Limited Storage Facility, Buildings, and Other Structures

Figure A1-2 illustrates the location of the Limited Storage Facility, buildings, and other structures on the Gage LSF site.

4.8 Recreation Areas

Recreation areas located within a half mile of the Gage LSF facility include Wanda Park, three blocks northeast of the Gage LSF site (Figure A1-3).

4.9 Runoff Control System

Concrete pavement and storm sewers control site drainage and surface runoff. Surface runoff drains naturally to the east to catch basins located along the eastern portions of the property. These combined storm/sanitary sewers connect with the Twelve-Town Sewer. The Limited Storage Facility, including the bulk and container unloading area and container storage area are enclosed and protected from the weather. The paved areas surrounding the Limited Storage Facility are sloped away from the facility to prevent surface runoff from entering the unloading bay. Any precipitation blown in through the bay doors or through the wall-ventilation openings is captured by the building's containment structures. The unloading bay area has a total containment capacity (sump and floor volume) of 9,000 gallons. The container storage area has a total containment capacity (sump and floor volume) of 695 gallons. All sumps are inspected daily for any accumulations. All sump accumulations are analyzed for hazardous constituents of concern. Based on the analysis, the accumulations are

recovered and properly stored for recycling, proper off-site disposal, or (if appropriate) discharged to the combined storm/sanitary sewer.

4.10 Access and Internal Roads

Access to the Limited Storage Facility areas is restricted to Silman Avenue. Silman Avenue is partially vacated with the City of Ferndale controlling the first 250 feet and with Gage LSF and Alpha & Omega Steel controlling the remainder. An automatic access gate, located 300 feet west of the Silman and Wanda Avenue intersection, regulates vehicular access to the Limited Storage Facility. Approximately 150 feet west of the Wanda Silman intersect is a second access gate allowing access to the raw material-product unloading area. Vehicular traffic within the facility is limited to incoming and outgoing tankers and propane-powered forklifts. Employee parking is restricted to street parking on Jewel and Silman Avenues, and in on-site employee parking areas on Parcels A and D. Vehicle exit points and traffic patterns can be found in Site Layout Map Figure A1-2 and the Evacuation Map Figure A1-6.

4.11 Storm, Sanitary, and Process Sewers

Non-contact cooling water from the recycling process, boiler condensate/blow-down, sanitary waste waters and storm-water runoff from the facility are discharged to the City of Detroit's wastewater treatment plant through a combined storm/sanitary sewer line. The on-site catch basins connect with a Twelve-Town interceptor drain that runs north along Wanda. The locations of these catch basins and drains are identified in Site Layout Map Figure A1-2 and Engineering Drawing in Appendix A1-5.

4.12 Loading and Unloading Areas

Hazardous wastes are received at the Gage LSF in bulk tank trailers and 55-gallon drums. Hazardous-waste shipments received at the Limited Storage Facility are unloaded within the confines of the specially designed Limited Storage Facility building. Prior to the acceptance and unloading of any incoming waste a sample of the waste is analyzed according to the Waste Analysis Plan (see Attachment A3). The unloading area provides two bays for the off-loading of bulk tankers and one bay for the off-loading of box trailers containing drums. The structure has equipment to contain and remove any spills or leaks and has a total containment capacity of 9,000 gallons. Bulk loads are unloaded either directly into the processing units or into the Limited Storage Facility Tank Farm. Containers are unloaded by lift truck and moved into the container storage portion to the Limited Storage Facility. The total containment capacity for the container storage area is 695 gallons. The design of the Limited Storage facility, in close proximity to the hazardous-waste storage tanks, allows for the secured transfer of generated hazardous wastes to bulk transport vehicles for off-site disposal. The location of the unloading/loading areas is illustrated in the Facility Layout Map Figure A1-2 and the engineering drawing provided in Appendix A1-5.

4.13 Fire-Control Facilities

There are six fire hydrants close to the Gage LSF. Hydrants are located at the following corners: The southeast corner of Jewell and Wanda; the southeast corner of Silman and Wanda; the southeast corner of Channing and Wanda; the southwest corner of Wordsworth and Wanda; the mid-point of Jewell south of the tank farm; and adjacent to the CN railroad on the northwest side of Gage LSF on the vacated portion of Silman Avenue. The Fire Department can respond to a fire at the Gage LSF facility within five minutes. The enclosed portion of the Limited Storage Facility is equipped with

complete automatic-dry pipe sprinkler systems, installed in accordance with NFPA 13. In addition, Gage LSF has two on-site foam trailers that can be used in association with the fire department to apply foam. Fire extinguishers are located throughout the facility, and employees are trained in their correct use.

4.14 Surface Waters

There are no surface water features or wetlands on or near the Gage LSF facility. The nearest surface water is the Red Run Drain that is located four miles north of the Gage LSF facility (See facility location map, Figure A1-1b).

5 Location Information [Form 5111 XIV.A.9]

(40 CFR 270.14 (b) (11))

5.1 Seismic Standard

The seismic standard is not applicable to facilities located in Michigan.

5.2 Floodplain Standard

The facility is not located within a 100-year floodplain. A flood plain determination is provided in Appendix A1-1.

6 Traffic Patterns [Form 5111 XIV.A.8]

(40 CFR 270.14 (b) (10))

Transport vehicles arriving and leaving the Gage LSF facility utilize I-75 Expressway, Nine Mile Road, and Wanda Avenue. The I-75 Expressway is a six-lane concrete limited-access highway running north and south. This roadway carries a moderate to heavy volume of commercial, industrial, and commuter traffic. Entrances/Exits are provided to the I-75 and Nine Mile Road interchange. Nine Mile Road is a four-lane concrete and asphaltic primary road running east-west. This roadway carries a moderate-to-heavy volume of commercial, industrial, commuter, and residential traffic. Wanda Avenue is a two-lane concrete and asphaltic secondary road running north and south. This roadway carries a moderate volume of commercial, industrial, and residential traffic.[2] Access to the Limited Storage Facility is from Wanda Avenue located along the eastern edge of the site. Vehicles enter and exit the Limited Storage Facility through the gate on Silman Avenue. Silman Avenue is a compacted-gravel dead end street. The first 250 feet of Silman Avenue is under the control of the City of Ferndale. The remaining length of Siman Avenue is vacated and under the joint control of Gage Products Company and Alpha & Omega Corporation. All roadways have a load-bearing capacity sufficient to carry over the road trucks. Traffic signals and stop signs control vehicular traffic leading to the site. On-site traffic is controlled by stop signs.

The on-site traffic patterns and parking areas at the Gage LSF facility can be found in the Facility Layout Map (Figure A1-2), the Traffic Route Map (Figure A1-5), and the facility evacuation map, (Figure A1-6). Employees enter the facility through gates on Wanda and Silman Avenues. All employees have been issued access control badges that must be worn on-site. The access cards provide the employees with a keyless entry system to secured buildings and gates. Visitors sign in at the office located at 821 Wanda and are issued a visitor identification card. During evenings, weekends, and holidays, the gates are locked, and security is provided by contracted security personnel. During evenings, weekends, and holidays the gates are locked and secured. The gate that is located on the south side of Silman Avenue is used by tanker trucks bringing raw materials to the facility and for shipment of bulk products. The gate and shipping/receiving dock that is located on the north side of Jewell Avenue is used primarily for outgoing shipments of 55-gallon drum or portable tanks (totes). Approximately six (6) waste transporting trucks pass through Silman Avenue daily when Gage LSF is operating. In addition, raw-material deliveries average about four (4) daily trucks. Also, approximately six (6) shipments of blended product occur. Stop signs and attended gates control access and exit to the Limited Storage Facility.

Waste-hauling vehicles entering the facility via the Silman Avenue gate proceed west 0.4 miles from the I-75/Nine Mile interchange, south 0.6 miles on Wanda and turn west onto Silman Avenue.

7 Records

7.1 Manifest System, Record Keeping and Reporting

(40 CFR 264.73 AND Michigan Act 451, rules 299.9608, 299.9609, and 299.9610)

As required by RCRA and Michigan Act 451, Gage Products Company operates the Limited Storage Facility in accordance with the regulations which address the use of the manifest system (Rule 299.9608), and Recordkeeping (Rules 299.9608, 299.9609, and 299.9610).

Prior to the acceptance of a waste stream from a customer (generator), Gage LSF will notify the customer/generator that Gage LSF has the proper permit (s) and can accept the waste the generator is shipping. A copy of this written approval notification will become a part of the operating record.

When a shipment of hazardous waste, accompanied by its manifest, is received at Gage LSF, the company agent will do all of the following:

- Examine the manifest for completion and accuracy.
- Sign and date each copy of the manifest to certify that the hazardous waste covered by the manifest was received.
- Note any significant discrepancies in the manifest (as defined in 299.9608 (4)) on each copy of the manifest.
- Immediately gives the transporter at least one copy of the signed manifest.
- Within thirty days after the delivery, send a copy of the manifest to the generator.
- Checks the completeness of the land disposal restriction notification form, if applicable.
- Retain at the facility a copy of each manifest sent to the state where the customer/generator resides and send the generator their copy within ten days after the end of the month in which the waste was received,
- Upon discovering a significant discrepancy, Gage LSF will attempt to reconcile the matter with the waste generator transporter through telephone conversations or otherwise. If the discrepancy is not resolved within fifteen days after receiving the waste, Gage LSF will immediately submit, to

the director and regional administrator, a letter describing the discrepancy and the attempts to reconcile it and a copy of the manifest or shipping paper related to the issue. Significant discrepancies are differences between the quantity and/or type of hazardous waste designated on the manifest and the actual quantity or type of hazardous waste actually received at Gage LSF.

(i) For the bulk waste, significant discrepancies are variations of more that 10 percent in weight.
(ii) For batch waste, a significant discrepancy is any variation in piece count.
(iii) For type, an obvious difference which may be discovered by inspection or waste analysis.

A decision regarding a rejected load will be made within twenty-four hours of receiving the load. Rejected loads will be handled in accordance with Section 7.1.1 below.

Manifest selection will be in accordance with the requirements specified in 40 CFR 262.20.

The manifest must contain (per 40 CFR.21) at a minimum, the following information:

- A manifest tracking number;
- Name and mailing address of generator;
- Each transport's name, EPA identification number, and phone number.
- The destination of the waste shipment, including address and EPA identification number.
- May designate an alternative hazardous-waste alternate facility, including address and EPA identification number.
- The Department of Transportation's proper shipping name, hazard class, and I.D. number.
- The quantity or volume of waste in the shipment.
- The number and type of containers in the shipment**.**
- The applicable EPA hazardous-waste number
- A signed, dated certification of the shipment's contents.
- The 24-hour telephone number of the person with detailed information of the hazardous characteristics of the materials being shipped.
- The proper use of technical names with any shipments using the N.O.S. shipping description.
- A completed land disposal restriction notification form, if applicable.

For waste shipments, a Gage LSF representative will sign and date the Generator's Certification section of the manifest and obtain the written signature of the transporter and the acceptance date. The Gage LSF representative will retain the specified copies and give the transporter the remaining copies. For Michigan manifests the generator retains the first (State copy) and the Generator First Copy. Then the generator mails the State copy of the manifest to the EGLE no later than 10 days after the month in which the shipment was made.

If Gage LSF does not receive a copy of the manifest (Generator Second Copy) with the handwritten signature of the owner or operator of the designated facility within 35 days of the date the waste was accepted by the initial transporter, the Gage LSF will contact the transporter and/or the owner or operator of the designated facility to determine the status of the waste. If Gage LSF does not receive a copy of the manifest with the handwritten signature of the owner or operator of the designated facility within 45 days of the date the waste was accepted by the initial transporter, Gage LSF will submit and Exception Report to the EGLE Director and to the Environmental Protection Agency Regional Administrator for Region V.

The Environmental, Health & Safety Department will make a decision regarding a notification of a rejected load by the receiving licensed disposal facility. Section 7.1.1 below describes how rejected loads will be handled.

7.1.1 Rejected Load Procedure

When a waste shipment does not conform with the approved waste stream profile or Gage LSF standards, the generator will be notified, and the load rejected. Loads which do not conform to the waste stream profile or permit conditions will be rejected following the requirements provided in 40 CFR 264.72.

7.2 General Facility Records

All records and plans required by 40 CFR 264.73 and Michigan Act 451, Rule 299.9609, as well as any other records required under the facility's permit or license, are retained at the facility and are available, at reasonable times, for inspection by designated representatives of the U.S. EPA and EGLE. All records are retained for a period of at least three years or longer, as specified by the regulations. A summary of the organization's recordkeeping procedures has been provided in Appendix A1-6. The following records are retained at the facility:

- Daily operating records which include, for each waste, the quantity, waste determination, date of storage, and location of the waste in the facility (cross-referenced to specific incoming manifest document numbers.)
- Record and results of analyses of wastes from each source, including initial analyses and any follow-up analyses.
- Act 64 Limited Storage Facility application, plus and modifications.
- Notice of EPA ID number.
- Inspection reports, logs and any results of inspections including all inspection reports prepared routinely by plant employees (see Inspections Attachment A5) and all inspection reports performed by outside inspection or testing services.
- Copies of the Procedures to Prevent Hazards (Preparedness and Prevention Attachment A6, Appendix A6-1).
- Copies of arrangements and coordination agreements with local authorities regarding the Contingency Plan. (Attachment A7)
- Copies of the written training program required by the Contingency Plan.
- Personnel training records including the job titles for each position having hazardous-waste management responsibilities, the name of each employee filling each job title, and the written job description for each hazardous-waste management positional listed, as outlined in Attachment A10.
- Documentation that the required training has been successfully completed by each employee with hazardous-waste management responsibilities.
- Copies of any written reports required to be submitted to the EPA or the EGLE after incidents occur at the facility which require implementation of the Contingency Plan per 40CFR 265.56 (j).
- The facility's copy of the manifests for each hazardous waste that had been received by Gage LSF.
- Copies of the Closure Plan (Attachment A11).
- Closure cost estimated and any annual adjustments (Attachment A12).
- Certificate of liability insurance or equivalent as required by the U.S. EPA and EGLE (Appendix A1-8).
- The Limited Storage Facility's Operating License as issued by the EGLE and any modifications to the permit.
- Permits which may be required.
- Copies of any reports, data, information, etc., requested by and submitted to, any federal, state, county, or any agency having authority, for five years.

- Records of waste shipments rejected.
- Generator Records (regarding waste material shipped from this facility):
- Copy of test results, analyses and any other determination made on the waste shipped off-site, for five years.
- Generator manifest copy signed by the initial transporter.
- Generator manifest copy signed by and returned by the disposal facility.
- Exception reports, as necessary, per 40 CFR 262.42.
- Land Ban records, per 40 CFR 268.7.
- Gage LSF, in compliance with Michigan's Act 451, Section R 299.9610, Rule 610, will prepare a biennial report on March 1 of even numbered years covering all activities during the precious year that are regulated by Act 451. This report includes:
  - EPA ID number, name and address;
  - The period covered by this report;
  - All of-site facilities, including EPA ID number from which the facility received hazardous waste during that period;
  - A description and quantity of each hazardous waste and method of treatment, storage or disposal, and;
  - The report will contain a signed certification by Gage LSF authorized representatives.

7.3 Land Disposal Restrictions Recordkeeping Requirements

All facilities that receive or generate restricted wastes are subject to land disposal restriction recordkeeping requirements. Generators are required to provide Gage LSF with the first shipment of the waste a written notice that describes the appropriate treatment standards set forth in 40 CFR 268 Subpart D and any applicable prohibition levels set forth in 40 CFR 268.32 or RCRA 3004 (d), respectively. These recordkeeping requirements are discussed further in the Waste Analysis Plan provided in Attachment A3.

For generated process wastes that will be managed at an off-site disposal facility, Gage LSF will comply with the same generator notice and certification requirements.

Gage LSF will maintain copies of all generator notices and certification and copies of notices and certification sent by Gage LSF to off-site disposal facilities for a minimum of five years.

8 Security Procedures and Equipment [Form 5111 XIV A.4]

Gage LSF uses a 24-Hour surveillance system and barriers as a means to control entry. These measures include, for Parcel C the Limited Storage Facility, a brick wall enclosure, barb-wired-topped 6-foot-high chain-link fence and secured gates. Two gates on Silman Avenue are used for vehicles entering or leaving with raw materials and hazardous waste materials. A third gate on Jewell Avenue provides access to a shipping/receiving well. In addition, at the west end of Parcel C is a railroad-spur entry gate. This gate is kept locked except when rail tankers delivering product or picking-up waste are entering or leaving. All gates are subject to employee surveillance during normal working hours. The access gate to the Limited Storage Facility remains closed except when trucks are entering or leaving (see Facility Lay Out Map Figure A1-2).

The Parcel C operation is staffed 24 hours per day, five (5) days per week by Gage LSF personnel. Site security is controlled by security personnel at night and on weekends. Routine security

surveillance includes inspection of the facility, equipment, and property, including fences, gates, doors, and lighting. All access points are locked and secured when the facility is not in operation.

Hazardous wastes are delivered to this site in licensed vehicles operated by common carriers. Vehicles are permitted access to the facility only if prior arrangements have been made with Gage LSF management personnel and if they are cleared by Gage Products personnel upon arrival at the facility.

All guests are required to sign in and out and are provided a visitors guide with safety evaluation maps and emergency contacts. These forms have been provided as Appendix A1-2.

Warning Signs:

Warning signs are posted at each gate of the facility. The sign plates read "NO TRESPASSING - FEDERALLY REGULATED FACILITY – FELONY OFFENSE –VIOLATORS WILL BE PROSECUTED." These signs are visible from all angle of approach and are legible from a distance of 25 feet. In addition, "No Smoking" signs are conspicuously placed wherever there is a potential hazard due to the close proximity to ignitable waste.

Waiver

Gage LSF does not request a waiver of the requirements stated in 40 CFR 264.14(a) (1) and (2) regarding injury to or violation by an intruder.

9 Compliance with Other Federal Laws [Form 5111 XIV B.1]

A status of compliance with federal laws applicable to the facility is provided in Appendix A1-3.

10 Permits or Licenses [Form 5111 XIV B.7]

The facility only has one other environmental permit.

- Air Permit EGLE AQD 64-18B SRN: N0842 Effective Date May 30, 2019

11 Capability Certification Professional Engineer [Form 5111 XIV B.8]

A professional engineer (PE) from Barr Engineering reviewed the engineering plans provided in Appendix A1-5, the previous engineer's calculations Appendix A1-4 and performed a site inspection of the hazardous waste storage areas covered under this RCRA permit application on September 6, 2024, to determine the facilities capability to manage hazardous waste. The PE's certified evaluation has been provided in Appendix A1-4 along with a copy of the previous 2013 evaluation and determination. The PE determined the Gage LSF facility was capable of managing of storing and managing the hazardous waste materials as outlined in this permit application.

12 Engineering Plans [Form 5111 XIV B.6]

Appendix A1-5 contains engineering drawings for each storage area. The drawings obtained in Appendix A1-5 include the following:

Drawing A-1: Floor Plan
Drawing A-2: Building Elevations
Drawing A-3: Building Detail Sections
Drawing A-4: Roof Plan and Sections
Drawing A-5: Stair Details
Drawing C-1&2: Site Plans Civil
Drawing S-1: Foundation Plan
Drawing S-2: Sections & Details
Drawing S-3: Catwalk Plan & Details
Drawing S-4: Tank Farm Plan
Drawing S-5: Tank Farm Concrete Details
Drawing S-6: Roof Framing Plan Details
Drawing M-1: Tank Farm Piping Plan
Drawing M-2: Tank Farm Piping Details
Drawing S-5 Revised, Tank Secondary Containment Liner Drawing
Calculations, Tank Secondary Containment Calculations (2 pages)

13 Photographs of Storage Areas [Form 5111 XI]

Photographs of the storage areas are provided in Appendix A1-7.

14 Insurance / Letter of Credit [Form 5111 XIV.A.14 and 15]

[40 CFR 270.14 (b)(17) and 264.147]

14.1 Sudden and Accidental Occurrences

Gage LSF is insured for liability arising from sudden and accidental occurrences in the amount of $1 million per occurrence and $2 million annual aggregate exclusive of legal defense costs. Financial responsibility for this liability coverage is demonstrated by Gage LSF's insurance policy (see Appendix A1-8).

14.2 Letter of Credit

A letter of credit has been included in Appendix A1-8

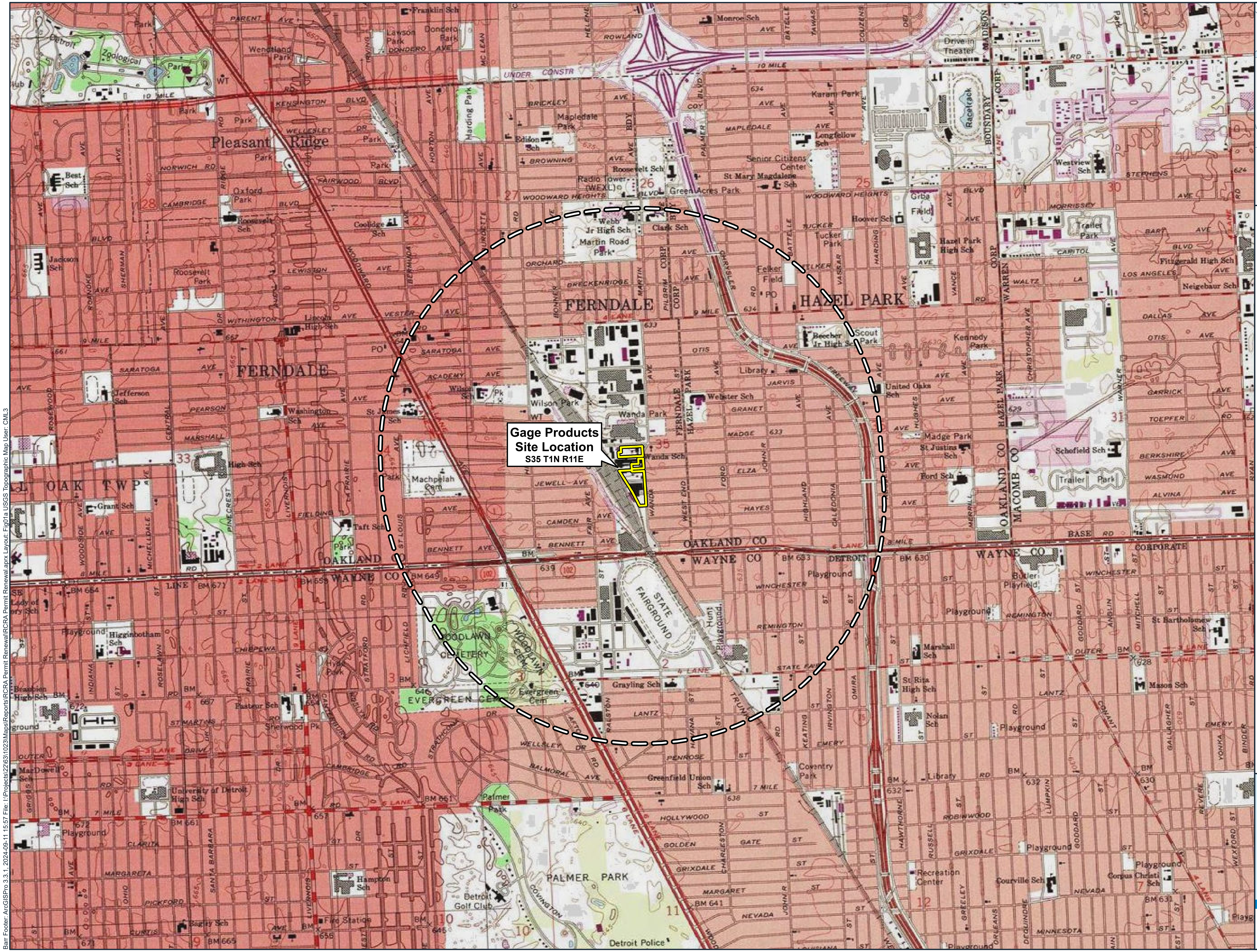
14.3 State Assumption of Responsibility

Gage LSF does not plan to request State assumption of the legal or financial responsibilities at this time.

Figures

Appendices

Figures



Property Boundary

Property Boundary 1-mile Buffer

0 2,000 4,000

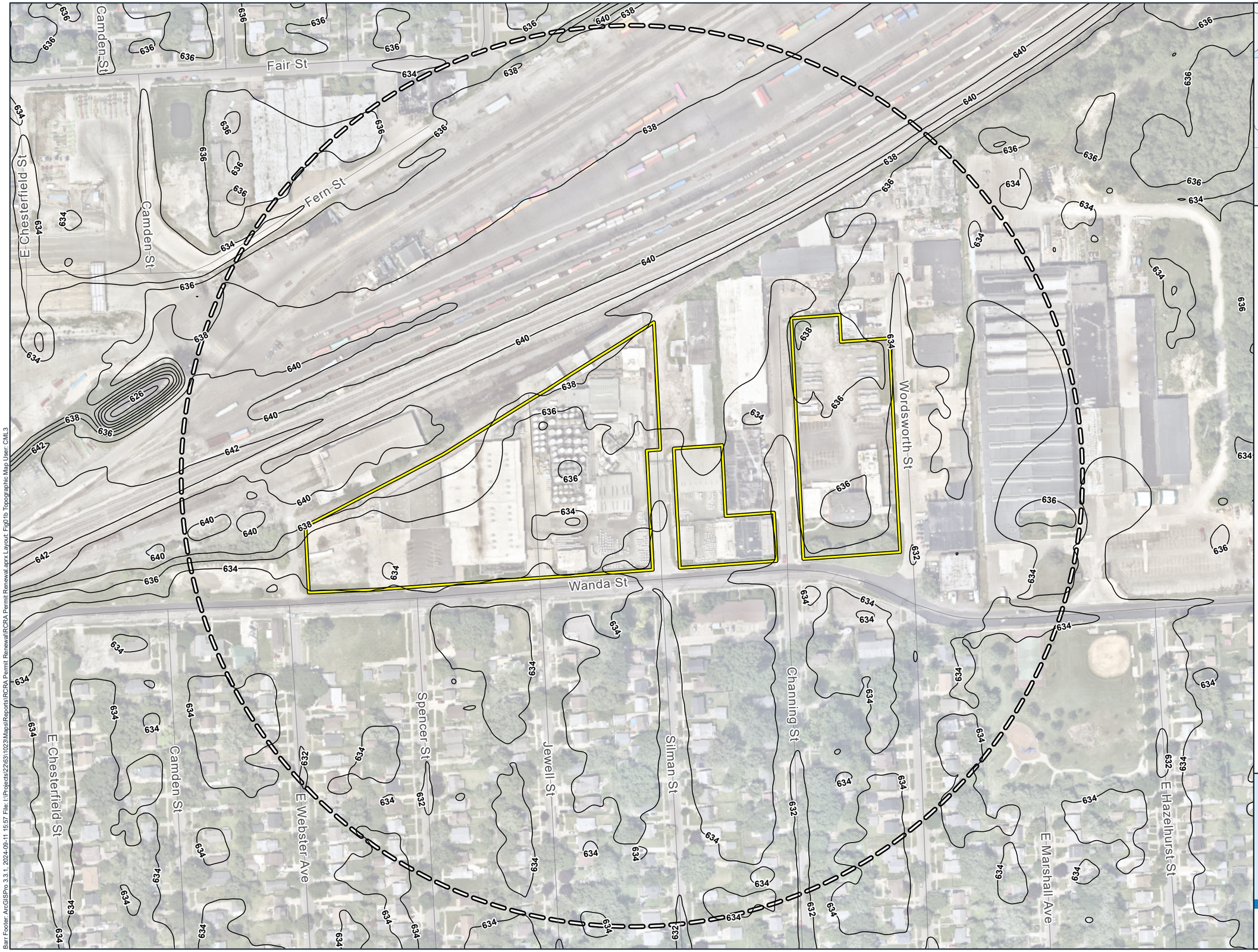
Feet

Basemap: USGS 7.5 Minute Quadrangle Map

Location Map
USGS Topographic Map
Gage Products Ferndale, MI

Attachment A1
FIGURE A1-1a

BARR



Property Boundary

1000-ft Buffer Around Center of Site

Elevation Contour (2-ft interval)

Notes:

• Elevation data from National Oceanic and Atmospheric Administration (NOAA) Digital Coast Data Access Viewer. Custom processing of "2016 - 2017 NRCS Lidar: 30 County MI". Charleston, SC: NOAA Office for Coastal Management. Accessed Sep 11, 2024 at https://coast.noaa.gov/dataviewer.

0 200 400

Feet

Aerial Image: Nearmap 5/31/2024

Topographic Map
Gage Products
Ferndale, MI

Attachment A1
FIGURE A1-1b

BARR

Barr Footer: ArcGISPro 3.3.1, 2024-09-11 15:57 File: I:\Projects\2263\1023\Maps\Reports\RCRA Permit Renewal\RCRA Permit Renewal.aprx Layout: Fig01b Topographic Map User: CML3

Property Boundary
Parcel Boundary
A Parcel ID
Site Feature

0 100 200
Feet

Aerial Image: Nearmap 5/31/2024

Site Layout
Gage Products
Ferndale, MI

Attachment A1
FIGURE A1-2

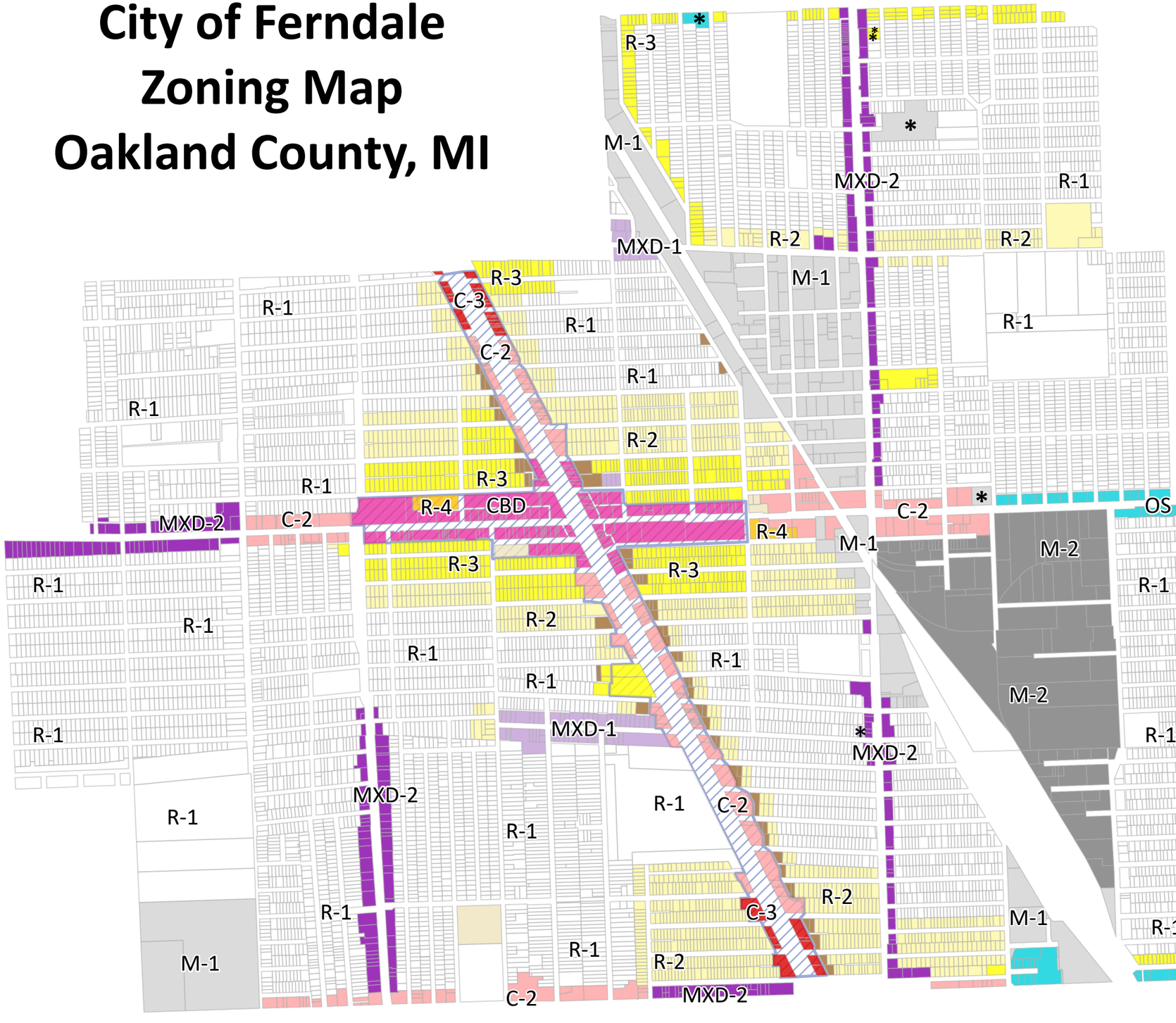
BARR

Barr Footer: ArcGISPro 3.3.1, 2024-09-12 08:29, File: I:\Projects\22\63\1023\Maps\Reports\RCRA Permit Renewal\RCRA Permit Renewal aprx Layout: Fig02 Site Layout User: CML3

City of Ferndale
Zoning Map
Oakland County, MI

Attachment A1
Figure A1-3

Land Use



Zoning Districts

- R-1 Single Family Residential
- R-2 Single/Two-Family Residential
- R-3 Single/Multiple-Family Residential
- R-4 Multiple-Family Residential
- MXD-1 Mixed Use 1
- MXD-2 Mixed Use 2
- CBD Central Business District
- C-2 General Commercial
- C-3 Extended Business
- M-1 Limited Industrial
- M-2 General Industrial
- P-1 Vehicle Parking
- OS Office Space
- PUD Planned Unit Development
- Transit Oriented Development Overlay

0 1,000 2,000 4,000 Feet

N

FERNDALE

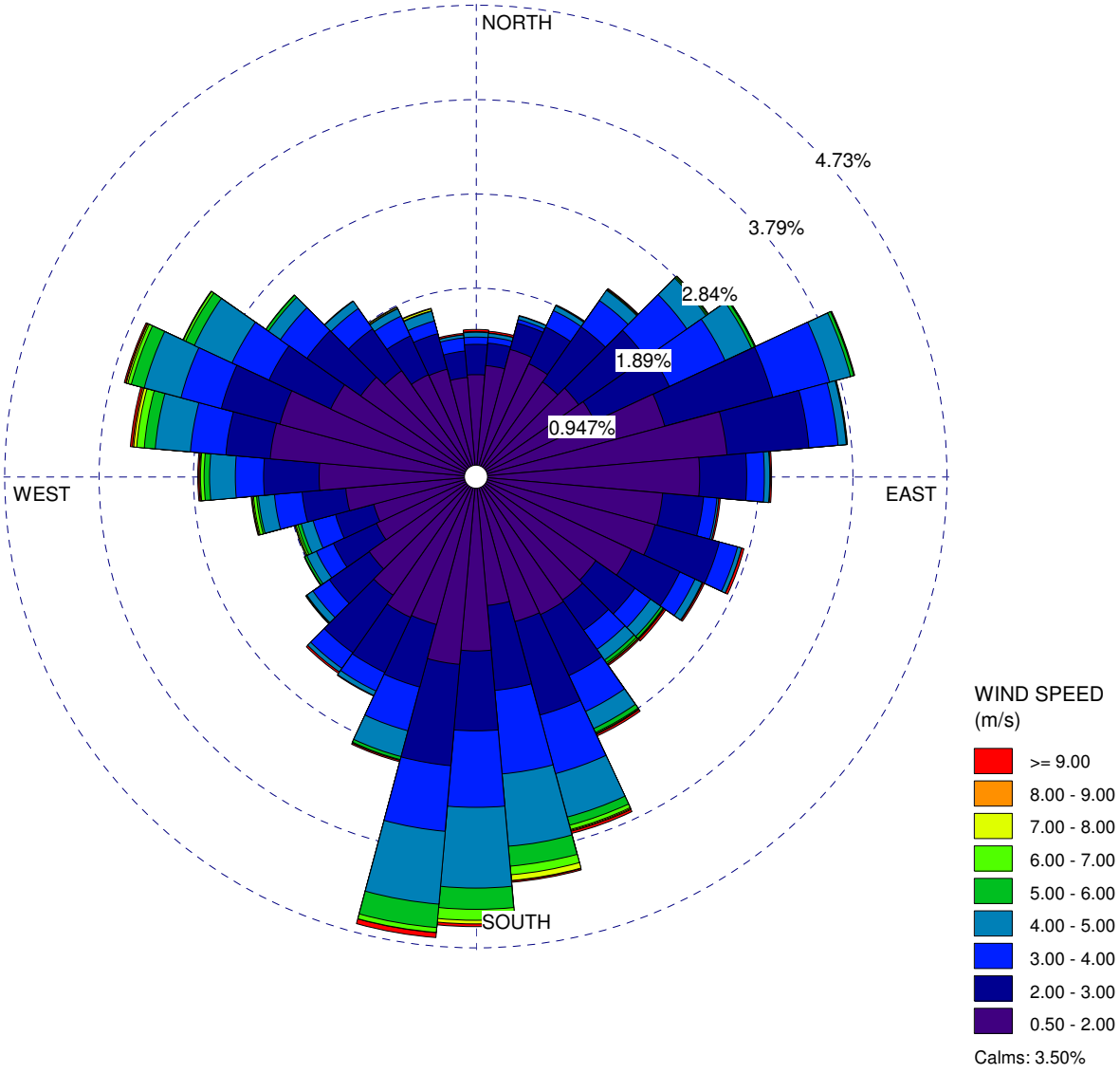
Note: *The property is subject to a conditional rezoning agreement.
Source: City of Ferndale. April 2021.

WIND ROSE PLOT:

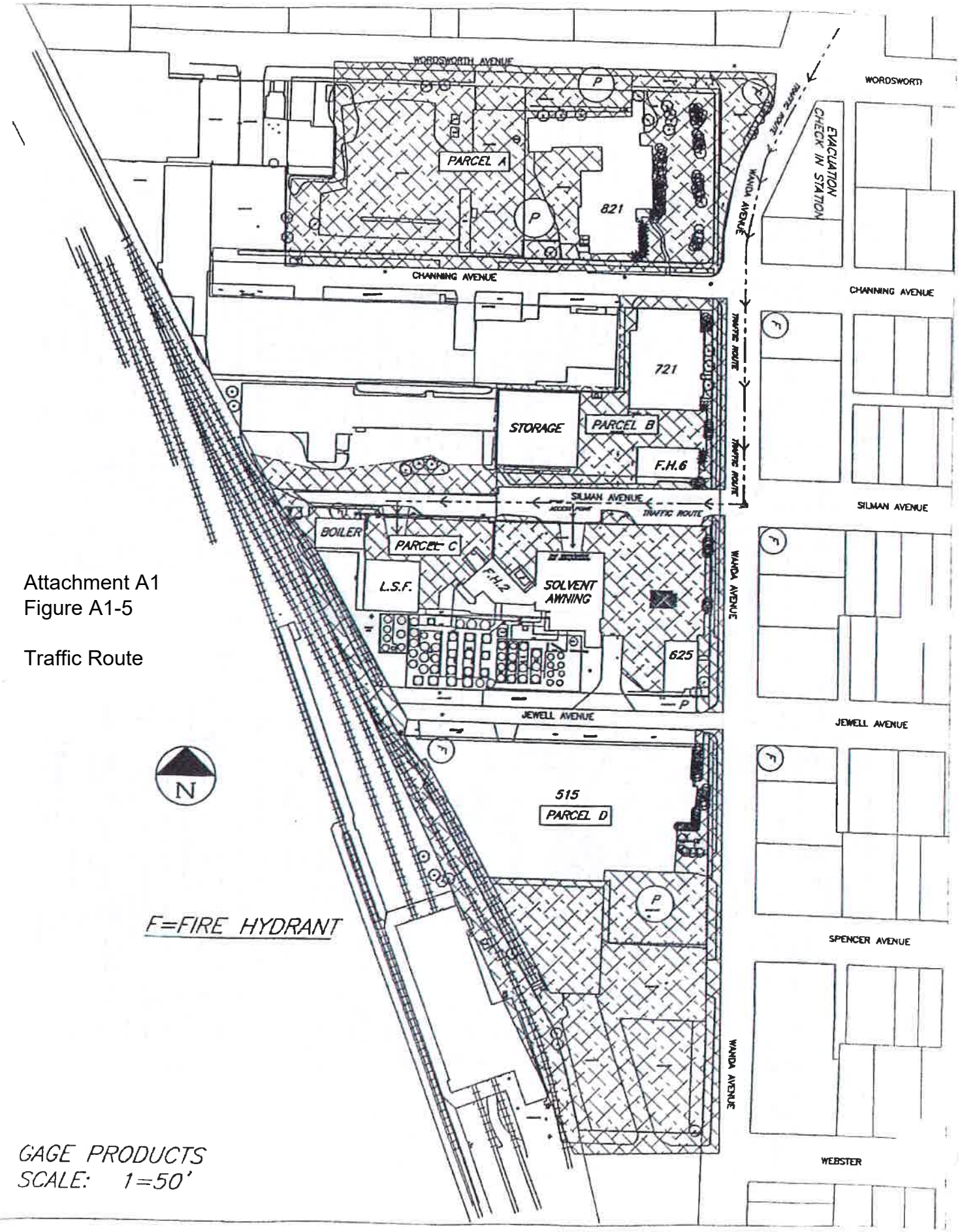
Oak Park - AQS ID: 261250001
Gage Products Company

DISPLAY:

Wind Speed
Direction (blowing from)

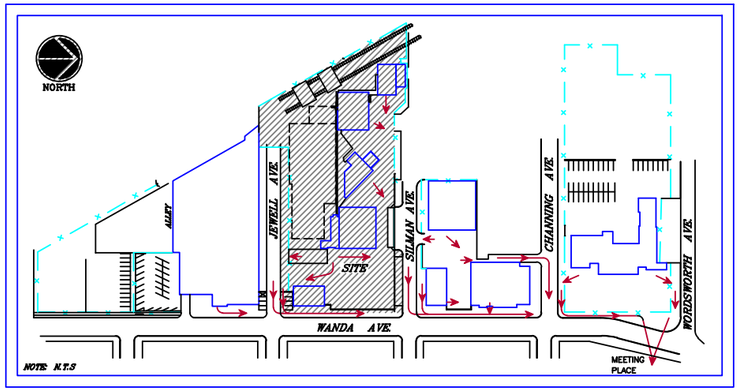


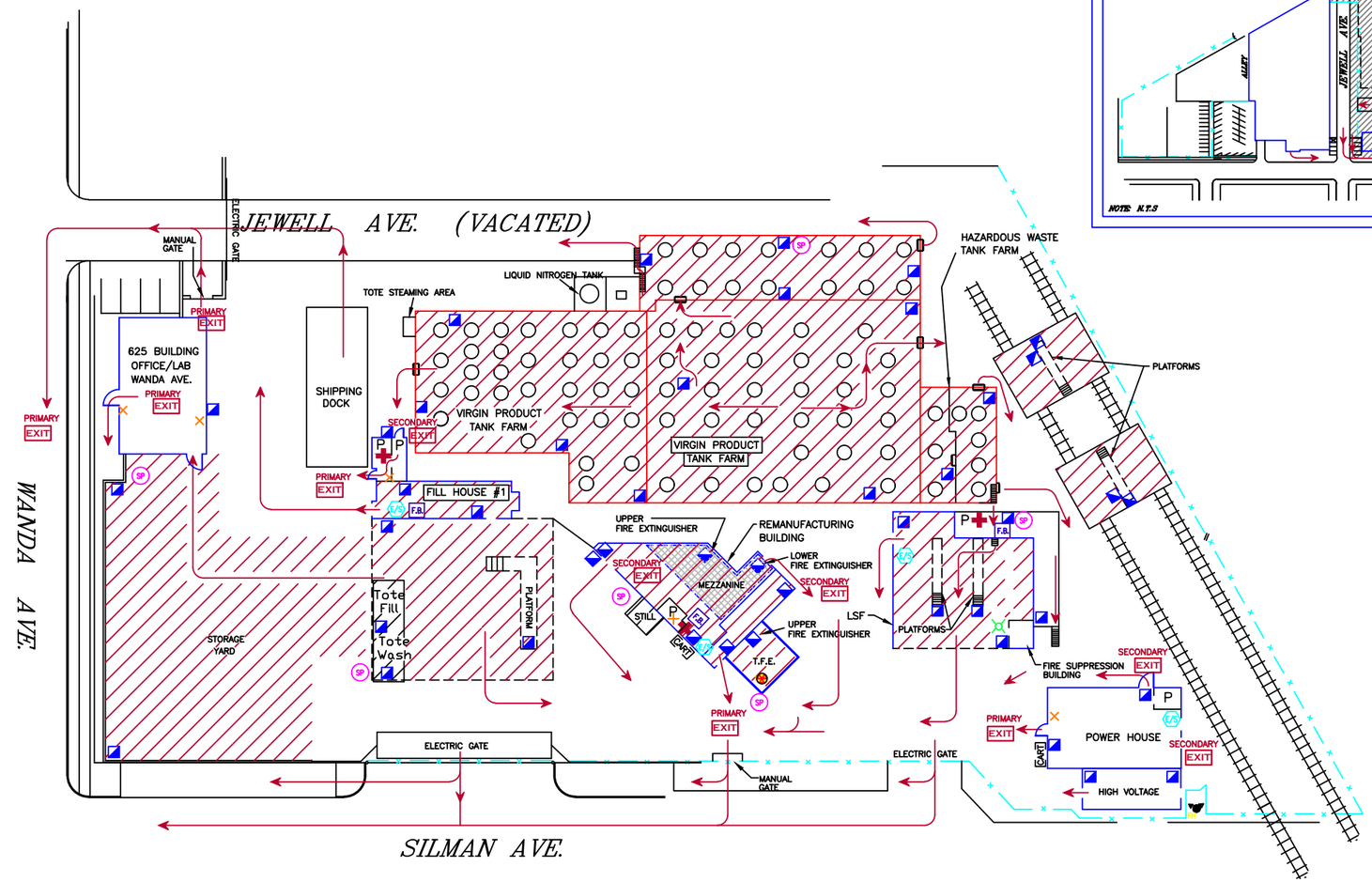
COMMENTS:	DATA PERIOD: **Start Date: 1/1/2018 - 00:00** **End Date: 12/31/2022 - 23:00**	**Attachment A1, Figure A1-4: Wind Rose**	
	CALM WINDS: **3.50%**	TOTAL COUNT: **43743 hrs.**	BARR
	AVG. WIND SPEED: **2.20 m/s**	DATE: **8/12/2024**	PROJECT NO.: **22631293.00**



Attachment A1
Figure A1-5

Traffic Route





NORTH

LEGEND

P	TELEPHONE
	FIRE ALARM
	FIRE EXTINGUISHER
	FIRST AID KIT
E/S	EYE WASH/SHOWER
SP	SPILL KIT
F.B.	FIRE BLANKET
CART	FIRE EXTINGUISHER (PORTABLE CART)
	FIRE HYDRANT
	EVACUATION ROUTE
	STAIRS/LADDER
EXIT	PRIMARY OR SECONDARY EXIT
	EMERGENCY EVACUATION PLAN
	FLAMMABLE BLEND/ TRANSFER/ STORAGE
	2 mCi CS-137 in Sealed Source Container

Attachment A1
Figure A1-6
Evacuation Map

REV#	REVISIONS	BY	DATE

GAGE PRODUCTS COMPANY
6-A 625 Lot
Evacuation Plan

REVISION #: 0
REV DATE: 20240816
DRAWN BY: MD

Appendices

Appendix A1-1

Flood Plain Letter

DEPARTMENT OF THE ARMY
DETROIT DISTRICT, CORPS OF ENGINEERS
BOX 1027
DETROIT, MICHIGAN 48231-1027

AUG 19 1985

IN REPLY REFER TO

Planning Division - SS

Mr. Chuck Czarnecki
Gage Products Company
625 Wanda Avenue
Ferndale, Michigan 48220

Dear Mr. Czarnecki:

This is in response to your August 9, 1985, telephone call and follow-up letter, dated August 12, 1985, requesting flood plain information for the City of Ferndale, Michigan.

Ferndale has been a participant in the National Flood Insurance Program (NFIP) since January 31, 1983. The Federal Emergency Management Agency of the Federal Insurance Administration, which administers the NFIP, has determined that Ferndale has no special flood hazard areas; therefore, a flood map for the community has not been published.

Although Ferndale may not be subject to the 100-year flood, floods of a greater magnitude could occur there. In addition, certain structures may be damaged by local drainage problems.

For insurance purposes, the entire city, including the property of Gage Products, is considered to be in Zone C, an area of minimal flood hazards. Flood insurance for Zone C may be purchased at the lowest rate. The option to buy flood insurance is up to the owner. There is no Federal flood insurance requirement for property in a Zone C. However, lending institutions may require that flood insurance be purchased.

If you have any further questions, please contact Mr. Joe Wanielista, project manager, Flood Plain Management Services, at 226-6773.

Sincerely,

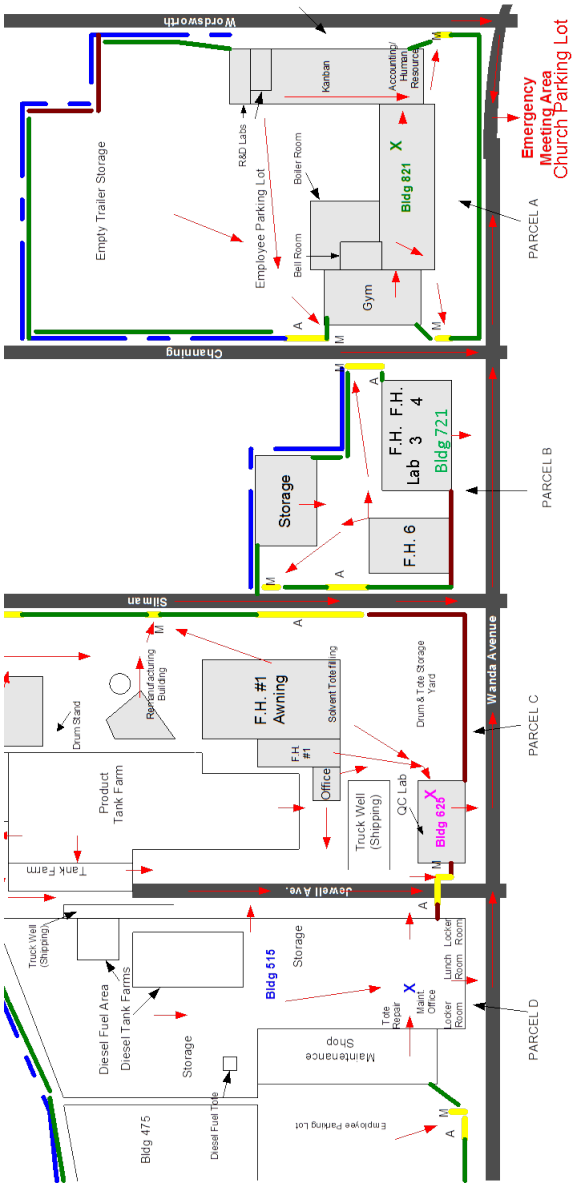
P. McCallister, P.E.
Chief, Planning Division

Figure B-4
100-Year Flood Plain Letter

Appendix A1-2

Visitor Guide and Sign-In

Facility Map



Emergency Call Information

9-1-1
Dial 9-1-1 in case of emergency

IN HOUSE:

Brenna Harden	719
David Doutsas (Safety)	589
Julie Mileskiy (Environmental)	574
Andrea Seyhel (EHS Coord.)	587

HOSPITAL:
Royal Oak Beaumont: 1-248-898-5000
Emergency Center: 1-248-898-2000
3601 West 13 Mile Road, West of Woodward Avenue

EMERGENCY SERVICES:
Poison Control: 1-800-222-1222
CHEMTREC: 1-800-424-9300
Fire Department: 911 or 248-546-2510
Police: 911 or 1-248-541-3650
Spill Response Contractors (Marine Pollution Control): 1-313-849-2333
Detroit Water Dept.: 1-313-267-6000 or 1-313-267-9000

EPA ID NUMBER:
MID 005 338 801

Welcome to Gage Products Company

GAGE solvents recycling fuels solutions

Visitor and Safety Information

rethink_refine_resolve®

Quality Policy

Gage Products Company realizes its Vision and Mission through our Gage Production System (GPS). We utilize our GPS to apply standardized tools and documented processes to achieve corporate objectives and improve customer satisfaction.

Environmental Policy

Gage Products Company conducts its operations to meet or exceed applicable environmental laws, regulations and other requirements to which we subscribe. Through our GPS we are committed to environmental protection, pollution prevention, and the continual improvement of our environmental management system in order to enhance environmental performance.

Gage Products established a GPS that conforms to ISO 9001, 14001, and 17025 standards.

GPS QR 017; Rev:17; Revision Date: 29 Jan 24

General Rules

- Contractors/Visitors must sign in and out at the applicable location:

a. Bldg. 821 – At reception
b. Bldg. 515 – At the maintenance office
c. Bldg. 625 (after hours) – At the guard station

- Contractors/Visitors will NOT be allowed to conduct any activities on the property without prior knowledge of an applicable Gage Employee.
- Wear visitor pass in plain view for identification purposes at all times. Return pass to reception area or your host when leaving.
- Advise your host if you expect phone calls, and no cell phone use in production areas or labs.
- No photographs are to be taken without the consent of the President of Gage Products Company
- Gage is regulated under U.S. Homeland Security – Any unauthorized access on Gage property is punishable as a federal felony offense.

The management of Gage Products Company holds in high regard the safety, welfare and health of its employees. We believe that "Production is not so urgent that we cannot take time to do our work safely."

Safety

- No smoking on Gage property.
- Canvas or open-toes shoes are not allowed in manufacturing and laboratory areas.
- Safety glasses with side shields, or goggles must be worn in areas requiring eye protection.
- Hard hats are required in manufacturing areas.
- Stay away from operating equipment, chemical containers, and laboratory equipment.
- Watch out for lift trucks (forklifts).
- Contractors will receive safety orientation by Environmental, Health, and Safety (EHS) or authorized maintenance personnel before working on Gage property, when and where applicable.
- Permits must be obtained from Maintenance or EHS for hot work, lockout/tagout, line breaking, and confined space entry.
- If evacuation alarms sound and/or you hear an overhead communication system statement that there is an emergency (i.e., spill, fire, explosion) that requires evacuation, exit the area and proceed to the offsite meeting area. There are Emergency Evacuation Maps located in each building.

GAGE PRODUCTS COMPANY
SIGN-IN/OUT FORM

DATE:_____

TIME IN:_____ **TIME OUT:**_____

GUEST NAME and Phone Number: _____

_____

COMPANY NAME:_____

HOST'S NAME:_____

I _____ have read and received a copy of the "Welcome to Gage Products Company" guest general, safety and environmental requirements. I understand I must follow these requirements for my own safety as well as the safety of employees and neighbors of Gage Products Company. I further understand that I must ***sign-out at the appropriate location*** when I leave the premises and return my badge.

_____ _____

GUEST SIGNATURE RECEPTIONIST SIGNATURE

Appendix A1-3

Statement of Compliance with Federal Laws

APPENDIX A1-3

EQP Form 5111 XIV B.1.

STATUS OF COMPLIANCE WITH OTHER FEDERAL LAWS.

At this time, we believe this facility is in compliance with the following federal laws: Wild and Scenic Rivers Act, National Historic Preservation Act of 1966, Endangered Species Act, Coastal Zone Management Act, and the Fish and Wildlife Coordination Act. Information will be provided in accordance with the requirements of 40 CFR part 270.14(b) (20) at the request of the EPA Region V Office or the Michigan Department of Environment, Great Lakes and Energy (EGLE).

We also believe that this facility is in compliance with Act 451, Rule 299.9602 in that the facility has been located, designed, and constructed and is operated in a manner that prevents: violations of the Federal Clean Water Act, Michigan Act 451 Part 31; exposure of humans or the environment to harmful quantities of hazardous waste or hazardous constituents; or pollution, impairment, or destruction of the natural resources of the state. This facility does not discharge to groundwater; all wastewater discharged to the municipal sewer system meets the applicable pretreatment standards for this facility, and no wastewater is discharged to surface waters of the state.

Regarding the Federal Clean Air Act and its implementing regulations, Gage Products Company is in discussions with EPA Region V about air permit compliance and related concerns that were raised by the agency in the notice and finding of violations (NFOVs) in 2024. The State of Michigan, via EGLE's Air Quality Division, has been included in communications regarding the NFOVs and prior information requests from EPA. The alleged noncompliance does not list emission units within the Limited Storage Facility (LSF) that is the subject of this permit renewal. Gage anticipates resolving the agency's concerns in the coming months.

Appendix A1-4

Capability Certification
Professional Engineer

ATTACHMENT A1, APPENDIX A1-4
PE CERTIFICATION AND CAPABILITY STATEMENT

2024 PE Inspection, Certification and Statement of Facility's Capability to Manage Waste

2013 PE Review, Calculations, Design Information and Certification

Statement of Facility's Capability to Manage Waste

Attachment A1, Appendix A1-4

Form EQP 5111 XIV B. 8.

Capability Certification / Compliance Schedule

The following information is provided in support of the Certification of Capability required to be included with 2024 Gage RCRA permit renewal application form EQP 5111, item XIV B.8.

1.0 General Information

In accordance with MI Public Act 451 Rule 324 Part 11123(2)(n)(iii) the following areas were reviewed in certifying that the Gage Products Facility is capable of treating, storing, or disposing of hazardous waste in compliance with this part: Limited Storage Facility (LSF) container storage area, tank farm storage area, and unloading area.

A licensed professional engineer (PE) from Barr Engineering Co. performed an inspection of the LSF container storage, tank storage, and unloading areas on September 6, 2024. The inspection included a review of AST inspection records and reports, a review of equipment inspection forms, interviews with site personnel, a review Subpart BB and Subpart CC Documents. The PE reviewed the secondary containment calculations, basis of design documentation, and construction materials documentation included in last RCRA Part B permit renewal application dated January 2013, Section D and the prior Certification of Capability to Manage Waste, Section L. The PE also reviewed supplemental information provided by Gage Products staff after the inspection confirming the presence of a microsilica concrete lining in both the container storage and tank storage areas.

2.0 LSF Container Storage

There have been no structural changes to the LSF container storage system since the previous PE review on 1/17/2013. The LSF container storage area is protected from weather, precipitation and UV exposure by a roof and partial wall enclosure. The LSF container storage area was found to be adequately bermed to prevent spill migration and is sloped toward the containment sump consistent with the Floor Plan in the May 1995 as builts included in Section D of the prior renewal application dated January 2013. The microsilica concrete lining of the drum storage area was in good condition. There was no evidence of spills. The container storage area was determined to be capable of storing and handling hazardous waste as described in this application.

3.0 LSF Tank Farm/Storage Tank System

Containment System:

The LSF tank storage area was inspected by Barr Engineering on September 6, 2024. There have been no structural changes to the LSF storage tank containment system since the previous professional engineer's inspection on 1/17/2013. The LSF tank storage area is protected from weather, precipitation and UV exposure by a roof. The containment structure is consistent with the Tank Farm Plan in the May 1995 as builts included in Section D of the prior renewal application dated January 2013. The tank secondary containment system is constructed of two layers of concrete. The outer layer is standard reinforced concrete with sealed joints. The inner concrete liner is made from microsilica concrete engineered to provide containment for the materials stored in the tanks. The original containment design drawings are included in Attachment A1, Appendix A1-5.

The LSF tank farm secondary containment system was determined to be capable of containing the hazardous wastes stored in the tanks as described in this application.

Tank Systems:

The stainless-steel tanks are managed following the API-653 inspection standard and are inspected on a cycle as recommended by the professional engineer performing the inspection. The tanks are inspected on a 5-year external inspection cycle, performed by Technical Service Professionals, LLC. The API-653 inspection reports are maintained on-site. The API-653 reports indicated the tanks and piping were suitable for their intended service. In addition to the API-653 program the facility performs separated inspections and maintenance of the tanks and associated piping/valves/pumps to ensure the tanks systems are capable of storing and handling hazardous waste.

Based on the API-653 inspectors reports and visual inspection of the tank systems, the LSF tank system was determined to be capable of containing the hazardous wastes stored in the tanks as described in this application.

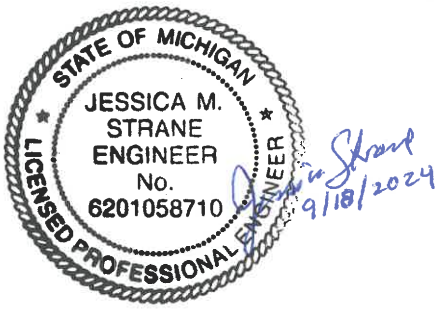
BARR
barr.com

Certification of Capability to Manage Waste

Barr Engineering, Inc. hereby provides this certification to manage waste for Gage Products Company for those areas outlined in the Company's renewal application. This Certification is in accordance with the State of Michigan Regulations (Part 111, Act 451, R.324.11123(2)(n)(iii) which indicates, *"A certification of the treatment, storage, or disposal facility's capability of treating, storing or disposing of hazardous waste in compliance with this part."* This certification will cover the applicable areas of the Limited Storage Facility (LSF) as outlined in the application including 1) LSF Building Hazardous Waste Drum Storage Area and 2) Tank Farm Hazardous Waste Storage.

I have reviewed the documentation and visited the Gage Products Company Limited Storage Facility located in Ferndale, MI. I certify that to the best of my knowledge, the Gage Products Company LSF is capable of storing and managing the hazardous waste materials as outlined in the October 2024 RCRA permit renewal application.

By:



Jessica M. Strane, PE

Jessica Strane
Signature, Jessica M. Strane, PE.

Date: 9/18/2024
Registration No. 6201058710
State of Michigan

BASIS OF DESIGN
CONTAINER STORAGE BUILDING

I. General

- Maximum Storage Capacity: 50, 55-gallon drums, (2,750 gallons - maximum).
- Waste Types: D001, D002, F001, F002, F003, and F005.
- Overall total storage volume, including bulk tank storage: 25,000 gallons - maximum.
- Dimensions: 62.8' x 66'(one bay for container unloading/loading and two bays for tank truck unloading/loading).
- Containment Volume: 2' x 6' x 3' (695 gallon capacity) with an additional sump in the tank truck loading/unloading area that measures 6' x 24' x 5' (2 bay), 9,000 gallon capacity.

II. Storage Layout:

- Palletized drums: 4 per pallet, maximum
- Maximum stack height: 2 layers on pallets or other wood base
- Aisle width: 24" minimum
- Main aisle: 12' minimum width
- Incompatible waste segregation: a concrete curb will serve to separate D002 wastes (maximum of 12 drums) from other wastes in storage area to prevent accidental mixing of any leaked wastes.
- Secondary containment: with regards to squirt protection, drums will be stored from 3'to 6' feet from storage area curbing depending upon their storage arrangement per the squirt calculations.

BASIS OF DESIGN
CONTAINER STORAGE BUILDING
(continued)

III. Building Configuration:

- Minimum 50'setback from all property lines.
- Containment Area: concrete floor and curbs with a seal coat of an abrasion-resistant sealandt. This coating provides an impervious barrier for all hazardous wastes and constituents to be stored in this area.
- Roofed area to prevent precipitation and runoff from entering storage area.
- Site Drainage: away from storage area, directed to storm sewers.
- Ventilation: natural ventilation through slotted side panels.

BASIS OF DESIGN
BULK TANK STORAGE AREA

I. General

- Maximum Starage Capacity: five vertical tanks. Three with 6,000 gallon capacity each; one with 3.250 gallon capacity; and one with 1,000 gallon capacity (22.250 gallons maximum).
- Waste types: D001, F001, F002, F003, and F005.
- Dimensions: approximately 48' x 15 1/1' area that contains five vertical tanks.
- Containment Volume: 18,000 gallons

II. Storage Layout

- The bulk tank storage area is made up of five vertical tanks. The tanks are located within a secondary containment area with cement walls and a collection sump.
- All tanks are spaced within the containment area to allow for routine monitoring of the tanks.
- Secondary containment: With regards to squirt protection, protective sheathing has been installed around the outside perimeter of the hazardous waste storage tanks.

III. Building Configuration

- Minimum 43' setback from south property line.
- Containment Area: Concrete floor and retaining walls with a seal coat of an abrasion-resistant sealant. This coating provides an impervious barrier for all hazardous wastes and constituents to be stored in this area. each tank also has a surrounding deflector wall to control squirt projection beyond the containment area should a tank develop a leak.
- Roofed area to prevent prevent precipitation and runoff from entering storage area.
- The containment area has collection sump for any liquid accumulations. Any liquids in sump will be analyzed to determine disposal options.
- Site Drainage: Away from storage area, directed to storm sewers.
- Ventilation: Natural ventilation, open areas between tanks.

Protection from Precipitation and Run-off/Run-on

The Limited Storage Facility prevents run-on from entering the facility by means of the walls of the building. At those locations where there are no walls, (truck entrances and doorways), run-on is prevented from entering the facility due to the slope away from the facility. The existing grade at the facility is approximately 638' to 638"-2". The elevation at the entrances to the Limited Storage Facility is 638'-9". This is 7" higher than existing grade. The 24-hour, 25-year storm will produce 0.18" of rain per hour, for a total rainfall of 4.32". Therefore, rainwater will be kept out of the Limited Storage Facility by means of site drainage and slope away from the Limited Storage Facility.

All waste handling activities will take place under a structure that provides protection from precipitation and run-off. The Limited Storage Facility has negligible potential for blowing precipitation to enter the facility, and run-off will be eliminated by the walls and ground slope where there are no walls. The tank storage area has walls completely surrounding the facility, so run-off/run-on potential does not exist. The sloped roof covering the tank storage area will prevent direct precipitation from entering the area, and blowing precipitation will be minimal. Gage Products presently has a canopy covering, similar to the proposed roof, over the truck unloading area. That area does not typically get wet during rain events. When blowing precipitation does enter the area, it causes the ground to become wet, but no standing water collects in the area. Due to the secondary containment structure of the tank storage area, any precipitation which may enter the area would be collected in the sump.

CORROSIVE AREA SQUIRT PROTECTION

In order to address squirt protection concerns, the height of the concrete curbing on the north and east sides of the corrosive storage area will be extended to an elevation of 648'-9", (approximately 6 feet above the finished floor). The building wall panel provides squirt protection on the west side of the storage area. A hanging metal access partition wall will be added on the south side of the corrosive storage area. This partition wall will extend from the top of the 8" curb to the 648'-9" elevation.

Table 4-4.2.7, if unprotected, or Table 4-6.1(a) if protected, in accordance with Section 4-6. The storage heights of containers on protected racks shall comply with Table 4-6.1(b), as applicable.

Exception: An unprotected liquid warehouse located a minimum of 100 ft (30 m) from exposed buildings or adjoining property that can be built upon is not required to conform to Table 4-4.2.7, if there is protection for exposures. Where protection for exposures is not provided, a minimum 200 ft (61 m) distance is required.

4-5.7.7 Class I liquids shall not be permitted in the basement areas of liquid warehouses. Class II and Class IIIA liquids may be stored in basements provided that automatic sprinkler protection and other fire protection facilities are provided in accordance with Section 4-6.

4-5.7.8 Limited amounts of combustible commodities, as defined in the scope of NFPA 231, *Standard for General Storage*, and NFPA 231C, *Standard for Rack Storage of Materials*, may be stored in liquid warehouses if protection is provided in accordance with Section 4-6, and the ordinary combustibles, other than those used for packaging the liquids, are separated a minimum of 8 ft (2.4 m) horizontally, by aisles or open racks, from the liquids in storage.

4-5.7.9 Empty or idle combustible pallet storage shall be limited to a maximum pile size of 2500 sq ft (232 m^2) and to a maximum storage height of 6 ft (1.8 m). Idle pallet storage shall be separated from liquids by at least 8-ft (2.4-m) wide aisles. However, pallet storage in accordance with NFPA 231, *Standard for General Storage*, shall be acceptable.

4-5.7.10 Containers in piles shall be separated by pallets or dunnage to provide stability and to prevent excessive stress on container walls. Portable tanks stored over one tier high shall be designed to nest securely, without dunnage. (*See NFPA 386, Standard for Portable Shipping Tanks for Flammable and Combustible Liquids, for information on portable tank design.*) Materials handling equipment shall be suitable to handle containers and tanks safely at the upper tier level.

4-5.7.11 No container or portable tank shall be stored closer than 36 in. (0.90 m) to the nearest beam, chord, girder, or other roof member in an unprotected warehouse.

4-5.7.12 Solid pile and palletized storage shall be arranged so that piles are separated from each other by at least 4 ft (1.2 m). Aisles shall be provided so that no container or tank is more than 12 ft (3.6 m) from an aisle. Where storage on racks exists as permitted in this Code, a minimum 4-ft (1.2-m) wide aisle shall be provided between adjacent rows of racks and any adjacent storage of liquids. Main aisles shall be a minimum of 8 ft (2.4 m) wide, and access shall be maintained to all doors required for egress.

4-5.7.13 Mixed Storage. When two or more classes of liquids are stored in a single pile, the maximum quantity permitted in that pile shall be the smallest of the two or more separate maximum quantities and the heights of storage permitted in that pile shall be the least of the two or more separate heights as given in Tables 4-4.2.7 or 4-6.1(a), as applicable. When two or more classes of liquids are stored in the same rack as permitted in this Code, the maximum height of storage permitted shall be the least of the two or more separate heights given in Table 4-6.1(b).

4-6 Protection Requirements for Protected Storage of Liquids.

4-6.1 Containers and portable tanks storing flammable and combustible liquids may be stored in the quantities and arrangements specified in Tables 4-6.1(a) and 4-6.1(b), provided the storage is pro-

Table 4-6.1(a) Storage Arrangements for Protected Palletized or Solid Pile Storage of Liquids in Containers and Portable Tanks

Class	Storage Level	Max. Stge. Height (ft.)		Max. Quantity per Pile (gal.)		Max. Quantity (gal.)	
		Containers	Port. Tanks	Containers	Port. Tanks	Containers	Port. Tanks
IA	Ground Floor	5	—	3,000	—	12,000	—
	Upper Floors	5	—	2,000	—	8,000	—
	Basements	——Not Permitted——		—	—	—	—
IB	Ground Floor	6½	7	5,000	20,000	15,000	40,000
	Upper Floors	6½	7	3,000	10,000	12,000	20,000
	Basements	——Not Permitted——		—	—	—	—
IC	Ground Floor	*6½	7	5,000	20,000	15,000	40,000
	Upper Floors	*6½	7	3,000	10,000	12,000	20,000
	Basements	——Not Permitted——		—	—	—	—
II	Ground Floor	10	14	10,000	40,000	25,000	80,000
	Upper Floors	10	14	10,000	40,000	25,000	80,000
	Basements	5	7	7,500	20,000	7,500	20,000
III	Ground Floor	20	14	15,000	60,000	50,000	100,000
	Upper Floors	20	14	15,000	60,000	50,000	100,000
	Basements	10	7	10,000	20,000	25,000	40,000

SI Units: 1 ft = 0.30 m; 1 gal = 3.8 L.

* These height limitations may be increased to 10 ft for containers of 5 gal or less in capacity.

NOTE: See Section 4-6 for protection requirements as applicable to this type of storage.

Table 4-6.1(b) Storage Arrangements for Protected Rack Storage of Liquids in Containers

Class	Type Rack	Storage Level	Max. Stge. Height (ft) Containers	Max. Quantity (gal) Containers
IA	Double Row or Single Row	Ground Floor	25	7,500
		Upper Floor	15	4,500
		Basements	Not Permitted	—
IB	Double Row or Single Row	Ground Floor	25	15,000
		Upper Floor	15	9,000
IC		Basements	Not Permitted	—
II	Double Row or Single Row	Ground Floor	25	24,000
		Upper Floor	25	24,000
		Basements	15	9,000
III	Multi-Row Double Row or Single Row	Ground Floor	40	48,000
		Upper Floor	20	48,000
		Basements	20	24,000

SI Units: 1 ft = 0.30 m; 1 gal = 3.8 L.

NOTE: See Section 4-6 for protection requirements as applicable to this type of storage.

tected in accordance with 4-6.2 and 4-6.5, as applicable.

4-6.1.1 Other quantities and arrangements may be used where suitably protected and approved by the authority having jurisdiction.

4-6.2. Where automatic sprinklers are used, they shall be installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, and approved by the authority having jurisdiction. (*For additional information, see Appendix D.*)

4-6.2.1 Other systems such as automatic foam-water systems, automatic water-spray systems, or other combinations of systems may be considered acceptable if approved by the authority having jurisdiction. (*For additional information, see Appendix D.*)

4-6.3 Racks storing Class I or Class II liquids shall be either single-row or double-row as described in NFPA 231C, *Standard for Rack Storage of Materials*.

4-6.4 Ordinary combustibles other than those used for packaging the liquids shall not be stored in the same rack section as liquids, and shall be separated a minimum of 8 ft (2.4 m) horizontally, by aisles or open racks, from liquids stored in racks.

4-6.5 In-rack sprinklers shall be installed in accordance with the provisions of NFPA 231C, *Standard for Rack Storage of Materials*, except as modified by 4-6.2. Alternate lines of in-rack sprinklers shall be staggered. Multiple levels of in-rack sprinkler heads shall be provided with water shields unless otherwise separated by horizontal barriers, or unless the sprinkler heads are listed for such installations.

4-7 Fire Control.

4-7.1 Suitable fire extinguishers or preconnected hose lines, either 1½-in. (3.8-cm) lined or 1-in. (2.5-cm) hard rubber, shall be provided where liquids are stored. Where 1½-in. (3.8-cm) fire hose is used, it shall be installed in accordance with NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*.

4-7.1.1 At least one portable fire extinguisher having a rating of not less than 20-B shall be located outside of, but not more than 10 ft (3 m) from, the door opening into any separate inside storage area.

4-7.1.2 At least one portable fire extinguisher having a rating of not less than 20-B shall be located not less than 10 ft (3 m), nor more than 50 ft (15 m), from any Class I or Class II liquid storage area located outside of a separate inside storage area.

4-7.1.3 In protected general purpose and liquid warehouses, hand hose lines shall be provided in sufficient number to reach all liquid storage areas.

4-7.1.4 The water supply shall be sufficient to meet the fixed fire protection demand, plus a total of at least 500 gal (1892 L) per minute for inside and outside hose lines. (*See C-4-6.2.*)

4-7.2 Control of Ignition Sources. Precautions shall be taken to prevent the ignition of flammable vapors. Sources of ignition include but are not limited to: open flames; lightning; smoking; cutting and welding; hot surfaces; frictional heat; static, electrical, and mechanical sparks; spontaneous ignition, including heat-producing chemical reactions; and radiant heat.

4-7.3 Dispensing of Class I and Class II liquids in general-purpose or liquid warehouses shall not be permitted unless the dispensing area is suitably cut off from other ordinary combustible or liquid storage areas, as specified in Section 4-4, and otherwise conforms with the applicable provisions of Section 4-4.

4-7.4 Materials with a water reactivity degree of 2 or higher as outlined in NFPA 704, *Standard System for the Identification of the Fire Hazards of Materials*, shall not be stored in the same area with other liquids.

4-8 Outdoor Storage.

4-8.1 Outdoor storage of liquids in containers and portable tanks shall be in accordance with Table 4-8, as qualified by 4-8.1.1 through 4-8.1.4 and 4-8.2, 4-8.3, and 4-8.4.

4-8.1.1 When two or more classes of materials are stored in a single pile, the maximum gallonage in that pile shall be the smallest of the two or more separate gallonages.

4-8.1.2 No container or portable tank in a pile shall be more than 200 ft (60 m) from a 12-ft (3.6-m) wide access way to permit approach of fire control apparatus under all weather conditions.

4-8.1.3 The distances listed in Table 4-8 apply to properties that have protection for exposures as defined. If there are exposures, and such protection for exposures does not exist, the distances in column 4 shall be doubled.

Master Builders Technologies Corrosion Resistance Guide

CEILCOTE® CORROSION CONTROL PRODUCTS

Monolithic Linings

Monolithic Flooring

Heavy-Duty Coatings

Master Builders Technologies

Introduction

340 corrosive environments are classified by their effect on CEILCOTE CORROSION CONTROL PRODUCTS, as determined by laboratory test and field experience.

Many applications are complicated by mixtures of chemicals and unexpected temperature fluctuations during operation. There may also be difficult conditions during product installation.

For these reasons, consult Master Builders Technologies before final material selection.

How to use this guide

Example: A steel tank for electroplating using acid-copper solution at 160°F. Select the best combination of materials to protect the tank interior and exterior, floor and trenches.

1. Tank Lining

Locate "Copper Plating, Acid" in the left hand column. Since the tank interior may be subjected to possible impact from falling parts, this should be a heavy duty polyester lining. All of these are rated A-1, so you have a choice of Ceilcrete, Flakeline 100 Series or Ceilcote Lining System. Flakeline could be ruled out if there will actually be impact or abrasion. ...ce between a Ceilcrete or a Ceilcote ...g series product will depend on economy or customer preference.

2. Tank Exterior

Refer to the columns under "Light Duty Linings." All are rated A-1 except Flakeline 600, rated A-2. Any of these products can be used, since those rated suitable for immersion are more than enough for spillage. Therefore, we use either one of the two lower cost products — Flakeline 300 or 600. Also refer to the CeilGard section of the chart.

3. Floor and Trenches

Consider first that the floor is subjected to spills (2) and the trench to immersion (1). Consider also that spills cool rapidly; the floor protection may see 140°F. or less. One of the Ceilcretes would be the best protection. However, if the housekeeping will be good and spills infrequent, you may select Corocrete T, which is good to 120°F., and is more economical.

...rench lining, consider that when a ...s emptied, preferably through a pipe from tank to trench, there may be exposure to 160°F. You, therefore, require a heavy duty lining; one of the Ceilcretes would be most economical.

Key to Chemical Resistant Chart

Rating	Meaning
A	Good to maximum temperature of product. In many cases, the maximum temperature recommendation varies for the type of substrate or type of service. See the temperature limit chart (opposite page).
B	Good to 180°F. (82°C.)
C	Good to 140°F. (60°C.)
D	Good to 120°F. (49°C.)
E	Good to 100°F. (38°C.)

Rating "E" is used for ambient temperature conditions.

1. Immersion, constant flow or condensing vapors. This condition applies to tanks, stacks, trenches, and floors with frequent spills that are not washed frequently or which have poor drainage.
2. Occasional splash or spillage applies to tank exteriors, walls, and floors that are not washed to dilute and remove spills.
3. Fumes that are not likely to condense.

T Varies with conditions and requires testing. This rating is given when we think the product will work, but have no test or service data.

N Not recommended. There are many cases where products rated N can be used for short term exposures or very dilute solutions. Such conditions are frequently found in chemical waste disposal operations. These require consultation with Master Builders Technologies experts.

Comments on ratings and product use

1. A product rated C-1 (140°F. immersion) can be assumed to rate a higher temperature for spillage.
2. Flakeline 222HT
   To achieve its maximum temperature rating of 150°F., Flakeline 222HT must be applied in three coats on steel, to a thickness of 45 to 75 mils.
3. Any product rated T or N for exposure to a strong, volatile solvent like Ethyl Acetate, Ethyl Ether or Methylene Chloride (one of the most difficult) could be suitable for splash and spill service because the solvents evaporate so quickly.
4. A Light duty lining such as Flakeline 252, rated A-1 (good to 130°F.) in a weak solvent like Hexane, can actually be used at much higher temperature if there is no water present.
5. Flakeline 200 Series rated E-1 (to 100°F.) in aqueous solutions will be satisfactory, in most cases, if the temperature outside the tank reaches 10°F-20°F higher than this during the day.
6. Resin Topcoats. — ΔT — (Delta T) is the difference between the vessel contents and the outside temperature. There is evidence that resin topcoats on Flakeline 100 Series can fail by blistering if the ΔT is higher than 90°F. As a general rule, we rate the top coated Flakeline at 160°F.
7. Sealants are rated only for spillage service. In many cases they can also be used in immersion service.
8. For aggressive conditions in concrete vessels, use an electrically conductive primer so the lining can be spark tested for voids.
9. Flooring is rated for temperature resistance on the basis of the first column: Frequent or Severe Spills. Constant flow over a floor, or puddles in floors, are considered immersion service.
10. Flakeline 100 Series linings are not recommended for concrete surfaces simply because it is impossible to test the thickness with a magnetic gauge. Thickness of other linings is easier to control.

Product Temperature Limits
(Wet Service unless Indicated Dry)

Linings	Steel Substrate Immersion, Constant Flow or Condensing Temperatures °F. Approx. °C.		Concrete Substrate Immersion, Constant Flow or Condensing Temperatures °F Approx. °C	
Ceilcrete® Series	160	71	180	82
Coroline® Series Except 505.2	160	71	180	82
Coroline® 505.2	160	71	160	71
Ceilcote Lining Series Except 68	160	71	160	71
Ceilcote Lining 68	140	60	140	60
Flakeline® 100 Series	200	93	—	—
CeilLine 80	160	71	—	—
Heavy-Duty Coatings	**Steel Substrate Immersion or Condensing Vapor °F Approx. °C**		**Steel Substrate (Dry Service) °F Approx. °C**	
Flakeline® 222HT & 282	150	66	350	177
Flakeline® 200 Series (Except 222HT & 282)	130	54	300	149
Flakeline® 300 Series	120	49	220	104
Flakeline® 600 Series and Flaketar™	120	49	220	104
Floor Toppings	**Frequent or Severe Spills °F Approx. °C**		**Occasional Splash, Spill or Rinse °F Approx. °C**	
Ceilcrete®	160	71	300	149
Coroline® Series	170	76	300	149
Ceilcote 681 Floor/Corocrete T	170	76	250	121
Ceilcote 682 Floor	180	82	250	121
Ceilcote 683 Floor/Corocrete SL	140	60	200	93
Ceilcote 685 Floor	180	82	250	121
Corocrete SR	140	60	200	93
Polyesters, Vinyl Esters. Refer to Following charts	**Rating (1) Immersion, Constant Flow Frequent Spillage, Condensing Vapors.**		**Ratings (2 and 3) Dry and Non-Condensing Vapors Occasional Spills, Rinse.**	
211-212	130°F	54°C	180°	82°C
232	130°F	54°C	250°	121°C
242	130°F	54°C	250°	121°C
251-252	130°F	54°C	250°	121°C
300-350	120°F	49°C	180°	82°C
222HT	150°F	66°C	400°	204°C
Epoxies	**Rating (1) Immersion, Constant Flow Frequent Spillage, Condensing Vapors.**		**Ratings (2 and 3) Dry and Non-Condensing Vapors Occasional Spills, Rinse.**	
650HB/FDA	120°F	49°C	250°F	121°C
661	120°F	49°C	225°F	106°C
600	120°F	49°C	225°F	106°C
615/620	Not Recommended		250°F/300°F	121°C/149°C
630	170°F	76°C	300°F	149°C
Urethanes	**Rating (1) Immersion, Constant Flow Frequent Spillage, Condensing Vapors.**		**Ratings (2 and 3) Dry and Non Condensing Vapors Occasional Spills, Rinse.**	
470	Not Recommended		250°F	121°C
480	Not Recommended		250°F	121°C
Expansion Joint Sealants	**Immersion or Condensing Vapors °F Approx. °C**		**Occasional Splash Spill or Rinse °F Approx. °C**	
Ceilcote EJ3 & 4	140	60	200	93
Ceilcote EJ10	120	49	180	82
Ceilcote EJ11	—	—	—	—

Notes on chemicals in Corrosion Chart

NOTE: 1 Lab tested at ambient temperature or at temperature rated. For higher temperatures, Master Builders Technologies should be consulted.

NOTE: 2 Requires carbon filler for Ceilcretes and Corolines, resin topcoats for Flakelines and CeilLine 80, a synthetic veil for the Ceilcote Lining Series.

NOTE: 3 Linings for Potassium or Sodium Chlorate are limited to 160°F. Coroline and Flakeline 100 Series are rated C-1, since there is no lette designation for 160°F. They are actually good for 160°F.

NOTE: 4 A lining for Bright Nickel plating tanks must be approved by the supplier of the bath salts. For wastes, this is not required.

Selecting the right floor system.

To help you determine the best floor system for your process environment, we have rated the performance of each system under a complete range of service conditions.

It may be necessary to combine materials or alter standard specifications to meet your requirements. Such versatility is built into Master Builders Technologies floor materials. Consult Master Builders Technologies concerning your specific application.

	WEAR			THERMAL			NEW/OLD CONCRETE					CHEMICAL SPILLAGE							SPECIALIZED AREAS					CONDITIONS		
	Heavy Truck Traffic	Occasional Truck Traffic	Foot Traffic Only	Thermal Shock 110°F to 40°F	Thermal Shock 220°F to 40°F	Thermal Shock 130°F to -20°F	Hairline Cracking	Mild Cracking	Cracking Cure Stress Relief	Construction Joint Cracking	Eroded Aggregate Exposed	Powdery Poorly Cured Surface	Mineral Acids Concentrated	Mineral Acids Dilute	Caustics	Aromatic Solvents	Chlorinated Solvents	Aliphatic Solvents	Fats and Oils	Organic Acids	Sanitary	Trenches	Foundations	Coolers and Freezers	Laboratories	Low Temp. Cure (Down to 30°F)	Damp Surfaces	Minimum Downtime
Ceilcote 681 Floor: **Unreinforced Topping, Traffic.** Aggregate-filled ⅛" to ¼" topping. High wear resistance, durability, and chemical resistance; convenient floor-patching maintenance material. Meets current USDA requirements.	E	E	E	G	F	G	F	F	N	E	N	F	G	E	F	F	E	G	F	G	N	N	G	F	E	E	E
Ceilcote 682 Floor: **Fiberglass Reinforced, Sanitary.** 100-mil floor. Epoxy resin modified for maximum cleanability, chemical, and thermal-shock resistance. Meets current USDA requirements.	F	G	E	E	E	E	E	E	E	E	G	F	G	E	G	G	E	E	G	E	N	N	E	E	E	E	F
Ceilcote 683 Floor: **Light Duty.** self-leveling 55-mil coating. Epoxy resin modified for um cleanability and chemical resistance. Meets current requirements.	F	G	E	G	F	G	G	F	N	G	N	F	G	E	G	G	E	E	G	E	N	N	F	E	E	E	E
Ceilcote 685 Floor: **Heavy Duty.** Fiberglass-reinforced 3/16" floor. Epoxy resin modified for maximum wearability, chemical, and thermal-shock resistance. Meets current USDA requirements.	E	E	E	E	G	G	G	G	F	E	G	F	G	E	G	G	E	E	G	G	N	E	E	F	E	E	F
Ceilcrete Series: Fiberglass Reinforced, Floor and Immersion. Fiberglass-reinforced 5/32" lining. Polyester resin modified for maximum chemical resistance. Available with: Silica filler — standard applications. Carbon filler — conductive or special corrosive environments. Abrasion-resistant filler — agitated slurries.	G	E	E	E	F	G	G	G	N	E	F	E	E	G	E	E	E	E	E	G	E	E	F	F	F	F	F
Coroline Series (505M 505.2 are FDA Acceptable) Fiberglass-reinforced 5/32" lining, Epoxy resins modified for maximum chemical resistance. Available with: Silica filler — standard applications. Carbon filler — conductive or special corrosive environments. Abrasion-resistant filler — agitated slurries.	G	E	E	E	G	G	G	F	N	E	F	F	G	E	E	E	E	E	G	G	E	E	F	F	N	F	F
Corocrete F: **Underlayment, Restoration (USDA Approved)** Aggregate filled ⅜"-6" polymer concrete. Ease of placement, rapid-setting and compatible with most Ceilcote systems.	E	E	E	G	F	G	F	F	N	E	N	N	F	G	N	N	F	F	F	N	N	N	G	N	F	F	E
Corocrete T: **Unreinforced Topping, Traffic (USDA Approved)** Aggregate filled ¼" topping. High wear resistance, durability and moderate chemical resistance.	E	E	E	G	F	F	F	F	N	E	F	N	G	G	F	N	G	G	F	G	N	N	N	N	F	F	G
Corocrete SL: **Medium Duty, Cleanable.** Semi-self-leveling 55 mil topping. Modified for maximum cleanability and chemical resistance. Skid resistance or smooth finish available. Meets current USDA requirements.	N	F	E	G	F	G	G	F	N	F	N	F	G	E	G	G	E	E	G	E	N	N	F	E	E	E	E
Corocrete SR: **Personnel Safety Floor.** Two coat roller applied skid resistant system. Nominal 40-60 mils, incorporates alumina grit for maximum wear and slip resistance.	G	E	E	G	F	G	G	F	N	G	F	N	F	G	F	F	G	G	F	G	N	E	F	F	N	N	G
Corocrete CS: **ete Sealer.** iscosity, one component system for use on virtually all new concrete surfaces where dusting is a problem. Ideal for warehouse applications.	G	E	E	G	F	G	N	N	N	G	E	F	G	G	G	G	G	G	F	G	E	E	G	F	N	N	E

E = Excellent G = Good F = Fair N = Not recommended

Master Builders Technologies

	Celline 80	Coroline 505/510/505.6/505.2	Coroline 505M	Coroline 550	Celcote 2500 International	Celcrete 2500 U.S.A.	Celcrete 5500	Celcrete 6400	Celcrete 6650	Flakeline 103	Flakeline 161	Flakeline 164	Flakeline 180	Celcote Lining 25	Celcote Lining 61	Celcote Lining 64	Celcote Lining 68	Celcote Lining 74	Celcote Lining 652	Flakeline 211/212	Flakeline 222HT	Flakeline 232
Acetaldehyde 100%	T	T	T	N	N	T	T	T	T	N	N	N	T	N	N	N	N	T	N	N	T	T
Acetic Acid - 10%	A1	T	T	T	C1	A1	A1	A1	A1	C1	B1	C1	A1	C1	A1	C1	N	A1	C1	A1	A1	A1
Acetic Acid - 10-50%	A1	N	N	N	D1	C1	C1	D1	A1	D1	C1	D1	C1	D1	C1	D1	N	A1	D1	A1	C1	A1
Acetic Acid 50% to (Glacial) 100%	D1	N	N	N	T	D1	D1	T	D1	T	D1	T	D1	T	D1	T	N	D1	T	E2	A1	A1
Acetic Anhydride	D1	N	N	N	E1	D1	D1	D1	D1	D1	D1	D1	D1	E1	D1	E1	N	D1	E1	D2	E1	E1
Acetone - 100%	C2	C2	C2	D2	N	C2	C2	N	C2	N	C2	N	C2	N	C2	N	N	C2	N	N	C2	D2
Acetone - 10%	C1	A1	C1	D1	E1	C1	C1	D1	A1	D1	C1	N	C1	E1	C1	N	E2	A1	E1	T	A1	A1
Acetyl Chloride - 100%	T	T	T	N	N	T	T	N	T	N	T	N	T	N	T	N	N	T	N	N	T	T
Acrylic Acid - 100%	D1	N	N	N	E1	D1	D1	D1	D1	D1	D1	D1	D1	E1	D1	D1	N	D1	E1	E2	A2	A2
Acrylonitrile	T	N	N	N	N	N	N	N	T	N	N	N	T	N	N	N	N	T	N	N	T	T
Adipic Acid - 25%	C1	C1	D1	D1	D1	C1	C1	D1	C1	C1	D1	D1	C1	D1	C1	D1	T	C1	D1	D1	C1	D1
Allyl Alcohol[1]	D1	E1	E1	T	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	T	D1	D1	T	D1	D1
Allyl Chloride	T	T	T	N	N	T	T	N	T	N	N	N	T	N	T	N	N	T	N	N	T	T
Alum (Saturated Solution)	C1	C1	C1	D1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	A1	C1	C1	D1	C1	D1
Aluminum Bromide	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	T	A1	A1	A1	A1	A1
Aluminum Chloride	A1	A1	A1	C1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Aluminum Nitrate (Saturated)	A1	A1	C1	C1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Aluminum Sulfate	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	A1	C1	C1	A1	A1	A1
Ammonia (Wet Gas)	C1	A1	A1	A1	C1	C1	C1	N	C1	B1	C1	N	C1	C1	C1	N	A1	C1	C1	N	A1	A1
Ammonium Chloride	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Ammonium Cocoampholyte[1] - 30%	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	T	C1	C1	T	C1	D1
Ammonium Fluoride - 10%[2]	C1	A1	C1	C1	A1	A1	A1	A1	A1	C1	C1	C1	C1	C1	C1	C1	A1	C1	C1	A1	A1	A1
Ammonium Hydroxide - 20%	D1	C1	C1	C1	D1	D1	D1	N	D1	N	N	N	N	D1	D1	N	E1	E1	D1	N	N	E1
Ammonium Lauryl Sulfate[1] - 30%	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	A1	D1	D1	A1	A1	A1
Ammonium Nitrate	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Ammonium Persulfate	A1	D1	D1	D1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Ammonium Sulfate	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Ammonium Sulfide	A1	A1	A1	A1	A1	A1	A1	D1	A1	A1	A1	D1	A1	A1	A1	D1	A1	A1	A1	A1	A1	A1
Ammonium Sulfite	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Ammonium Xylene Sulfonate[1] - 40%	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	A1	C1	C1	A1	D1	D1
Amyl Acetate[1]	D1	T	T	T	E1	D1	D1	D1	D1	D1	D1	D1	D1	E1	D1	D1	N	D1	T	N	D1	D1
Amyl Alcohol	N	D1	D1	D1	C1	C1	C1	C1	C1	A1	A1	A1	A1	A1	A1	A1	A1	A1	D1	A1	A1	A1
Aniline	D1	N	N	N	N	T	T	E1	D1	N	T	E1	D1	N	T	E1	N	D1	N	N	D1	D1
Aniline Hydrochloride	A1	C1	C1	D1	C1	C1	C1	N	A1	D1	T	T	A1	C1	T	N	T	A1	C1	T	C1	A1
Anodizing-Chromic			See Chromic Acid - 10%																			
Anodizing-Sulfuric			See Sulfuric Acid - 20-50%																			
Antimony Chloride (tri)	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	E1	E1	E1
Aqua Regia	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Arsenous Acid	C1	T	T	T	D1	D1	D1	D1	C1	C1	A1	A1	C1	C1	A1	A1	T	C1	C1	D1	C1	D1
Barium Chloride	A1	C1	C1	C1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Barium Hydroxide	C1	A1	A1	A1	C1	C1	C1	E1	C1	C1	C1	E1	C1	C1	C1	E1	A1	C1	C1	N	C1	D1
Barium Sulfide	C1	A1	A1	C1	C1	C1	C1	E1	C1	C1	C1	E1	C1	C1	C1	E1	A1	C1	C1	E1	C1	D1
Benzal Chloride	T	D1	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Benzaldehyde	E1	T	T	T	N	T	T	N	E1	N	T	N	E1	N	T	N	N	E1	N	N	E1	E1
Benzene (Benzol)	D1	D1	D1	T	N	E1	D1	E1	D1	N	D1	E1	D1	N	E1	E1	N	D1	N	N	D1	D1
Benzene Sulfonic Acid 50-100%	C1	T	T	T	C1	C1	C1	D1	C1	B1	C1	D1	C1	C1	C1	D1	N	C1	C1	A1	C1	A1
Benzene Thiol	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Benzyl Alcohol[1]	D1	D1	D1	D1	D1	D1	D1	T	D1	D1	D1	T	D1	D1	D1	T	T	D1	T	T	D1	D1
Benzoic Acid (Saturated)	A1	C1	C1	C1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Benzoyl Chloride	T	D1	D1	D1	T	T	T	N	T	T	T	N	T	T	T	N	T	T	T	T	T	T
Benzyl Chloride[1]	T	D1	T	T	N	T	T	N	T	N	T	N	T	N	T	N	N	T	N	N	T	T
Black Liquor (Paper)	C1	A1	A1	C1	C1	C1	C1	C1	C1	C1	C1	N	C1	C1	C1	N	A1	C1	C1	N	C1	D1
Boric Acid (Saturated)	A1	C1	C1	C1	A1	A1	A1	A1	A1	B1	A1	D1	A1	A1	A1	D1	A1	A1	A1	A1	A1	A1
Bromine, Wet Gas	D1	N	N	N	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	N	D1	D1	T	D1	D1
Bromine, Dry Gas	D3	N	N	N	D3	D3	D3	D3	D3	D3	D3	D3	D3	D3	D3	D3	N	D3	D3	T	D3	D3
Bromine Water - 5%	D1	N	N	N	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	N	D1	D1	T	D1	D1
Butanol Normal	D1	C1	C1	C1	D1	C1	C1	D1	C1	D1	C1	D1	D1	D1	C1	D1	T	D1	D1	A1	C1	A1
Butyl Acetate	E2	T	N	N	N	N	N	N	E2	N	N	N	E2	N	N	N	N	E2	N	N	E2	E2

CEILCOTE
Corrosion Control Products

	DUTY LININGS										FLOOR TOPPINGS							SEALANTS		
	Flakeline 242 242	Flakeline 251/252	Flakeline 252 International	Flakeline 261/262	Flakeline 282	Flakeline 300/350	Flakeline 600 & Flaketar 661	Ceilcote 681/685 Corocrete T	Ceilcote 682/683 Corocrete SL/SR	Ceilcrete 695	Ceilcrete 2500 U.S.A.	Ceilcrete 2500 Int.	Ceilcrete 5500	Ceilcrete 6400	Ceilcrete 6650	Coroline 505/510	Ceilcote EJ10	Ceilcote EJ11	Ceilcote EJ3/4
Acetaldehyde 100%	N	D2	N	N	D2	N	N	N	E2	D2	D2	N	D2	N	D2	D2	N	N	N
Acetic Acid - 10%	A1	A1	A1	A1	A1	A1	N	D2	D2	A2	A2	A2	A2	A2	A2	D2	D2	E2	D2
Acetic Acid - 10-50%	D1	A1	D1	D1	C1	D2	N	N	N	A2	A2	A2	A2	A2	A2	N	D2	T	T
Acetic Acid 50% to (Glacial) 100%	D2	A2	D2	D2	A2	N	N	N	N	A2	C2	D2	A2	D2	A2	N	N	N	N
Acetic Anhydride	E2	D2	D2	D2	E1	E2	N	N	N	A2	D2	D2	D2	D2	D2	N	T	N	T
Acetone - 100%	N	E2	N	N	C2	N	N	N	D2	C2	E2	N	E2	E2	C2	C2	N	N	N
Acetone - 10%	E1	A1	E1	D1	A1	E2	E2	D2	D2	A2	A2	A2	A2	A2	A2	A2	T	T	T
Acetyl Chloride - 100%	N	T	N	T	T	N	N	D1	T	T	T	T	T	T	T	T	N	T	N
Acrylic Acid - 100%	E2	A2	E2	E2	A2	E2	N	N	N	A2	C2	D2	C2	D2	A2	N	N	T	N
Acrylonitrile	N	N	N	N	T	N	N	N	N	T	T	N	T	N	T	N	N	T	N
Adipic Acid - 25%	D1	D1	D1	D1	C1	D2	T	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	E2	D2
Allyl Alcohol	D1	D1	D1	D1	D1	E1	T	D2	D2	A2	A2	A2	A2	A2	A2	D2	T	E2	T
Allyl Chloride	N	T	N	T	T	N	N	N	T	D2	T	N	T	T	D2	T	T	T	T
Alum (Saturated Solution)	D1	D1	D1	D1	C1	D2	D2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	D2	D2
Aluminum Bromide	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	E2	D2
Aluminum Chloride	A1	A1	A1	A1	A1	A1	E1	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	D2	D2
Aluminum Nitrate (Saturated)	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	D2	D2
Aluminum Sulfate	A1	A1	A1	A1	A1	E1	E1	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	D2	D2
Ammonia (Wet Gas)	A1	A1	A1	N	A1	N	E1	A2	A2	A2	A2	A2	A2	D2	A2	A2	D2	E2	T
Ammonium Chloride	A1	A1	A1	A1	A1	E1	E1	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	D2	D2
Ammonium Cocoampholyte - 30%[1]	D1	D1	D1	D1	C1	T	T	T	T	A2	A2	A2	A2	A2	A2	A2	D2	D2	D2
Ammonium Fluoride - 10%[2]	A1	A1	A1	A1	A1	D2	D2	E2	D2	A2	A2	A2	A2	A2	A2	A2	D2	E2	D2
Ammonium Hydroxide - 20%	E1	E1	E1	N	N	N	E1	A2	A2	A2	A2	A2	A2	D2	A2	A2	D2	E2	T
Ammonium Lauryl Sulfate - 30%[1]	A1	A1	A1	A1	A1	A1	D2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	D2	D2
Ammonium Nitrate	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	D2	D2
Ammonium Persulfate	A1	A1	A1	A1	A1	A1	A2	D2	D2	A2	A2	A2	A2	A2	A2	D2	D2	D2	D2
mmonium Sulfate	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	D2	D2
mmonium Sulfide	A1	A1	A1	E1	A1	A2	E1	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	D2	D2
Ammonium Sulfite	A1	A1	A1	A1	A1	A1	E1	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	D2	D2
Ammonium Xylene Sulfonate - 40%[1]	D1	D1	D1	D1	D1	D1	T	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	D2	D2
Amyl Acetate[1]	T	D1	D1	D1	D1	N	T	T	T	D2	D2	D2	D2	D2	D2	D2	N	N	N
Amyl Alcohol	A1	A1	A1	A1	A1	A1	A2	D2	D2	A2	A2	A2	A2	A2	A2	A2	D2	E2	T
Aniline	N	T	N	E1	D1	N	N	N	N	D2	T	N	T	D2	D2	N	N	E2	N
Aniline Hydrochloride	D1	D1	D1	N	C1	T	T	T	T	A2	A2	A2	A2	A2	A2	D2	T	T	T
Anodizing-Chromic			See Chromic Acid - 10%																
Anodizing-Sulfuric			See Sulfuric Acid - 20-50%																
Antimony Chloride (tri)	E1	E1	E1	E1	E1	T	T	E2	E2	D2	D2	D2	D2	D2	D2	E2	D2	C2	D2
Aqua Regia	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Arsenous Acid	D1	D1	D1	D1	C1	D1	T	T	T	A2	A2	A2	A2	A2	A2	A2	D2	D2	D2
Barium Chloride	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	D2	D2
Barium Hydroxide	D1	D1	D1	E1	C1	D2	D1	A2	A2	A2	A2	A2	A2	D2	A2	A2	D2	E2	T
Barium Sulfide	D1	D1	D1	E1	C1	D2	D1	A2	A2	A2	A2	A2	A2	D2	A2	A2	D2	E2	D2
Benzal Chloride	T	T	T	T	T	T	N	T	T	T	T	T	T	T	T	D2	N	E2	T
Benzaldehyde	N	T	N	N	E1	N	N	T	T	D2	T	T	T	T	D2	T	T	N	T
Benzene (Benzol)	N	D1	N	D1	D1	D2	N	D2	D2	D2	D2	N	D2	D2	D2	D2	N	T	N
Benzene Sulfonic Acid 50-100%	A1	A1	A1	A1	C1	E1	T	T	T	A2	A2	A2	A2	A2	A2	T	T	T	T
Benzene Thiol	N	N	N	N	N	N	N	N	N	T	T	N	N	N	N	N	N	T	N
Benzyl Alcohol[1]	D1	D1	D1	T	D1	D1	T	T	T	D2	D2	D2	D2	T	D2	D2	T	D2	T
Benzoic Acid (Saturated)	A1	A1	A1	A1	A1	A1	E1	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	E2	D2
Benzoyl Chloride	T	T	T	N	T	T	T	T	T	T	T	T	T	N	T	D2	T	T	T
Benzyl Chloride[1]	N	T	N	N	T	N	T	T	T	D2	T	T	T	T	D2	D2	N	T	N
Black Liquor (Paper)	D1	D1	D1	N	C1	N	E1	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	T	T
Boric Acid (Saturated)	A1	A1	A1	A1	A1	E1	E1	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	D2	D2
Bromine, Wet Gas	D1	D1	D1	D1	D1	T	N										N	D2	N
Bromine, Dry Gas	D3	D3	D3	D3	D3	T	N										N	D2	N
Bromine Water - 5%	D1	D1	D1	D1	D1	T	N	N	N	A2	A2	A2	A2	A2	A2	N	N	D2	N
Butanol Normal	A1	A1	A1	A1	A1	E1	T	D2	D2	A2	A2	A2	A2	A2	A2	A2	T	D2	T
ityl Acetate	N	N	N	N	E2	T	T	T	T	D2	D2	D2	D2	D2	D2	D2	N	N	N

KEY TO CHEMICAL RESISTANCE CHART

Rating Description
- A Good to Maximum Temperature of Product
- B Good to 180 °F (82 °C) Maximum
- C Good to 140 °F (60 °C)
- D Good to 120 °F (49 °C) Ambient
- E Good to 100 °F (37 °C)

Rating Description
- 1 Immersion or Constant Flow or Condensing Vapor
- 2 Occasional Splash or Spill
- 3 Fumes Only, Not Condensing
- N Not Recommended

Rating Description
- T Varies With Conditions. May Require Test. Consult Master Builders Technologies for Recommendation.

Master Builders Technologies

HEAVY DUTY LININGS — LIGHT

	Ceilfine 80	Coroline 505/510/505.6/505.2	Coroline 505M	Coroline 550	Ceilcrete 2500 International	Ceilcrete 2500 U.S.A.	Ceilcrete 5500	Ceilcrete 6400	Ceilcote 6650	Flakeline 103	Flakeline 161	Flakeline 164	Flakeline 180	Ceilcote Lining 25	Ceilcote Lining 61	Ceilcote Lining 64	Ceilcote Lining 68	Ceilcote Lining 74	Ceilcote Lining 652	Flakeline 211/212	Flakeline 222HT	Flakeline 232
Butyl Acrylate[1]	T	N	N	N	N	T	T	N	T	N	T	N	T	N	T	N	T	T	N	N	E1	E1
Butyl Amine	T	N	N	N	N	N	N	N	T	N	N	N	T	N	N	N	N	T	N	N	T	T
Butyl Carbitol[1]	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	T	D1	D1	T	D1	D1
Butyl Carbitol Acetate[1]	E1	D1	T	N	N	T	T	E1	E1	N	T	E1	E1	N	T	E1	N	E1	N	N	E1	E1
Butyl Cellosolve[1]	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	T	D1	D1	T	D1	D1
Butyl Cellosolve Acetate[1]	E1	D1	T	N	T	E1	E1	E1	E1	T	E1	E1	E1	T	E1	E1	N	E1	T	N	E1	E1
Butyl Ether[1]	D1	T	T	T	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	T	D1	D1	T	C1	D1
Butyl Acid Levulinic[1]	D1	D1	T	T	D1	D1	D1	T	D1	D1	D1	T	D1	D1	D1	T	N	D1	D1	T	D1	D1
Butyric Acid - 100%[1]	D1	N	N	N	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	N	D1	D1	T	D1	D1
Cadmium Plating - Cyanide	C1	A1	A1	A1	C1	C1	C1	N	C1	C1	C1	N	C1	C1	C1	N	A1	C1	C1	N	A1	A1
Calcium Bisulfite	A1	C1	C1	C1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Calcium Chloride	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Calcium Hydroxide[2]	C1	A1	A1	A1	C1	C1	C1	D2	C1	N	N	N	N	C1	C1	N	A1	C1	C1	N	N	A1
Calcium Hypochlorite - 5%[2]	D1	N	N	N	D1	D1	D1	D1	D1	N	N	N	N	E1	C1	N	N	A1	A1	N	N	D1
Calcium Nitrate	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Caprylic Acid (Octanoic Acid)[1]	A1	N	N	N	C1	C1	C1	C1	A1	C1	C1	C1	A1	C1	C1	C1	N	A1	C1	E1	C1	D1
Carbolic Acid (Phenol) - 88%	E1	N	N	N	N	N	N	N	E1	N	N	N	E1	N	N	N	N	E1	N	N	E1	E1
Carbon Bisulfide (Di) Fumes (Wet)	C1	D1	D1	D1	D1	E1	E1	N	C1	D1	E1	N	C1	D1	E1	N	T	C1	N	N	C1	A1
Carbon Tetrachloride	C1	C1	C1	D1	E1	C1	C1	C1	A1	E1	C1	C1	C1	E1	C1	C1	A1	A1	E2	T	A1	D1
Castor Oil	C1	D1	D1	D1	A1	A1	A1	A1	A1	C1	C1	C1	C1	A1	A1	A1	E1	A1	A1	D1	A1	D1
Cellosolve[1]	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	T	D1	D1	D1	C1	D1
Cellosolve Acetate[1]	D1	D1	T	T	N	E1	E1	E1	D1	N	E1	E1	D1	N	E1	E1	T	D1	N	N	D1	D1
Chloroacetic Acid - 1-20%[1]	B1	N	N	N	C1	A1	A1	D1	A1	C1	B1	D1	B1	C1	A1	D1	N	A1	C1	D1	D1	D1
Chloroacetic Acid - 20-50%[1]	D1	N	N	N	E1	D1	D1	E1	D1	E1	D1	D1	D1	E1	D1	D1	N	D1	E1	T	D1	D1
Chloroacetic Acid - 50-100%[1]	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	E2	E2	
Chlorine Dioxide Solution	C1	N	N	N	A1	A1	A1	D1	C1	A1	A1	D1	C1	A1	A1	D1	N	C1	C1	T	A1	A1
Chlorine Gas - Dry	A3	N	N	N	A3	A3	A3	A3	A3	B3	B3	B3	B3	A3	A3	A3	N	A3	A3	D3	A3	A3
Chlorine Gas - Wet	A3	N	N	N	A3	A3	A3	A3	A3	B3	B3	B3	B3	A3	A3	A3	N	A3	A3	N	A3	A3
Chlorine Water - Saturated	A1	N	N	N	A1	A1	A1	A1	A1	B1	B1	B1	B1	A1	A1	A1	N	A1	A1	E1	A1	A1
Chlorobenzene (Mono)[1]	D1	D1	D1	T	N	E1	E1	N	D1	N	E1	N	D1	N	E1	N	N	D1	N	T	D1	D1
Chlorobutane[1]	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	T	D1	D1	T	D1	D1
Chloroform	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	E2	E2	
Chlorophenol	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Chlorosulfonic Acid	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Chlorotoluene[1]	D1	D1	E1	T	N	E1	E1	N	D1	N	E1	N	D1	N	E1	N	N	D1	N	N	D1	D1
Chromic Acid - 10%	A1	N	N	N	N	N	N	A1	A1	N	N	B1	E1	N	N	A1	N	E1	N	N	E1	E1
Chrome Plating 20-48 oz/gal[2]	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	C1	N	T	N	D2	D2	D2
Chromic Chloride	A1	C1	C1	C1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Citric Acid	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Copper Plating - Cyanide	D1	A1	A1	A1	D1	D1	D1	D1	D1	D1	D1	D1	D1	C1	C1	N	A1	C1	C1	N	D1	D1
Copper Plating - Acid	A1	D1	D1	D1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Corn Oil	A1	D1	D1	D1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Cottonseed Oil	A1	D1	D1	D1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Cresol (Cresylic Acid)[1]	T	N	N	N	N	T	T	N	T	N	T	N	T	N	T	N	N	T	N	N	T	T
Cresylic Acid[1]	T	N	N	N	N	T	T	N	T	N	T	N	T	N	T	N	N	T	N	N	T	T
Cumene[1]	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	N	D1	D1	D1	D1	D1
Cyclohexane[1]	C1	C1	C1	C1	D1	A1	A1	C1	A1	D1	B1	C1	C1	D1	A1	C1	T	C1	D1	D1	C1	D1
Cyclohexanone[1]	D1	D1	D1	T	E1	D1	D1	T	D1	E1	D1	T	D1	E1	D1	T	N	D1	E1	T	D1	D1
Cymene[1]	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	A1	D1	D1	T	D1	D1
Dextrose	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Dibromopropane Phosphate[1]	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	T	E1	E1	E1	E1	E1
Dibutyl Phthalate	C1	A1	A1	A1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	T	C1	C1	D1	A1	D1
Dichloro Acetic Acid - 20%[1]	D1	N	N	N	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	N	D1	D1	D1	D1	D1
Diethanolamine[1]	D1	N	N	N	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	T	D1	D1	D1	D1	D1
Diethylene Chloroformate[1]	T	T	T	T	N	T	T	N	T	N	T	N	T	N	T	N	N	T	N	N	E2	E2
Diethylketone - 100%[1]	E1	T	T	T	N	T	T	T	E1	N	T	T	E1	N	T	T	N	E1	N	N	E1	E1
Dimethylaminopropylamine	T	N	N	N	N	N	N	N	T	N	N	N	T	N	N	N	N	T	N	N	T	T
Dimethyl Aniline	D1	T	T	T	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	T	D1	D1	D1	D1	D1

* Lining Series

CEILCOTE Corrosion Control Products

	DUTY LININGS									FLOOR TOPPINGS								SEALANTS	
	Flakeline 242	Flakeline 251/252	Flakeline 252 International	Flakeline 261/262	Flakeline 282	Flakeline 300/350	Flakeline 600/Flaketar 661	Ceilcote 681/685/Corocrete T	Ceilcote 682/683/Corocrete SL/SR	Ceilcrete 695	Ceilcrete 2500 U.S.A.	Ceilcrete 2500 International	Ceilcrete 5500	Ceilcrete 6400	Ceilcrete 6650	Coroline 505/510	Ceilcote EJ10	Ceilcote EJ11	Ceilcote EJ3/4
Butyl Acrylate[1]	N	T	N	T	E1	N	N	N	T	D2	T	N	T	N	D2	N	N	D2	N
Butyl Amine	N	N	N	N	T	N	N	N	N	T	N	N	T	N	T	N	N	T	N
Butyl Carbitol[1]	D1	D1	D1	D1	D1	T	T	D2	D2	C2	C2	C2	C2	C2	C2	A2	N	D2	T
Butyl Carbitol Acetate[1]	N	E1	N	E1	E1	N	N	T	T	C2	D2	N	D2	D2	C2	C2	N	T	N
Butyl Cellosolve[1]	D1	D1	D1	D1	D1	T	T	T	D2	C2	D2	D2	D2	D2	D2	D2	N	E2	N
Butyl Cellosolve Acetate[1]	T	E1	T	E1	E1	N	N	N	E2	D2	D2	T	D2	D2	C2	C2	N	T	T
Butyl Ether[1]	D1	D1	D1	D1	C1	T	N	T	D2	C2	D2	D2	D2	D2	D2	D2	N	T	T
Butyl Acid Levulinic[1]	D1	D1	D1	T	D1	T	N	T	T	D2	D2	D2	D2	T	D2	D2	T	T	T
Butyric Acid - 100%[1]	D1	D1	D1	D1	D1	T	N	N	N	D2	D2	D2	D2	D2	D2	T	T	T	T
Cadmium Plating - Cyanide	A1	A1	A1	N	A1	N	A1	A2	A2	A2	A2	A2	A2	N	A2	A2	D2	E2	D2
Calcium Bisulfite	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Calcium Chloride	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Calcium Hydroxide[2]	A1	A1	A1	N	N	N	A1	A2	A2	A2	A2	A2	A2	N	A2	A2	A2	D2	A2
Calcium Hypochlorite - 5%[2]	D1	D1	D1	N	N	N	N	T	T	D2	D2	D2	D2	N	D2	T	T	D2	T
Calcium Nitrate	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Caprylic Acid (Octanoic Acid)[1]	D1	D1	D1	D1	D1	D1	N	N	T	C2	C2	C2	C2	C2	C2	N	T	T	T
Carbolic Acid (Phenol) - 88%	N	N	N	N	E1	N	N	N	N	D2	N	N	N	N	D2	N	N	E2	N
Carbon Bisulfide (Di) Fumes (Wet)	N	E1	D1	N	C1	N	N	N	N	D2	D2	N	D2	N	C2	D2	N	D2	N
Carbon Tetrachloride	D1	D1	D1	D1	A1	A2	A2	D2	D2	C2	C2	D2	C2	D2	C2	A2	N	E2	N
Castor Oil	D1	D1	D1	D1	A1	T	T	T	A2	A2	A2	A2	A2	A2	A2	A2	D2	D2	T
Cellosolve[1]	D1	D1	D1	D1	A1	T	T	D2	D2	C2	C2	D2	C2	D2	C2	C2	N	E2	T
Cellosolve Acetate[1]	N	E1	N	E1	D1	N	N	N	T	D2	D2	T	D2	D2	D2	C2	N	N	N
Chloroacetic Acid - 1-20%[1]	D1	D1	D1	D1	D1	E1	N	N	T	A2	A2	C2	A2	C2	A2	T	T	T	T
Chloroacetic Acid - 20-50%[1]	E1	D1	E1	D1	D1	N	N	N	N	C2	C2	D2	C2	D2	C2	N	N	T	N
Chloroacetic Acid - 50-100%[1]	N	E2	N	N	E2	N	N	N	N	E2	E2	T	E2	T	E2	N	N	T	N
Chlorine Dioxide Solution	A1	A1	A1	A1	A1	N	N	N	N	A2	A2	A2	A2	A2	A2	N	T	E2	N
Chlorine Gas - Dry	A3	A3	A3	A3	A3	E3	N										T	E2	N
Chlorine Gas - Wet	A3	A3	A3	A3	A3	E3	N										T	E2	N
Chlorine Water - Saturated	A1	A1	A1	A1	A1	E2	N	N	T	A2	A2	A2	A2	A2	A2	N	T	E2	N
Chlorobenzene (Mono)[1]	N	D1	N	N	D1	T	N	N	T	D2	D2	N	D2	N	D2	D2	N	E2	N
Chlorobutane[1]	D1	D1	D1	D1	D1	T	T	T	T	D2	D2	D2	D2	D2	D2	D2	T	T	T
Chloroform	N	E2	N	N	E2	N	N	N	T	E2	T	N	T	N	E2	T	N	E2	N
Chlorophenol	N	N	N	N	N	N	N	T	T	E2	T	T	T	T	T	E2	N	T	N
Chlorosulfonic Acid	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	E2	N
Chlorotoluene[1]	N	D1	N	N	D1	N	N	N	T	D2	D2	N	D2	N	D2	D2	N	T	N
Chromic Acid - 10%	N	N	N	A1	E1	N	E2	D2	D2	A2	A2	A2	A2	A2	A2	C2	D2	T	N
Chrome Plating 20 - 48 oz/gal[2]	N	N	N	D2	D2	N	N	N	N	D2	D2	D2	D2	C2	D2	N	N	T	N
Chromic Chloride	A1	A1	A1	A1	A1	A1	A1	D2	A2	A2	A2	A2	A2	A2	A2	A2	A2	T	D2
Citric Acid	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	C2	E2	C2
Copper Plating - Cyanide	D1	D1	D1	N	D1	N	D1	A2	A2	C2	C2	C2	C2	C2	C2	A2	D2	E2	D2
Copper Plating - Acid	A1	A1	A1	A1	A1	A1	A2	D2	D2	A2	A2	A2	A2	A2	A2	C2	C2	T	N
Corn Oil	A1	A1	A1	A1	A1	A1	T	C2	A2	A2	A2	A2	A2	A2	A2	A2	T	D2	D2
Cottonseed Oil	A1	A1	A1	A1	A1	A1	T	C2	A2	A2	A2	A2	A2	A2	A2	A2	T	D2	D2
Cresol (Cresylic Acid)[1]	N	T	N	N	N	N	N	N	N	T	T	N	T	N	T	N	N	E2	N
Cresylic Acid[1]	N	T	N	N	N	N	N	N	N	T	T	N	T	N	T	N	N	E2	N
Cumene[1]	D1	D1	D1	D1	D1	D2	N	T	T	D2	D2	D2	D2	D2	D2	D2	N	T	T
Cyclohexane[1]	D1	D1	D1	D1	D1	D1	T	C2	C2	C2	C2	C2	C2	C2	C2	C2	N	E2	D2
Cyclohexanone[1]	E1	D1	E1	T	D1	T	N	T	E2	D2	D2	E2	D2	D2	D2	A2	N	N	N
Cymene[1]	D1	D1	D1	D1	D1	T	T	T	D2	D2	D2	D2	D2	D2	D2	D2	N	T	T
Dextrose	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Dibromopropane Phosphate[1]	E1	E1	E1	E1	E1	E1	T	D2	D2	D2	D2	D2	D2	D2	D2	D2	T	T	T
Dibutyl Phthalate	D1	D1	D1	D1	A1	D1	T	D2	D2	A2	A2	A2	A2	A2	A2	A2	T	E2	T
Dichloro Acetic Acid - 20%[1]	D1	D1	D1	D1	D1	D2	N	N	N	D2	D2	D2	D2	D2	D2	T	T	T	T
Diethanolamine[1]	D1	D1	D1	D1	D1	D1	T	N	N	D2	D2	D2	D2	D2	D2	T	T	T	T
Diethylene Chloroformate[1]	N	E2	N	N	E2	N	N	N	D2	D2	D2	D2	D2	D2	D2	D2	T	T	T
Diethylketone - 100%[1]	N	T	N	T	T	N	N	T	T	D2	D2	N	D2	N	D2	D2	N	N	N
Dimethylaminopropylamine	N	N	N	T	T	N	N	N	N	T	T	N	T	N	T	N	N	T	N
Dimethyl Aniline	D1	D1	D1	D1	D1	D1	N	N	T	D2	D2	D2	D2	D2	D2	T	N	T	T

KEY TO CHEMICAL RESISTANCE CHART

Rating Description
- A Good to Maximum Temperature of Product
- B Good to 180 °F (82 °C) Maximum
- C Good to 140 °F (60 °C)
- D Good to 120 °F (49 °C) Ambient
- E Good to 100 °F (37 °C)

Rating Description
- 1 Immersion or Constant Flow or Condensing Vapor
- 2 Occasional Splash or Spill
- 3 Fumes Only, Not Condensing
- N Not Recommended

Rating Description
- T Varies With Conditions May Require Test. Consult Master Builders Technologies for Recommendation

Master Builders Technologies

HEAVY DUTY LININGS — LIGHT

	Ceiline 80	Coroline 505/510/505.2/505.6	Coroline 505M	Coroline 550	Ceilcrete 2500 International	Ceilcrete 2500 U.S.A.	Ceilcrete 5500	Ceilcrete 6400	Ceilcrete 6650	Flakeline 103	Flakeline 161	Flakeline 164	Flakeline 180	Ceilcote Lining 25	Ceilcote Lining 61	Ceilcote Lining 64	Ceilcote Lining 68	Ceilcote Lining 74	Ceilcote Lining 652	Flakeline 211/212	Flakeline 222HT	Flakeline 232
Dimethyl Carbamoyl Chloride[1]	E1	E1	E1	T	E1	E1	E1	T	E1	E1	E1	T	E1	E1	E1	T	T	E1	E1	T	E1	E1
Dimethyl Carbonyl Chloride[1]	T	E1	E1	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Dimethyl Formamide[1]	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	T	N	N	T	T	T
Dimethyl Sulfoxide[1]	T	T	T	N	E1	E1	E1	T	T	E1	E1	T	T	E1	E1	T	T	T	N	T	T	T
Dinitro Benzene[1]	T	E1	T	T	E1	T	T	E1	T	E1	T	E1	T	E1	T	E1	T	T	T	T	T	T
Dinitro Toluene[1]	T	E1	T	T	E1	T	T	E1	T	E1	T	E1	T	E1	T	E1	T	T	T	T	T	T
Dodecyl Alcohol (Lauryl)[1]	A1	D1	D1	T	C1	C1	C1	D1	A1	C1	C1	D1	A1	C1	C1	D1	E2	A1	C1	T	A1	D1
Ethoxy Ethanol[1]	E1	E1	T	E2	T	E1	E1	T	E1	T	E1	T	E1	T	E1	T	N	E1	T	T	E1	E1
Ethoxylated Nonyl Phenol[1]	T	C1	T	T	T	T	T	D1	T	T	T	D1	T	T	T	D1	T	T	T	T	E2	E2
Ethyl Acetate	T	T	N	N	N	T	T	N	T	N	T	N	T	N	T	N	N	T	N	N	T	T
Ethyl Acrylate	T	E1	N	N	N	T	T	N	T	N	T	N	T	N	T	N	N	T	N	N	T	T
Ethyl Alcohol	C1	C1	T	T	C1	C1	C1	D1	C1	C1	C1	D1	C1	C1	C1	D1	D2	C1	C1	E1	C1	D1
Ethylamine	T	N	N	N	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Ethyl Bromide	N	T	T	N	N	T	T	N	N	N	T	N	N	N	T	N	N	N	N	N	N	N
Ethyl Chloride	E1	T	T	N	T	D1	D1	E1	E1	T	D1	E1	E1	T	D1	E1	N	E1	T	T	E1	E1
Ethyl Chloroformate	T	T	T	N	N	T	T	N	T	N	T	N	T	N	T	N	T	T	N	N	T	T
Ethyl Ether	T	T	T	T	N	T	T	N	T	N	T	N	T	N	T	N	T	T	N	T	T	T
Ethyl Hexyl Acrylate	T	E2	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	E2	E2
Ethylene Dichloride	N	E1	N	N	N	T	T	N	N	N	T	N	N	N	T	N	N	N	N	T	N	N
Ethylene Glycol	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Ethylene Oxide (Dilute)	T	N	N	N	N	E1	E1	N	T	N	E1	N	T	N	E1	N	N	T	N	N	T	T
Ethyl Sulfate[1]	E1	E1	T	T	T	T	T	E1	E1	T	T	E1	E1	T	T	E1	N	E1	E1	T	E1	E1
Ferric Chloride	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Ferric Sulfate	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Fluosilicic Acid* - 25%	N	T	T	T	C1	C1	C1	C1	C1	N	N	N	N	E1	E1	E1	T	E1	E1	N	N	N
Formaldehyde	C1	D1	D1	D1	D1	C1	C1	C1	C1	D1	C1	C1	C1	D1	C1	C1	A2	C1	C1	A1	A1	A1
Formic Acid	D1	N	N	N	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	N	D1	T	T	D1	D1
Furfural to 10%	E1	T	T	T	E1	E1	E1	T	E1	E1	E1	T	E1	E1	E1	T	T	E1	E1	T	E1	E1
Furfuryl Alcohol	E1	D1	D1	T	T	E1	E1	E1	E1	T	E1	E1	E1	T	E1	E1	T	E1	T	T	E1	E1
Gasoline																						
Aviation	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Diesel	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Jet Fuel	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Premium Unleaded	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Unleaded	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Glucose	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Glycerine	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Glycolic Acid to 70%	D1	T	N	N	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	T	D1	D1	D1	D1	D1	D1
Gold Plating (Cyanide)	D1	A1	A1	A1	D1	D1	D1	N	D1	D1	D1	N	D1	D1	D1	N	A1	D1	D1	N	D1	D1
Grape Juice	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Green Liquor (Paper Ind)	C1	A1	A1	A1	C1	C1	C1	N	C1	C1	N	C1	C1	C1	C1	N	A1	C1	C1	N	C1	A1
Heptane	A1	A1	A1	A1	C1	A1	A1	A1	A1	C1	A1	A1	A1	C1	A1	A1	A1	A1	C1	A1	A1	A1
Hexane	A1	A1	A1	A1	D1	A1	A1	D1	A1	D1	A1	D1	A1	D1	A1	C1	A1	A1	C1	D1	A1	A1
Hydrazine - 35%	N	E1	T	T	T	T	T	N	N	T	T	N	T	T	T	N	T	N	N	N	N	N
Hydrazine Hydrate	T	E1	T	T	T	T	T	N	T	T	T	N	T	T	T	N	T	T	T	T	T	T
Hydriodic Acid - 20%	C1	T	T	T	C1	C1	C1	T	C1	C1	C1	T	C1	C1	C1	T	T	C1	C1	D2	C1	D1
Hydrobromic Acid - 20%	A1	T	T	T	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	N	A1	A1	A1	A1	A1
Hydrobromic Acid - 48%	C1	N	N	N	C1	C1	C1	A1	C1	C1	C1	A1	C1	C1	C1	A1	N	C1	C1	A1	C1	A1
Hydrochloric Acid - 10%	A1	E1	D2	D2	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	E2	A1	A1	A1	A1	A1
Hydrochloric Acid - 20%	A1	D2	D2	D2	A1	A1	A1	A1	A1	B1	B1	B1	B1	A1	A1	A1	D2	A1	A1	A2	A1	A2
Hydrochloric Acid - 37%	D2	N	N	N	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	N	D1	D1	E2	E1	E2
Hydrofluoric Acid - 1-10%[2]	D2	E1	E1	E1	D1	D1	D1	D1	D1	D2	D2	D2	D2	D1	D1	D1	E2	D1	D1	D2	D2	D2
Hydrofluoric Acid - 20%[2]	E2	E2	E2	E2	D1	D1	D1	D1	D1	E2	E2	E2	E2	D2	D2	D2	N	D2	D2	D2	D2	D2
Hydrofluoric Acid - 21 - 48%[2]	N	N	N	N	E1	E1	E1	E1	E1	N	N	N	N	E1	E1	E1	N	E1	E1	N	N	N
Hydrofluosilicic Acid 10%[2]	E1	C1	C1	C1	A1	A1	A1	A1	A1	E1	E1	E1	E1	A1	A1	A1	E2	A1	A1	E1	E1	E1
Hydrofluosilicic Acid - 35%[2]	D2	D2	D2	D2	D1	D1	D1	D1	D1	D2	D2	D2	D2	D1	D1	D1	T	D1	D1	D2	D2	D2
Hydrogen Peroxide - 30%	C1	T	T	T	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	E2	C1	C1	T	C1	D1
Hydrogen Sulfide Gas	A1	A1	C1	C1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Hypo (Photographic Solution)	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	D1	A1	A1	A1	A1	A1	A1
Hypochlorous Acid	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	T	T	N	N	N	N
Iodine, Crystals & Vapor	C1	T	T	T	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	T	C1	C1	D1	C1	D1
Isooctylthioglycolate[1]	D1	T	T	T	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	T	D1	D1	T	D1	D1	D1

CEILCOTE Corrosion Control Products

	DUTY LININGS										FLOOR TOPPINGS							SEALANTS		
	Flakeline 242	Flakeline 251/252	Flakeline 252 International	Flakeline 261/262	Flakeline 282	Flakeline 300/350	Flakeline 600 & Flaketar 661	Ceilcote 681/685/Corocrete T	Ceilcote 682/683/Corocrete SL/SR	Ceilcrete 695	Ceilcrete 2500 U.S.A.	Ceilcrete 2500 International	Ceilcrete 5500	Ceilcrete 6400	Ceilcrete 6650	Coroline Series	Ceilcote EJ10	Ceilcote EJ11	Ceilcote EJ3/EJ4
Dimethyl Carbamoyl Chloride[1]	E1	E1	E1	E1	E1	T	N	T	D2	C2	C2	C2	C2	D2	C2	D2	T	T	T
Dimethyl Carbonyl Chloride[1]	T	T	T	T	T	N	N	T	T	D2	D2	D2	D2	D2	D2	D2	T	T	T
Dimethyl Formamide[1]	N	T	N	T	T	N	N	N	T	T	T	N	T	T	T	T	N	T	N
Dimethyl Sulfoxide[1]	D2	E1	E1	T	T	N	N	N	T	T	D2	D2	D2	T	T	T	N	T	N
Dinitro Benzene[1]	T	T	E1	E1	T	T	N	T	T	D2	D2	D2	D2	D2	D2	D2	T	T	T
Dinitro Toluene[1]	T	T	E1	E1	T	T	N	T	T	D2	D2	D2	D2	D2	D2	D2	T	T	T
Dodecyl Alcohol (Lauryl)[1]	D1	D1	D1	D1	A1	D2	T	D2	D2	A2	A2	A2	A2	A2	A2	A2	D2	D2	D2
Ethoxy Ethanol[1]	T	E1	T	T	E1	T	T	E2	E2	D2	D2	D2	D2	D2	D2	D2	T	T	T
Ethoxylated Nonyl Phenol[1]	T	T	T	E1	T	T	T	T	T	D2	D2	D2	D2	D2	D2	C2	T	T	T
Ethyl Acetate	N	E2	N	N	E2	N	N	T	E2	D2	D2	T	D2	N	D2	D2	N	N	N
Ethyl Acrylate	N	T	N	N	E2	N	N	N	T	D2	T	N	T	N	D2	D2	N	N	N
Ethyl Alcohol	D1	D1	D1	D1	C1	E1	E2	D2	C2	C2	C2	C2	C2	D2	C2	C2	E2	D2	E2
Ethylamine	T	T	T	T	T	N	N	N	N	T	T	T	T	T	T	N	N	T	N
Ethyl Bromide	N	N	N	N	N	N	N	N	T	T	T	T	T	T	T	T	N	T	N
Ethyl Chloride	T	D1	T	D1	T	E2	N	T	T	D2	D2	T	D2	D2	D2	T	N	T	N
Ethyl Chloroformate	N	T	N	N	T	N	N	N	D2	D2	D2	D2	D2	D2	D2	D2	T	T	T
Ethyl Ether	E2	D2	E2	E2	D2	N	N	N	D2	D2	D2	D2	D2	D2	D2	D2	N	T	T
Ethyl Hexyl Acrylate	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	D2	N	T	T
Ethylene Dichloride	N	T	N	N	N	N	N	N	N	D2	D2	N	D2	N	D2	D2	N	T	N
Ethylene Glycol	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Ethylene Oxide (Dilute)	N	E1	N	N	T	N	N	N	D2	D2	D2	D2	D2	D2	D2	D2	T	T	T
Ethyl Sulfate[1]	E1	T	T	E1	E1	T	T	T	D2	D2	T	T	T	D2	D2	D2	T	T	T
Ferric Chloride	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Ferric Sulfate	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Fluosilicic Acid* - 25%	N	N	N	N	N	N	N	D2	D2	C2	C2	C2	C2	C2	C2	T	C2	C2	E2
Formaldehyde	A1	A1	A1	A1	A1	A1	D2	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Formic Acid	T	D1	D1	D1	D1	T	N	N	N	D2	D2	D2	D2	D2	D2	N	N	E2	N
Furfural to 10%	E1	E1	E1	T	E1	T	T	T	T	E2	E2	E2	E2	E2	E2	T	T	E2	T
Furfuryl Alcohol	T	E1	T	E1	E1	T	N	D2	D2	D2	D2	T	D2	D2	D2	D2	T	D2	T
Gasoline																			
Aviation	N	A1	A1	A1	A1	A1	D2	E2	E2	E2	E2	E2	E2	E2	E2	E2	E2	E2	E2
Diesel	N	A1	A1	A1	A1	A1	D2	E2	E2	E2	E2	E2	E2	E2	E2	E2	E2	E2	E2
Jet Fuel	N	A1	A1	A1	A1	A1	C2	E2	E2	E2	E2	E2	E2	E2	E2	E2	E2	E2	E2
Premium Unleaded	A1	A1	A1	A1	A1	A1	D2	E2	E2	E2	E2	E2	E2	E2	E2	E2	E2	E2	E2
Unleaded	A1	A1	A1	A1	A1	A1	E1	E2	E2	E2	E2	E2	E2	E2	E2	E2	E2	E2	E2
Glucose	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Glycerine	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Glycolic Acid to 70%	D1	D1	D1	D1	D1	D2	N	D2	D2	A2	A2	A2	A2	A2	A2	T	T	T	T
Gold Plating (Cyanide)	D1	D1	D1	D1	D1	N	A2	A2	A2	A2	A2	A2	A2	E2	A2	A2	A2	T	A2
Grape Juice	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Green Liquor (Paper Ind)	A1	A1	A1	N	A1	N	A1	A2	A2	A2	A2	A2	A2	E2	A2	A2	A2	T	T
Heptane	A1	A1	D1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	N	T	E2
Hexane	A1	A1	D1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	N	D2	E2
Hydrazine - 35%	N	T	T	N	N	T	T	T	D2	T	T	T	T	N	T	D2	T	T	T
Hydrazine Hydrate	T	T	T	N	T	T	N	N	T	T	T	T	T	N	T	D2	T	T	T
Hydriodic Acid - 20%	D1	D1	D1	D1	C1	N	N	N	T	C2	C2	C2	C2	T	C2	T	D2	T	T
Hydrobromic Acid - 20%	A1	A1	A1	A1	A1	A1	N	N	T	A2	A2	A2	A2	A2	A2	T	T	T	N
Hydrobromic Acid - 48%	A1	A1	A1	A1	A1	A2	N	N	N	A2	A2	A2	A2	A2	A2	T	T	T	N
Hydrochloric Acid - 10%	A1	A1	A1	A1	A1	A2	D2	D2	C2	A2	A2	A2	A2	A2	A2	C2	D2	D2	D2
Hydrochloric Acid - 20%	A2	A2	A2	A2	A1	D2	D2	D2	D2	A2	A2	A2	A2	A2	A2	D2	D2	D2	N
Hydrochloric Acid - 37%	D2	D2	D2	D2	D2	E2	N	N	E2	D2	D2	D2	D2	D2	D2	D2	N	D2	N
Hydrofluoric Acid - 1-10%[2]	D2	D2	D2	D2	N	N	D2	N	D2	C2	C2	C2	C2	C2	C2	D2	D2	D2	N
Hydrofluoric Acid - 20%[2]	D2	D2	D2	D2	N	N	N	N	N	D2	D2	D2	D2	D2	D2	E2	T	D2	N
Hydrofluoric Acid 21-48%[2]	N	N	N	N	N	N	N	N	N	E2	E2	E2	E2	E2	E2	N	N	T	N
Hydrofluosilicic Acid 10%[2]	E1	E1	E1	E1	N	E2	E2	N	D2	A2	A2	A2	A2	A2	A2	C2	D2	D2	T
Hydrofluosilicic Acid - 35%[2]	D1	D1	D1	D1	N	T	T	N	E2	C2	C2	C2	C2	C2	C2	D2	D2	D2	T
Hydrogen Peroxide - 30%	D1	D1	D1	D1	C1	D2	D2	D2	D2	C2	C2	C2	C2	C2	C2	D2	T	D2	D2
Hydrogen Sulfide Gas	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	D2	D2
Hypo (Photographic Solution)	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Hypochlorous Acid	N	N	N	N	N	N	N	N	N	N	N	N	N	N	T	N	N	T	N
Iodine, Crystals & Vapor	D1	D1	D1	D1	C1	D1	T	T	T	C2	C2	C2	C2	C2	C2	T	T	T	T
Isooctylthioglycolate[1]	D1	D1	D1	D1	D1	D1	T	T	T	D2	D2	D2	D2	D2	D2	T	T	T	T

KEY TO CHEMICAL RESISTANCE CHART

Rating Description
- A Good to Maximum Temperature of Product
- B Good to 180 °F (82 °C) Maximum
- C Good to 140 °F (60 °C)
- D Good to 120 °F (49 °C) Ambient
- E Good to 100 °F (37 °C)

Rating Description
- 1 Immersion or Constant Flow or Condensing Vapor
- 2 Occasional Splash or Spill
- 3 Fumes Only, Not Condensing
- N Not Recommended

Rating Description
- T Varies With Conditions, May Require Test. Consult Master Builders Technologies for Recommendation.

Master Builders Technologies

HEAVY DUTY LININGS — LIGHT

	Celline 80	Coroline 505/510/505.2/505.6	Coroline 505M	Coroline 550	Celcrete 2500 International	Celcrete 2500 U.S.A.	Celcrete 5500	Celcrete 6400	Celcrete 6650	Flakeline 103	Flakeline 161	Flakeline 164	Flakeline 180	Celcote Lining 25	Celcote Lining 61	Celcote Lining 64	Celcote Lining 68	Celcote Lining 74	Celcote Lining 652	Flakeline 211/212	Flakeline 222HT	Flake[illegible]232
Isophorone[1]	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E2	E1	E1	D2	E1	E1
Isopropyl Acetate	E1	T	T	T	N	T	T	T	E1	N	T	T	E1	N	T	T	N	E1	N	N	E2	E2
Isopropyl Alcohol	C1	C1	C1	D1	D1	C1	C1	C1	C1	D1	C1	C1	C1	D1	C1	C1	D2	C1	D1	D1	C1	D1
Isopropyl Ether	T	E1	T	T	N	T	T	T	T	N	T	T	T	N	T	T	T	T	N	D2	E2	E2
Jet Fuel JP-4	A1	A1	A1	A1	D1	A1	A1	D1	A1	D1	A1	D1	A1	D1	A1	D1	D2	A1	D1	A1	A1	A1
Kerosene	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Ketchup	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Lactic Acid 1-20%	A1	T	T	T	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	T	A1	A1	A1	A1	A1
Lactic Acid Concentrated	A1	N	N	N	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	N	A1	A1	A1	A1	A1
Lard	A1	E1	E1	E1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Lauric Acid	A1	T	T	T	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	N	A1	A1	A1	A1	A1
Lead Acetate	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Lecithin[1]	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1
Levulinic Acid (Saturated)	A1	D1	D1	D1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	T	A1	A1	A1	A1	D1
Linseed Oil	A1	D1	D1	D1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	T	A1	A1	A1	A1	A1
Lithium Hydroxide - 10%[2]	N	A1	A1	A1	D1	D1	D1	N	D1	N	N	N	N	D1	D1	N	N	D1	D1	N	N	N
Lithium Hydroxide (Saturated)[2]	N	A1	A1	A1	C1	C1	C1	N	C1	N	N	N	N	C1	C1	N	N	C1	C1	N	N	N
Maleic Acid	A1	N	N	N	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	N	A1	A1	A1	A1	A1
Malic Acid[1]	C1	C1	C1	T	C1	C1	C1	D1	C1	C1	C1	D1	C1	C1	C1	D1	T	C1	C1	A1	C1	A1
Mercury and Salts	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Methanol 100%	N	D2	D2	D2	N	E2	E2	N	N	N	E2	N	N	N	E2	N	E2	N	N	E2	E2	E2
Methyl Acetate	T	T	N	N	N	T	T	N	T	N	T	N	T	N	T	N	N	T	N	N	E2	E2
Methylamyl Alcohol[1]	E1	E1	T	T	N	E1	E1	E1	E1	N	E1	E1	E1	N	E1	E1	T	E1	E1	T	E1	E1
Methylene Chloride	E2	E2	N	N	N	N	N	N	E2	N	N	N	E2	N	N	N	N	E2	N	N	E2	E2
Methyl Chloride	E1	N	N	N	N	N	N	N	E2	N	N	N	E2	N	N	N	N	E2	N	N	E2	E2
Methyl-Ethyl Ketone	E2	E2	E2	T	N	E2	E2	N	E2	N	E2	N	E2	N	E2	N	N	E2	N	N	E2	E2
Methyl Oleate[1]	D1	E1	T	T	E1	E1	E1	E1	D1	E1	E1	E1	D1	E1	E1	E1	T	D1	E1	E1	D1	D1
Methyl Isobutyl Ketone[1]	E1	E1	E1	T	N	T	T	N	E1	N	T	N	E1	N	T	N	N	E1	N	N	E1	E1
Milk - Fresh & Sour	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Molasses	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Naphtha - Aliphatic	A1	A1	C1	C1	C1	A1	A1	A1	A1	C1	A1	A1	A1	C1	A1	A1	A1	A1	A1	A1	A1	A1
Naphtha, Aromatic (Coal Tar)	C1	D1	D1	D1	T	D1	D1	D1	C1	T	D1	D1	C1	T	D1	D1	T	C1	T	T	C1	D1
Naphthalene (In Benzene)	D1	D1	D1	T	N	D1	D1	E1	D1	D1	D1	E1	D1	N	D1	E1	T	D1	N	D2	D1	D1
Naphthenic Acid[1]	D1	D1	D1	D1	T	D1	D1	T	D1	T	D1	T	D1	T	D1	T	T	D1	T	D1	D1	D1
Nickel Plating, Bright[4]	A1	C1	C1	T	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A2	A1	A1	A1	A1	A1
Nitric Acid - 5%	A1	E2	E2	E2	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	N	A1	A1	A1	A1	A1
Nitric Acid - 10%	B1	E2	E2	E2	C1	C1	C1	A1	A1	C1	C1	B1	B1	C1	C1	B1	N	C1	C1	D1	A1	A1
Nitric Acid - 25%	C1	N	N	N	D1	D1	D1	C1	C1	D1	D1	C1	C1	D1	D1	C1	N	C1	D1	D2	C1	D1
Nitric Acid - 40%	C1	N	N	N	D1	D1	D1	D1	D1	D1	D1	C1	D1	D1	D1	D1	N	D1	D1	E2	D2	D2
Nitric Acid - 60%	D1	N	N	N	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	N	D1	N	N	D2	D2
Nitric Acid - 73%	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	E2	E2
Nitrilotriethanol[1]	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E2	E1	E1	T	E1	E1
Nitrobenzene	E1	E1	T	T	N	T	T	T	E1	N	T	T	E1	N	T	T	N	E1	N	N	E1	E1
Nitromethane	T	T	T	T	E1	T	T	N	T	E1	T	N	T	E1	T	N	T	T	T	T	D2	D2
Octanoic Acid	See Caprylic Acid																					
Octanol[1]	E1	E1	T	T	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	T	E1	E1	E1	E1	E1
Oils																						
Sour Crude Petroleum	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Animal	A1	T	T	T	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	T	A1	A1	A1	A1	A1
Mineral	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Vegetable	A1	D1	D1	D1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	T	A1	A1	A1	A1	A1
Oleic Acid	A1	N	N	N	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	N	A1	A1	A1	A1	A1
Oleum	See Sulfuric Acid																					
Oxalic Acid (Saturated)	A1	T	T	T	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	T	A1	A1	A1	A1	A1
Para Xylene	D1	D1	T	T	N	D1	D1	E1	D1	N	D1	E1	D1	N	D1	E1	T	D1	N	N	D1	D1
Pelargonic Acid[1]	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E2	E1	E1	E1	E1	E1
Pentachloroethane	E1	N	N	N	T	T	T	T	E1	T	T	T	E1	T	T	T	N	E1	N	N	E1	E1

CEILCOTE Corrosion Control Products

	DUTY LININGS										FLOOR TOPPINGS							SEALANTS		
	Flakeline 242	Flakeline 251/252	Flakeline 252 International	Flakeline 261/262	Flakeline 282	Flakeline 300/350	Flakeline 600/Flaketar 661	Ceilcote 681/685/Corocrete T	Ceilcote 682/683/Corocrete SL/SR	Ceilcrete 695	Ceilcrete 2500 U.S.A.	Ceilcrete 2500 International	Ceilcrete 5500	Ceilcrete 6400	Ceilcrete 6650	Coroline 505/510	Ceilcote EJ10	Ceilcote EJ11	Ceilcote EJ3/EJ4
Isophorone[1]	E1	E1	E1	E1	E1	T	T	E2	E2	D2	D2	E2	D2	D2	D2	D2	T	T	T
Isopropyl Acetate	N	E2	N	T	E2	N	N	E2	D2	D2	D2	D2	D2	D2	D2	D2	N	N	N
Isopropyl Alcohol	D1	D1	D1	D1	C1	E1	D2	C2	A2	A2	A2	A2	A2	C2	A2	A2	D2	D2	D2
Isopropyl Ether	N	E2	N	E2	E2	T	N	E2	D2	D2	D2	D2	D2	D2	D2	D2	T	T	T
Jet Fuel JP-4	D1	A1	D1	D1	A1	A1	D1	C2	A2	A2	A2	A2	A2	A2	A2	A2	N	D2	D2
Kerosene	A1	A1	A1	A1	A1	A1	A1	C2	A2	A2	A2	A2	A2	A2	A2	A2	N	D2	D2
Ketchup	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Lactic Acid 1-20%	A1	A1	A1	A1	A1	A1	T	T	D2	A2	A2	A2	A2	A2	A2	T	T	D2	T
Lactic Acid Concentrated	A1	A1	A1	A1	A1	A2	N	N	N	A2	A2	A2	A2	A2	A2	N	N	D2	N
Lard	A1	A1	A1	A1	A1	A1	D2	D2	D2	A2	A2	A2	A2	A2	A2	D2	N	D2	T
Lauric Acid	A1	A1	A1	A1	A1	A1	N	N	T	A2	A2	A2	A2	A2	A2	T	N	T	T
Lead Acetate	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	T	A2
Lecithin[1]	A1	A1	A1	A1	A1	A1	D1	D2	D2	D2	D2	D2	D2	D2	D2	D2	A2	E2	A2
Levulinic Acid (Saturated)	A1	A1	A1	A1	A1	A1	T	T	D2	A2	A2	A2	A2	A2	A2	D2	D2	E2	D2
Linseed Oil	A1	A1	A1	A1	A1	A1	T	D2	D2	A2	A2	A2	A2	A2	A2	D2	N	D2	T
Lithium Hydroxide* - 10%	N	N	N	N	N	N	E1	A2	A2	A2	A2	A2	A2	N	A2	A2	E2	E2	E2
Lithium Hydroxide* (Saturated)	N	N	N	N	N	N	E1	A2	A2	A2	A2	A2	A2	N	A2	A2	D2	D2	D2
Maleic Acid	A1	A1	A1	A1	A1	A1	N	N	N	A2	A2	A2	A2	A2	A2	N	T	T	T
Malic Acid[1]	A1	A1	A1	A1	A1	A1	T	D2	C2	A2	C2	C2	C2	D2	A2	C2	D2	E2	D2
Mercury and Salts	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Methanol 100%	E2	D2	E2	E2	E2	E2	E2	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	E2	D2
Methyl Acetate	N	E2	N	N	D2	N	N	D2	D2	D2	D2	D2	D2	D2	D2	D2	N	N	N
Methylamyl Alcohol[1]	E1	E1	N	E1	E1	T	T	T	E2	E2	E2	E2	E2	E2	E2	E2	E2	E2	E2
Methylene Chloride	N	N	N	N	E2	N	N	N	N	E2	E2	N	N	N	E2	E2	N	E2	N
Methyl Chloride	N	N	N	N	E2	N	N	N	N	E2	N	N	N	N	E2	N	N	T	N
Methyl-Ethyl Ketone	N	E2	N	N	E2	N	N	T	E2	D2	E2	E2	E2	E2	E2	D2	N	N	N
ethyl Oleate[1]	E1	E1	E1	E1	D1	E1	T	T	D2	D2	D2	D2	D2	D2	D2	D2	N	T	T
Methyl Isobutyl Ketone[1]	N	T	N	N	E1	N	N	N	D2	D2	D2	N	D2	N	D2	D2	N	N	N
Milk - Fresh & Sour	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Molasses	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Naphtha - Aliphatic	A1	A1	A1	A1	A1	A1	A1	C2	C2	A2	A2	C2	A2	A2	A2	A2	N	D2	E2
Naphtha, Aromatic (Coal Tar)	T	D1	T	D1	C1	T	T	D2	D2	A2	C2	D2	C2	D2	C2	C2	N	D2	E2
Naphthalene (In Benzene)	N	D1	D1	E1	D1	E2	E2	T	D2	C2	C2	D1	C2	D2	C2	C2	N	E2	N
Naphthenic Acid[1]	T	D1	T	T	D1	D2	T	E2	E2	C2	D2	T	D2	T	D2	C2	N	T	T
Nickel Plating, Bright[4]	A1	A1	A1	A1	A1	A1	E2	D2	C2	A2	A2	A2	A2	A2	A2	A2	A2	T	E2
Nitric Acid - 5%	A1	A1	A1	A1	A1	A2	E2	E2	E2	A2	A2	A2	A2	A2	A2	D2	D2	E2	N
Nitric Acid - 10%	D1	D1	D1	D1	A1	D2	N	N	N	A2	B2	B2	B2	A2	A2	D2	D2	E2	N
Nitric Acid - 25%	D2	D2	D2	D2	C1	E2	N	N	N	B2	C2	C2	C2	B2	B2	N	T	E2	N
Nitric Acid - 40%	D2	E1	E1	E1	D1	E2	N	N	N	C2	C2	C2	C2	B2	C2	N	T	E2	N
Nitric Acid - 60%	E2	E2	E2	D2	D2	N	N	N	N	D2	D2	D2	D2	D2	D2	N	T	E2	N
Nitric Acid - 73%	N	N	N	N	E2	N	N	N	N	E2	N	N	N	N	E2	N	N	E2	N
Nitrilotriethanol[1]	E1	E1	E1	E1	E1	T	T	D2	D2	D2	D2	D2	D2	D2	D2	D2	T	T	T
Nitrobenzene	N	T	N	T	E1	N	N	N	T	E2	T	N	T	T	E2	E2	N	E2	T
Nitromethane	T	T	E1	N	T	T	T	T	T	E2	D2	T	T	E2	T	E2	N	N	T
Octanoic Acid	(see Caprylic Acid)																		
Octanol[1]	E1	E1	E1	E1	E1	E1	T	T	T	D2	D2	D2	D2	D2	D2	D2	T	N	T
Oils																			
Sour Crude Petroleum	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	N	E2	A2
Animal	A1	A1	A1	A1	A1	A1	T	E2	E2	A2	A2	A2	A2	A2	A2	D2	N	E2	A2
Mineral	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	N	E2	A2
Vegetable	A1	A1	A1	A1	A1	A1	T	D2	D2	A2	A2	A2	A2	A2	A2	C2	N	E2	A2
Oleic Acid	A1	A1	A1	A1	A1	A1	N	N	N	A2	A2	A2	A2	A2	A2	N	N	T	D2
Oleum	See Sulfuric Acid																		
Oxalic Acid (Saturated)	A1	A1	A1	A1	A1	A1	T	A2	A2	A2	A2	A2	A2	A2	A2	T	A2	D2	A2
Para Xylene	N	D1	N	E1	D1	N	N	D2	D2	A2	D2	D2	D2	D2	D2	D2	N	E2	N
Pelargonic Acid[1]	E1	E1	E1	E1	E1	E1	T	T	D2	C2	C2	C2	C2	C2	C2	D2	N	T	N
Pentachloroethane	N	N	N	N	E1	N	N	E2	N	E2	E2	E2	E2	T	E2	E2	N	E2	N

KEY TO CHEMICAL RESISTANCE CHART

Rating Description
- A Good to Maximum Temperature of Product
- B Good to 180 °F (82 °C) Maximum
- C Good to 140 °F (60 °C)
- D Good to 120 °F (49 °C) Ambient
- E Good to 100 °F (37 °C)

Rating Description
- 1 Immersion or Constant Flow or Condensing Vapor
- 2 Occasional Splash or Spill
- 3 Fumes Only, Not Condensing
- N Not Recommended

Rating Description
- T Varies With Conditions, May Require Test. Consult Master Builders Technologies for Recommendation.

Master Builders Technologies

	Ceiline 80	Coroline 505/510/505.2/505.6	Coroline 505M	Coroline 550	Ceilcrete 2500 International	Ceilcrete 2500 U.S.A.	Ceilcrete 5500	Ceilcrete 6400	Ceilcrete 6850	Flakeline 103	Flakeline 161	Flakeline 164	Flakeline 180	Ceilcote Lining 25	Ceilcote Lining 61	Ceilcote Lining 64	Ceilcote Lining 68	Ceilcote Lining 74	Ceilcote Lining 652	Flakeline 211/212	Flakeline 222HT	Flakeli...
Perchloric Acid - 30%	E1	N	N	N	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	N	E1	E1	N	E1	E1	
Perchloroethylene	D1	D1	D1	D1	E1	D1	D1	D1	D1	E1	D1	D1	D1	E1	D1	D1	T	D1	D1	E2	D1	D1
Phenol - 5%	C1	N	N	N	N	E1	E1	C1	C1	N	E1	C1	C1	N	E1	C1	N	C1	N	N	D1	D1
Phenol - 85%	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Phenol Sulfonic Acid - 65%	N	N	N	N	T	T	T	T	N	T	T	T	N	T	T	T	N	E1	N	N	N	N
Phosphoric Acid - 20%	A1	N	N	N	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	N	A1	A1	A1	A1	A1
Phosphoric Acid - 85%	A1	N	N	N	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	N	A1	A1	A1	A1	A1
Phosphorous Oxychloride[1]	T	C1	T	T	N	N	N	E1	T	N	N	E1	T	N	N	E1	T	T	N	N	T	T
Phosphorous Trichloride[1]	T	C1	T	T	N	T	T	N	T	N	T	N	T	N	T	N	T	T	N	N	N	N
Picric Acid - 10% in Alcohol	D1	T	T	T	E1	D1	D1	E1	D1	E1	D1	E1	D1	E1	D1	D1	T	D1	E1	T	D1	D1
Polyacrylic Acid - 50%[1]	D1	D1	T	T	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	T	D1	D1	D1	D1	D1
Potassium Acetate	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Potassium Bichromate	A1	T	T	T	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	T	A1	A1	A1	A1	A1
Potassium Bromide	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Potassium Carbonate - 25%	C1	A1	A1	A1	C1	C1	C1	E1	C1	C1	C1	E1	C1	C1	C1	E1	A1	C1	C1	E2	C1	A1
Potassium Chlorate[3]	C1	C1	C1	C1	A1	A1	A1	T	A1	C1	C1	T	C1	A1	A1	A1	A1	A1	A1	A2	A1	A1
Potassium Chloride	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Potassium Cyanide	C1	A1	A1	A1	C1	C1	C1	T	C1	C1	C1	T	C1	C1	C1	T	A1	C1	C1	N	C1	A1
Potassium Fluoride[2]	C1	A1	A1	A1	A1	A1	A1	A1	A1	C1	C1	C1	C1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Potassium Hydroxide - 10%[2]	D1	A1	A1	A1	D1	D1	D1	N	D1	N	N	N	N	D1	D1	N	A1	D1	D1	N	N	D1
Potassium Hydroxide - 50%[2]	C1	A1	A1	A1	C1	C1	C1	N	C1	N	N	N	N	E1	C1	N	C1	C1	C1	N	N	A1
Potassium Nitrate	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Potassium Permaganate	A1	T	T	T	A1	A1	A1	C1	A1	A1	A1	C1	A1	A1	A1	C1	T	A1	A1	A1	A1	A1
Potassium Persulfate	A1	T	T	T	A1	A1	A1	D1	A1	A1	A1	D1	A1	A1	A1	D1	T	A1	A1	A1	A1	A1
Potassium Sulfate	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Propanediol[1]	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1
Propionic Acid - 100%[1]	D1	N	N	N	E1	D1	D1	T	D1	E1	D1	T	D1	E1	D1	T	N	D1	E1	T	D1	D1
Propylene Glycol	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Pyridine	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Rayon Spin Liquor	A1	C1	C1	C1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	D1	A1	A1	A1	A1	A1
Salicylaldehyde[1]	E1	T	T	T	N	E1	E1	E1	E1	N	E1	E1	E1	N	E1	E1	T	E1	N	D2	E1	E1
Salicylic Acid	C1	C1	C1	T	C1	C1	C1	T	C1	C1	C1	T	C1	C1	C1	T	T	C1	C1	D2	C1	D1
Salt Brine	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Silicon Tetrachloride[1]	T	T	T	T	N	E1	E1	N	T	N	E1	N	T	N	E1	N	T	T	N	N	T	T
Sodium Acetate	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Sodium Bicarbonate	A1	A1	A1	A1	A1	A1	A1	A1	A1	N	N	N	N	A1	A1	N	A1	A1	A1	N	N	A1
Sodium Bisulfate	C1	A1	A1	A1	C1	C1	C1	N	E1	E1	E1	N	E1	C1	C1	N	C1	C1	C1	N	E1	E1
Sodium Bisulfite	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Sodium Bromate	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Sodium Carbonate - Sat'd[2]	C1	A1	A1	A1	C1	C1	C1	N	E1	N	N	N	N	C1	C1	N	C1	C1	C1	N	N	E1
Sodium Chloride	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Sodium Chlorite - Sat'd	D1	N	N	N	D1	C1	C1	C1	D1	D1	C1	C1	D1	D1	C1	C1	N	D1	D1	A2	A1	A1
Sodium Chromate[3]	A1	C1	C1	C1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	T	A1	A1	A1	A1	A1
Sodium Chlorate[3]	C1	C1	C1	C1	A1	A1	A1	A1	A1	C1	C1	C1	C1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Sodium Cyanide - 15%	A1	A1	A1	A1	C1	A1	A1	D1	A1	C1	B1	D1	A1	C1	A1	D1	A1	A1	C1	B1	A1	A1
Sodium Dichromate	A1	D1	D1	D1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Sodium Fluoride[2]	C1	A1	A1	A1	A1	A1	A1	A1	A1	C1	C1	C1	C1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Sodium Hydrosulfide - 45%[2]	C1	A1	A1	A1	A1	A1	A1	C1	A1	C1	C1	D1	C1	A1	A1	C1	A1	A1	A1	E1	A1	A1
Sodium Hydroxide - 10%[2]	E1	A1	A1	A1	D1	D1	D1	N	N	N	N	N	N	D1	D1	N	D1	D1	D1	N	N	E1
Sodium Hydroxide - 50%[2]	E1	A1	A1	A1	C1	C1	C1	N	C1	N	N	N	N	C1	C1	N	A1	C1	C1	N	N	A1
Sodium Hypochlorite - 3%[2]	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	D1	D1	N	D2	D2
Sodium Hypochlorite - 17%[2]	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	D1	D1	N	D2	D2
Sodium Lauryl Sulfate - 20%	C1	C1	C1	C1	D1	D1	D1	D1	C1	D1	D1	D1	C1	D1	D1	D1	E1	C1	D1	D2	C1	D1
Sodium Oxalate	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Sodium Peroxide - Peroxide Bleach[1]	A1	A1	A1	A1	A1	A1	A1	T	A1	A1	A1	T	A1	A1	A1	T	A1	A1	A1	T	A1	A1
Sodium (Acid) Phosphate	A1	C1	C1	C1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Sodium Phosphate (Tri)	D1	A1	A1	A1	C1	C1	C1	N	C1	E1	E1	N	E1	A1	A1	N	E1	C1	C1	N	E1	E1

CEILCOTE Corrosion Control Products

	DUTY LININGS										FLOOR TOPPINGS									SEALANTS
	Flakeline 242	Flakeline 251/252	Flakeline 252 International	Flakeline 261/262	Flakeline 282	Flakeline 300/350	Flakeline 600/Flaketar 661	Ceilcote 681/685/Corocrete T	Ceilcote 682/683/Corocrete SL/SR	Ceilcrete 695	Ceilcrete 2500 U.S.A.	Ceilcrete 2500 International	Ceilcrete 5500	Ceilcrete 6400	Ceilcrete 6850	Corotine 505/510	Ceilcote EJ10	Ceilcote EJ11	Ceilcote EJ3/EJ4
Perchloric Acid - 30%	E1	E1	E1	E1	E1	D2	N	T	T	D2	D2	D2	D2	D2	D2	T	T	T	N
Perchloroethylene	E2	D1	E2	D1	D1	E2	E2	E2	D2	D2	D2	E2	D2	D2	D2	C2	N	T	T
Phenol - 5%	N	E1	N	E1	D1	N	N	N	N	B2	D2	T	D2	B2	B2	N	N	E2	T
Phenol - 85%	N	N	N	N	N	N	N	N	N	D2	N	N	N	N	D2	N	N	E2	N
Phenol Sulfonic Acid - 65%	N	T	T	T	E1	N	N	N	N	D2	T	T	T	T	D2	N	N	D2	N
Phosphoric Acid - 20%	A1	A1	A1	A1	A1	A1	E2	D2	D2	A2	A2	A2	A2	A2	A2	N	D2	E2	D2
Phosphoric Acid - 85%	A1	A1	A1	A1	A1	A1	N	N	N	A2	A2	A2	A2	A2	A2	N	T	E2	T
Phosphorous Oxychloride[1]	N	N	N	N	T	N	E2	E2	E2	T	N	N	N	N	T	C2	T	T	T
Phosphorous Trichloride[1]	N	T	N	N	T	N	E2	E2	E2	T	T	N	T	N	N	C2	T	T	T
Picric Acid - 10% in Alcohol	T	D1	E1	E1	D1	N	N	N	T	C2	C2	D2	C2	D2	D2	T	D2	D2	D2
Polyacrylic Acid - 50%[1]	D1	D1	D1	D1	D1	D1	T	T	T	D2	D2	D2	D2	D2	D2	D2	D2	T	T
Potassium Acetate	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	E2	A2
Potassium Bichromate	A1	A1	A1	A1	A1	A1	T	E2	E2	A2	A2	A2	A2	A2	A2	C2	D2	E2	D2
Potassium Bromide	A1	A1	A1	A1	A1	A1	A1	A2	C2	A2	A2	A2	A2	A2	A2	A2	A2	E2	A2
Potassium Carbonate - 25%	A1	A1	A1	E1	A1	E2	A1	A2	A2	A2	A2	A2	A2	D2	A2	A2	A2	D2	E2
Potassium Chlorate[3]	A1	A1	A1	T	A1	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2	A2	A2	D2	A2
Potassium Chloride	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Potassium Cyanide	A1	A1	A1	T	C1	N	E1	A2	A2	A2	A2	A2	A2	D2	A2	A2	A2	D2	A2
Potassium Fluoride[2]	A1	A1	A1	A1	N	N	D2	D2	C2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Potassium Hydroxide - 10%[2]	D1	D1	D1	N	N	N	A1	A2	A2	C2	C2	C2	C2	N	C2	A2	C2	E2	N
Potassium Hydroxide - 50%[2]	A1	A1	A1	N	N	N	A1	A2	A2	C2	C2	C2	C2	N	C2	A2	C2	E2	N
Potassium Nitrate	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	E2	A2
Potassium Permaganate	A1	A1	A1	A1	A1	A1	T	D2	D2	A2	A2	A2	A2	A2	A2	D2	D2	E2	D2
Potassium Persulfate	A1	A1	A1	A1	A1	A1	T	C2	C2	A2	A2	A2	A2	C2	A2	D2	D2	E2	D2
Potassium Sulfate	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Propanediol[1]	D1	D1	D1	D1	D1	D1	D1	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	E2	D2
ropionic Acid - 100%[1]	E1	D1	E1	T	D1	T	N	N	N	D2	D2	D2	D2	T	D2	N	N	T	N
opylene Glycol	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Pyridine	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Rayon Spin Liquor	A1	A1	A1	A1	A1	A1	E2	D2	D2	A2	A2	A2	A2	A2	A2	C2	D2	E2	D2
Salicylaldehyde[1]	D2	E1	E1	E1	E1	E2	T	T	D2	D2	D2	N	D2	D2	D2	T	T	T	T
Salicylic Acid	D1	D1	D1	T	C1	D2	T	D2	D2	C2	C2	C2	C2	C2	C2	C2	C2	E2	C2
Salt Brine	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Silicon Tetrachloride[1]	N	E1	N	N	T	N	T	T	T	D2	D2	D2	D2	D2	D2	T	T	T	T
Sodium Acetate	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	T	A2
Sodium Bicarbonate	E1	E1	E1	N	N	N	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Sodium Bisulfate	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Sodium Bisulfite	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Sodium Bromate	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Sodium Carbonate - Sat'd[2]	E1	E1	E1	N	N	N	A1	A2	A2	A2	A2	A2	A2	D2	A2	A2	A2	D2	D2
Sodium Chloride	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Sodium Chlorite - Sat'd	D1	D1	D1	D1	D1	N	N	T	T	C2	B2	C2	B2	B2	C2	T	D2	D2	D2
Sodium Chromate[3]	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Sodium Chlorate	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Sodium Cyanide - 15%	A1	A1	A1	A1	A1	D2	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Sodium Dichromate	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Sodium Fluoride[2]	A1	A1	A1	A1	E1	E2	E2	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	T	A2
Sodium Hydrosulfide - 45%[2]	A1	A1	A1	E1	A1	E2	A2	C2	A2	A2	A2	A2	A2	A2	A2	C2	A2	D2	T
Sodium Hydroxide - 10%[2]	E1	D1	D1	N	N	N	D1	A2	A2	C2	C2	C2	C2	N	C2	A2	N	D2	A2
Sodium Hydroxide - 50%[2]	E1	E1	E1	N	N	N	E1	A2	A2	C2	C2	C2	C2	N	C2	A2	N	D2	A2
Sodium Hypochlorite - 3%[2]	D2	D2	D2	N	N	N	N	N	D2	D2	D2	D2	D2	N	D2	N	D2	E2	N
Sodium Hypochlorite - 17%[2]	E2	E2	E2	N	N	N	N	N	N	E2	E2	E2	E2	N	E2	N	N	E2	N
Sodium Lauryl Sulfate - 20%	D1	D1	D1	D1	C1	D2	A2	C2	C2	A2	C2	A2	C2	C2	A2	B2	D2	E2	D2
Sodium Oxalate	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	T	A2
Sodium Peroxide - Peroxide Bleach[1]	A1	A1	A1	T	A1	T	D1	A2	A2	A2	A2	A2	A2	D2	A2	A2	A2	D2	N
Sodium (Acid) Phospate	A1	A1	A1	A1	A1	A1	D1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Sodium Phosphate (Tri)	E1	E1	E1	N	E1	N	E1	A2	A2	A2	A2	A2	A2	N	A2	A2	A2	A2	A2

. TO CHEMICAL RESISTANCE CHART

Rating Description
- A Good to Maximum Temperature of Product
- B Good to 180 °F (82 °C) Maximum
- C Good to 140 °F (60 °C)
- D Good to 120 °F (49 °C) Ambient
- E Good to 100 °F (37 °C)

Rating Description
- 1 Immersion or Constant Flow or Condensing Vapor
- 2 Occasional Splash or Spill
- 3 Fumes Only, Not Condensing
- N Not Recommended

Rating Description
- T Varies With Conditions, May Require Test. Consult Master Builders Technologies for Recommendations.

Master Builders Technologies

HEAVY DUTY LININGS — LIGHT

	Ceiline 80	Coroline 505/510/505.2/505.6	Coroline 505M	Coroline 550	Ceilcrete 2500 International	Ceilcrete 2500 U.S.A.	Ceilcrete 5500	Ceilcrete 6400	Ceilcrete 6650	Flakeline 103	Flakeline 161	Flakeline 164	Flakeline 180	Ceilcote Lining 25	Ceilcote Lining 61	Ceilcote Lining 64	Ceilcote Lining 68	Ceilcote Lining 74	Ceilcote Lining 652	Flakeline 211/212	Flakeline 222HT	232	F
Sodium Polymethacrylate[1]	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1
Sodium Sulfate	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Sodium Sulfide (Saturated)[2]	A1	A1	A1	A1	A1	A1	A1	E1	A1	A1	A1	E1	A1	A1	A1	E1	A1	A1	A1	E1	A1	A1	A1
Sodium Sulfite	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Sodium Tartrate	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Sodium Thiosulfate (Hypo)	A1	A1	A1	A1	C1	A1	A1	T	A1	C1	A1	T	A1	C1	A1	T	A1	A1	A1	A1	A1	A1	A1
Soybean Oil	A1	T	T	T	A1	A1	A1	T	A1	A1	A1	T	A1	A1	A1	T	A1	A1	A1	A1	A1	A1	A1
Stearic Acid	A1	N	N	N	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	N	A1	A1	A1	A1	A1	A1
Styrene	D1	N	N	N	N	N	N	N	D1	N	N	N	D1	N	N	N	N	D1	N	E2	D1	D1	D1
Sugar	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Sulfamic Acid - 25%	C1	T	T	T	C1	C1	C1	A1	C1	C1	C1	C1	C1	C1	C1	A1	T	C1	C1	A1	A1	A1	A1
Sulfite Liquor (Paper)	A1	A1	A1	A1	A1	A1	A1	D1	A1	A1	A1	D1	A1	A1	A1	D1	A1	A1	A1	A1	A1	A1	A1
Sulfur Dioxide (Wet)	A1	C1	C1	D1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Sulfur Trioxide (Wet)	A1	D1	D1	E1	A1	A1	A1	A1	A1	B1	B1	B1	A1	A1	A1	A1	E2	A1	A1	A1	A1	A1	A1
Sulfuric Acid - 10%	A1	D1	E1	E1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	E2	A1	A1	A1	A1	A1	A1
Sulfuric Acid - 25%	A1	E2	E2	E2	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	N	A1	A1	A1	A1	A1	A1
Sulfuric Acid - 50%	A1	D2	D2	D2	A1	A1	A1	A1	A1	B1	B1	B1	B1	A1	A1	A1	N	A1	A1	A1	A1	A1	A1
Sulfuric Acid - 70%	C1	N	N	N	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	N	C1	C1	A2	D1	E1	E1
Sulfuric Acid - 75%	D1	N	N	N	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	N	E1	E1	D2	E1	E1	E2
Sulfuric Acid - 93-98%	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	E2	E2	E2
Tall Oil	A1	B1	B1	C1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A2	A1	A1	A1	A1	A1	A1
Tartaric Acid	A1	T	T	T	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A2	A1	A1	A1	A1	A1	A1
Tetrachloroethane[1]	D1	E1	E1	T	N	E1	E1	N	D1	N	E1	N	D1	N	E1	N	N	D1	N	N	D1	D1	D1
Tetrachloroethylene[1]	See Perchlorethylene																						
Tetrahydrofuran	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	E2	E2	E2
Tetrahydrofurfuryl Alcohol[1]	E1	T	T	T	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	T	E1	E1	T	E1	E1	E1
Thionyl Chloride	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Thionyl Chloride - Water Sol'n	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Tin Plating (Fluoborate)	See Fluoboric Acid																						
Tin Plating (Stannate)	See Sodium Hydroxide																						
Toluol (Toluene)	E1	E1	T	T	N	N	N	N	E1	N	N	N	E1	N	N	N	N	E1	N	N	E1	E1	E1
Toluene Sulfonic Acid	A1	T	T	T	A1	A1	A1	D1	A1	A1	A1	D1	A1	A1	A1	D1	T	A1	A1	T	A1	A1	A1
Toluidine[1]	T	T	T	T	N	E1	E1	N	T	N	E1	N	T	N	E1	N	N	T	N	N	T	T	T
Triethylamine[1]	E1	T	T	T	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	N	E1	E1	T	E1	E1	E1
Triethylenetetramine[1]	T	T	T	T	E1	E1	E1	E1	T	E1	E1	E1	T	E1	E1	E1	N	E1	N	T	T	T	T
Triethyl Phosphite[1]	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	T	E1	E1	E1	E1	E1	E1
Trichloroacetic Acid - 20%	A1	N	N	N	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	N	A1	A1	A1	A1	A1	A1
Trichlorobenzene (1,2,4-)[1]	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	T	E1	E1	T	E1	E1	E1
Trichloroethane[1]	E1	E1	E1	T	N	E1	E1	N	E1	N	E1	N	E1	N	E1	N	N	E1	N	N	E1	E1	E1
Trichloroethylene	E2	E1	T	T	N	E1	E1	N	E1	N	E1	N	E1	N	E1	N	N	E2	N	N	E2	E2	E2
Tricresyl Phosphate 100%	C1	C1	C1	C1	T	T	T	T	C1	T	T	T	C1	T	T	T	D2	C1	C1	T	C1	D1	D1
Trisodium Phosphate (Sat'd)[2]	C1	A1	A1	A1	A1	A1	A1	E1	A1	C1	C1	E1	C1	A1	A1	E1	A1	A1	A1	D2	A1	A1	A1
Turpentine	A1	D1	D1	D1	C1	C1	C1	D1	A1	C1	C1	D1	A1	C1	C1	D1	T	A1	C1	E1	A1	A1	A1
Urea Solutions	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Vinegar	A1	E1	E1	E1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	E1	A1	A1	A1	A1	A1
Vinyl Chloride	T	T	T	N	N	T	T	N	N	N	T	T	N	T	N	N	N	T	N	N	E2	E2	E2
Water, Distilled & Demineralized	A1	A1	A1	A1	A1	A1	A1	A1	A1	B1	B1	B1	B1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
White Liquor (Paper)	C1	A1	A1	A1	A1	A1	A1	N	A1	C1	C1	N	C1	A1	A1	N	A1	A1	A1	N	A1	A1	A1
Wine	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
Xylol (Xylene)	D1	D1	T	T	N	N	N	N	D1	N	N	N	D1	N	N	N	N	D1	N	N	D1	D1	D1
Zinc Plating - Acid Fluoborate	See Fluoboric Acid																						
Zinc Plating - Cyanide	See Sodium Hydroxide 10%																						
Zinc Plating - Acid Sulfate	A1	C1	C1	C1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	E1	A1	A1	A1	A1	A1	A1

CEILCOTE Corrosion Control Products

	DUTY LININGS							FLOOR TOPPINGS										SEALANTS	
	Flakeline 242	Flakeline 251/252	Flakeline 252 International	Flakeline 261/262	Flakeline 282	Flakeline 300/350	Flakeline 600/Flaketar 661	Ceilcote 681/685/Corocrete T	Ceilcote 682/683/Corocrete SL/SR	Ceilcrete 695	Ceilcrete 2500 U.S.A.	Ceilcrete 2500 International	Ceilcrete 5500	Ceilcrete 6400	Ceilcrete 6650	Coroline Series	Ceilcote EJ10	Ceilcote EJ11	Ceilcote EJ3/EJ4
Sodium Polymethacrylate[1]	D1	D1	D1	D1	D1	D1	D1	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	E2	D2
Sodium Sulfate	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Sodium Sulfide (Saturated)[2]	A1	A1	A1	E1	A1	E2	A2	A2	A2	A2	A2	A2	A2	D2	A2	A2	D2	D2	D2
Sodium Sulfite	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Sodium Tartrate	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Sodium Thiosulfate (Hypo)	A1	A1	A1	T	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Soybean Oil	A1	A1	A1	A1	A1	A1	A2	D2	C2	A2	A2	A2	A2	A2	A2	D2	N	D2	D2
Stearic Acid	A1	A1	A1	A1	A1	A1	N	D2	D2	A2	A2	A2	A2	A2	A2	D2	N	T	D2
Styrene	N	N	N	N	D1	E2	N	D2	D2	D2	D2	N	D2	N	D2	D2	N	E2	N
Sugar	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Sulfamic Acid - 25%	A1	A1	A1	A1	A1	A1	T	T	T	A2	A2	B2	B2	A2	B2	D2	D2	E2	D2
Sulfite Liquor (Paper)	A1	A1	A1	D1	A1	A1	A2	A2	A2	A2	A2	A2	A2	C2	A2	A2	A2	E2	A2
Sulfur Dioxide (Wet)	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	D2	D2
Sulfur Trioxide (Wet)	A1	A1	A1	A1	A1	A1	E1	E2	E2	A2	A2	A2	A2	A2	A2	C2	D2	D2	N
Sulfuric Acid - 10%	A1	A1	A1	A1	A1	A1	E2	D2	D2	A2	A2	A2	A2	A2	A2	C2	D2	D2	N
Sulfuric Acid - 25%	A1	A1	A1	A1	A1	A2	N	E2	E2	A2	A2	A2	A2	A2	A2	D2	D2	D2	N
Sulfuric Acid - 50%	A1	A1	A1	A1	A1	A2	N	E2	E2	A2	A2	A2	A2	A2	A2	D2	D2	D2	N
Sulfuric Acid - 70%	E1	E1	E1	E1	E1	E2	N	N	N	A2	A2	A2	A2	A2	A2	N	D2	D2	N
Sulfuric Acid - 75%	E1	E1	E1	E1	E1	D2	N	N	N	B2	C2	C2	C2	B2	C2	N	E2	D2	N
Sulfuric Acid - 93-98%	N	N	N	N	E2	N	N	N	N	D2	N	N	N	N	N	N	N	E2	N
Tall Oil	A1	A1	A1	A1	A1	A1	E2	C2	C2	A2	A2	A2	A2	A2	A2	A2	A2	N	T	D2
Tartaric Acid	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Tetrachloroethane[1]	N	E1	N	N	D1	N	N	N	T	D2	E2	N	D2	E2	D2	D2	N	T	N
Tetrachloroethylene[1]	See Perchlorethylene																		
Tetrahydrofuran	N	N	N	N	E2	N	N	N	N	E2	N	N	N	N	E2	N	N	N	N
Tetrahydrofurfuryl Alcohol[1]	E1	E1	E1	E1	E1	T	T	D2	D2	D2	D2	D2	D2	D2	D2	D2	T	T	T
Thionyl Chloride	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	T	N
Thionyl Chloride - Water Sol'n	N	N	N	N	N	N	N	N	N	T	N	N	N	N	T	T	N	T	N
Tin Plating (Fluoborate)	See Fluoboric Acid																		
Tin Plating (Stannate)	See Sodium Hydroxide																		
Toluol (Toluene)	N	N	N	N	E1	N	N	E2	E2	D2	E2	E2	E2	E2	D2	D2	N	E2	N
Toluene Sulfonic Acid	A1	A1	A1	D1	A1	N	T	D2	D2	A2	A2	A2	A2	C2	A2	D2	T	T	T
Toluidine[1]	N	E1	N	N	T	N	N	T	T	T	D2	N	D2	N	T	T	N	T	N
Triethylamine[1]	E1	E1	E1	E1	E1	T	T	N	T	D2	D2	D2	D2	D2	D2	D2	T	T	T	T
Triethylenetetramine[1]	N	E1	E1	E1	T	T	N	N	T	D2	D2	D2	D2	D2	D2	D2	T	T	T	T
Triethyl Phosphite[1]	E1	E1	E1	E1	E1	E1	T	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	T	T	T
Trichloroacetic Acid - 20%	A1	A1	A1	A1	A1	A1	N	N	N	A2	A2	A2	A2	A2	A2	A2	N	D2	T	T
Trichlorobenzene (1,2,4-)[1]	E1	E1	E1	E1	E1	T	T	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	N	T	T
Trichloroethane[1]	N	E1	N	N	E1	N	N	D2	D2	D2	D2	N	D2	N	D2	D2	D2	N	E2	N
Trichloroethylene	N	E2	N	N	E2	N	N	N	E2	D2	D2	N	D2	D2	D2	D2	D2	N	E2	N
Tricresyl Phosphate 100%	C1	T	T	T	A1	T	E2	E2	E2	C2	E2	E2	E2	E2	C2	C2	T	T	T
Trisodium Phosphate (Sat'd)[2]	A1	A1	A1	E1	A1	D2	A1	A2	A2	A2	A2	A2	A2	C2	A2	A2	C2	D2	C2
Turpentine	A1	A1	A1	D1	A1	E1	T	D2	D2	A2	C2	C2	C2	D2	A2	A2	N	E2	T
Urea Solutions	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Vinegar	A1	A1	A1	A1	A1	A1	E2	D2	D2	A2	A2	A2	A2	A2	A2	B2	D2	D2	D2
Vinyl Chloride	N	E2	N	N	E2	N	N	N	N	E2	E2	N	E2	N	E2	E2	N	T	N
Water, Distilled & Demineralized	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
White Liquor (Paper)	A1	A1	A1	N	A1	N	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	T	D2
Wine	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	D2	A2
Xylol (Xylene)	N	N	N	N	D1	N	N	E2	E2	D2	E2	E2	E2	E2	D2	D2	N	E2	N
Zinc Plating - Acid Fluoborate	See Fluoboric Acid																		
Zinc Plating - Cyanide	See Sodium Hydroxide 10%																		
Zinc Plating - Acid Sulfate	A1	A1	A1	A1	A1	A1	D1	C2	C2	A2	A2	A2	A2	A2	A2	A2	A2	D2	D2

KEY TO CHEMICAL RESISTANCE CHART

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- E Good to 100 °F (37 °C)

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Master Builders Technologies

PROTECTIVE COATINGS

	CeilGard® 650 HB	CeilGard 650/FDA	CeilGard 615/620	Flakeline 630	CeilGard 470	CeilGard 480
Acetic Acid - 10%	N	N	N	N	D2	C2
Acetone - 10%	E2	E2	E2	E1	D2	D2
Acetone - 100%	E2	E2	E2	E1	E2	D2
Alum	D2	D2	C2	C1	C2	B2
Aluminum Chloride	D2	D2	C2	C1	C2	B2
Aluminum Sulfate	D2	D2	C2	C1	C2	E2
Ammonia Anhydrous Liquid	D2	D2	C2	E1	B2	B2
Ammonia Aqua	D2	D2	D2	C2	B2	B2
Ammonia Wet Gas	D2	D2	D2	C2	B3	B3
Ammonium Chloride	D2	D2	A2	B2	C2	E2
Ammonium Hydroxide - 20%	D2	D2	A2	C2	B2	B2
Ammonium Nitrate	D2	D2	A2	C2	C2	E2
Ammonium Sulfate	D2	D2	A2	C2	C2	E2
Aniline	N	N	N	N	N	N
Benzene	E2	E2	D2	E1	D2	E1
Benzoic Acid	D2	D2	C2	B2	B2	B2
Benzyl Chloride	N	N	N	C2	D2	D2
Black Liquor (Paper)	D2	D2	C2	C1	C2	B2
Bleach	N	N	N	C2	C2	B2
Boric Acid	D2	D2	D2	C2	B2	B2
Bromine Water - 5%	N	N	N	C2	C2	B2
Butanol	D2	D2	C2	D1	C2	C2
Butyl Cellosolve	D2	D2	C2	D1	C2	C2
Butyl Cellosolve Acetate	D2	D2	C2	D1	C2	C2
Cadmium Plating (Cyanide)	A2	A2	A2	C2	C2	B2
Calcium Bisulfite	A2	A2	A2	C1	B2	B2
Calcium Chloride	A2	A2	D2	C2	C2	E2
Calcium Hydroxide	A2	A2	C2	C1	C2	C2
Calcium Hydrochlorite 5%	N	N	N	N	C2	C2
Calcium Nitrate	D2	D2	C2	C1	C2	A2
Carbon Bisulfide Fumes	E2	E2	D2	C2	D2	C2
Carbon Tet	E2	E2	E2	E1	C2	B2
Cellosolve	D2	D2	D2	D1	C2	C2
Chlorine Gas (Wet)	N	N	N	N	N	N
Chlorine Water	N	N	E2	C2	N	N
Chlorobenzene	D2	D2	D2	D1	C2	C2
Chloroform	N	N	N	N	N	N
Chromic Acid - 10%	N	N	N	E2	C2	C2
Chrome Plating	N	N	N	D2	N	N
Chromic Chloride	D2	D2	C2	C1	C2	C2
Citric Acid	D2	D2	D2	C2	C2	C2
Copper Plating (Cyanide)	E2	D2	C2	C2	C2	C2
Copper Plating (Acid)	N	N	D2	C2	C2	C2
Dextrose	E1	D1	C2	C1	C2	C2
Ethanol	C2	C2	C2	D1	C2	C2
Ethyl Acetate	E2	E2	D2	C2	E2	E2

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CEILCOTE Corrosion Control Products

PROTECTIVE COATINGS

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Ethylene Dichloride	N	N	N	N	N	N
Ethylene Glycol	D2	D2	D2	C1	C2	C2
Ferric Chloride	D2	D2	C2	C1	C2	C2
Ferric Sulfate	D2	D2	C2	C1	D2	C2
Fertilizer - Dry	A3	A3	A3	B3	D2	C2
Fertilizer - Liquid	D2	C2	C2	C1	C2	C2
Formaldehyde	D2	D2	D2	D1	C2	C2
Gasoline - Aviation	C2	C2	C2	C1	C2	C2
Gasoline - Diesel	C2	C2	C2	C1	D2	D2
Gasoline - Jet Fuel	D2	D2	C2	C1	D2	C2
Gasoline - Prem. Unleaded	D2	D2	C2	D1	C2	C2
Gasoline - Unleaded	E2	E2	E2	C1	C2	C2
Glycerine	D1	D1	B2	B1	C2	D1
Green Paper Liquor	D2	D2	A2	C1	C2	C2
Hexane	E1	E1	C2	C1	D2	C2
HCL - 1-10%	E2	E2	D2	C2	C2	C2
Hydrofluosilicic Acid	A2	A2	A2	C2	C2	C2
Hydrogen Peroxide - 30%	A2	A2	A2	C2	C2	C2
H_2S - Wet	E2	E2	E2	B2	D2	C2
Hypo (Photographic Liquid)	D1	D1	A2	C1	C2	C2
IPA	D2	D2	A2	C1	C2	C2
JP4 Jet Fuel	D2	D2	C2	C1	D2	C2
Kerosene	D1	D1	C2	B1	C2	C2
Lactic Acid - 1-10%	D2	D2	D2	B2	C2	C2
MeOH	C2	C2	C2	C2	C2	C2
MEK	N	N	N	C2	D2	C2
MIBK	D2	D2	D2	C2	D2	C2
MICK	D2	D1	D2	C1	C2	C2
Molasses	E1	D1	C2	C1	C2	A2
Muriatic Acid	N	N	N	N	N	N
Naptha (Aliphatic)	D1	D1	E2	C1	D2	D2
Naptha (Aromatic)	D2	D2	D2	C1	C2	C2
Nitric Acid - 5%	E2	E2	E2	D2	C2	C2
Nitric Acid - 10%	N	N	E2	D2	C2	C2
Nitrobenzene	E2	E2	D2	C2	E2	E2
Oil, Animal	D2	D2	C2	C1	C2	C2
Oil, Mineral	E1	E1	C2	C1	C2	D2
Petroleum, Sour Crude	D2	C2	C2	C1	C2	D2
Oil, Vegetable	D2	D1	C2	C1	C2	D2
Para Xylene	E2	E2	D2	C1	N	N
Perchloroethylene	E2	D2	D2	C1	N	E2
Phenol - 5%	N	N	N	D2	N	D2
Phenol - 85%	N	N	N	D2	N	N
Phosphoric Acid - 20%	N	N	N	D2	C2	C2
Phosphoric Acid - 85%	N	N	N	E2	N	N
Potassium Bichromate	D2	D2	C2	B2	C2	C2

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Potassium Chloride	E1	E1	C2	C1	C2	C2
Potassium Hydroxide - 10%	A2	A2	A2	C1	C2	C2
Potassium Hydroxide - 50%	A2	A2	A2	C1	D2	C2
Propylene Glycol	E1	D1	A2	C1	C2	A2
Rayon Spin Liquor	N	N	C2	B2	C2	C2
Salt Brine	D1	D1	B2	C1	C2	C2
Sodium Bicarb	E1	D1	C2	C1	C2	A2
Sodium Bisulfate	D2	D2	C2	C2	C2	C2
Sodium Carbonate	D1	D1	C2	C1	C2	A2
Sodium Chlorate	D1	D1	A2	C1	C2	C2
Sodium Chloride	E1	E1	C2	C1	D2	C2
Sodium Chromate	D2	D2	C2	C2	C2	C2
Sodium Dichromate	C2	C2	C2	C2	C2	C2
Sodium Hydroxide - 10%	C2	E1	C2	C1	C2	C2
Sodium Hydroxide - 50%	C2	E1	C2	C1	D2	C2
Sodium Hypochlorite - 3%	N	N	N	N	C2	C2
Sodium Phosphate - 25%	C2	E1	C2	C2	C2	A2
Sodium Sulfate	C2	D1	C2	C1	C2	C2
Sodium Sulfide	C2	C2	C2	C1	C2	C2
Sodium Sulfite	C2	C2	C2	C1	C2	A2
Sodium Thiosulfate	C2	D1	C2	C1	C2	C2
Styrene	E2	E2	D2	D1	C2	C2
Sugar	E1	D1	C2	C1	C2	C2
Sulfur Dioxide (Wet) Sulfurous Acid	E2	D2	D2	C2	C2	C2
Sulfur Trioxide (Wet)	E2	E2	E2	C2	D2	C2
Sulfuric Acid - 10%	N	N	N	D2	D2	D2
Sulfuric Acid - 25%	N	N	N	D2	D2	D2
Sulfuric Acid - 50%	N	N	N	E2	N	N
Sulfuric Acid - 70%	N	N	N	N	N	N
Sulfuric Acid - 75%	N	N	N	N	N	N
Sulfuric Acid - 93-98%	N	N	N	N	N	N
Tall Oil	D2	D2	C2	C2	C2	C2
Toluene	E2	D2	D2	D1	C2	C2
Trichloroethane	E2	E2	C2	E2	E2	D2
Trichlorothylene	E2	E2	E2	E2	E2	D2
Tricresyl Phosphate	E1	E1	C2	C1	C2	C2
Trisodium Phosphate	E1	D1	C2	C1	C2	C2
Turpentine	E1	D1	C2	B1	C2	D2
Urea	D2	D2	C2	C1	C2	C2
Vinegar	E2	D2	D2	D2	D2	C2
Water, Distilled	E1	D1	C2	D1	D2	A2
White Liquor - Paper	C2	C2	C2	C1	C2	C2
Wine	E1	E1	A2	D1	C2	C2
Xylol	E2	D2	C2	D1	C2	C2
Zinc Plating (Acid Sulfate)	D2	D2	D2	C2	D2	C2

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Solving corrosion problems for industry, worldwide

Master Builders Technologies

From floors to stacks, Ceilcote corrosion control products from Master Builders, helps hundreds of industries solve their toughest corrosion problems.

Master Builders Technologies is industry's partner in corrosion problem-solving. As the pioneer and technological leader in polymer linings, coatings, flooring and grout, we have become an increasingly important factor in the cost-effective operation of hundreds of industrial plants and processes.

Our corrosion-fighting products are state-of-the-art. Proven products such as Ceilcrete, Brutem, Ceilcote, Coroline, Tarpon Flake, Concresive, Poly Plus and Flakeline are unsurpassed in solving industry's toughest corrosion problems.

Master Builders Technologies product and service base has expanded in both scope and reach. We tap a tremendous range of company assets to meet our customers' needs, from special formulations through skilled installation, anywhere in the World.

Protective Coatings

Our family of Coatings for metal, concrete and other substrates solves corrosion problems by the hundreds. These easy to apply coatings include polyesters, epoxies, coal tar expoxies, urethanes, phenolics, epoxy novolacs and specialized formulations that will cure below freezing.

Nowhere else will you find such a wide range of protection from atmospheric corrosion.

Monolithic Linings

The corrosive environments encountered in many industries we serve vary widely in the demands they make on linings. Pickling tanks require one type; flocculation tanks another. The oil and gas industry requires protection for facilities aboveground, belowground and underwater. An electric utilities gas desulfurization system may require five different lining types.

But so long as the corrosion problem can be solved by a polymer-based lining — and the exceptions are rare — Master Builders Technologies has the solution.

Our linings are monolithic, without seams or joints. They form a continuous, protective barrier against corrosion. They are made of epoxy, polyester and other special polymers. They adhere to carbon steel, alloy and concrete surfaces.

They provide excellent resistance to permeation, chemicals, abrasion and, of course, corrosion. They have immersion temperature resistance to 200 degrees F. and dry temperature resistance to 400 degrees F. They cure quickly, are easy to maintain and provide long, cost-effective service life. Today, millions of square feet

of Master Builders Technologies linings protect industrial installations-worldwide.

Flooring Systems

Our flooring systems supply specialized materials which solve the specific corrosion problems found in a wide range of industries, from utilities turbine rooms to pharmaceutical plants. Our floors protect concrete from attack by acids, alkalis and chemicals of all kinds — including water and lubricating oils. They are further specialized to solve problems of abrasion and skid resistance and heavy traffic. From light-duty concrete sealers to heavy-duty

trowel-applied systems, Master Builders Technologies provides the answers.

YOUR BEST DEFENSE AGAINST CORROSION

Ceilcote® Corrosion Control Products offer a broad spectrum of solutions to your corrosion problems in moderate to the most aggressive chemical environments. Whether subjected to chemical immersion, spillage, fumes, or environmental corrosion, our range of polymer linings, floorings and coatings form a continuous protective barrier against corrosion.

Highly engineered fillers combined with flake, mat or fabric reinforcement, and a full range of polymer-based matrix systems optimize resistance to permeation and chemical attack.

Special formulations resist 98% sulfuric acid, bridge cracks in concrete, resist abrasion, mechanical abuse, and cure below freezing.

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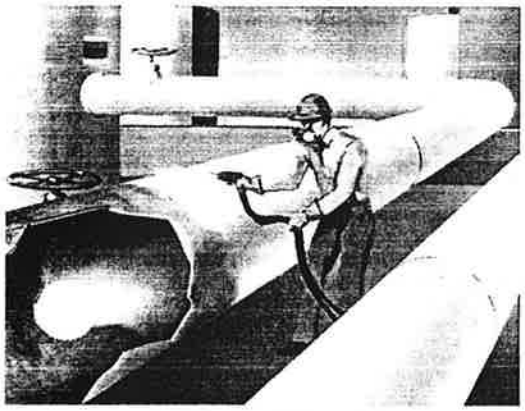

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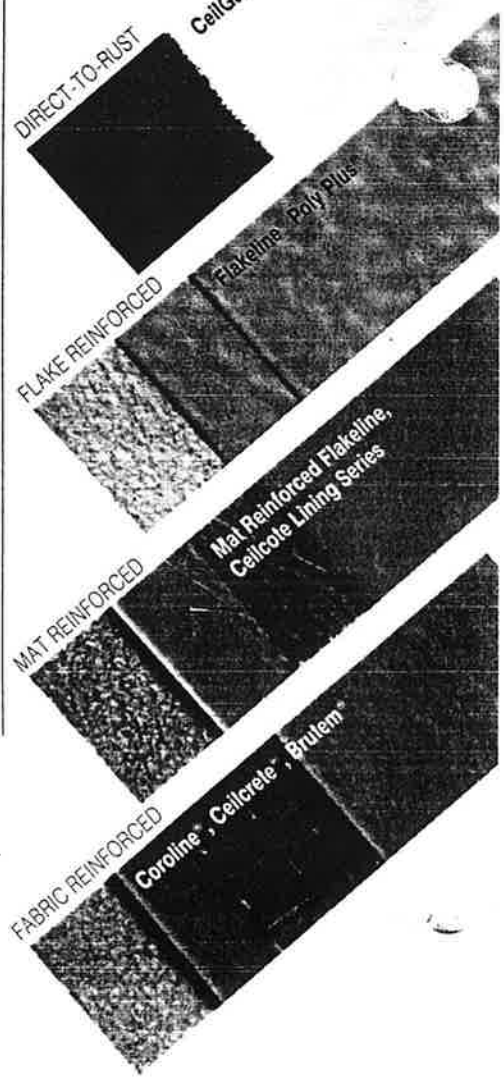

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TRUCK UNLOAD AND LIMITED STORAGE FACILITY

CEILCRETE*

REINFORCED TROWEL APPLIED POLYESTER TOPPING/LINING

DESCRIPTION:

CEILCRETE is a time-tested and proven development in corrosion-proof surfacing, designed especially for the protection of concrete and steel against the attack of corrosive chemicals. With nearly 30 years of service in corrosive environments, long-term case histories and reliability are to be expected.

CEILCRETE has three components: a liquid resin, a liquid hardener, and a powder, which are mixed together immediately before use. CEILCRETE is trowel applied in combination with a heavy-duty reinforcing layer of fiberglass or synthetic cloth. The resultant mixture hardens to 75% of its ultimate strength in 8-16 hours at 75°F and will withstand light service at that time. Ultimate strength is developed in two or three days. P-380 Primer is used to ensure excellent bond strength to concrete.

TYPES:

CEILCRETE 2500S and B (Silica and Carbon filled)—Resistant to alkali and acid. B type is electrically conductive and non-sparking; is best for strong alkali and chromic acid.

CEILCRETE 550S and B—Excellent resistant to strong acids as well as solvents.

CEILCRETE 6400S and B—Unusual resistance to strong acids such as nitric, sulfuric, and chromic. Limited resistance to alkalis.

CEILCRETE 6650S, B, and HF—Same resistance to alkalis and acid as 2500; also excellent for many solvents, chlorinated aromatics and aliphatics.

CEILCRETE 695—Exceptional resistance to strong acids (concentrated sulfuric) and moderate to high concentrations of alkalis. Also has good resistance to solvents and organics. Refer to Ceilcote Bulletin 5-13.7.

CEILCRETE "AR"—designation reference to more abrasion resistant version which incorporates a special hard filler in the topcoat.

USES:

Tank lining	Concrete pipe lining
Trench lining	Chimney lining
Equipment foundations	Scrubber lining
Tank pads	Floor covering
Pump bases	— Acid proof
Piers	— Spark proof
	— Conductive

BID SPECIFICATION:

Shall be a fiberglass reinforced, silica or carbon filled, modified polyester resin-based lining, manufactured by the Ceilcote Company and installed at a nominal 1/8" total thickness per manufacturer's recommended practices or as directed by a Ceilcote Field Supervisor.

* Reg. U.S. Pat. & Tm. Off.

PHYSICAL PROPERTIES:

The CEILCRETE types differ somewhat in physical properties but generally meet or exceed the following standards:

Tensile Strength—2,000-2,500 psi (ASTM C 307-83)
Compressive Strength—11,000-13,000 psi (ASTM C 579-82)
Taber Abrasion Factor—70-100 (CS 17F wheel, 1,000 gm wt., 5,000 revolutions)
Coefficient of expansion (in/in/°F) range, 70°F-210°F reinforced with Type H Cloth—$12\text{-}15 \times 10^{-6}$
Electrical Properties[1] **Megger Reading** (3 ft. span)—0 to 200,000 ohms (500 to 10,000 ohms typical)
Permeance (ASTM E 96)—0.0135 @ 125 mils thickness

[1]Refer to carbon filled

FLASH POINTS (Pensky-Martens Closed Cup):

CEILCRETE 2500, 5500 Liquids	91°F	(32.8°C)
CEILCRETE 6650 Liquid	83°F	(28°C)
CEILCRETE 6400 Liquid	87°F	(30.6°C)
CEILCRETE 695 Liquid	82°F	(28°C)
P-370 Liquid	73°F	(22.8°C)
P-380 Liquid	83°F	(28.3°C)
Hardener No. 2	175°F	(79.4°C)
Hardener No. 3	210°F	(98.9°C)
T-431 Smoothing Liquid	131°F	(55°C)
T-410 Solvent	52°F	(11°C)

CHEMICAL RESISTANCE:

With the types of CEILCRETE available, most chemical requirements can be met; however, there are limitations which require special consideration.

1. Certain strong solvents and organic chemicals.
2. Very strong alkalis.
3. Very strong oxidizing acids.

For specific chemical resistance, refer to the Ceilcote Master Corrosion Resistance Guide (Bulletin 1-4) or contact The Ceilcote Company. Chemical resistance data on CEILCRETE systems are developed using ASTM C 267 and ASTM C 868 in addition to actual installation performance history.

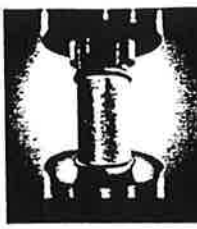
TEMPERATURE RESISTANCE:

CEILCRETE is recommended for continuous immersion at temperatures up to 160°F on steel or concrete substrates. Splash or spillage temperature for floor applications should be limited to 300°F or less, depending upon severity of service. Specific temperature resistance is dependent on the chemical environment.

DESIGN INFORMATION:

Reinforcement
CEILCRETE is installed with a reinforcing layer of fiberglass fabric. The reinforcement performs the following functions:

1. Lowers the coefficient of expansion.
2. Minimizes effects of resin shrinkage.
3. Minimizes possibility of thin spots because of the multi-layer application.



Force 10,000™
High Performance Concrete Admixture

GRACE · CONCRETE ADMIXTURES

DESCRIPTION:

FORCE 10,000™ is a microsilica-based liquid admixture designed to increase concrete compressive and flexural strengths, increase durability, reduce permeability and improve hydraulic abrasion-erosion resistance. FORCE 10,000 contains a minimum of 5.5 pounds of microsilica and weighs 11.5±0.1 pounds per gallon.

USES:

FORCE 10,000 can be used to consistently produce concrete with strengths of 6,000 psi and higher in most instances with locally available materials and existing methods. It may also be used in precast and prestress applications where high early strengths are required.

The addition of FORCE 10,000 also produces concrete with increased watertightness and dramatically reduced permeability compared to conventional mixes. Reduced permeability is an important advantage in slowing the intrusion of chloride where corrosion of reinforcing steel is a potential problem. Examples are parking garages, bridge decks and concrete in a marine environment. FORCE 10,000 also enhances the durability of concrete against aggressive chemical attack and in hydraulic abrasion-erosion applications.

CHEMICAL ACTION:

FORCE 10,000 improves concrete through two mechanisms. The extremely fine microsilica particles are able to fill the microscopic voids between the cement particles, creating a less permeable structure. In addition, the microsilica reacts with the free calcium hydroxide within the concrete to form additional calcium silicate hydrate (glue), producing a tighter paste-to-aggregate bond.

ADDITION RATE:

FORCE 10,000 dosage rates will vary based on the requirements of the application. Dosage rates should be calculated on percent microsilica per hundred weight of cement, or on pounds per cubic yard of concrete, as appropriate. Dosage rates will be as specified. If not specified, consult your Grace representative for your particular job needs.

COMPATIBILITY WITH OTHER ADMIXTURES:

FORCE 10,000 is compatible with all conventional air entraining agents, water reducers, superplasticizers, set retarders and DCI® corrosion inhibitor. Only non-chloride set accelerators, such as Daraset® ,may be used with FORCE 10,000 concrete. All admixtures must be added separately to assure their prescribed performance. Trial mixes and pretesting of concrete are recommended to optimize dosage rates, and ensure ultimate performance.

CONCRETE MIX:

FORCE 10,000 can be used in either central or transit mix concrete production, and in mobile mixers. FORCE 10,000 may be used in conjunction with water reducing admixtures (both normal and high range as approved by ASTM) to assure workability of the mix.

FORCE 10,000 does not affect concrete set times. When slump life extension is desired for transportation, finishing, etc, FORCE 10,000 may be used with an ASTM C494, Type G, slump extending superplasticizer like DARACEM™ 100 as manufactured by W.R. Grace & Co.-Conn., or approved equal.

MIX WATER REDUCTION:

Mix water adjustment is essential to account for the water in FORCE 10,000 and thus maintain the desired water/cement ratio. The mix water added at the batch plant must be reduced by 5.6 pounds of water per gallon of FORCE 10,000.

FINISHING AND CURING OF SLABS:

FORCE 10,000 concrete can be used in flatwork with little or no modification to the recommended practices outlined in ACI 302, "Guide for Concrete Floor and Slab Construction."

FORCE 10,000 will reduce the surface bleed water of concrete in large applications. ACI 308, "Standard Practice for Curing Concrete", must be followed to ensure that any problems that can occur due to decreased bleeding are minimized. Your Grace representative is available to review your particular job needs.

PRECONSTRUCTION TRIAL MIX:

It is strongly recommended that trial mixes be made several weeks before construction start up. This will allow the concrete producer an opportunity to determine the proper batching sequence and amounts of other admixtures needed in order to deliver the required concrete mix to the jobsite. A trial mix will also help determine whether the combination of concrete materials and construction practices will allow the concrete to meet a specified performance. Grace's broad experience with this product can help the concrete producer deliver a satisfactory product regardless of the mixture proportions. Contact your Grace salesman for help with trial mixes.

DISPENSING FORCE 10,000:

Dispensing equipment for the liquid FORCE 10,000 will be provided by W.R. Grace & Co.-Conn.

PACKAGING/AVAILABILITY:

FORCE 10,000 is available in bulk via Grace delivery vehicles. It is also available in 55 gallon drums.

FREEZING POINT:

FORCE 10,000 will freeze at approximately 32 degrees Fahrenheit. Care should be taken to prevent FORCE 10,000 from freezing, since once frozen the admixture is no longer useable.

FLAMMABILITY:

None.

GRACE
Concrete Products

FT-48

Printed in U.S.A. 3/90 FA/GPS/5000

Force 10,000® concrete. Strength, durability, and versatility through microsilica technology.

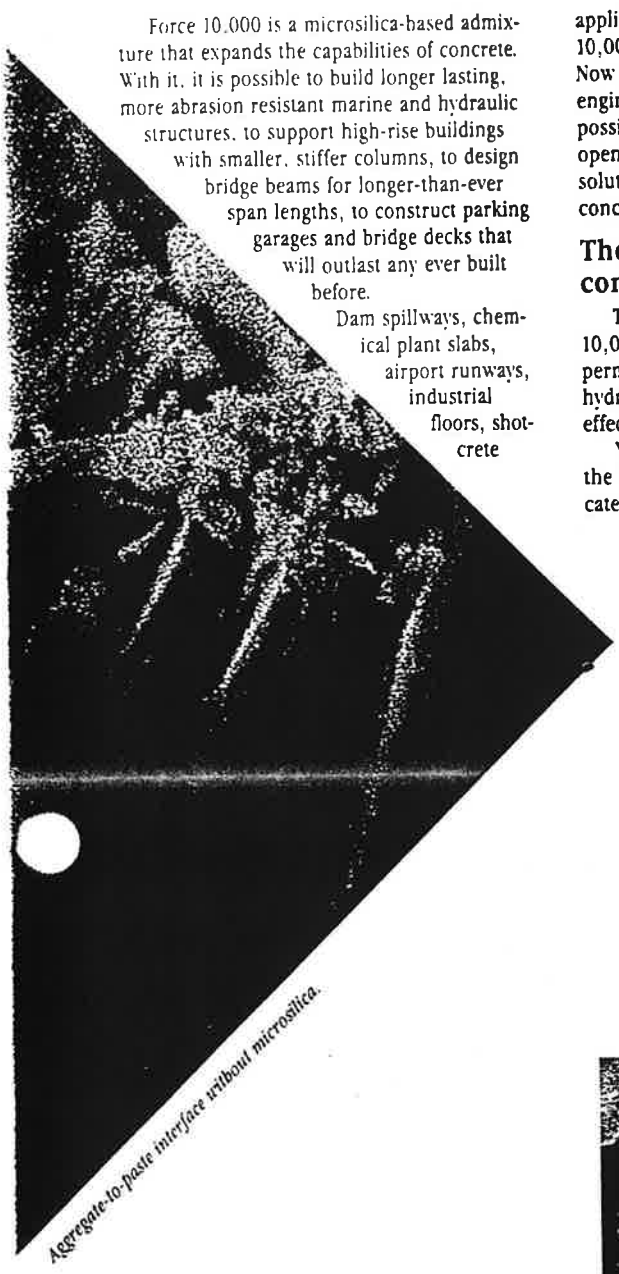
Force 10,000 is a microsilica-based admixture that expands the capabilities of concrete. With it, it is possible to build longer lasting, more abrasion resistant marine and hydraulic structures, to support high-rise buildings with smaller, stiffer columns, to design bridge beams for longer-than-ever span lengths, to construct parking garages and bridge decks that will outlast any ever built before.

Dam spillways, chemical plant slabs, airport runways, industrial floors, shotcrete applications — wherever it's used, Force 10,000 concrete performs beyond expectations. Now there is the means to satisfy a range of engineering requirements not previously possible with ordinary concrete, a way to open the door to new uses of concrete, a solution for getting more performance from concrete.

The effect of microsilica on concrete chemistry.

The microsilica (silica fume) in Force 10,000 improves the strength and reduces the permeability of concrete by altering the hydration reaction and by the "microfiller effect".

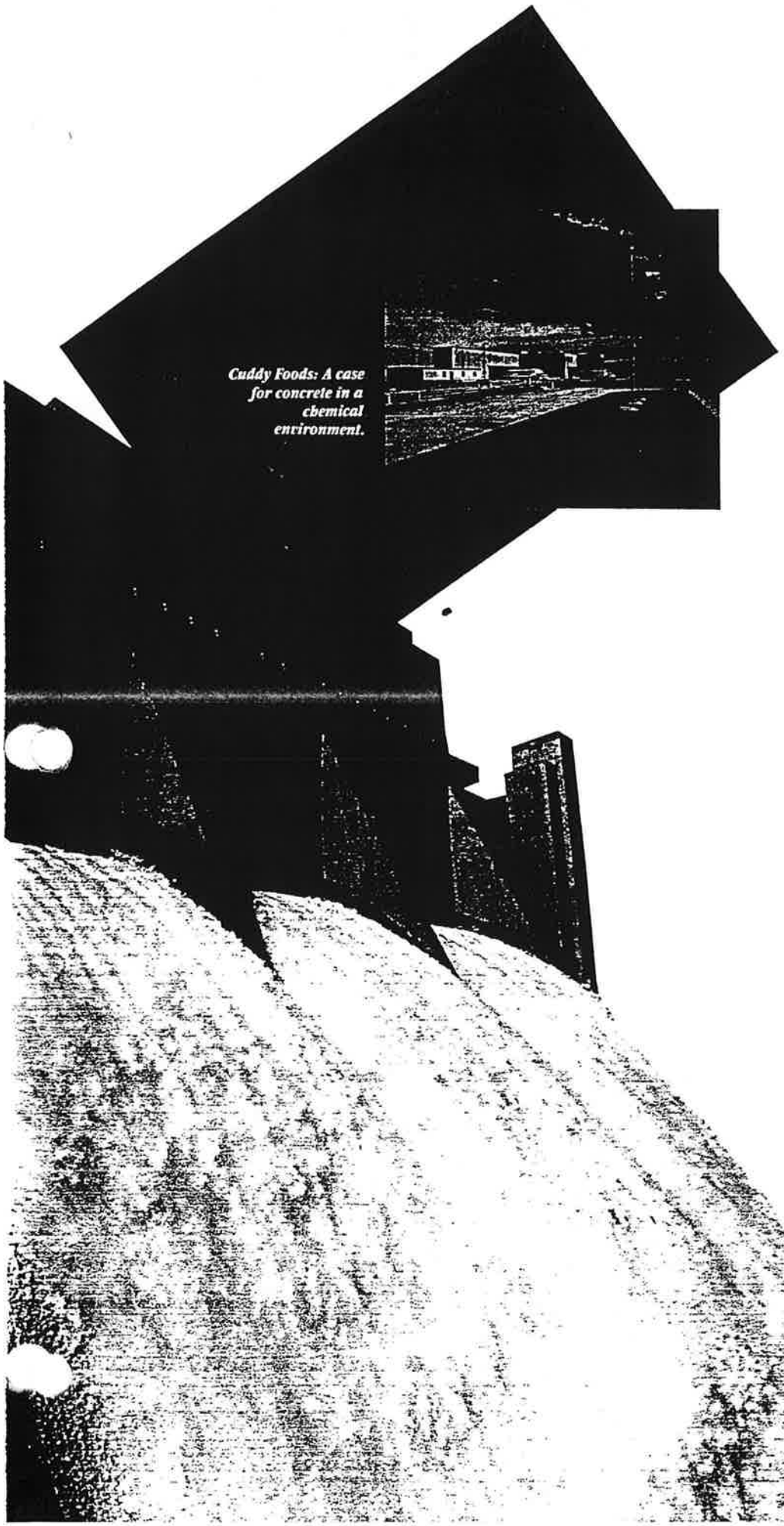
When water is added to portland cement, the hydration reaction produces calcium silicate hydrate, the glue which holds the system together, and calcium hydroxide, a weaker product which can occupy as much as 25% of the volume of the cement paste. Since Force 10,000 contains pozzolans (finely divided materials that are siliceous in nature and have little cementitious value by themselves), it will react with a portion of the calcium hydroxide in concrete to produce a greater amount of aggregate-binding calcium silicate gel. More glue in the mix improves bonding within the concrete matrix and reduces permeability.



Aggregate-to-paste interface without microsilica.

Aggregate-to-paste interface with microsilica.

The microfiller effect.
In a typical mix of 600 pounds cement and 45 pounds microsilica, there are more than 50,000 particles of microsilica for each grain of cement. The extreme fineness of microsilica allows it to fill the microscopic voids between cement particles, which reduces permeability and improves the paste-to-aggregate bond.



Cuddy Foods: A case for concrete in a chemical environment.

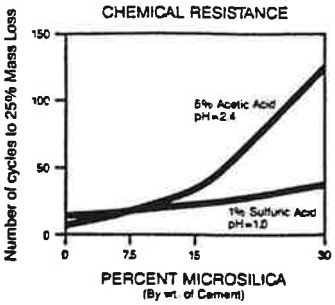
Force 10,000. Concrete that stands up to chemical attack and hydraulic abrasion.

The level of impermeability of Force 10,000 concrete makes it ideal for structures subject to chemical attack or the abrasive force of moving water. It is very difficult for most chemicals to penetrate Force 10,000's structural matrix, or for water to abrade it. Thus, it can significantly lengthen the service life of flooring in food processing plants, wineries, chemical plants, paper mills, and waste treatment plants, and add years to the life of dam spillways, tunnels, concrete pipes, roads, and bridge overlays. Force 10,000 concrete's ability to outperform conventional concrete in those applications makes it highly cost-effective.

Microsilica concrete provides a lean solution for a fat problem.

Cuddy Foods of London, Ontario, Canada, processes one million chickens per week, a busy manufacturing procedure which leaves large amounts of fat and acids on the plant floor. Even though the floors are cleaned nightly, it's a highly corrosive environment for concrete, one made worse by the abrasive (600 psi) steam spray used to scour the slabs. The incessant barrage took its toll; Cuddy Foods' previous concrete floor showed signs of deterioration after just one year. Thought was given to replacing the old concrete with paving bricks or sulphur bricks, but they were too costly. Force 10,000 concrete offered a long-term solution at a substantial savings over any other method. A series of trial batches showed that the necessary strengths and resistance to chemicals and abrasion could be attained. A final mix was designed, and the floor was placed.

After two and a half years in the same corrosive environment, the Force 10,000 floor shows no signs of spalling, breakdown, or deterioration.



Note. Each cycle consists of 7 days in solution, remove and wire brush, 7 days dry.

ENGINEERING BULLETIN
FORCE 10,000®/NUMBER ONE

FORCE 10,000® MICROSILICA AND ITS USES IN CONCRETE

One of the newest construction materials available to designers and engineers is Force 10,000®, a microsilica-based concrete admixture which expands the versatility and capability of portland cement concrete. This new technology can dramatically improve concrete strengths, durability and impermeability, allowing concrete to be used in ways never before possible. Applications of Force 10,000 are broad, and include high-strength structural columns, less permeable parking garage decks, and abrasion resistant hydraulic structures.

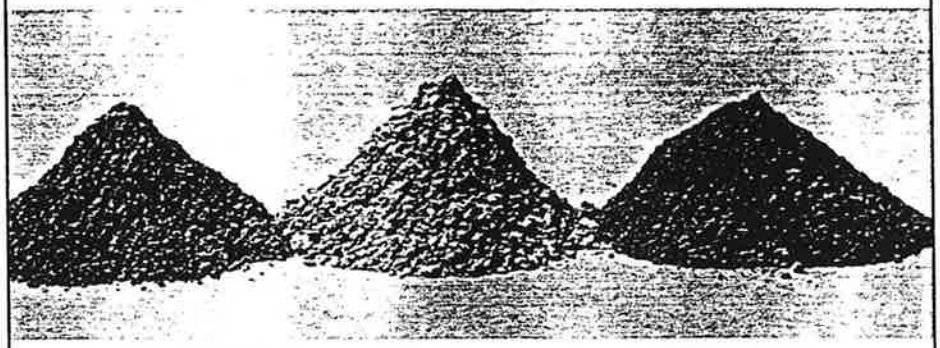
This introductory bulletin will describe what microsilica is and how it works in concrete, as well as some of the practical considerations specifiers should be aware of when considering microsilica concrete. Additional Engineering Bulletins will discuss specific applications of Force 10,000 concrete.

Background

Condensed silica fume is a by-product from silicon and ferrosilicon industries, where these metals are produced in submerged electric arc furnaces. As the molten metal is produced, a silica-based gas is emitted. This gaseous fume, as it rises, cools rapidly and forms extremely minute, glassy, spherical particles. The condensed silica fume, referred to as microsilica, is collected in a bag house, a system for filtering the hot air and gases vented from the furnace.

Until the last few decades, the micro-silica particles were considered a waste product and discarded. However, during the 1950's European researchers began to examine potential uses and investigate potential applications for microsilica, including its use in combination with portland cement.

Figure 1.



CEMENT FLY ASH MICROSILICA

Physical and Chemical Composition

The physical characteristics of microsilica are quite different than standard concrete components, but the chemical make-up is rather similar. Microsilica is an extremely fine particulate, with average diameters 100 times finer than cement particles. Specific gravities of microsilica are low, about 2.2, versus 3.15 for most portland cements. Because microsilica is an extremely fine material, its raw bulk densities are very low, varying from 9 to 25 pounds per cubic foot, versus a dry bulk density of 94 pounds per cubic foot for cement. Figure 1 provides a visual comparison of cement, fly ash, and microsilica.

The chemical make-up of microsilica is almost pure silicon dioxide (SiO_2). Table 1 compares a typical chemical analysis of the three common concrete constituents pictured above.

Table 1.

CHEMICAL ANALYSIS

	Cement	Fly Ash	Microsilica
SiO_2 Silica	21.3%	49.0%	92-98%
Al_2O_3	4.5	24.6	0.5
Fe_2O_3	4.0	7.3	2.1
MgO	2.4	1.6	0.3
CaO	63.1	9.1	0.8
Na_2O	0.1	0.2	0.1
K_2O	1.2	0.6	1.0
SO_3	2.2	0.4	0.2

How Microsilica Works in Concrete

Microsilica improves concrete through two primary mechanisms — the basic pozzolanic reaction, and a microfiller effect.

When water is added to portland cement hydration occurs forming two products, as shown below:

$$\text{Cement} + \underset{H_2O}{\text{Water}} \longrightarrow \underset{CSH}{\text{Calcium Silicate Hydrate}} + \underset{Ca(OH)_2}{\text{Calcium Hydroxide}}$$

The calcium silicate hydrate formed is the glue, or binder, which holds the system together. The weaker calcium hydroxide does not contribute as a binder, and can occupy as much as one quarter of the volume of the hydration products. Further, the calcium hydroxide can combine with carbon dioxide to form a soluble salt which will leach through the concrete, and can cause efflorescence, a familiar architectural problem. When high amounts of calcium hydroxide are present, concrete may be more vulnerable to sulphate attack, chemical attack, and adverse alkali-aggregate reactions.

The pozzolanic microsilica reacts with the calcium hydroxide and water to produce more aggregate-binding calcium silicate gel, while simultaneously reducing the calcium hydroxide content, as shown in the chemical reaction below:

$$\underset{Ca(OH)_2}{\text{Calcium Hydroxide}} + \underset{SiO_2}{\text{Microsilica}} + \underset{H_2O}{\text{Water}} \longrightarrow \underset{CSH}{\text{Calcium Silicate Hydrate}}$$

This additional glue improves bonding within the concrete matrix and helps reduce permeability, while the reduction in calcium hydroxide improves concrete durability.

The beneficial effect of microsilica can be seen more dramatically from the two scanning electron photomicrographs shown in Figures 2 and 3:

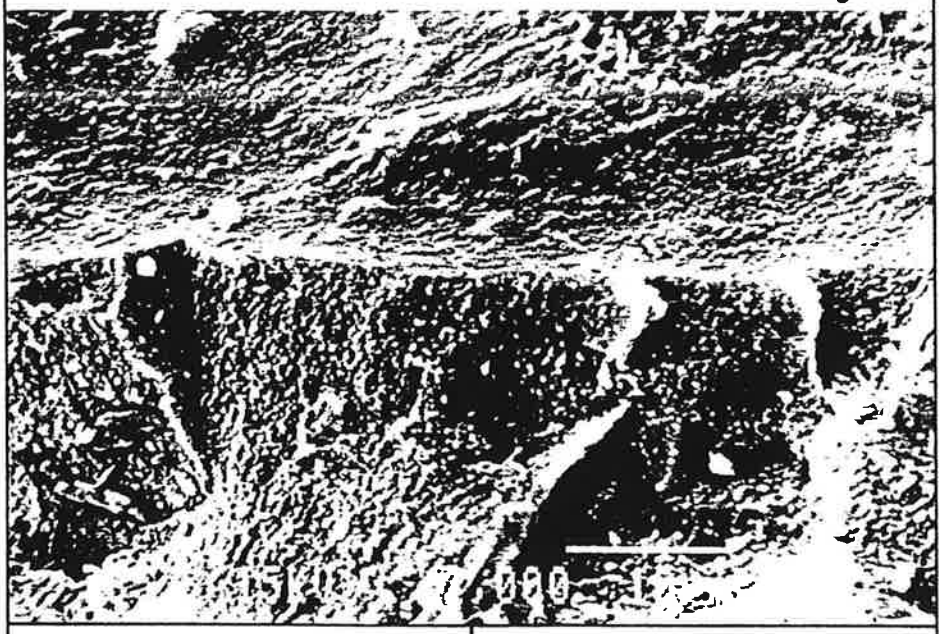
Figure 2 is magnified over two thousand times and highlights the aggregate-to-paste interface of a concrete matrix without microsilica.

Concrete Without Microsilica

Figure 2.

Concrete With Microsilica

Figure 3.



The top portion of the photo is a socket formerly occupied by an aggregate. Calcium hydroxide crystals are present underneath the interface, thereby preventing a good paste-(lower left corner) -to-aggregate bond.

Conversely, Figure 3 shows a similar view with microsilica concrete. The top portion shows an aggregate socket with no calcium-hydroxide crystals beneath the interface. The paste forms an excellent bond to the aggregate, producing stronger concrete, and reducing permeability.

The second mechanism by which microsilica improves concrete quality is through the so-called "microfiller effect." Most condensed silica fume has an average particle size of about 0.15 micrometers, while a typical portland cement has an average particle size of 15 micrometers.

GRACE
Concrete Products

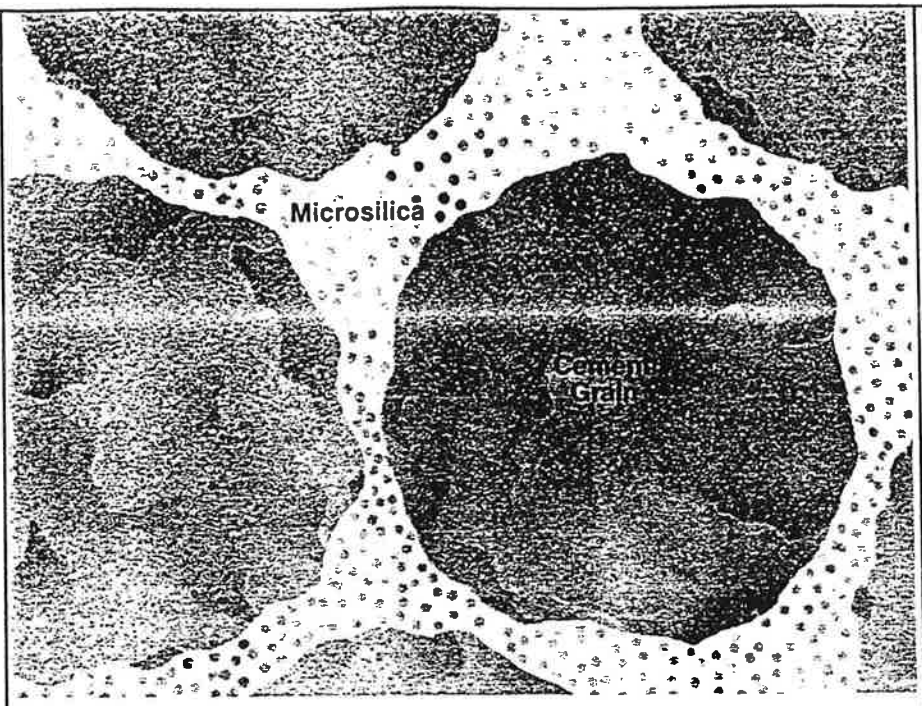


Figure 4.

Because of this size relationship, in a typical mix (e.g., 600 pounds cement and 60 pounds of microsilica) there are over 50,000 particles of microsilica for each grain of cement, as depicted in Figure 4 above.

The extreme fineness of microsilica allows it to fill the microscopic voids between cement particles. The microfiller effect is credited with greatly reducing permeability and improving the paste-to-aggregate bond of microsilica concrete compared to conventional concrete.

Placing, Finishing and Curing Considerations

Microsilica concrete is not difficult to work with, but because it is used for special applications, care should be taken to ensure that good quality concreting practices are followed.

The water demand of concrete can increase when microsilica is added to the mix. Just as with aggregates, the smaller sized microsilica particles have an increased surface area, and thereby, increased water demand. One method of compensating for this effect is to increase the water content; however, this leads to a lower quality concrete. The use of a superplasticizer, or high-range water reducer, in conjunction with the microsilica is almost universally recommended.

Depending on the dosage of microsilica, the fresh concrete may be more cohesive and sticky than conventional concrete. Due to this cohesiveness, slumps one to two inches higher than normal should be used for similar types of placement. For ease of placement, the highest practical slump (attained through the use of superplasticizers) should be specified. Despite the increased cohesiveness, microsilica concrete produces a very creamy paste and is very pumpable.

One of the biggest differences in using microsilica concrete occurs during finishing. The addition of microsilica will virtually eliminate bleed water, making it more susceptible than conventional concrete to plastic shrinkage cracking. Practices outlined in the Guide for Concrete Floor and Slab Construction (ACI 302) and Hot Weather Concreting (ACI 305) should be followed to provide a good surface.

Finishing and curing practices which have worked successfully in the field generally involve underfinishing and overcuring the concrete. Curing should begin immediately following the finishing operation, and can include fog misting and placing wet burlap over the surface. Careful attention to curing is essential; as with any concrete, microsilica concrete will perform much better when properly cured. The Standard Practice of Concrete Curing (ACI 308) should be closely followed.

The addition of microsilica can also influence the color of both plastic and hardened concrete. Typically, a microsilica concrete is darker gray than conventional concrete, and it can become almost black, depending on the dosage of microsilica used. This does lighten or bleach out with time.

Specifying Microsilica in Concrete

Microsilica is typically specified in dosages expressed by weight of cement. Dosages will vary depending on the application and the level of protection required, and typically range between 5% and 15% microsilica by weight of cement.

Grace has developed sample specifications for high strength, corrosion protection and durability applications using Force 10,000 concrete. Your Grace representative will be able to work with you to modify the sample specifications to meet your specific needs.

Summary of Benefits

Because of the pozzolanic nature and extreme fineness of the microsilica, Force 10,000's use in concrete can improve many of its properties, opening up a wide range of applications. Its benefits include:

Dramatically Increased Strength

- Ready-mixed concrete compressive strengths of 10,000 to 20,000 psi
- Flexural strengths of 1,500 to 2,000 psi

Significantly Reduced Permeability/Increased Resistivity

- Rapid chloride permeability test results below 500 coulombs
- Reduced water and gas permeability
- High resistivities providing corrosion protection

Improved Durability

- Higher resistance to aggressive chemical attack
- Better resistance against sulfate attack
- Improved hydraulic abrasion-erosion resistance
- Better resistance to adverse alkali-aggregate reactivity

These benefits make microsilica concrete suitable for a number of applications, ranging from structural beams and columns, to parking garage and marine structures, to chemical plant slabs, to dam spillways. These benefits and applications will be topics of future Engineering Bulletins.

ENGINEERING BULLETIN
FORCE 10,000® /NUMBER THREE

WATER AND GAS PERMEABILITY OF FORCE 10,000® CONCRETE

There are many applications in industry which require a concrete with very low permeability. Structures where contamination from either the inside or outside is critical — such as waste water treatment plants or water containment vessels — may need such protection. Tunnel linings also may require a less permeable concrete to protect against water seepage and permeation of certain gases. Additionally, reduced permeability is important in structures which are in environments exposed to salts — both road and marine — where the salts eventually migrate into the concrete and initiate corrosion of reinforcing steel.

In all of these applications, Force 10,000, a microsilica-based concrete admixture, can provide reduced permeability through two different mechanisms. First, the fine particle size of the microsilica (one-hundredth the size of cement grains) acts to fill in potential voids or gaps within the matrix. Second, the pozzolanic microsilica combines with the free lime (calcium hydroxide) in the concrete system to produce additional paste (calcium-silicate-hydrate), providing better bonding between the aggregates, and reducing the potential for creation of "transmission" channels. Thus the permeation of liquids and gases can be significantly reduced versus conventional concrete.

This Engineering Bulletin describes the results from both water and gas permeability tests run on Force 10,000 concrete. (In reference to the permeability of chlorides, Force 10,000 not only reduces concrete permeability, but also increases resistivity, thus reducing the concrete's ability to pass electrical currents and impeding the corrosion process. This is the topic of a separate Engineering Bulletin.)

Water Permeability

To evaluate the water permeability of Force 10,000 concrete, Grace contracted an independent testing agency, Law Engineering, to perform the standard U.S. Army Corps of Engineer's Test CRD-C48-73, "Method of Test for Water Permeability of Concrete." Basically, the test involves placing a specific head pressure on the concrete specimen and measuring the flow rate of water through this specimen over time. Once a stable rate is achieved, the permeability coefficient of the specimen can be calculated by applying d'Arcy's law for unidirectional flow at constant head pressure.

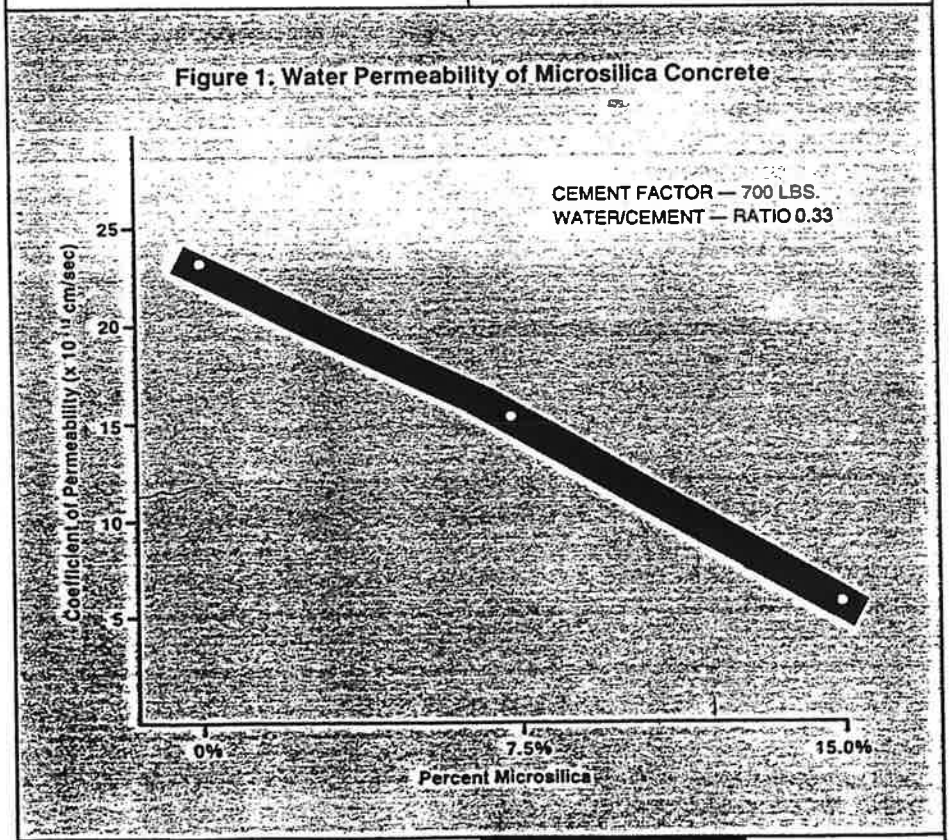
In this particular test the concrete was exposed to head pressures of 240 psi (or about 16 atmospheres). The specimens, with a 6 inch diameter, were cast at Grace's lab, and given to Law Engineering for testing. The three comparison samples each had 700 pounds of cement and a water/cement ratio of 0.33. The microsilica dosages were 0%, 7.5%, and 15% by weight of cement.

The permeability results of the three mixes are shown below in Figure 1:

As shown, the coefficient of permeability of the concrete decreased significantly with the addition of microsilica: by 30% for a 7.5% dosage rate, and by 73% for the 15% dosage rate. The microsilica concrete values were both below 20×10^{-12} cm/sec, which is considered to be very low permeability for concrete.

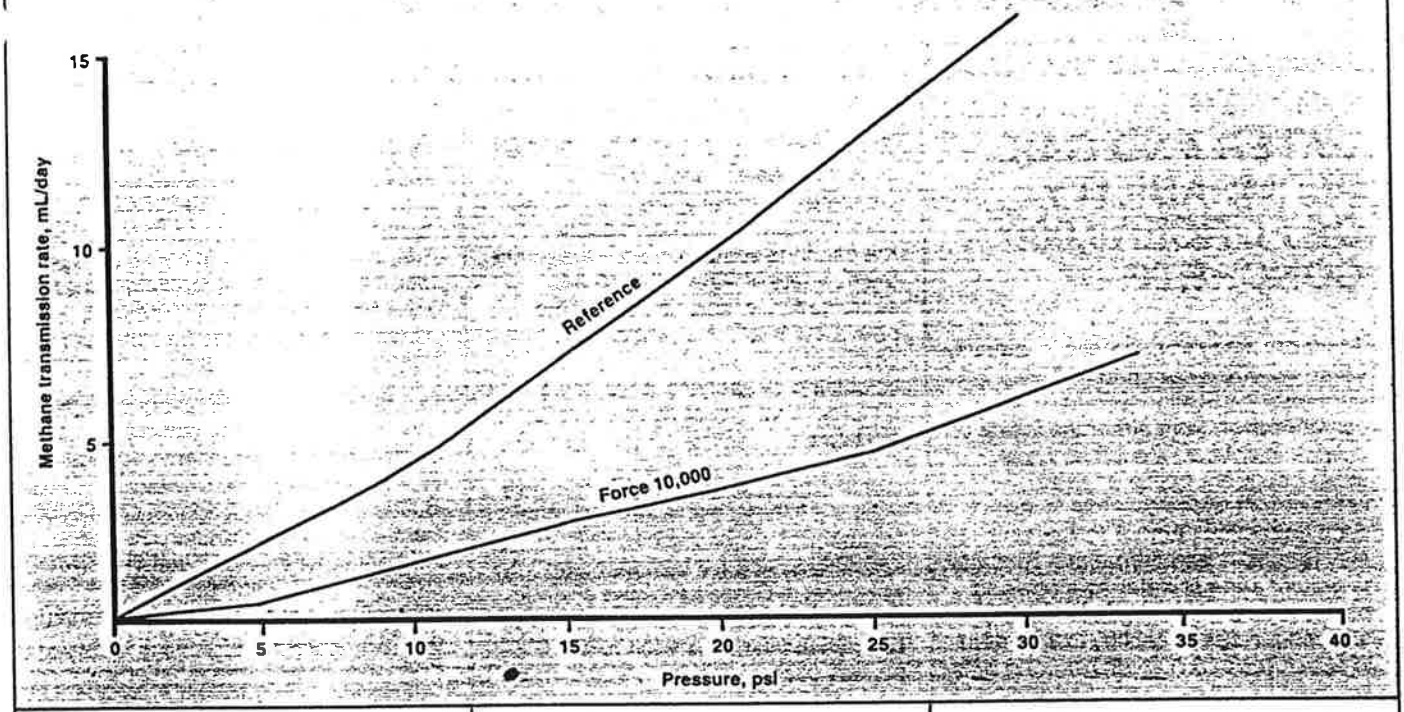
In addition to this work performed by Law Engineering, others have conducted tests with similar results. E. J. Sellevold, of the Norwegian Building Research Institute, concluded from a review of European lab and field data that for equal compressive strength levels, concrete with microsilica is more impermeable than ordinary portland cement concrete. From this he concluded that the "efficiency" factor for microsilica in concrete is greater with respect to permeability than to compressive strength (Effect of Microsilica on the Durability of Concrete Structures, Concrete International, December 1987, p. 39-43).

Figure 1: Water Permeability of Microsilica Concrete



GRACE Concrete Products

Figure 2. Methane Gas Transmission Rates



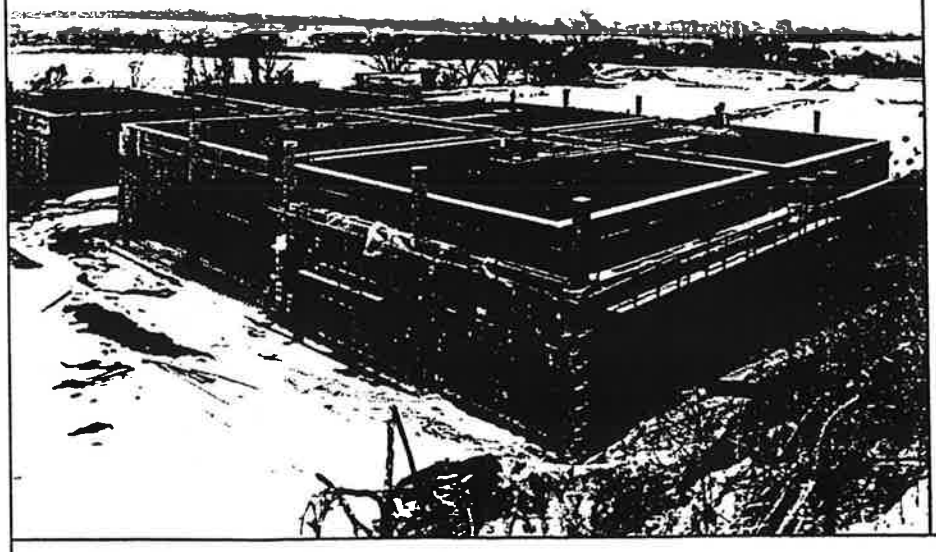
Gas Permeability

Grace is also examining the permeability of microsilica concrete to methane and nitrogen gases. The test used, developed by Matrecon, Inc., compares the gas permeability of concrete at pressures ranging from 5 to 30 psi. While testing is still continuing, Matrecon concluded that microsilica significantly reduced the permeation of methane gas through the concrete, as shown in Figure 2.

Methane transmission rates, measured in milliliters per day, were significantly reduced for the microsilica concrete at all pressure levels tested between 5 psi and 30 psi. Significant benefits are shown at lower pressures (5 psi) which more accurately reflects conditions likely to be encountered in a tunnel environment.

Summary

As shown in the previous two Figures, Force 10,000 can significantly reduce the permeability of concrete to both liquids and gases. At dosages of 15% microsilicia by weight of cement, the water permeability was reduced by over 70% versus the reference. Similarly, methane gas transmission rates were more than halved with microsilica concrete. In applications where water and gas permeability reductions are important, such as tunnel linings and storage vessels, Force 10,000 can be used to improve the concrete properties.



Force 10,000 Microsilica can be used to reduce water permeability in a wide range of applications including: water treatment plants, water containment vessels and tunnel linings.

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Concrete Products

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ENGINEERING BULLETIN

FORCE 10,000® /NUMBER FOUR

CORROSION PROTECTION USING FORCE 10,000 MICROSILICA

This Engineering Bulletin briefly examines how the addition of microsilica to concrete can help protect the reinforcement against chloride-induced corrosion. A description of the reinforcement corrosion process is given. Laboratory studies and field data are used to quantify corrosion test results and better explain protection requirements. Microsilica, also known as silica fume or condensed silica fume, is available as a dry powder, a densified powder or as a liquid slurry admixture.

The Chloride-Induced Corrosion Process

The chloride-induced corrosion of reinforcement in concrete is an electrochemical process caused by chlorides which migrate through the pores of the concrete to attack the steel. The alkaline environment of concrete creates a thin, passivating layer around all the embedded steel. Chlorides attack the steel through defects in this protective barrier to start the corrosion process. Iron at the anode (usually the top mat of reinforcement in a slab) chemically combines with the chloride ion and eventually becomes the corrosion product, ferric oxide (Fe_2O_3). Buildup of ferric oxide causes staining and cracking of the concrete. During this corrosion process, electrons are released and travel to the cathodic steel to form hydroxl ions (OH^-). The cathode is located where there is good access to oxygen, usually the bottom mat of reinforcement in a slab. The hydroxl ions travel through the concrete to the anodic steel, completing the corrosion process. Chlorides are available primarily from deicing salts and marine environments. Clearly if the permeability of the concrete were significantly reduced, it would take longer for chlorides to travel from the concrete surface to the reinforcement. This would increase the time to corrosion-initiation and extend the service life of the structure. Also if the resistivity of the concrete were increased, the corrosion process could be slowed even if chlorides reach the reinforcement.

Concrete Permeability

When cement combines with water the resulting chemical reaction forms calcium silicate hydrate (CSH) "glue" and calcium hydroxide. The CSH binds the aggregate together while the crystalline calcium hydroxide simply occupies space and contributes to a weaker and more permeable concrete matrix. Microsilica consists primarily of silicon dioxide (SiO_2) which, when added to fresh concrete during the batching process, chemically combines with the calcium hydroxide to form more CSH. See the W. R. Grace & Co.–Conn. Engineering Bulletin, Number One, "Force 10,000 Microsilica and its Uses in Concrete", for a more complete explanation. Additionally, microsilica is roughly one-one hundredth the size of a cement grain which helps to fill in the voids between the larger CSH particles and the aggregate. The addition of microsilica to the concrete mix results in a significantly less permeable matrix.

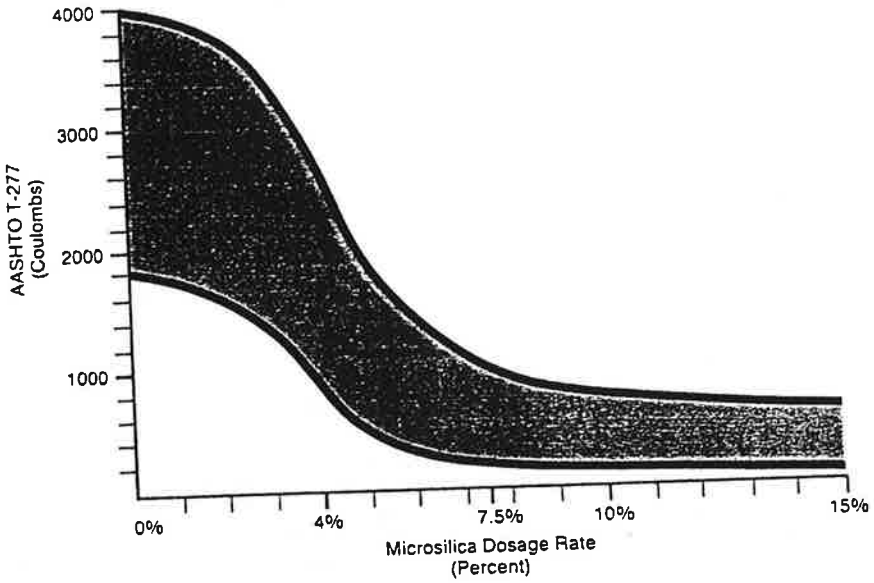
The most common test method used to measure the chloride permeability of concrete is AASHTO T-277, "Rapid Determination of the Chloride Permeability of Concrete"[1]. As the name implies, this test is a rapid method for determining concrete chloride permeability for research and ongoing construction projects. Actually, this test does not measure permeability but rather the resistivity of the concrete which has a good inverse correlation with concrete permeability. The test consists of a four-inch-diameter by two-inch-thick specimen which is subjected to a 60 volt potential for six hours to measure the electrical charge passed in coulombs. AASHTO anticipates a precision variability of 19.5% while ASTM expects it to be higher. See the Grace Technical Bulletin, "Understanding the Rapid Chloride Permeability Test" (GEN-87-01) for a complete description. There are at least a dozen parameters which can affect the final coulomb reading, so an exact, reproducible test measurement is nearly impossible. Five chloride permeability categories were, therefore, created as shown in Table 1. Concretes with coulomb readings in the same category are considered to have equivalent chloride permeability. Design engineers who specify microsilica generally require a coulomb reading in the 100 to 1,000 coulomb category which is classified as "very low".

It is recommended that test specimens be 4" x 8" cylinders cast from a ready-mix truck at the job site according to ASTM C-31 and cured for 90 days prior to testing. Some engineers believe inaccuracies exist in the FHWA rapid permeability test method and are specifying "percent microsilica by

Table 1 — AASHTO T-277 Chloride Permeability Based on Charge Passed

Charge Passed (coulombs)	Chloride Permeability	Typical of
>4,000	High	High water-cement ratio (>0.6). Conventional PCC.
2,000-4,000	Moderate	Moderate water-cement ratio (0.4-0.5). Conventional PCC.
1,000-2,000	Low	Low water-cement ratio (<0.4). Conventional PCC.
100-1,000	Very Low	Latex modified concrete, "Iowa" dense concrete.
<100	Negligible	Polymer impregnated concrete. Polymer concrete.

Figure 1. Expected Range of AASHTO T-277 Test Results at a Water-Cement Ratio of 0.40 at 90 Days.



Division of W. R. Grace & Co., measure actual chloride contents in the concrete as a function of time, mix design and depth in the concrete. From these data, the actual chloride permeability of the concrete can be measured as an effective diffusion coefficient. These are compared to AASHTO T-277 results in Table 2. Using these diffusion coefficients and further calculations, Grace has been able to estimate the amount of chloride reaching the reinforcement in certain structures as a function of time. See your Grace representative for further details.

This chloride ponding test data proves that as more microsilica is added to a constant mix design, the concrete chloride permeability is reduced. These data also qualitatively agree with the AASHTO T-277 test method which states that as the coulombs measured decrease, the chloride permeability also decreases.

weight of cement" rather than coulomb levels. Usually a specified microsilica quantity is based on the severity of the service environment. Two common microsilica dosage rates are 7.5 percent by weight of cement in parking structures and 10 percent for piles in a marine environment. Combining microsilica with other corrosion protection systems, such as DCI corrosion inhibitor, is also a common practice.

Laboratory and field tests[2,3,4,5,6] have been performed to measure the effect of microsilica dosage rates on the permeability of concrete. Figure 1 shows the results of these studies utilizing a 650 pound cement factor mix at a 0.40 water-cement ratio after 90 days of curing. Two points are apparent from this figure: 1) as more microsilica is added to the concrete the chloride permeability (as measured in coulombs) is reduced; and 2) the coulombs measured usually vary for samples of the same mix design. The actual coulomb test result is very dependent on the concrete materials used, microsilica amount and testing accuracy.

A method used by Grace to determine actual chloride ingress into concrete with and without microsilica consists of cyclic ponding of concrete blocks and "lollipops" (Figure 2) with a sodium chloride solution for extended lengths of time. These ongoing tests[6], performed at the Construction Products

Figure 2. Chloride Ponding Test Specimens

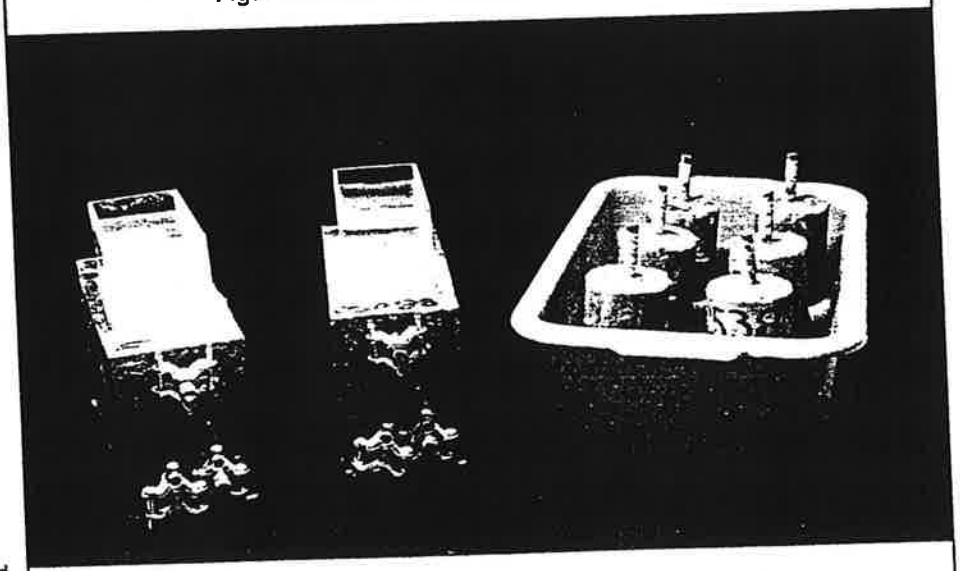


Table 2 — Effective Diffusion Coefficients Versus AASHTO T-277 Results

Mix	Water Cement Ratio	Microsilica (%)	28 — Day AASHTO T-277 (coulombs)	Effective Diffusion Coefficient (10^{-8} cm²/sec)
A	0.48	0.0	3700	9
B	0.48	15.0	225	0.6
C	0.43	7.5	380	0.8
D	0.38	0.0	2660	2
E	0.38	15.0	100	0.3

Cement Factor: 600 lbs./cubic yard

Concrete Resistivity

Concrete resistivity, the resistance of concrete to the passage of a corrosion-induced electrical current, is also an index of corrosion protection. In a concrete structure when chlorides attack the reinforcement, electrons are released at the anode and travel via the steel to the cathode. At the cathode, hydroxl ions are produced which travel to the anode through the concrete to complete the corrosion circuit. **Macrocell corrosion** takes place between an anode and cathode separated by a large distance such as a top and bottom mat of reinforcement in a slab. By increasing the resistivity of the concrete, the process of macrocell corrosion may be slowed but not stopped. **Microcell corrosion** is defined as that which takes place when the anode and cathode are adjacent to each other on the same reinforcement. Microcell corrosion is usually not affected by increased concrete resistivity and may be less severe than macrocell corrosion. The addition of microsilica to the concrete increases its resistivity and, thus, reduces the macrocell corrosion rate.

The resistivity of moist concrete with a water-cement ratio between 0.50 to 0.35 is normally between 2,000 to 12,000 ohm-cm. Microsilica can raise the resistivity to 30,000 ohm-cm or greater. The macrocell corrosion process for concrete at 30,000 ohm-cm should be approximately six times slower than that of 5,000 ohm-cm concrete. Laboratory research tests at Grace continue to measure these concrete properties. Table 3 shows 28-day compressive strengths, coulombs and resistivity measurements for concrete with a cement factor of 600 pounds per cubic yard[6].

Table 3 — Concrete Properties

Mix #	Microsilica by Mass of Cement* (%)	Water-Cement Ratio	28-Day Compressive Strength (psi)	28-Day Chloride Permeability (coulombs)	28-Day Resistivity (Kohm-cm)
1	0	0.48	5160	360	7.7
2	3.75	0.48	5417	3175	16.3
3	7.5	0.48	6346	348	45.4
4	15.0	0.48	7357	198	94.7
5	0	0.43	5264	2585	9.3
6	3.75	0.43	6547	2210	22.1
7	7.5	0.43	7214	213	67.7
9	15.0	0.43	8582	98	118.0
10	0	0.38	5782	3485	10.8
11	3.75	0.38	9312	736	24.3
12	7.5	0.38	9288	132	73.9
13	15.0	0.38	12119	75	161.0

*Cement Factor: 600 lbs./cubic yard

Quality Concrete

Even though microsilica improves the various properties of concrete, the first line of defense against chloride-induced corrosion is quality concrete. Quality concrete results when the concrete mix design, construction practices and structural design comply with the guidelines of the American Concrete Institute.(ACI).

Design and Construction Recommendations

When designing a microsilica concrete mix for chloride-induced corrosion protection, two types of specifications may be used: a performance type or a prescription type. A performance specification requires a maximum coulomb level to be met at 90 days and allows the concrete producer to design the mix to meet this. A prescription specification lists the ingredients of the mix such as maximum water-cement ratio and percent microsilica. Use a performance or a prescription type specification but not both. A common practice is to specify a maximum coulomb level (performance type) to be met before the project starts and then to require that mix design be used throughout the project.

Some design recommendations from ACI-318 "Building Code Requirements for Reinforced Concrete" for corrosive environments include the following:

- Water-cement ratio = 0.40 maximum
- Concrete cover over the reinforcement = 1½" minimum
  = 2" recommended
- Air-entrainment for freeze-thaw durability = 6 ± 1½% for ¾" aggregate.
- Proper concrete finishing and curing techniques.

One of the more important aspects of quality concrete is curing. Microsilica concrete usually does not bleed as much as normal concrete due to the lower water-cement ratio and the reduced permeability of the concrete. One method to help alleviate this problem is to use fog misting. Fog misting should begin soon after placing and be maintained until proper curing has begun in order to minimize surface drying. ACI-308 "Standard Practice for Curing Concrete" must be followed to guard against plastic shrinkage cracks. To allow the concrete to cure properly for maximum corrosion protection performance, as with strength and durability, ACI recommends seven days of wet curing. It is better to underfinish and overcure microsilica concrete.

ACI 357 "Guide for the Design and Construction of Fixed Offshore Concrete Structures" gives recommendations for marine concrete design.

Conclusions

1. Microsilica in concrete can significantly increase the service life of a structure in a corrosive environment.
2. The greatest benefit of adding microsilica to concrete for corrosion protection is that it significantly reduces the chloride permeability of concrete which slows down the chloride ingress.
3. Microsilica increases the resistivity of concrete which impedes the electrical current generated by macrocell corrosion.
4. Reducing the water-cement ratio of concrete and increasing the microsilica content lowers permeability and increases resistivity.
5. Designing for quality concrete, as defined by ACI guidelines, is the first line of defense against chloride-induced corrosion.

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3. "Microsilica and Concrete Durability" N. S. Berke, Paper No. 870275, Presented at 67th Annual Transportation Research Board Meeting, January 11-14, 1988, Washington, D.C.
4. "Influence of Force 10,000 Condensed Silica Fume Concrete Admixture on Chloride Ion Permeability", S. L. Marusin, T. J. Rowe, and D. W. Deno, WJE Report No. 860348, Wiss, Janney, Elstner Associates, Inc., Arlington, TX 1986.
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Concrete Products

ENGINEERING BULLETIN
Force 10,000®/Number Five

MECHANICAL PROPERTIES OF FORCE 10,000® CONCRETE

Force 10,000®, a microsilica-based concrete admixture from Grace Construction Product Division, has gained acceptance in a number of diverse applications. These include environments which are highly corrosive, chemically saturated, or very abrasive and where less-permeable, more-durable concrete is required. In addition, Force 10,000 is being utilized in structural members requiring concrete with improved mechanical properties. This includes ready-mix concrete for columns and beams for high-rise construction and for prestressed girders and piles.

This Engineering Bulletin will discuss the influence of microsilica on some of the principal mechanical properties of importance to design engineers. Some of these are increased compressive strength, modulus of elasticity, flexural strength (modulus of rupture), split tensile, shrinkage, and creep.

Test Data

Data for this Bulletin were obtained from various sources. The Construction Products Division of W. R. Grace & Co.–Conn. ran a multitude of laboratory and field tests with the results incorporated here. Other data were taken from published literature and are referenced. Wiss, Janney, Elstner Associates (WJE), Irving, Texas was contracted to run mechanical property tests for concrete with various microsilica dosage rates. The standard reference mixes listed with the WJE test results were developed at Grace. Tests were made with either a liquid-slurry microsilica product or a dry-densified product.

Compressive Strength

Compressive strength is the primary performance measure of concrete and is a property which microsilica strongly benefits. To better understand the contribution of microsilica to high strength concrete versus that of other standard mix ingredients, Grace studied the strength contributions in psi per pound of cement, types C and F fly ashes,

Figure 1
Compressive Strength Contribution

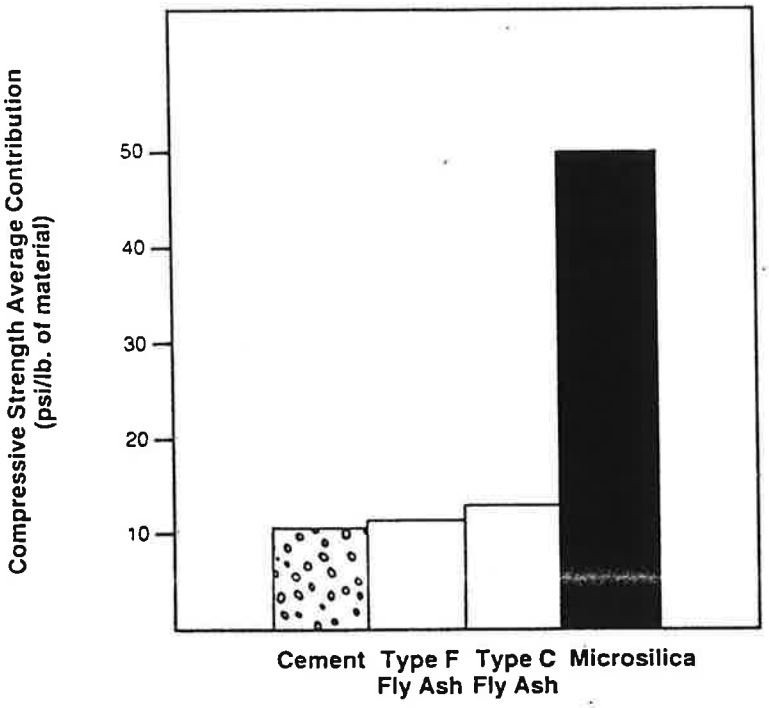


Figure 2
Compressive Strength (28 days) vs. Microsilica Dosage Rate

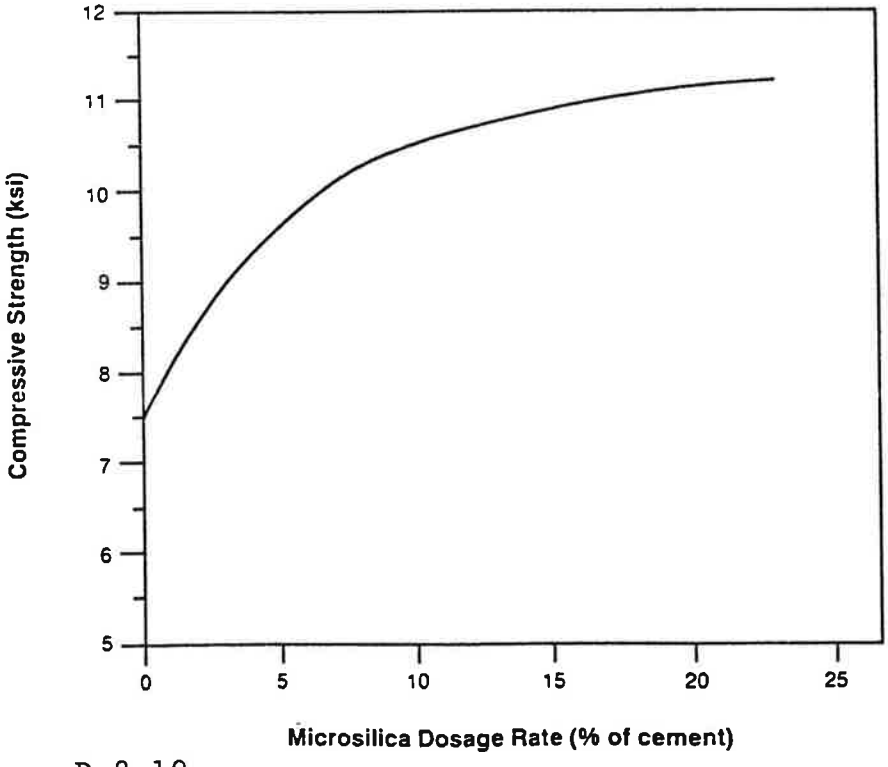


Table 1
Compressive Strength Concrete Mix Designs

	Figure 1	Figure 2
Cement (lbs.)	550 to 800	700
Coarse Aggregate (lbs.)	1710 to 1610	1720
Fine Aggregate (lbs.)	1060 to 1325	1060
Water/Cement Ratio	0.40	0.40
Fly Ash (lbs.)	0 to 140	0
Microsilica (%)	0 to 20	0 to 22.5
Air Content (%)	1.5	1.5
Admixtures added for workability		

and microsilica. These are summarized in Figure 1. The values are an average from many different mix designs and microsilica dosage rates.

Pound for pound, microsilica is significantly more efficient in compressive strength development than both cement and fly ash. At 28 days, microsilica can be almost 5 times more effective than cement in contributing to compressive strength. This is a result of both the pozzolanic nature and fineness of the microsilica, which are described in detail in Force 10,000 Engineering Bulletin Number One.

Figure 2 shows how microsilica influences the compressive strength of concrete at 28 days. Table 1 gives the concrete mix design which corresponds to the results in Figures 1 and 2. Concrete with 5% or 10% microsilica content exhibits good strength gains and even 15% dosages provide additional benefits, although the added benefit for the incremental 5% addition is less.

Despite increased nominal strength at dosages in excess of 20%, the compressive strength contribution is lower than in the 5% to 15% dosage range. Therefore, for high-strength applications, microsilica dosages are typically 15% or less. Table 2 gives the concrete mix designs and compressive strength results from the addition of 5%, 10% and 15% microsilica in the WJE study. All compressive strength tests were run according to ASTM C39.

Because of microsilica's exceptional strength contribution, concrete compressive strengths in excess of 10,000 psi are easily and routinely available with Force 10,000. For two major high-rise projects in Seattle[1], ready-mixed microsilica concrete consistently produced 19,000 psi at 56 days (56 or 90-day compressive strengths are typically specified for high-strength concrete).

It should be noted from Table 2, that high strength concrete may be produced without microsilica. However, with microsilica it can be mass produced on a more consistant basis and with greater workability.

Table 2
Wiss, Janney, Elstner Mechanical Properties Study
Concrete Mix Designs

	Reference Mixes				
	Similar Mix Design	Similar Strength	Mix A	Mix B	Mix C
Cement, Type I	700	850	691	696	694
Fly Ash, Type C	—	—	—	149	—
Coarse Aggregate	1,850	1,775	1,842	1,857	1,852
Fine Aggregate	1,400	1,325	1,356	1,174	1,280
Microsilica (Force 10,000)					
— lbs/cy	0	0	32	66	100
— % of cement	0	0	4.6	9.4	14.4
Water/Cement Ratio	0.35	0.30	0.35	0.35	0.35
Daracem 100 (oz/cwt)	18	26	18	18	18
Air Content (%)	1.5	1.6	2.4	1.9	2.0

Test Results (28 Days)

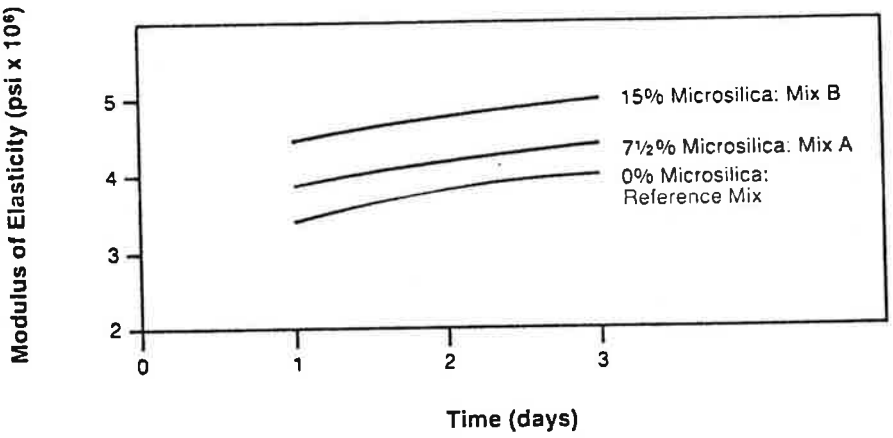
Compressive Strength (psi)	6,500 to 7,500	11,000	9,790	11,570	11,350
Modulus of Elasticity (psi x 10^6)	4.5 to 5.1	5.7 to 6.0	6.09	6.37	6.25
Poisson's Ratio	0.20	0.20	0.20	0.21	0.20
Flexural Strength (psi)	650 to 950	1,200 to 1,300	1,295	1,525	1,530
Split Tensile (psi)	550 to 650	650 to 800	750	760	690
Length Change at one year (μin./in.)	−400 to −600	−500 to −700	−387	−365	−458
Unit Creep at two years (μin./in./psi)	0.35 to 0.50	0.25 to 0.50	.15	—	—

NOTE: All weights in pounds per cubic yards of concrete.
Reference Mixes by Grace and WJE for comparison. Similar Strength Reference Mixes were performed under laboratory conditions.

Table 3
Modulus of Elasticity Study Concrete Mix Designs

	Reference Mix	Mix A	Mix B
Cement, Type I (lbs.)	658	658	752
Coarse Aggregate (lbs.)	1800	1800	1800
Fine Aggregate (lbs.)	1336	1278	1148
Microsilica (Force 10,000)			
— lbs/cy	0	49	113
— % of cement	0	7.5	15.0
Water/Cement Ratio	0.40	0.40	0.35
WRDA-19 (oz/cwt)	12	18	20
Air Content (%)	1.5	1.5	2.3

Figure 3
Modulus of Elasticity Study
(0 to 3 days)



The modulus of elasticity of concrete is dependent upon the modulus of both the paste and aggregates and their relative amounts in the mix. Typically, the modulus of normal paste ranges from 2.5 to 3.5 million psi, whereas moduli for aggregates are significantly higher. Stress differential occurs at the paste-aggregate bond, and values for the resultant concrete moduli can be in the 3 to 5 million psi range for normal strength concrete. With microsilica pastes, the modulus of concrete can be increased to ranges of 5 to 7 million psi, approaching that of some aggregates. The mix then behaves as if it were homogeneous, the stress differential between paste and aggregate is decreased, and the overall concrete modulus of elasticity can average 6 million psi and more.

For three different concrete mixes run by WJE, the modulus at 28 days ranged from 6.1 to 6.4 million psi as summarized in Table 2. These are values for 9,700 to 11,600 psi compressive strength concrete. For higher strength concrete, such as for the Seattle projects referenced earlier, the modulus of elasticity was typically 6.8 to 7.2 million psi at 56 days.

A study was conducted at the Grace[2] laboratory to measure modulus of elasticity for various dosage rates of microsilica and cement factors. Table 3 lists these mix designs. Figure 3 shows the modulus of elasticity for the first three days while Figure 4 shows the values at three to twenty-eight days.

Modulus of Elasticity

As tested according to ASTM C469, the modulus of elasticity, or slope of the stress-strain curve increases proportionally for high strength concrete. This is used for determining deformation and stiffness of a structure. For high-rise buildings, the stiffer the structure, the less it sways and drifts, increasing safety factors and the comfort level for occupants on higher floors. For a recently-constructed 56-story building in Seattle, column stiffness was of extreme importance. By going to a higher-strength, stiffer concrete, designers were able to use ten-foot diameter core columns occupying only sixty percent of the area which would have been required by normal-strength columns. This resulted in a significant increase in usable floor space, considerable construction cost savings and a stiffer structure.

Figure 4
Modulus of Elasticity Study
(3 to 90 days)

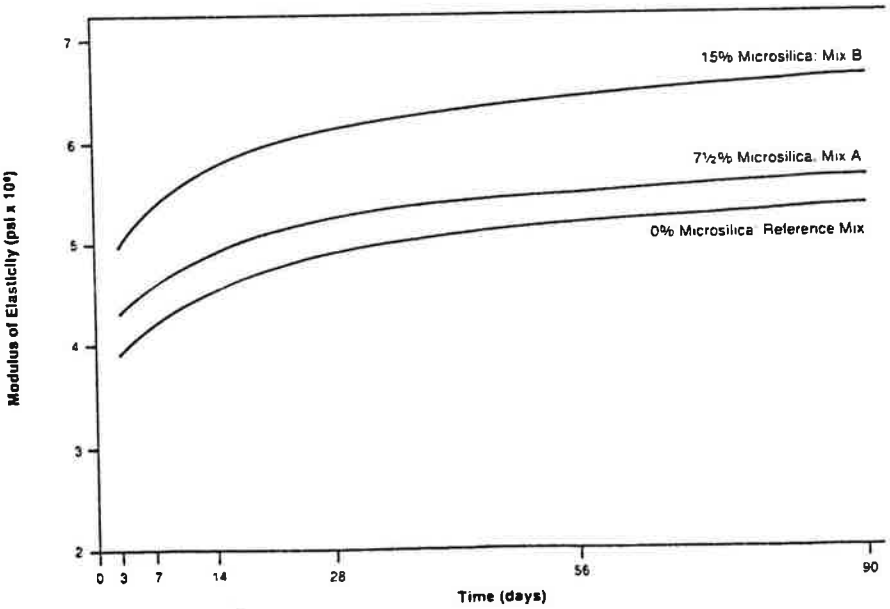


Figure 5
Compressive Strength Results from Modulus of Elasticity Study

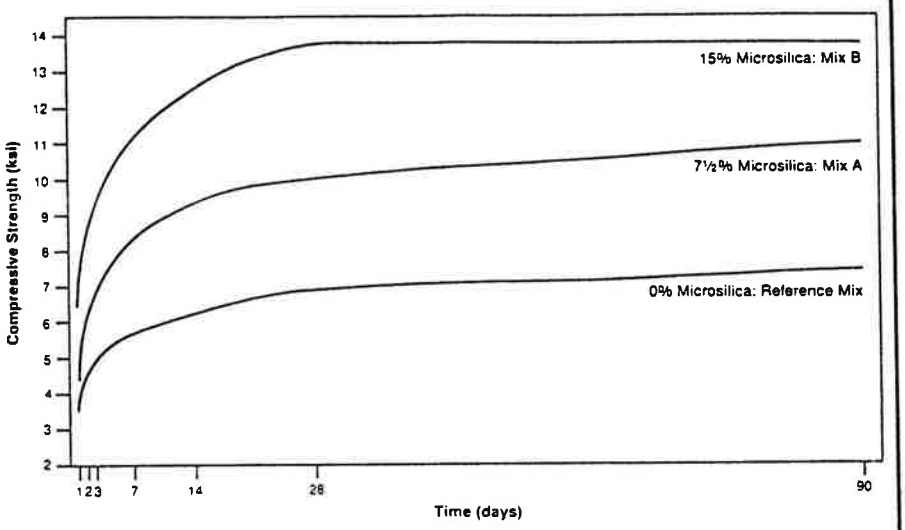


Figure 5 shows the corresponding compressive strength curves. These figures show that higher-strength concretes produce greater modulus of elasticity values which help reduce deflection in columns and beams.

Although a greater modulus of elasticity indicates a more brittle material, this is easily corrected through the use of additional reinforcement for high-strength concrete design. The benefits of higher strength concrete and a stiffer structure outweigh any inconvenience. This does not mean, however, that a large increase in compressive strength represents a corresponding large increase in modulus of elasticity. In fact from the Grace study, 28-day compressive strengths for the Reference Mix was 7,400 psi and the 7½% microsilica mix 10,500 psi while corresponding moduli of elasticity were 4.9×10^6 and 5.2×10^6 psi respectively (Figure 4). Concretes of similar compressive strength, with or without microsilica, exhibit moduli of elasticity which are similar as shown in Table 2.

Poisson's Ratio

In the study performed by WJE on Force 10,000 concrete, Poisson's ratio, the ratio of strain in the lateral direction to strain in the vertical direction, averaged between 0.20 and 0.21 for all three mixes. This value is in line with normal strength concrete.

Flexural Strength (Modulus of Rupture)

The flexural strength, or modulus of rupture, as measured by ASTM C78, becomes an important material parameter in airport and roadway paving applications, in building floors or roof decks and in pavement repair and bonded overlays where flexural failure is more probable than failure in compression. Since flexural strength of the aggregate is usually significantly greater than that of the paste, it becomes extremely important to have good paste-to-aggregate bonding which ties the aggregate together. Because Force 10,000 paste provides excellent bonding to the aggregate, the concrete flexural strengths are greatly improved. Flexural values 800 psi in 24 hours have been achieved with Force 10,000, with 28 day values in excess of 1,500 psi. The WJE 28-day results were 1295 psi for 5% microsilica, 1525 for 10% microsilica plus fly ash, and 1530 psi for 15% microsilica (Table 2). Concrete with microsilica produces greater flexural strengths than similar compressive strength concrete without microsilica (Table 2).

In another Grace laboratory study[3], flexural strengths were measured at 1, 7 and 28 days for concrete containing 0%, 5%, 10% and 15% microsilica. Table 4 lists the concrete mix designs used. Figure 6 gives the flexural strength results from this study and Figure 7 the compressive strength results.

ACI 318 recommends using the equation: $7.5\sqrt{f'_c}$ for estimating concrete flexural strength for design purposes when testing is not available. For Force 10,000 concrete, studies by Grace and WJE have shown that flexural strength results were over 50% greater than the ACI formula prediction. This is attributed in part to the better paste to aggregate bo developed by microsilica concrete, and in part to the conservative nature of the ACI 318 equation.

Data presented in the ACI 363R "State of the Art Report on High Strength Concrete"[4] show that the ACI 318 equation seriously understates the

Table 4

Flexural Strength Study Concrete Mix Designs

	Reference Mix	Mix A	Mix B	Mix C
Cement, Type I (lbs.)	658	658	658	658
Coarse Aggregate (lbs.)	1800	1800	1800	1800
Fine Aggregate (lbs.)	1358	1320	1278	1221
Microsilica (Force 10,000)				
— lbs/cy	0	33	66	99
— % of cement	0	5.0	10.0	15.0
Water/Cement Ratio	0.40	0.40	0.40	0.40
WRDA-19 (oz/cwt)	12	18	18	
Air Content (%)	1.5	1.5	1.5	

Figure 6
Flexural Strength Study

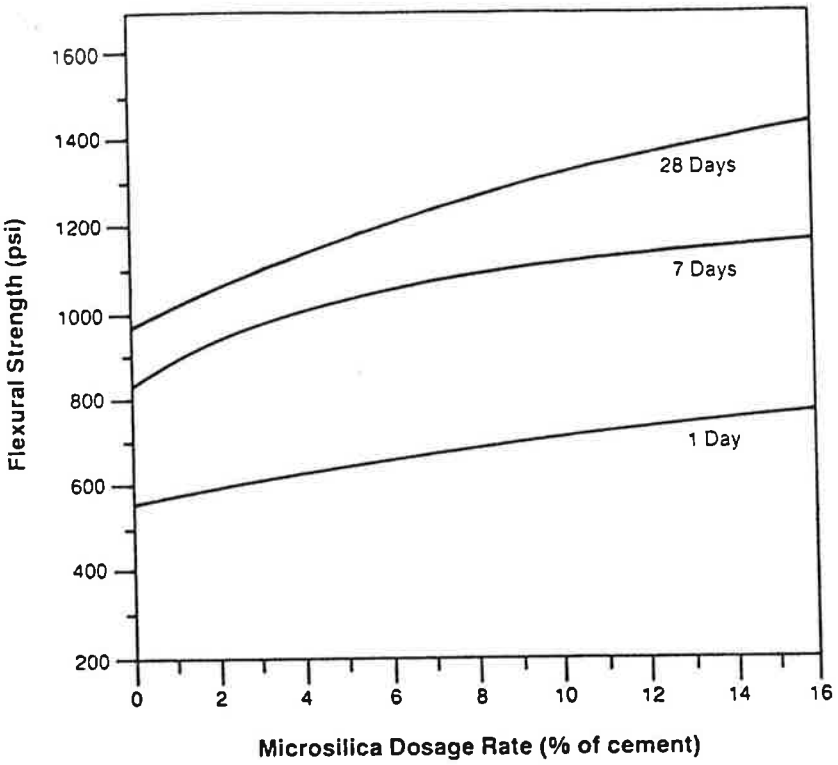
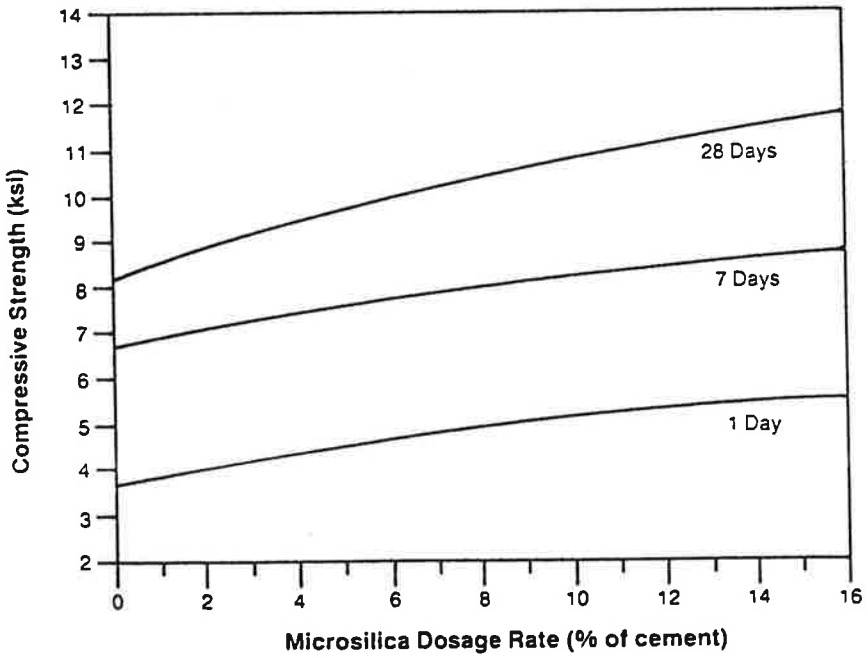


Figure 7
Compressive Strength Results from Flexural Strength Study



flexural strength of high-strength concrete. The relationship is more accurately represented by: $f_r = 11.7\sqrt{f'_c}$. The W. R. Grace data compare favorably to the ACI 363R equation but better fit the following: $f_r = 0.5\, f'^{0.85}_c$. This equation predicts somewhat higher flexural strength at high compressive strengths than does the ACI 363R equation. The Grace data and all of these formulas are shown in Figure 8.

Split Tensile

Split tensile strengths as measured by ASTM C496 are important in design considerations when assurances of adequate concrete shear strength is required. In general it is a measure of concrete quality. Values for the WJE test are shown in Table 2.

Length Change

Two types of shrinkage cracking are well-known in concrete: plastic and drying shrinkage. Plastic shrinkage typically occurs during the first twelve hours after placement, and is due to a rapid drying of the concrete surface. Since concrete which contains 5% and higher microsilica dosage rate bleeds less in slabs than normal concrete, it is important to maintain an adequate surface moisture level with fog misting and moist curing during this critical time period. Following good curing practices as outlined in ACI guidelines will alleviate most plastic shrinkage cracking.

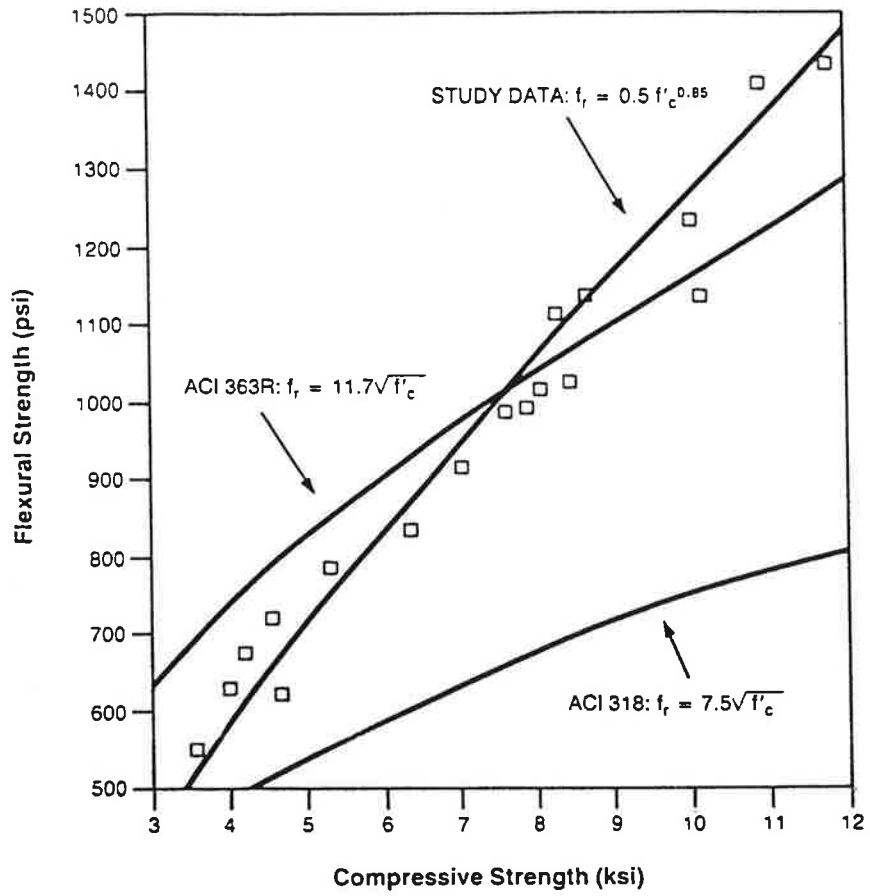
Drying shrinkage occurs following the initial set, and is affected by the volumes of the cement paste and aggregate, and by the stiffness and maximum size of the aggregate. Tests were performed according to ASTM C157 with results at one year from the WJE report shown in Table 2. The microsilica concrete shrinkage values are less than concrete without microsilica at one year.

Creep

The WJE study tested for concrete creep according to ASTM C512. Creep is the measure of axial deformation of a material under continuous load. The two-year creep value for the 5% microsilica concrete mix is shown in Table 2. This value is considered better than normal-strength concrete.

Figure 8

Flexural Strength versus Compressive Strength



Conclusion

Concrete compressive strengths have been climbing higher over recent years. The addition of microsilica has resulted in a quantum leap to even higher strengths and increases in all other mechanical properties of concrete. These increased values will allow the structural engineer to design concrete structures today which were only a dream yeaterday.

References

1. "Concrete Strength Record Jumps 36% ", K. A. Godfrey, Jr., October 1987, Civil Engineering.
2. "Modulus of Elasticity Study of Force 10,000 Concrete", M. P. Dallaire, N. S. Berke, June 1989, Unpublished.
3. "Flexural Strength Study of Force 10,000 Concrete", M. P. Dallaire, N. S. Berke, April 1989, Unpublished.
4. "State-of-the-Art Report on High Strength Concrete", ACI 363.

FT-29 Printed in U.S.A. 4/90 FA/GPS/5000

Calculation Sheet

Computed by WALTERS Subject _____ Sheet 1 of _____
Checked by _____ Job No. 603088
Client GAGE Date AUG 23, 1989

CONTAINMENT VOLUMES

CONTAINER STORAGE AREA

MAXIMUM STORAGE STORAGE OF HAZARDOUS CHEM = 75000 GAL
TANK FARM TANK VOLUME = 6000 + 6000 + 6000 + 3250 + 1000
= 22,250 GAL
MAX. CONTAINER STORAGE VOLUME = 27000 - 22,250 = 2,750 GALL

FROM 40 CFR 264 SUBPART I - USE AND MANAGEMENT OF CONTAINE

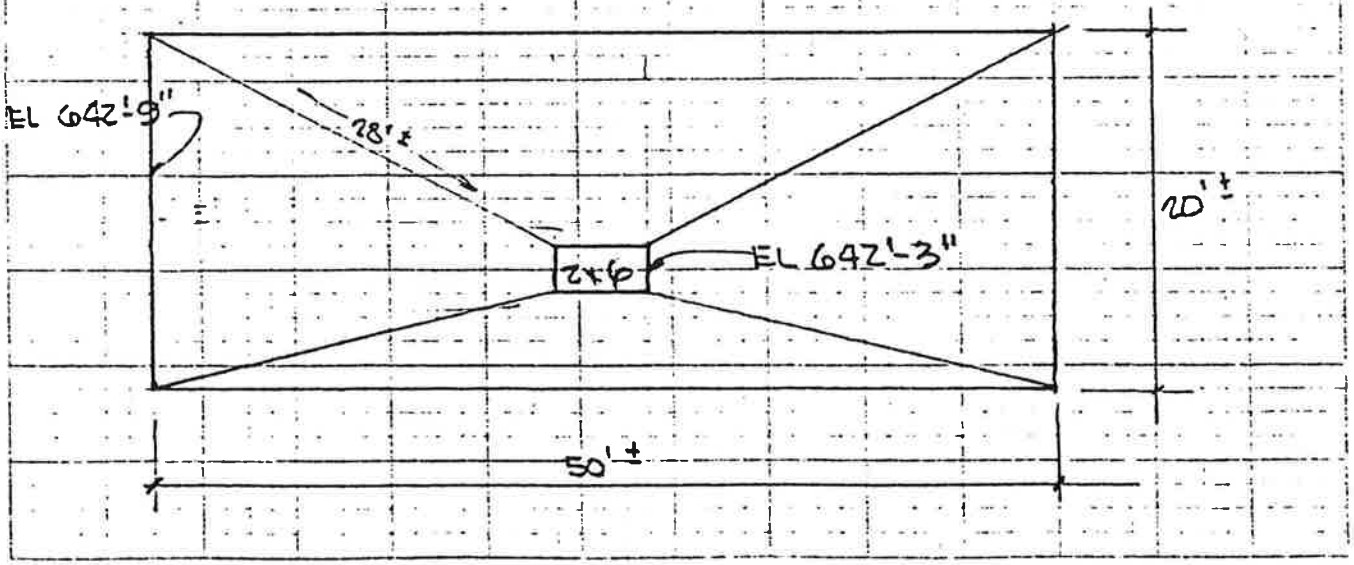
PARAGRAPH 264.175 CONTAINMENT

CONTAINMENT VOLUME = (.10)(TOTAL VOL OF CONTAINERS)
OR = LARGEST CONTAINER

∴
VOL1 = (.10)(2,750 GAL) = 275 GALLONS
VOL2 = 550 GALLONS (SEE MINUTES MTG Nº 1)

USE: 550 GALLONS

CONTAINMENT AREA



Calculation Sheet

Computed by WALTERS Subject _____ Sheet 2 of _____
Checked by _____ Job No. 63088
Client GRACE Date AUG 29, 1989

SLOPE FLOOR @ 1/4" / FT FROM FURTHEREST CORNER TO SUMP

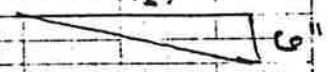
$\Delta = (1/4)(28) = 7"$

USE: 6"

FIRST FLR EL = 638'-9"
SECOND FLR EL = 638'-9" + 4'-0" = 642'-9"
CONTAINER STORAGE SUMP EL = 642'-9" - 6" = 642'-3"

CALCULATE CONSERVATIVE FLOOR CONTAINMENT:

EAST-WEST SLOPE = (1/2)(25)(.5)(1')(7.48)(2) = 200 GALLONS



NORTH-SOUTH SLOPE = (1/2)(10)(.5)(6')(7.48)(2) = 225 GALLONS

CHECK FOR AN ASSUMED DEPTH OF 2" OVER THE ENTIRE AREA

VOL = (50)(20)(.17)(7.48) = 1,250 GALLONS > 425

ASSUME A 2'x2' SUMP INTERIOR PLAN DIMENSION 3' DEEP

CONTAINMENT VOL = (2)(2)(3)(7.48) = 90 GALLONS

TRY 2 x 6 x 3' DEEP ◄—— USE

CONTAINMENT VOL = (2)(6)(3)(7.48) = 270 GALLONS

THEREFORE

TOTAL CONTAINMENT VOL = 200 + 225 + 270 = 695 GALLONS

O.K.

Calculation Sheet

Computed by WALTERS Subject _____ Sheet 3 of _____
Checked by _____ Job No. 603088
Client _____ Date AUG 24, 1982

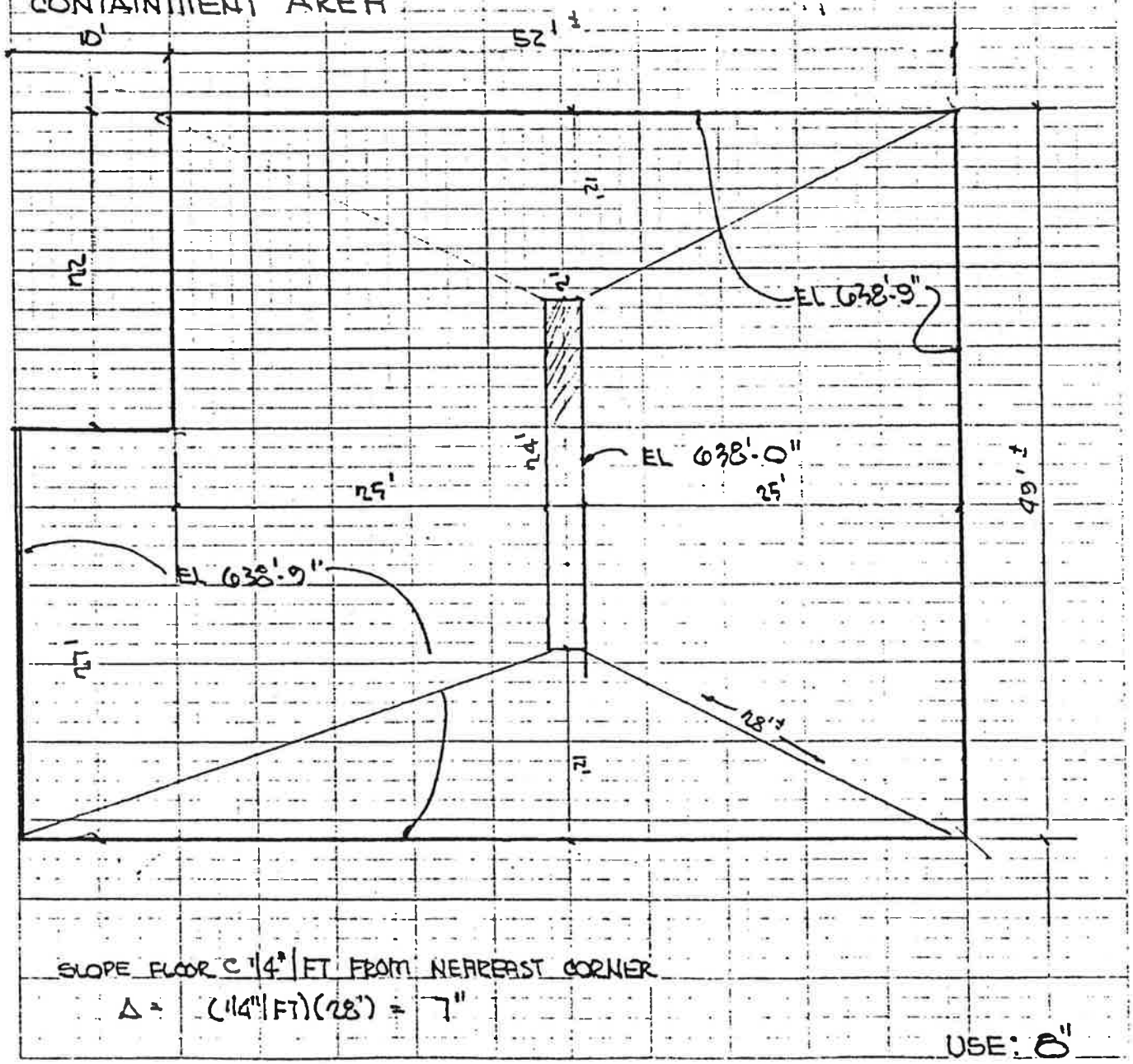
UNLOADING AREA

MAXIMUM STORAGE OF HAZARDOUS CHEM = 6000 GALL

FROM PART 5 ROLE 158

CONTAINMENT VOL = (6000)(1.5) = 9000 GALLONS

CONTAINMENT AREA



SLOPE FLOOR @ 1/4" / FT FROM NEAREST CORNER

Δ = (1/4" / FT)(28') = 7"

USE: 8"

Calculation Sheet

Computed by WALTERS Subject _____ Sheet 9 of _____
Checked by _____ Job No. 63088
Client GAGE Date AUG 29, 1989

TRUCK UNLOAD FLOOR CONTAINMENT

TOP OF FLOOR ELEVATION: BLDG. PERIMETER 638'-9"

TOP OF TRENCH GRATE AT SUMP 638'-0"

△ OF FLOOR = 9" = 0.75'

CALCULATE CONSERVATIVE FLOOR CONTAINMENT:

VOL1 = (.5)(75)(.75)(24)(2)(7.48) = 3,350

VOL2 = (.5)(12)(.75)(4)(2)(7.48) = 259

3600 GAL (CONSERVATIVE)

CHECK NUMBER BY ASSUMING A 1" DEPTH OVER TOTAL FLOOR AREA

VOL CHECK = (52)(50)(.17)(7.48) = 3,306 GAL

DETERMINE THE DEPTH OF A 1'X4' SUMP

VOL SUMP = 9000 - 3600 = 5400 GALLONS

$5400 = (1)(24)(X)(7.48)$

$X = \frac{5400}{(2)(24)(7.48)} = 15$ ft TO DEEP

ASSUME A 4' WIDE TRENCH BELOW

$5400 = (4)(24)(X)(7.48)$ TO DEEP

X = 7.5 ft

ASSUME A 6' WIDE TRENCH

$X = 5400/(6)(24)(7.48) = 5.0$ ← OK

Stored Waste Containment

Volume Calculation

1. Gross Area: 47.833' x 15.167' + 9.833' x 4.5' = 769.7'
2. Average Btm. of Containment: $\frac{637.333 + 636.79167}{2} = 637.06'$
3. T.O. Wall = 641'
4. Average Depth = 641' - 637.06' = 3.94'

Tank Pad Reduction

5. Average Depth = 637.75 - 637.06' = 0.69'
6. $[(3) \times \pi\ 5^2 + (1) \times \pi \times 4.25^2] \times 0.69' = 201$ cf
7. Tank skirt height to bottom of tank:
   - 9' Ø → 36"
   - 7'-6" Ø → 36"
   - 5' Ø → 36"
8. Assume no volume reduction until 637.75' + 3' - 637.06' = 3.69
9. Net volume to 3.69'
   769.7' x 3.69' - 201 cf = 2639.2 cf
10. Net volume from 3.69 to 3.94'
    $[769.7' - (3 \times \pi\ 4.5^2 + \pi \times 3.75^2 + \pi \times 2.5^2)] \times 0.25' = 128.7$ cf
11. Total Net Volume
    2639.2 + 128.7 = 2767.9 cf
    = 20,704 gallons
12. 20 minutes sprinkling
    0.37 gpm/ft^2 x 20 min. x 769.7' = 5696 gallons H_20
13. Total volume available to contain spillage:
    20,704 - 5,696 = 15008 gallons
    15,008 gallons/6,000 gallons = ≈ 250%

Explanation of Calculations

1. Calculate the gross interior area of the stored waste containment (Reference Sht S4 for dimensions).
2. Calculate the average elevation of the sloped containment slab (Reference elevations Sht S4).
3. Top of wall elevation (Reference Section 1 Sht. S5).
4. Calculate average containment depth by subtracting 3 from 2.

5&6. Calculate the average volume of the concrete tank pads so this can be subtracted form the gross volume.

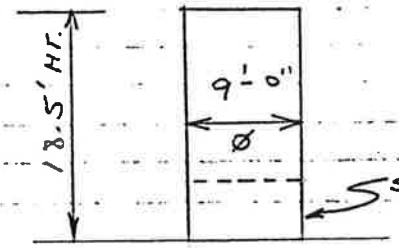
7&8. Indicate height from top of tank pads to average btm. of tanks so we know at what elevation we need to start deducting volume of storage tanks.

9. Calculate net volume stored to bottom of tanks by multiplying results of 1 and 8 and subtracting results of 6.
10. Calculate net volume stored from bottom of tanks to the top of the lowest containment wall section.
11. Add result of 9 and 10.
12. Containment area will be sprinkled for fire protection. Currently, there are no NFPA or BOCA guidelines for containing sprinkled water. The 20-minute time period used is from the latest addition of the uniform building code which is typically used by western states. Here we are calculating how much water will be sprinkled in 20 minutes, based on flow rates provided by the fire protection system designer.
13. Total volume available for containment is calculated by subtracting result of 12 from result of 11.

TANK FOUNDATIONS CHECK

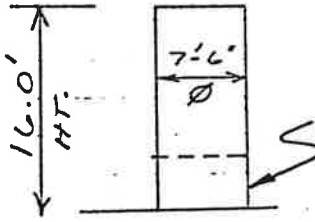
TANK SIZES:

CASE I 6000 GALLON



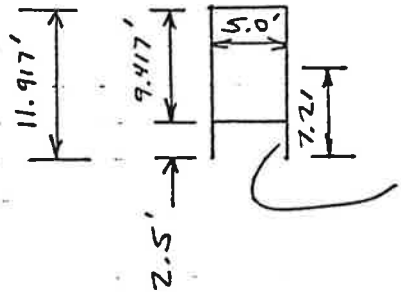
WT. EMPTY = 6540 lbs
EST. OPERATING WT = 65,000 lb.

CASE II 3250 GALLON



WT. EMPTY = 4600 lbs
EST. op. WT = 37,000 lbs.

CASE III 1000. GALLON



WT. EMPTY = 1725 lbs
EST. op. WT = 11,500 lbs

CALCULATE BOCA WIND LOAD

WIND SPEED = 75 MPH

$P_d = P_e \; I^2 \; C_p$

P_e = 13 psf (EXP B 20'-40')

$I = 1.0$

$h/D = 12/5 = 2.4$ WORST CASE

$D\sqrt{P_e} = 5 * \sqrt{13} = 18.0 > 2.5$

USE $C_p = 0.8$

$P_d = 13 * 0.75 = 9.75$ psf

USE 10 PSF MINIMUM

CASE I

$W = 18.5 * 9.0 * 10$ psf $= 1665$ lbs

$M = 1665 * 18.5/2 = 15401$ lb-ft

"AREA" OF RING = $\pi d = \pi * 9 = 28.3$ FT

"SECTION MODULUS" OF RING = $\frac{\pi d^2}{4} = \frac{\pi * 9^2}{4} = 63.6$

LOAD AT BASE

WIND = $\frac{15401}{63.6} = 242$ lbs

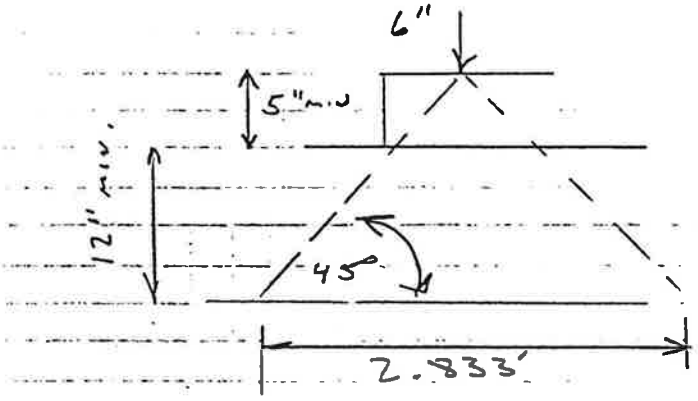
EMPTY = $\frac{6540}{28.3} = 231$ lbs

FULL = $\frac{65{,}000}{28.3} = 2297$ lbs

EMPTY − WIND = 231 − 242 = 11 plf = (uplift)

FULL + WIND = 2297 + 242 = 2539 plf = (down)

∴ ASSUME MINIMAL FASTENING TO KEEP TANK FROM BLOWING OVER.



$2539 / 2.833 = 896$ psf

< 2000 psf

So OK

CASE II

$W = 16.0' * 7.5' * 10$ psf $= 1200$ lbs

$M = 1200 * 16/2 = 9600$ lb-ft

"AREA" $= \pi d = \pi * 7.5 = 23.6$

"SECTION" $= \frac{\pi * 7.5^2}{4} = 44.2$

WIND $= 9600 / 44.2 = 217$ plf

EMPTY $= 4600 / 23.6 = 195$ plf

FULL $= 37{,}000 / 23.6 = 1568$

EMPTY - WIND = 195 - 217 = 22 PLF (UPLIFT)

FULL + WIND = 1568 + 217 = 1785 PLF (down)

OK IN COMPARISON TO CASE I

CASE III

W = 11.917 * 5 * 10 PSF = 596 lbs

M = 596 * 11.917/2 = 3551 lb-ft

"AREA" = πd = $\pi * 5$ = 15.7

"SECTION" = $\frac{\pi d^2}{4}$ = $\frac{\pi 5^2}{4}$ = 19.6

WIND = $3551 / 19.6$ = 181

EMPTY = 1725/15.7 = 110 PLF

FULL = 11500/15.7 = 732 PLF

EMPTY - WIND = 71 PLF UPLIFT

$71 * 15.7/2$ = 557 lbs

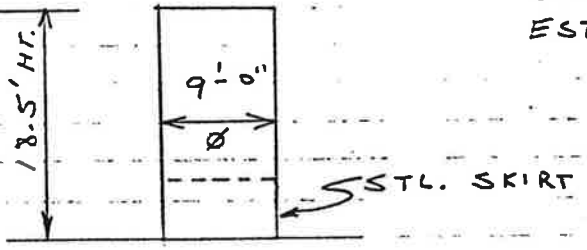
(1) - 5/8" Ø HILTI "KWIK BOLT"
GOOD FOR 1650 lbs TENSION
SO ASSUME OK

FULL + WIND = 913 PLF — OK IN COMPARISON TO CASE I

TANK FOUNDATIONS CHECK

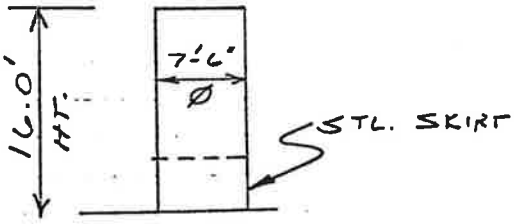
TANK SIZES:

CASE I 6000 GALLON



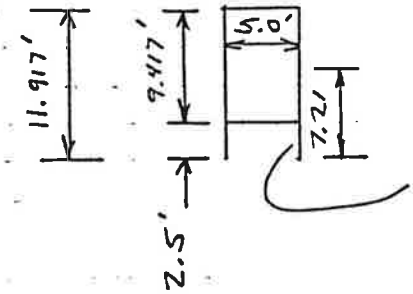
WT. EMPTY = 6540 lbs
EST. OPERATING WT = 65,000 lb

CASE II 3250 GALLON



WT. EMPTY = 4600 lbs
EST. op. WT = 37,000 lbs.

CASE III 1000. GALLON



WT. EMPTY = 1725 lbs
EST. op. WT = 11,500 lbs

CALCULATE BOCA WIND LOAD

WIND SPEED = 75 MPH

$P_d = P_e \; I^2 \; C_p$

P_e = 13 PSF (EXP B 20'-40')

$I = 1.0$

$h/D = 12/5 = 2.4$ WORST CASE

$D\sqrt{P_e} = 5 * \sqrt{13} = 18.0 > 2.5$

USE $C_p = 0.8$

$P_d = 13 * 0.75 = 9.75$ PSF

USE 10 PSF MINIMUM

CASE I

$W = 18.5 * 9.0 * 10$ PSF $= 1665$ lbs

$M = 1665 * 18.5/2 = 15401$ lb-ft

"AREA" OF RING = $\pi d = \pi * 9 = 28.3$ FT

"SECTION MODULUS" OF RING = $\frac{\pi d^2}{4} = \frac{\pi * 9^2}{4} = 63.6$

LOAD AT BASE

WIND = $\frac{15401}{63.6} = 242$ lbs

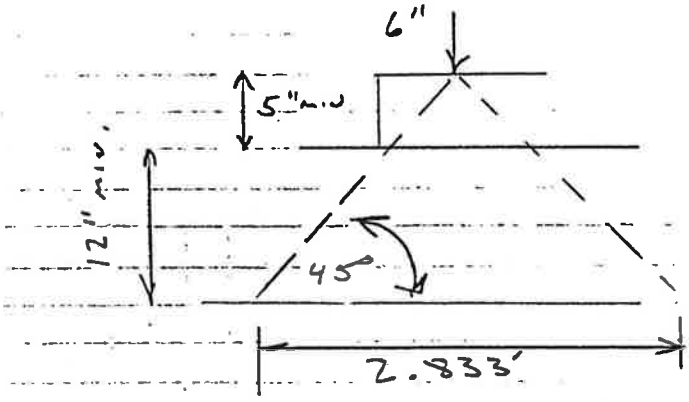
EMPTY = $\frac{6540}{28.3} = 231$ lbs

FULL = $\frac{65{,}000}{28.3} = 2297$ lbs

Empty − wind = 231 − 242 = 11 pli = (uplift)

Full + wind = 2297 + 242 = 2539 pli = (down

∴ Assume minimal fastening to keep tank from blowing over.



$2539 / 2.833 = 896$ psi =

< 2000 psi =

So OK

Case II

$W = 16.0' * 7.5' * 10$ psf $= 1200$ lbs

$M = 1200 * 16/2 = 9600$ lb-ft

"Area" $= \pi d = \pi * 7.5 = 23.6$

"Section" $= \frac{\pi * 7.5^2}{4} = 44.2$

Wind $= 9600 / 44.2 = 217$ psi =

Empty $= 4600 / 23.6 = 195$ psi =

Full $= 37{,}000 / 23.6 = 1568$

EMPTY - WIND = 195 - 217 = 22 PLF (UPLIFT)

FULL + WIND = 1568 + 217 = 1785 PLF (DOWN)

OK IN COMPARISON TO CASE I

CASE III

W = 11.917 * 5 + 10 PSF = 596 lbs

M = 596 * 11.917/2 = 3551 lb-ft

"AREA" = πd = $\pi * 5$ = 15.7

"SECTION" = $\frac{\pi d^2}{4}$ = $\frac{\pi 5^2}{4}$ = 19.6

To here

(1.8)

WIND = $3551 / 19.6$ = 181

EMPTY = 1725/15.7 = 110 PLF

FULL = 11500/15.7 = 732 PLF

EMPTY - WIND = 71 PLF UPLIFT

$71 * 15.7/2$ = 557 lbs

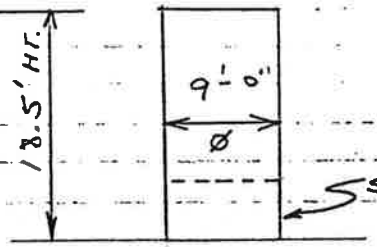
(1) - 5/8" Ø HILTI "KWIK BOLT"
GOOD FOR 1650 lbs TENSION
SO ASSUME OK

FULL + WIND = 913 PLF - OK IN COMPARISON TO CASE I

TANK FOUNDATIONS CHECK

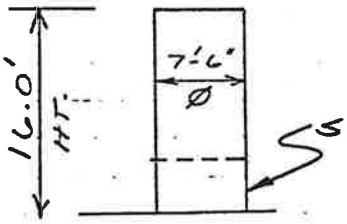
TANK SIZES:

CASE I 6000 GALLON



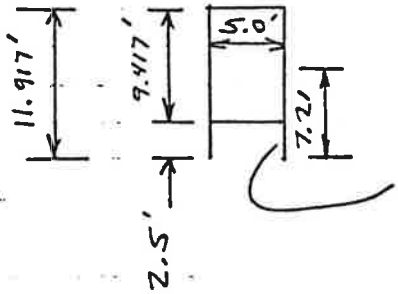
WT. EMPTY = 6540 lbs
EST. OPERATING WT = 65,000 lbs

CASE II 3250 GALLON



WT. EMPTY = 4600 lbs
EST. op. WT = 37,000 lbs.

CASE III 1000. GALLON



WT. EMPTY = 1725 lbs
EST. op. WT = 11,500 lbs

CALCULATE BOCA WIND LOAD

WIND SPEED = 75 MPH

$P_d = P_e \; I^2 \; C_p$

P_e = 13 PSF (EXP B 20'-40')

$I = 1.0$

$h/D = 12/5 = 2.4$ WORST CASE

$D\sqrt{P_e} = 5 * \sqrt{13} = 18.0 > 2.5$

USE $C_p = 0.8$

$P_d = 13 * 0.75 = 9.75$ PSF

USE 10 PSF MINIMUM

CASE I

$W = 18.5 * 9.0 * 10$ PSF $= 1665$ lbs

$M = 1665 * 18.5/2 = 15401$ lb-ft

"AREA" OF RING = $\pi d = \pi * 9 = 28.3$ FT

"SECTION MODULUS" OF RING = $\frac{\pi d^2}{4} = \frac{\pi * 9^2}{4} = 63.6$

LOAD AT BASE

WIND = $\frac{15401}{63.6} = 242$ lbs

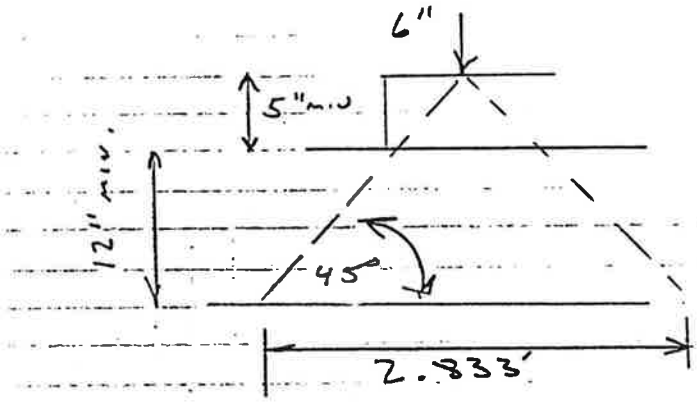
EMPTY = $\frac{6540}{28.3} = 231$ lbs

FULL = $\frac{65{,}000}{28.3} = 2297$ lbs

Empty − wind = 231 − 242 = 11 plf = (uplift)

Full + wind = 2297 + 242 = 2539 plf = (down)

∴ Assume minimal fastening to keep tank from blowing over.



$2539 / 2.833 = 896$ psi

< 2000 psi

So OK

Case II

$W = 16.0' * 7.5' * 10$ psf $= 1200$ lbs

$M = 1200 * 16/2 = 9600$ lb-ft

"Area" $= \pi d = \pi * 7.5 = 23.6$

"Section" $= \frac{\pi * 7.5^2}{4} = 44.2$

Wind $= 9600 / 44.2 = 217$ plf

Empty $= 4600 / 23.6 = 195$ plf

Full $= 37{,}000 / 23.6 = 1568$

EMPTY - WIND = 195 - 217 = 22 PLF (UPLIFT)

FULL + WIND = 1568 + 217 = 1785 PLF (DOWN)

OK IN COMPARISON TO CASE I

CASE III

W = 11.917 * 5 * 10 PSF = 596 lbs

M = 596 * 11.917/2 = 3551 lb-ft

"AREA" = πd = $\pi * 5$ = 15.7

"SECTION" = $\frac{\pi d^2}{4}$ = $\frac{\pi 5^2}{4}$ = 19.6

to here (P.4)

WIND = 3551 / 19.6 = 181

EMPTY = 1725 / 15.7 = 110 PLF

FULL = 11500 / 15.7 = 732 PLF

EMPTY - WIND = 71 PLF UPLIFT

71 * 15.7/2 = 557 lbs

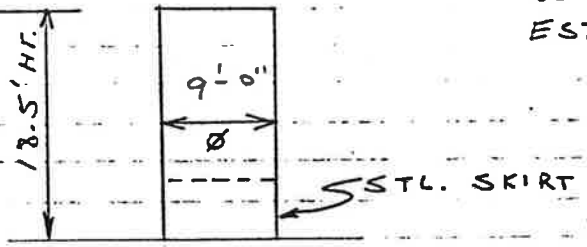
(1) - 5/8" Ø HILTI "KWIK BOLT"
6000 LBS / 1650 lbs TENSION
SO ASSUME OK

FULL + WIND = 913 PLF - OK IN COMPARISON TO CASE I

TANK FOUNDATIONS CHECK

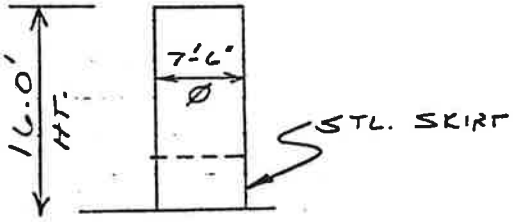
TANK SIZES:

CASE I 6000 GALLON



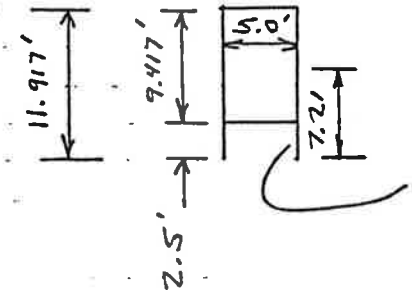
WT. EMPTY = 6540 lbs
EST. OPERATING WT = 65,000 lb

CASE II 3250 GALLON



WT. EMPTY = 4600 lbs
EST. op. WT = 37,000 lbs.

CASE III 1000. GALLON



WT. EMPTY = 1725 lbs
EST. op. WT = 11,500 lbs

CALCULATE BOCA WIND LOAD

WIND SPEED = 75 MPH

$P_d = P_e \; I^2 \; C_p$

P_e = 13 PSF (EXP B 20'-40')

$I = 1.0$

$h/D = 12/5 = 2.4$ WORST CASE

$D\sqrt{P_e} = 5 * \sqrt{13} = 18.0 > 2.5$

USE $C_p = 0.8$

$P_d = 13 * 0.75 = 9.75$ PSF

USE 10 PSF MINIMUM

CASE I

$W = 18.5 * 9.0 * 10$ PSF $= 1665$ lbs

$M = 1665 * 18.5/2 = 15401$ lb-ft

"AREA" OF RING = $\pi d = \pi * 9 = 28.3$ FT

"SECTION MODULAS" OF RING = $\frac{\pi d^2}{4} = \frac{\pi * 9^2}{4} = 63.6$

LOAD AT BASE

WIND = $\frac{15401}{63.6} = 242$ lbs

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Full + wind = 2297 + 242 = 2539 pli = (do

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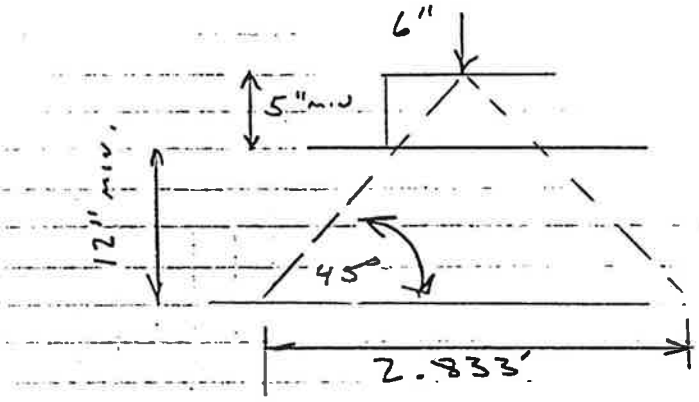

$2539 / 2.833 = 896$ psi

< 2000 psi

So OK

Case II

$W = 16.0' + 7.5' + 10$, psf $= 1200$ lbs

$M \doteq 1200 + 16/2 = 9600$ lb-ft

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FULL + WIND = 1568 + 217 = 1785 PLF (DOWN)

OK IN COMPARISON TO CASE I

CASE III

W = 11.917 * 5 + 10 PSF = 596 lbs

M = 596 * 11.917/2 = 3551 lb-ft

"AREA" = πd = $\pi * 5$ = 15.7

"SECTION" = $\frac{\pi d^2}{4}$ = $\frac{\pi 5^2}{4}$ = 19.6

To here (p.8)

WIND = $3551 / 19.6$ = 181

EMPTY = 1725/15.7 = 110 PLF

FULL = 11500/15.7 = 732 PLF

EMPTY - WIND = 71 PLF UPLIFT

$71 * 15.7/2$ = 557 lbs

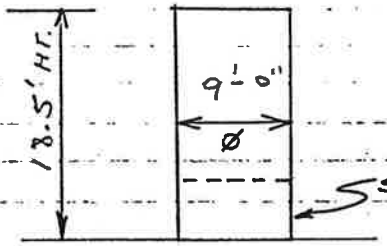
(1) - 5/8" Ø HILTI "KWIK BOLT"
GOOD FOR 1650 lbs TENSION
SO ASSUME OK

FULL + WIND = 913 PLF — OK IN COMPARISON TO CASE I

TANK FOUNDATIONS CHECK

TANK SIZES:

CASE I 6000 GALLON



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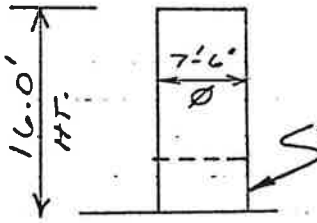
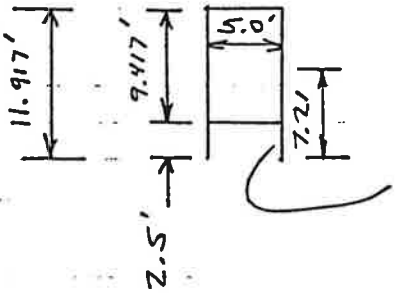


WT. EMPTY = 4600 lbs
EST. op. WT = 37,000 lbs.

CASE III 1000. GALLON



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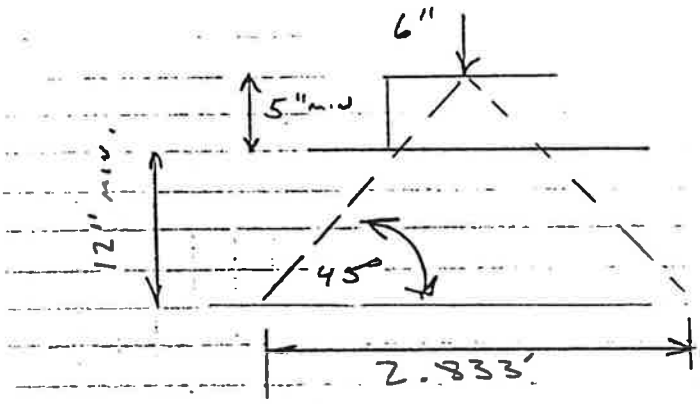

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< 2000 psf

So OK

Case II

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to here

(1.5)

WIND = 3551/19.6 = 181

EMPTY = 1725/15.7 = 110 PLF

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EMPTY - WIND = 71 PLF UPLIFT

71 * 15.7/2 = 557 lbs

(1) - 5/8" Ø HILTI "KWIK BOLT"
GOOD FOR 1650 lbs TENSION
SO ASSUME OK

FULL + WIND = 913 PLF - OK IN COMPARISON TO CASE I

SQUIRT CALCULATION

The purpose of this demonstration is to predict the distance a liquid stream will travel from an opening. This is important when considering the possible failure of a tank or container under a worst-case scenario. The secondary containment system must be capable of containing a squirt release.

The container storage areas at Gage will include both a single and double layer of drums stored on pallets. For this squirt demonstration the following assumptions have been made:

1. Atmospheric pressure exists inside the drum at the time of a leak.
2. The drums are filled to the top.
3. Viscosity losses are zero.
4. The discharge coefficient for an orifice $C_v = 0.94$.

Using Bernoulli's Equation: $V_1^2/2g + P_1/W + Z_1 = V_2^2/2g + P_2/W + Z_2$

Refer to Figure 1:

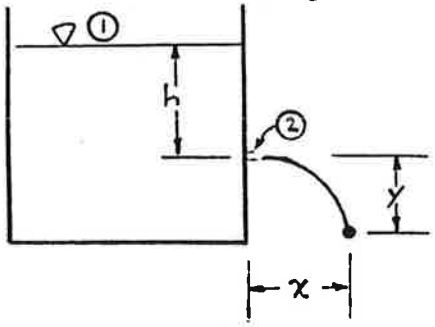
- with a point of reference through the opening (point 2)

$Z_1 = h$
$Z_2 = 0$
$V_1 = 0$
$P_1/W = P_2/W = 0$

$V_2 = C_v \sqrt{2gh}$

where C_v = discharge coefficient
= 0.94 (typical)

Figure 1
Path of a Liquid Stream



x - coordinate at $t = V_x t = t\, C_v\, (2gh)^{0.5}$

y - coordinate at $t = V_{avg} t = g\, t^2/2$ where V_{avg} = average velocity

solving for $x = (4y\, C_v^2 h)^{0.5}$

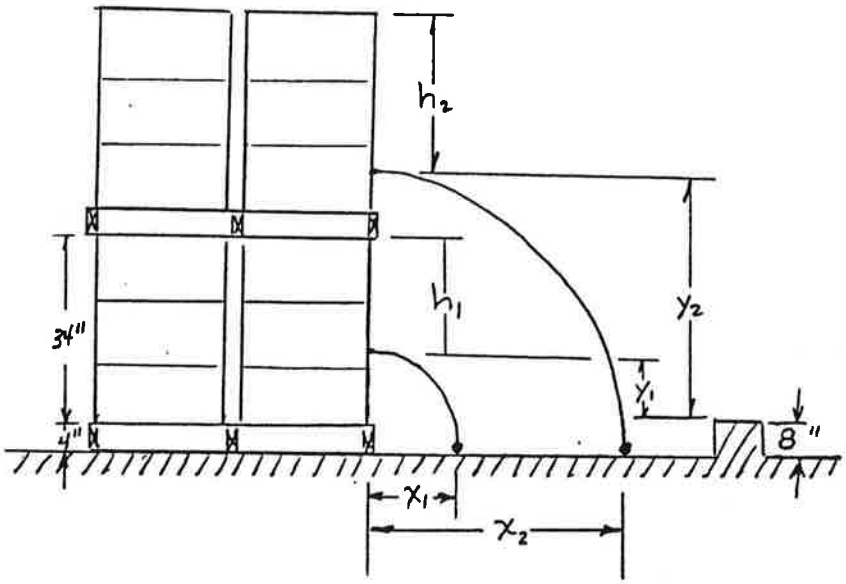


Figure 2
Drum Stacking Arrangement

Table 1
Calculation of Squirt

	h(ft)	y(ft)	x(ft)
Top of Drum			
Top Pallet	0	6.07	0.00
	0.5	5.57	3.14
	1.0	5.07	4.23
	1.5	4.57	4.92
	2.0	4.07	5.36
Top Pallet	2.5	3.57	5.62
Bottom of Drum	2.83	3.24	5.69
Top of Drum	0	2.91	0.00
Lower Pallet	0.5	2.41	2.06
	1.0	1.91	2.60
	1.5	1.41	2.73
	1.75	1.16	2.68
	2.0	0.91	2.54
Lower Pallet	2.5	0.41	1.90
Bottom of Drum	2.83	0.08	0.89

Where:

h = liquid head above orifice
y = vertical distance from orifice to top of curb
x = horizontal distance liquid travels
$= (4yC_v^2h)^{0.5}$

Conclusions:

1. If the drums are stacked only one high on a pallet, they must be placed at least 2.73 feet from the edge of a 3-inch curb to prevent a liquid stream from possibly squirting over it.

2. If the drums are stacked two high on pallets, they must be placed at least 5.7 feet from the edge of a 3-inch curb to prevent a liquid stream from possibly squirting over it.

HANDS & ASSOCIATES, INC.
500 Griswold, Suite 1650
Detroit, MI 48226
Phone (313)-963-8870
Fax (313) 963-8876

Certification of Capability to Manage Waste

Hands & Associates, Inc. hereby provides this certification to manage waste for Gage Products Company for those areas outlined in the Company's renewal application. This certification is in accordance with State of Michigan Regulations (Part 111, Act 451, R. 324.11123(iii) which reads "*A certification of the treatment, storage, or disposal facility's capability of treating, storing, or disposing of hazardous waste in compliance with this part.*" This certification will cover the applicable areas of the plant as outlined in the application including; 1) LSF Building – Hazardous Waste drum storage, and 2) Tank Farm Storage.

I have reviewed the documentation and visited the Limited Storage Facility (LSF) at Gage Products Company located in Ferndale, MI. I certify that to the best of my knowledge the LSF is capable of storing and managing the hazardous waste materials as outlined this renewal application.

By:

Lawrence M. Hands, P.E.

Lawrence M Hands

Signature, Lawrence M. Hands, PE

Date Jan 25, 2013 Registration No. 6201028820

State Michigan

I

OPERATING LICENSE APPLICATION FORM FOR
HAZARDOUS WASTE TREATMENT, STORAGE, AND DISPOSAL FACILITIES

Application Section: L

(Form EQP 5111 (Rev 10/2010) ITEM XIV: OTHER REQUIRED ATTACHMENTS

B. Supplemental Information

8. Capability certification/compliance schedule)

Certification of Capability to Manage Waste
Supplemental Information

The following information is provided in support of the Certification of Capability.

1.0 General Information

In accordance with MI Public Act 451 Rule 324 Part 11123(iii) the following areas were reviewed in certifying that the Gage Products Facility is capable of treating, storing, or disposing of hazardous waste in compliance with this part: Limited Storage Facility (LSF) Drum Storage and Tank Farm Storage.

Certification support includes: familiarity with site operations for approximately 20 years (with recent site inspection conducted on January 17, 2013); review of AST inspection records and reports; review of daily and weekly equipment inspection forms; interviews with site personnel; review of ROP and Subpart BB and Subpart CC Documents.

2.0 LSF Drum Storage

The LSF drum storage area was inspected by Hands & Associates, Inc. (HANDS) periodically over several years and most recently on 1/17/13. The LSF drum storage area was found to be adequately bermed to prevent spill migration, and with a containment sump present. The area was covered, with no evidence of spills. This area is capable of storing and handling hazardous waste as described in this application.

3.0 LSF Tank Farm/Storage Tank System

The LSF tank area was inspected by Hands & Associates, Inc. (HANDS) periodically over several years and most recently on 1/17/13. The LSF tank farm area was found to be adequately contained by concrete secondary containment walls to prevent spill migration, and with a containment sump present. The Gage LSF was constructed with a sealant applied to the concrete secondary containment to prevent spills from penetrating the concrete. In addition, the tank farm dike is constructed with micro silica-filled concrete that makes it more impervious. The containment structure is well maintained for ensuring integrity.

Review of LSF tank ultrasound thickness testing conducted on June 23, 2011 by TSP Environmental, Inc. which was based on the requirements of API-653, the reports state that all LSF tanks and associated piping systems were certified fit for service.

A tank inspection and associated piping/valves/pumps inspection program is implemented and maintained such that this area is capable of storing and handling hazardous waste as described in this application.

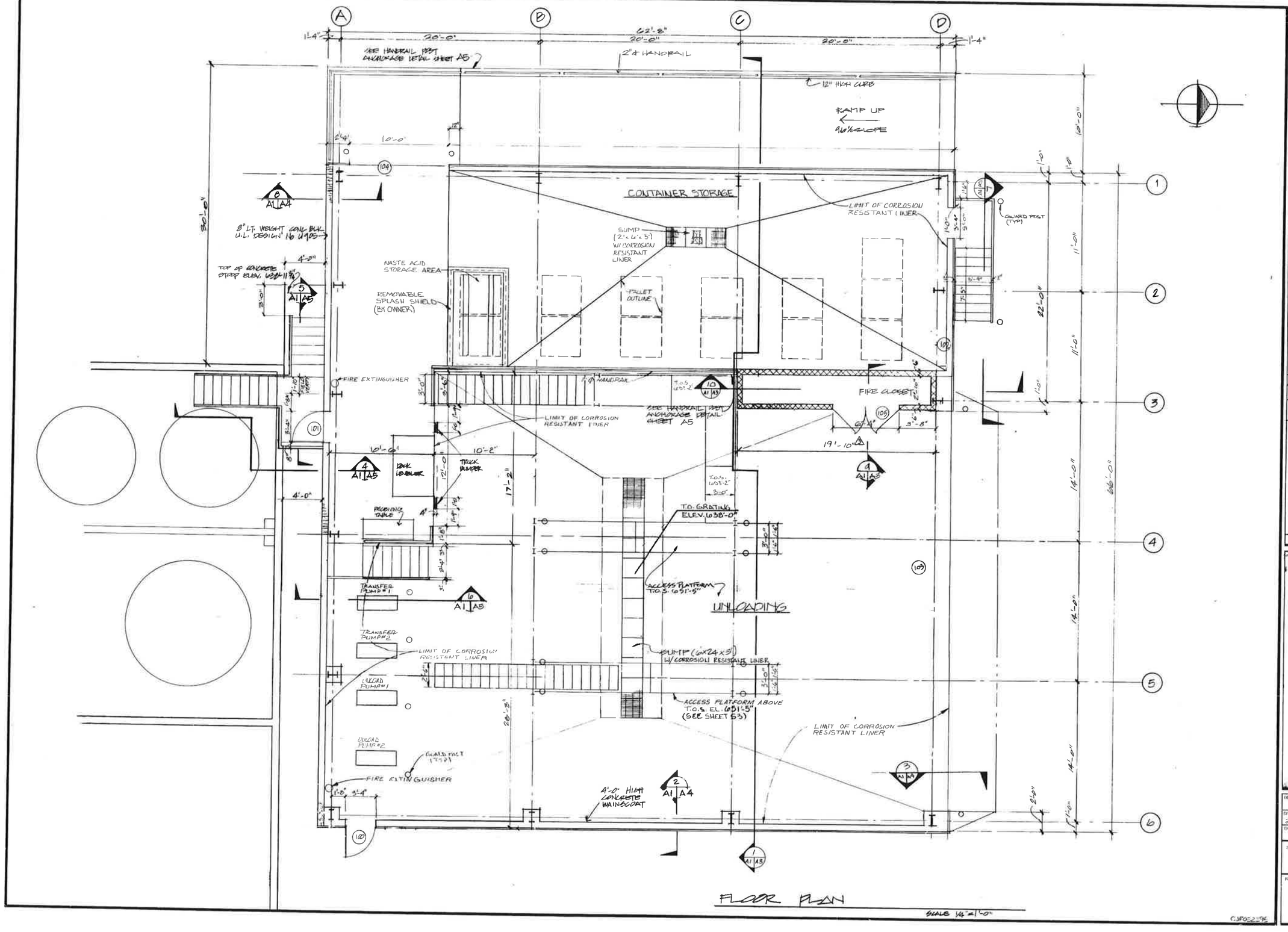
Appendix A1-5

Engineering Plans

APPENDIX A1-5

Engineering Plans

VEENSTRA



FLOOR PLAN

SCALE 1/8"=1'-0"

C:\F052-9K

WW Facilities Group
Engineering
Construction Management
5555 Glenwood Hills Parkway SE • Grand Rapids, MI 49512 • (616) 942-1900

NO	DATE	BY	REVISIONS	DATE	BY

AS BUILT 6/95
BIDS 11/27/92

REVISED IN ACCORDANCE WITH CONSTRUCTION RECORDS

HAZARDOUS WASTE UNLOADING & LIMITED STORAGE FACILITY

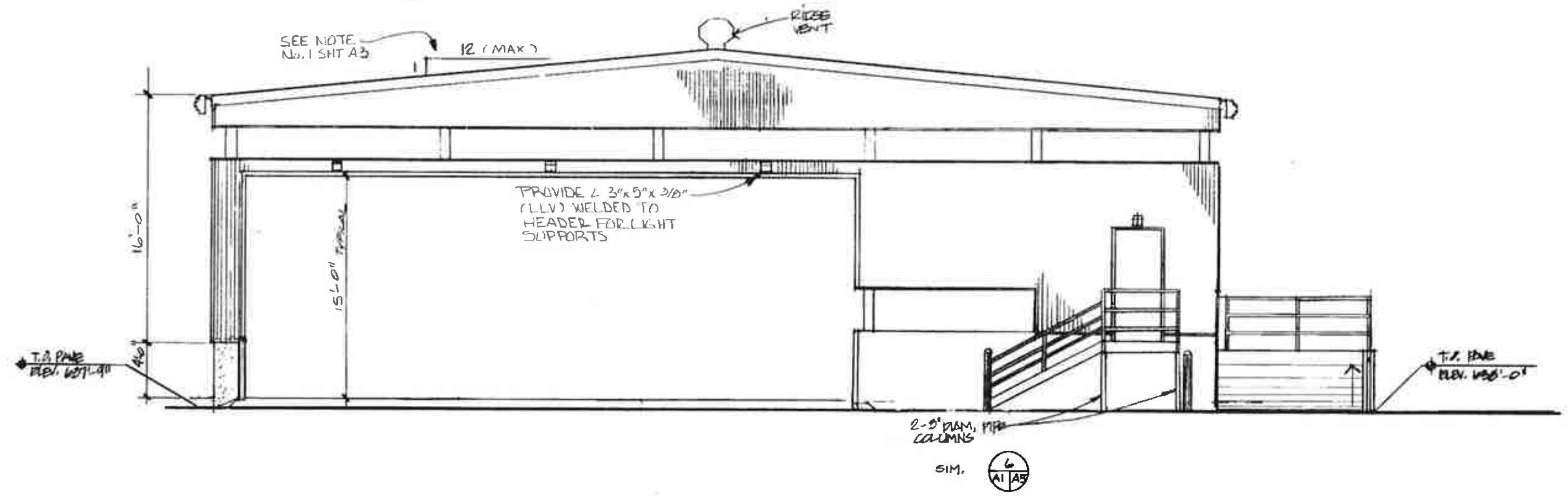
FLOOR PLAN

GAGE PRODUCTS, CO. FERNDALE, MICHIGAN

DESIGNED BY	DATE
DRAWN BY DMN	DATE 8.4.92
CHECKED BY	DATE
SCALE AS SHOWN	
HORIZONTAL	
VERTICAL	
PROJECT 83651	

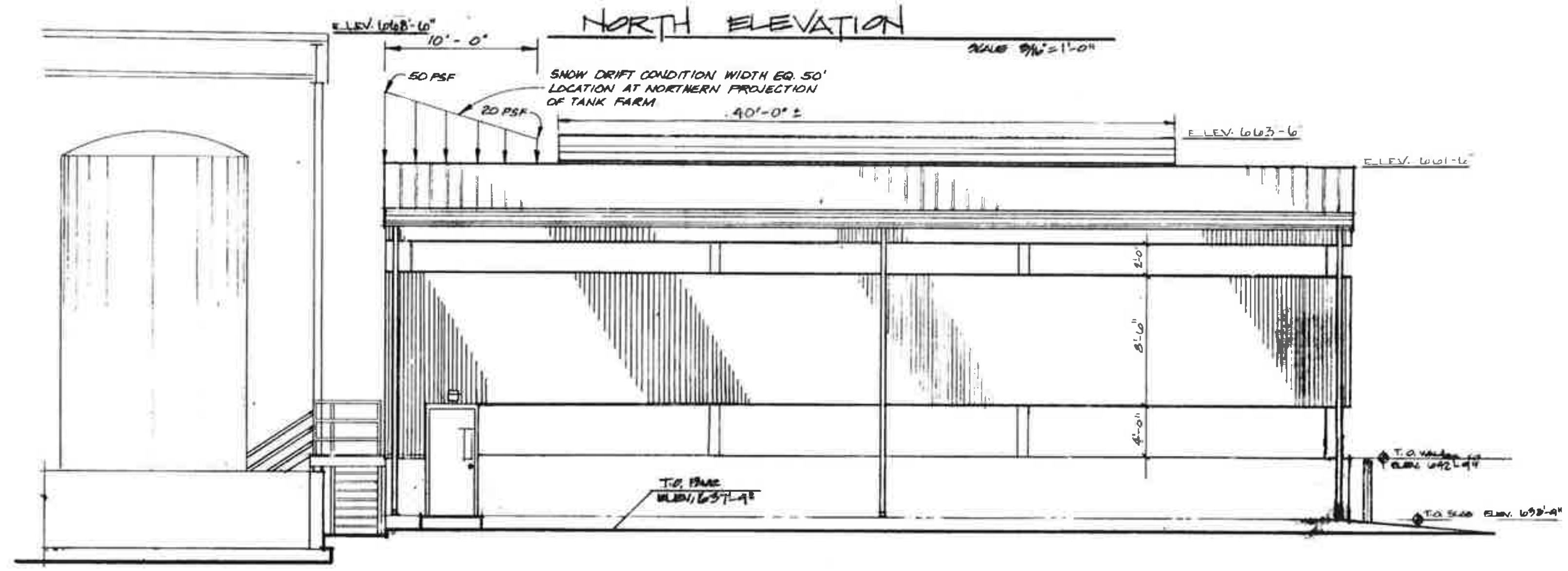
A1

SHEET NO



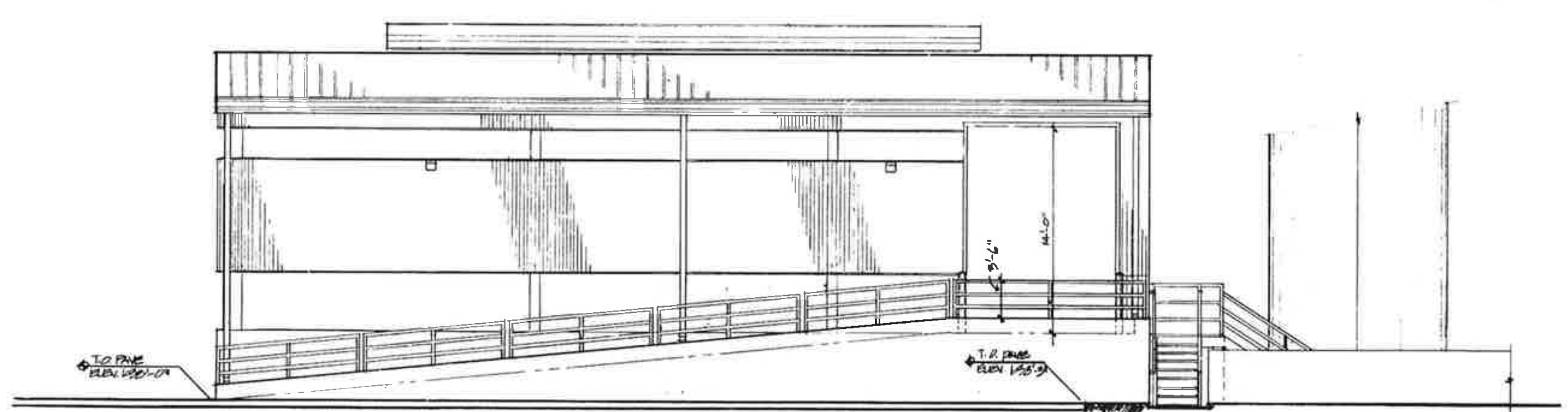
NORTH ELEVATION

SCALE 3/16"=1'-0"



EAST ELEVATION

SCALE 3/16"=1'-0"



WEST ELEVATION

SCALE 3/16"=1'-0"

WW Facilities Group
Engineering and Construction Management
5555 Glenwood Hills Parkway SE • Grand Rapids MI 49508 • (616) 942-9600

NO	REVISIONS	BY	DATE
	Rim 11/29/93		

HAZARDOUS WASTE UNLOADING & LIMITED STORAGE FACILITY

BUILDING ELEVATIONS

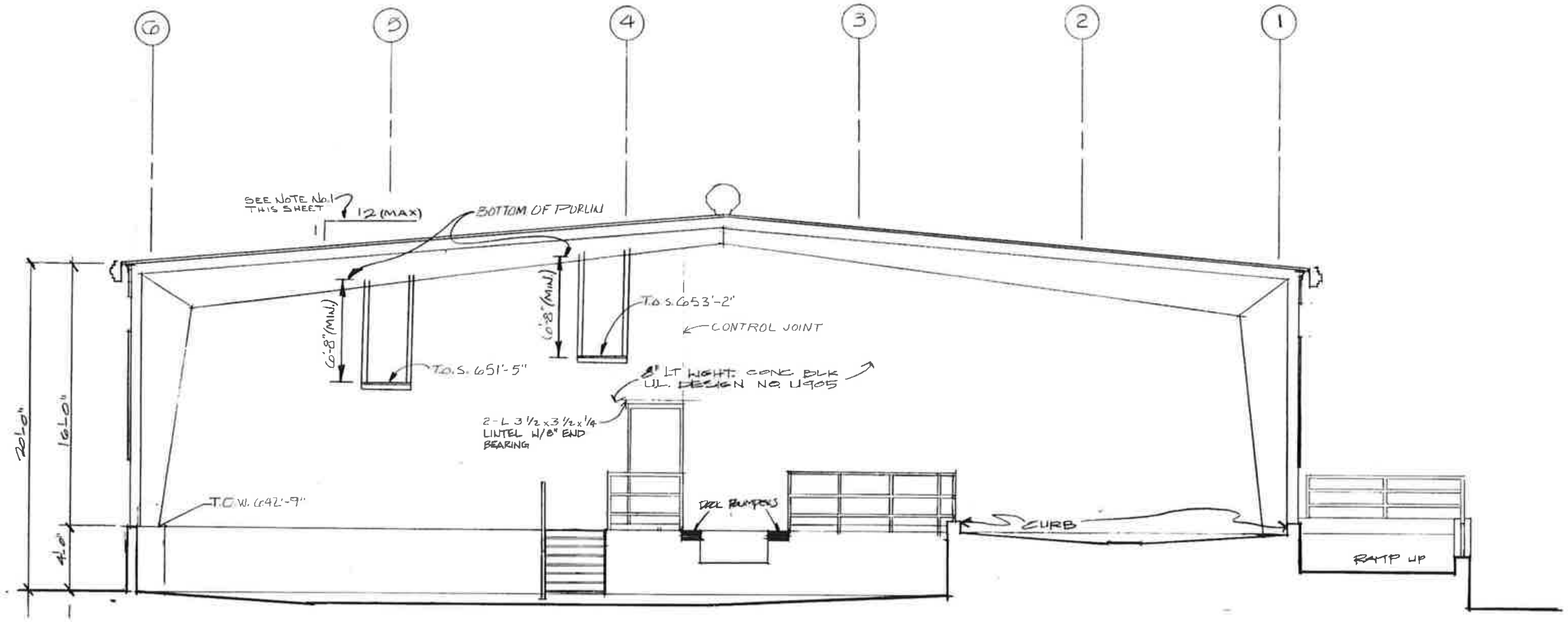
GAGE PRODUCTS, CO. FERNDALE, MICHIGAN

DESIGNED BY	DATE
DRAWN BY GGBR	DATE 8-97
CHECKED BY	DATE
SCALE AS SHOWN HORIZONTAL	
AS SHOWN VERTICAL	
PROJECT 63088	

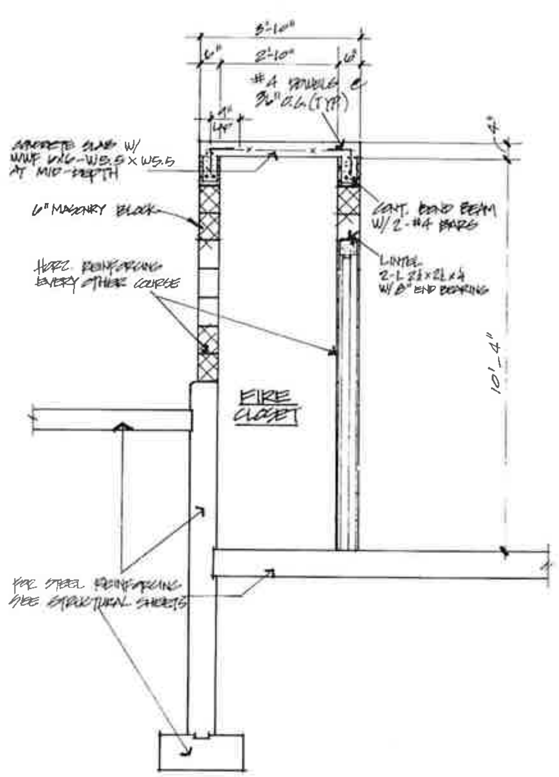
A2

SHEET NO.

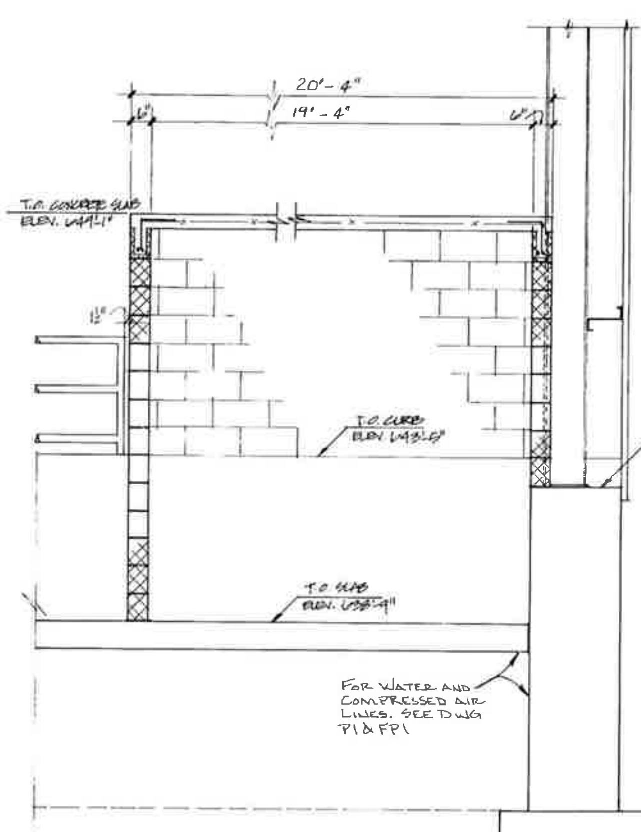
DT070390



SECTION 1 A1/A3
1/4"=1'-0"



SECTION 9 A1/A3
SCALE 1/2"=1'-0"



SECTION 10 A1/A3
SCALE 1/2"=1'-0"

NOTES

1. THE ROOF SLOPE MAY BE STEEPER THAN 1 ON 12 DUE TO STRUCTURAL BUILDING FRAME MANUFACTURE REQUIRMENTS FOR CLEARANCE ABOVE CATWALKS AND PLATFORMS.

CJF 112494

WW Facilities Group
Engineering and Construction Management
5555 Glenwood Hills Parkway SE • Grand Rapids, MI 49508 • (616) 942 9600

NO	REVISIONS	BY	DATE
	ASBUILTS 5/95		
	BIDS 11/29/93		

REVISED IN ACCORDANCE WITH CONSTRUCTION RECORDS

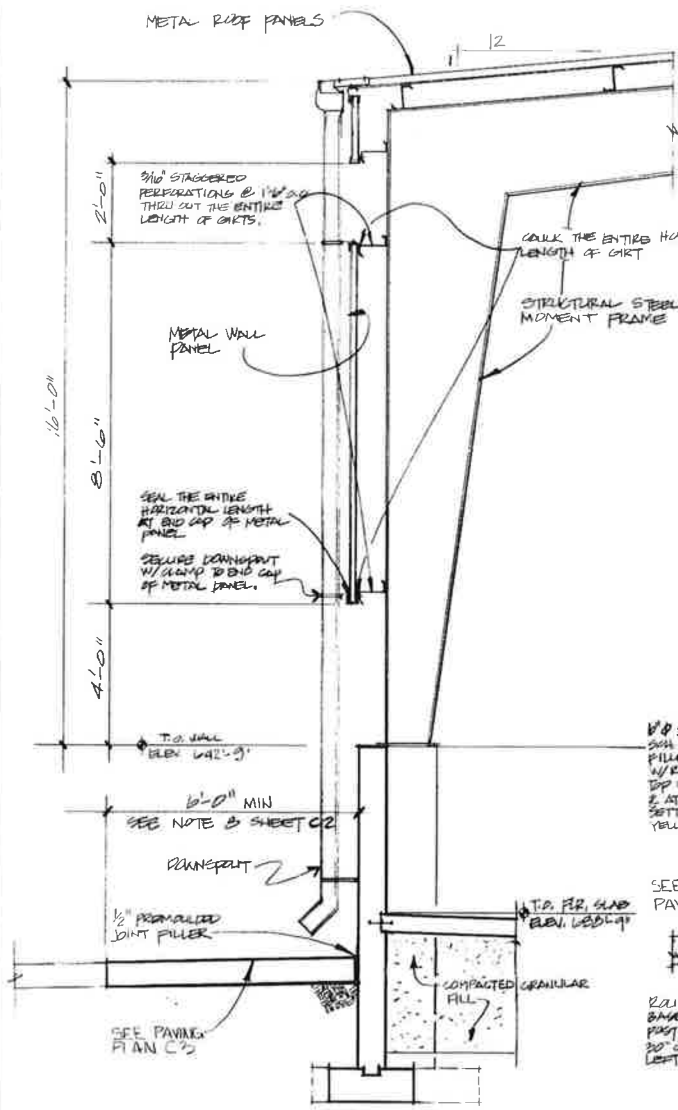
HAZARDOUS WASTE UNLOADING & LIMITED STORAGE FACILITY

BUILDING SECTIONS

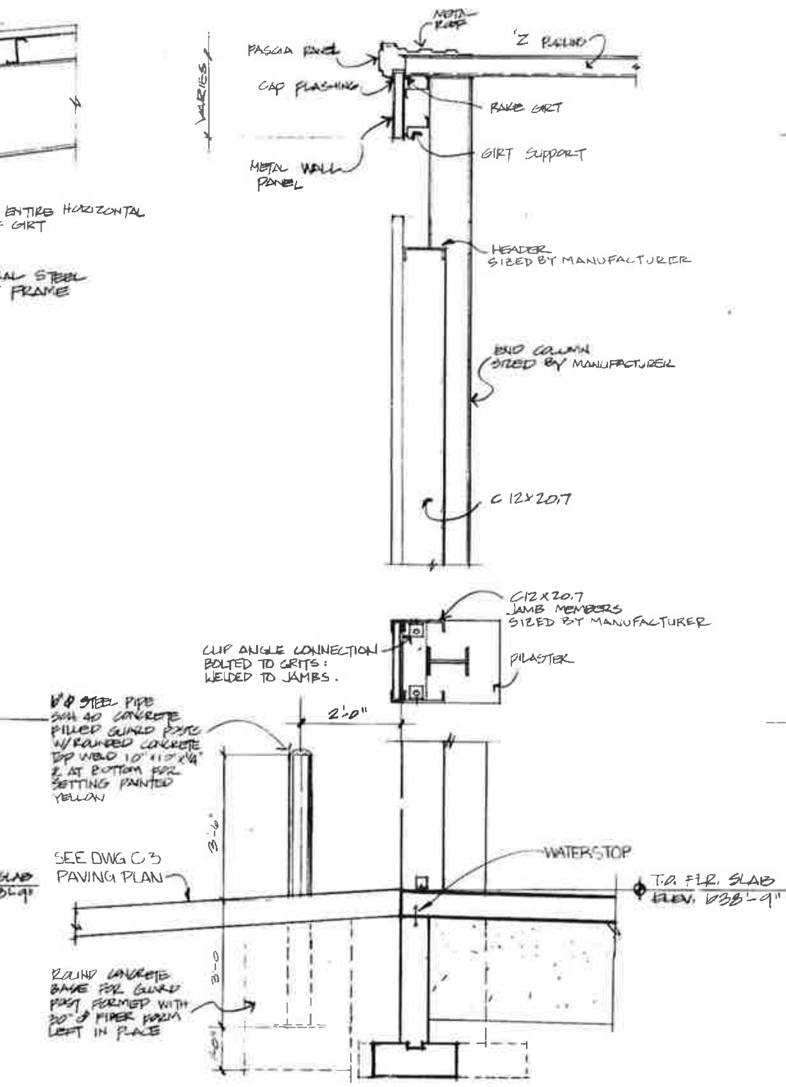
GAGE PRODUCTS, CO. FERNDALE, MICHIGAN

DESIGNED BY | DATE
DRAWN BY DMN | DATE 8-4-89
CHECKED BY | DATE
SCALE HORIZONTAL / VERTICAL
PROJECT 63080

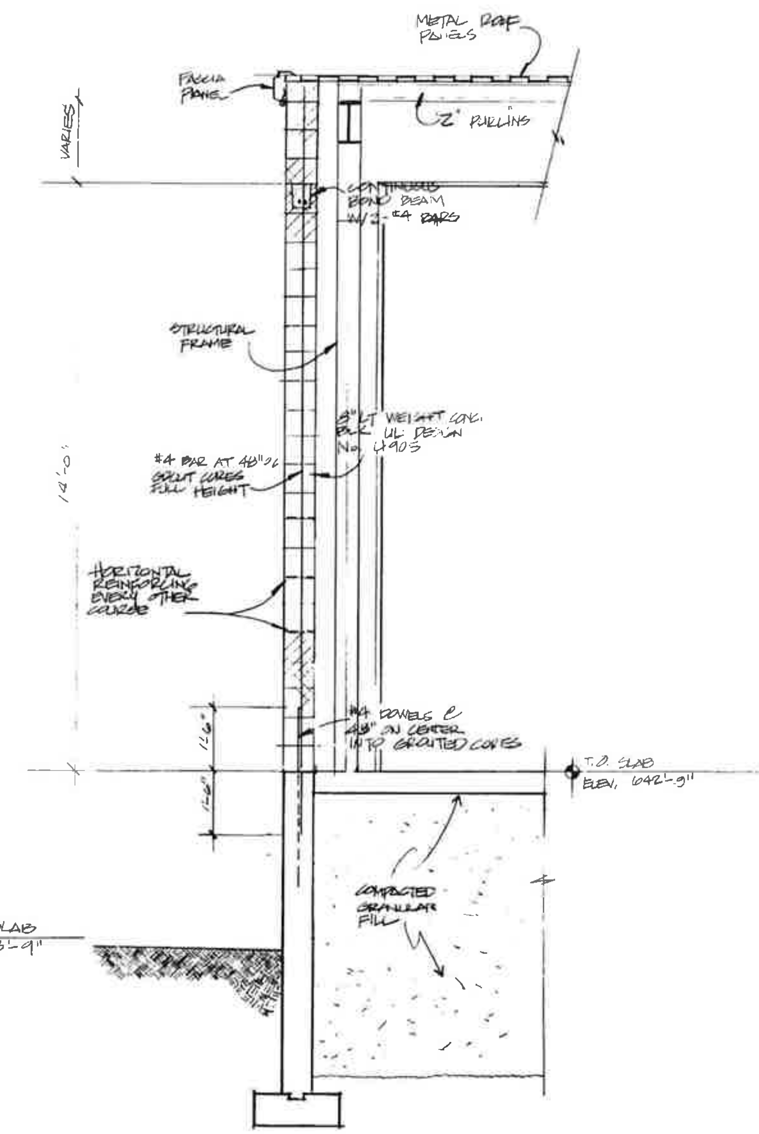
A3
SHEET NO.



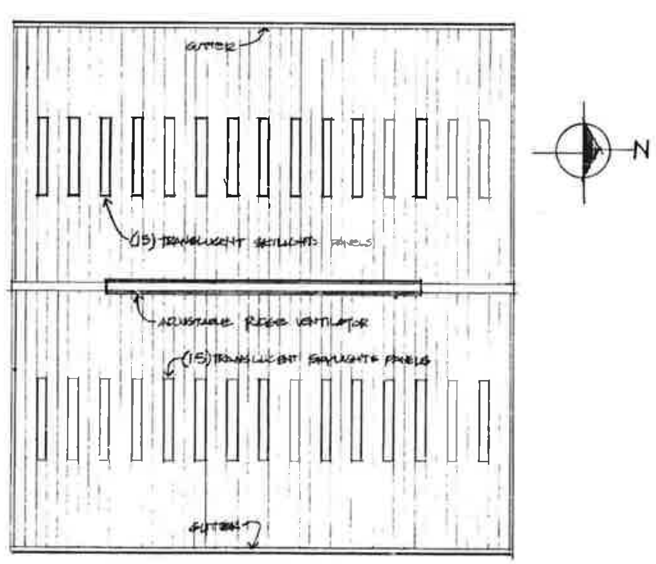
SECTION 2 / A1 A4
SCALE 1/4"=1'-0"



SECTION 3 / A1-5 A4
SCALE 1/2"=1'-0"



SECTION B / A-1 A4
SCALE 1/2"=1'-0"



ROOF PLAN
SCALE 1/32"=1'-0"

DOOR SCHEDULE										
No.	MATER.	WIDTH	HEIGHT	THICK.	TYPE	FRAME	SILL	HARDW.	RATING	REMARKS
100	STEEL	3'-0"	7'-0"	—	H.M.	STEEL	N.A.	1	NONE	
101	STEEL	3'-0"	7'-0"	—	H.M.	STEEL	N.A.	1	2 HOUR	
102	N.A	3'-0"	7'-0"	—	N.A.	—	N.A.	—	—	DOOR OPENING ONLY.
103	N.A	40'-0"	15'-0	—	N.A.	—	N.A.	—	—	DOOR OPENING ONLY.
104	N.A	10'-0"	14'-0"	—	N.A	—	N.A.	—	—	DOOR OPENING ONLY.
105	STEEL	PR 3'-0"	7'-0"	—	H.M	STEEL	N.A.	2	NONE	

WW Facilities Group

NO.	REVISIONS	DATE
	AS BUILT 6/95	
	BIDS 11/29/93	

HAZARDOUS WASTE UNLOADING & LIMITED STORAGE FACILITY

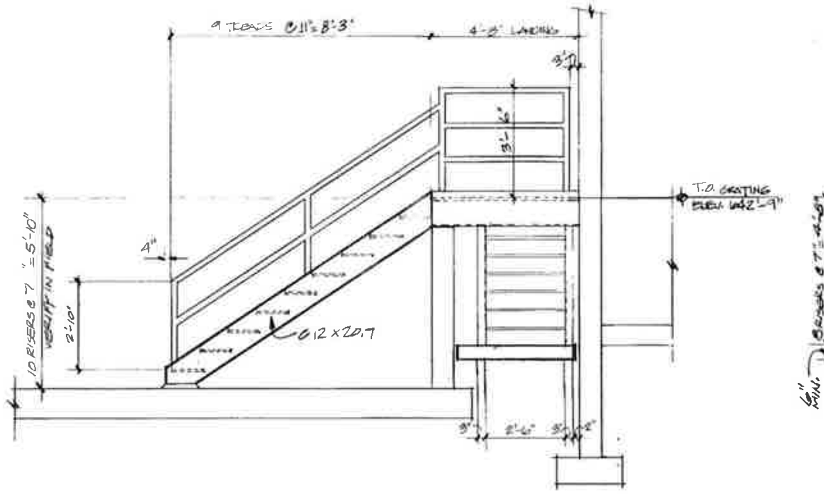
ROOF PLAN & SECTIONS

GAGE PRODUCTS, CO. FERNDALE, MICHIGAN

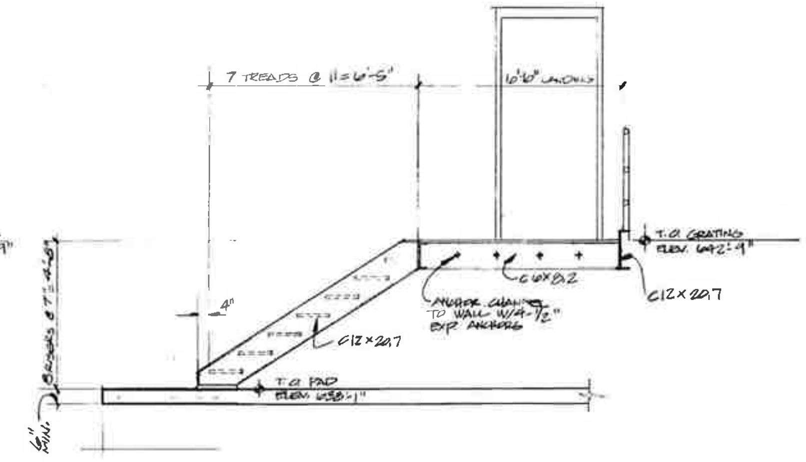
WDW	10/89
GSB	10/89
WDW	10/89
SCALE: AS SHOWN	
AS SHOWN	

83651

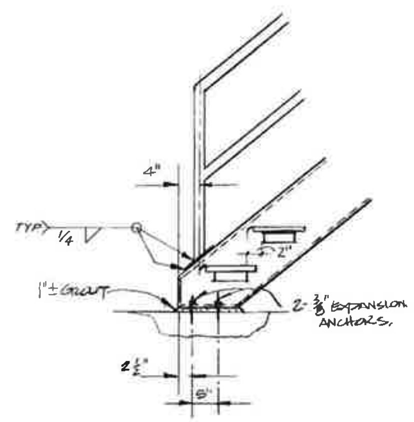
A4



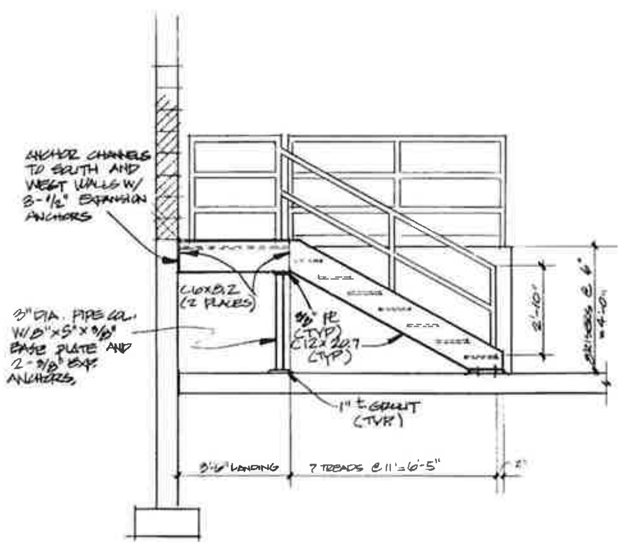
SECTION (4 / A1 A5)
SCALE 3/8" = 1'-0"



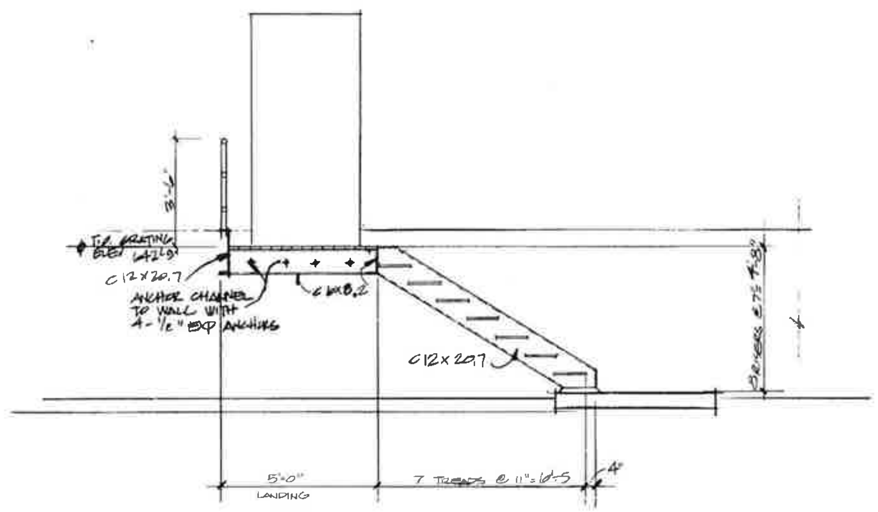
SECTION (5 / A1 A5)
SCALE 3/8" = 1'-0"



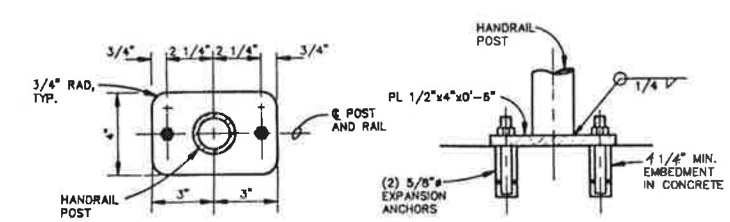
TYPICAL STAIR DETAIL
NO SCALE



SECTION (6 / A1 A5)
SCALE 3/8" = 1'-0"



SECTION (7 / A1 A5)
SCALE 3/8" = 1'-0"



PLAN

ELEVATION

HANDRAIL POST ANCHORAGE *TO CONCRETE*
SCALE: 3" = 1'-0"

WW Facilities Group
Engineering and
Construction Management
5555 Glenwood Hills Parkway SE • Grand Rapids, MI 49508 • (616) 942-9600

NO	REVISIONS	BY	DATE
	B.D.S. 11/29/93		

REVISED IN ACCORDANCE WITH CONSTRUCTION RECORDS

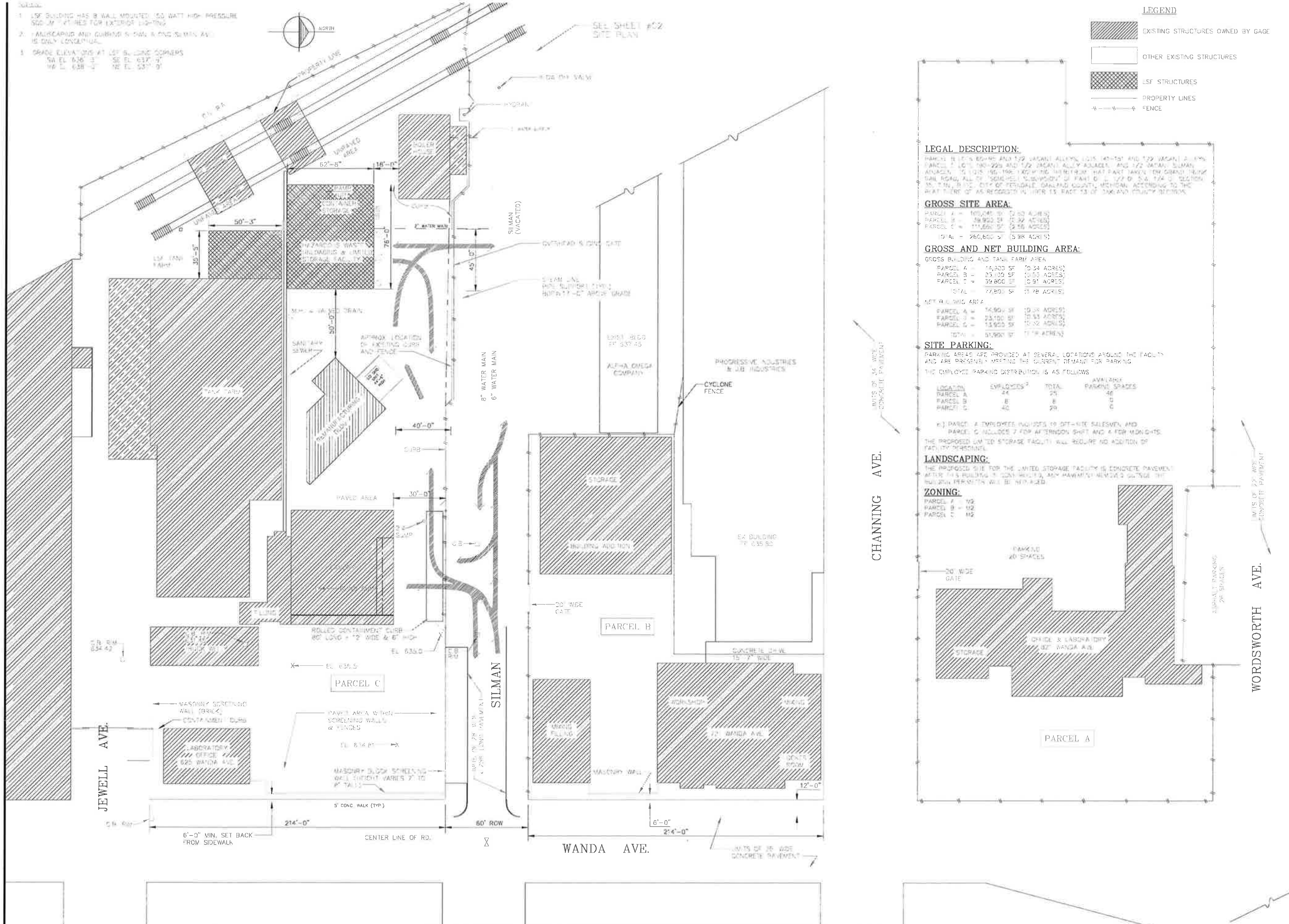
HAZARDOUS WASTE UNLOADING & LIMITED STORAGE FACILITY

STAIR DETAILS

GAGE PRODUCTS, CO. FERNDALE, MICHIGAN

DESIGNED BY D.N.	DATE 10/89
DRAWN BY G.B.	DATE 10/89
CHECKED BY W.D.W.	DATE 10/89
SCALE AS SHOWN HORIZONTAL	
AS SHOWN VERTICAL	
PROJECT 63088	

SHEET NO. **A5**



HAZARDOUS WASTE UNLOADING & LIMITED STORAGE FACILITY

LOCATION PLAN

GAGE PRODUCTS, CO. FERNDALE, MICHIGAN

NO	REVISIONS	BY	DATE
	REVISIONS 11/29/93		
	PLAN COMMISSION COMMENTS 1/24/94		
	ASBUILTS 9/95		

REVISED IN ACCORDANCE WITH CONSTRUCTION RECORDS

W W Engineering & Science
A Summit Company
Suite 210 44496 Shelden Road Plymouth, MI 48170 (313) 416-5678

DESIGNED BY / DATE
DRAWN BY / DATE
CHECKED BY / DATE
FILE / EDIT
SCALE
DRAWING
PLOT
PROJECT

C1

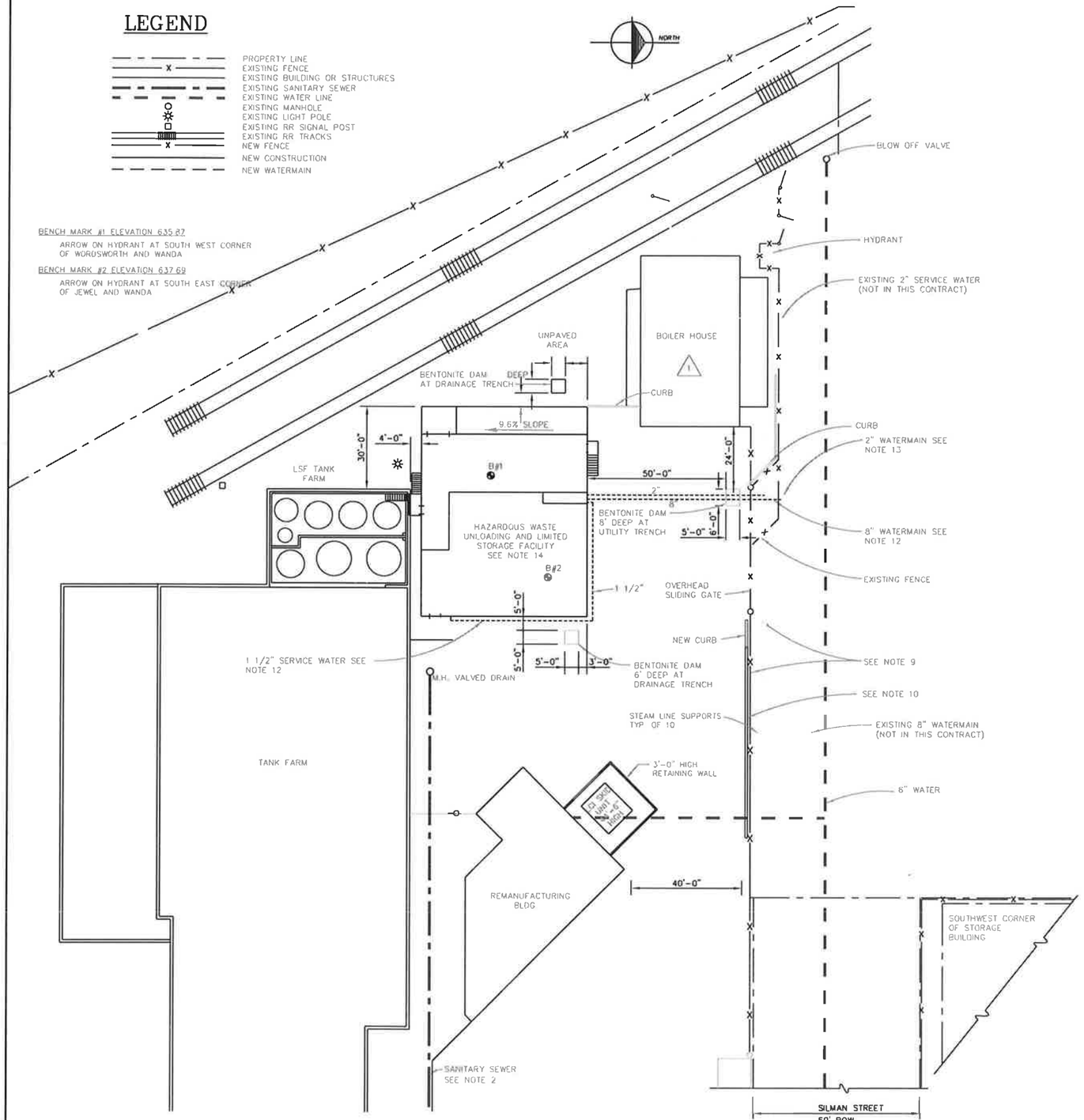
SHEET NO

LEGEND

PROPERTY LINE
EXISTING FENCE
EXISTING BUILDING OR STRUCTURES
EXISTING SANITARY SEWER
EXISTING WATER LINE
EXISTING MANHOLE
EXISTING LIGHT POLE
EXISTING RR SIGNAL POST
EXISTING RR TRACKS
NEW FENCE
NEW CONSTRUCTION
NEW WATERMAIN

BENCH MARK #1 ELEVATION 635.87
ARROW ON HYDRANT AT SOUTH WEST CORNER OF WORDSWORTH AND WANDA

BENCH MARK #2 ELEVATION 637.69
ARROW ON HYDRANT AT SOUTH EAST CORNER OF JEWEL AND WANDA

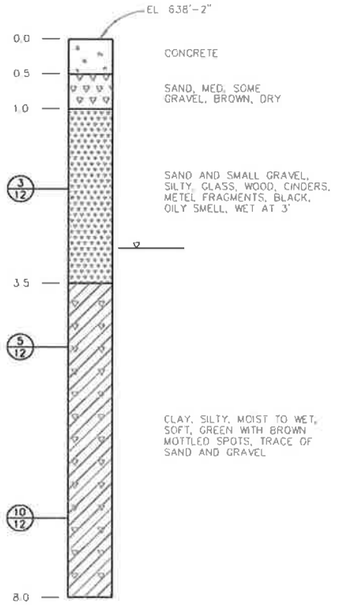


SITE PLAN

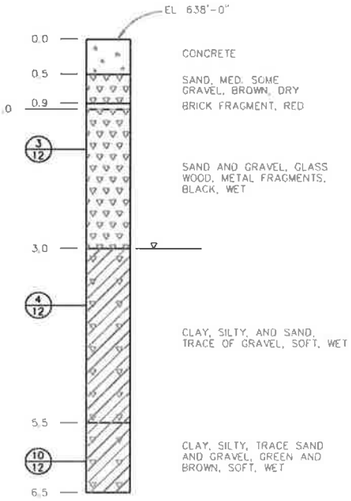
NOTES

1. ELEVATIONS AND DIMENSIONS OF EXISTING STRUCTURES AND PLANT UTILITIES HAVE BEEN BASED ON THE BEST INFORMATION AVAILABLE AT THE TIME OF DESIGN AND MUST BE VERIFIED IN THE FIELD BY THE CONTRACTOR. THE CONTRACTOR WILL BE RESPONSIBLE TO VERIFY ALL DIMENSIONS AND ELEVATIONS BEFORE PROCEEDING WITH ANY WORK. IMMEDIATELY NOTIFY THE OWNER OF ANY CONFLICTS WHICH WILL EFFECT THE PROGRESS OF THE WORK.
2. THE EXACT LOCATION OF THE SANITARY SEWER IS NOT GUARANTEED. CONTRACTOR SHALL DETERMINE THE ACTUAL LOCATION PRIOR TO STARTING WORK AND NOTIFY OWNER IF THE ACTUAL LOCATION WILL INTERFERE WITH THE PROSECUTION OF THE WORK. WHERE THE UTILITIES SAFELY PASS UNDER THE FOOTING, ENCASE IN CONCRETE. THE DEPTH OF THE SANITARY SEWER IS ESTIMATED TO BE 9.5' FEET.
3. FOUNDATIONS SHALL BE PLACED ON UNDISTURBED NATURAL SOIL WITH AN ALLOWABLE SOIL BEARING PRESSURE OF 2000 PSF. IF UNACCEPTABLE SOIL CONDITIONS ARE ENCOUNTERED, THE ENGINEER SHALL BE CONSULTED FOR DIRECTION WITH REGARD TO FOUNDATION CONSTRUCTION.
4. THE FLOOR SLAB SUB-BASE SHALL BE PLACED ON NATURAL SUBGRADE MATERIAL AFTER THE CONCRETE HAS BEEN STRIPPED AND THE SUBGRADE PROOFROLLED. IF UNDERCUTTING IS REQUIRED TO REMOVE UNSUITABLE SUBGRADE MATERIAL OR IF THE NATURAL SUBGRADE IS BELOW THE DESIGN LEVEL, COMPACTED GRANULAR FILL SHALL BE USED TO ACHIEVE THE DESIRED SUBGRADE ELEVATION. MATERIAL MEETING THE GRADATIONAL REQUIREMENTS FOR MDOT CLASS II MATERIAL SHALL BE USED FOR FILL, AND SHALL BE COMPACTED TO 95% OF THE MAXIMUM DRY DENSITY AS DETERMINED IN ACCORDANCE WITH ASTM STANDARD D-1557 (MODIFIED PROCTOR).
5. TESTING OF FOUNDATION SUBGRADE, FOUNDATION AND FLOOR SLAB CONCRETE, GRANULAR BACKFILL, AND OTHER TESTING REQUIRED WILL BE BY A CONSULTANT SELECTED BY, AND AS DIRECTED BY, THE OWNER.
6. OWNER'S REPRESENTATIVE TO BE ON-SITE DURING PERFORMANCE OF ALL WORK. CONTRACTOR SHALL NOTIFY OWNER'S REPRESENTATIVE AT LEAST 24 HOURS BEFORE THE PERFORMANCE OF ANY WORK.
7. REMOVE EXISTING CATCH BASIN, GRAVITY DRAINAGE LINE AND 4'Wx 6'Lx 5'D CONCRETE VAULT. CATCH BASIN HAS BEEN FILLED WITH CONCRETE. INSTALL NEW TERMINAL MANHOLE 20'-0" EAST OF BUILDING WALL.
8. REMOVE CONCRETE PAVEMENT A MINIMUM OF 6 FEET FROM THE BUILDING FACE OR AS REQUIRED TO MATCH EXISTING CONCRETE GRADES. VERTICAL SAW CUT ALL PAVEMENT AT RIGHT ANGLES OR PARALLEL TO BUILDING FACES. COMPACTION OF SUBBASE SHALL MEET REQUIREMENTS AS STIPULATED IN NOTE 4 ABOVE.
9. REMOVE EXISTING FENCE AND GATE AS REQUIRED, INSTALL NEW FENCE AS SHOWN.
10. REMOVE EXISTING CONCRETE CURB FLUSH WITH EXISTING CONCRETE PAVEMENT INSTALL NEW CURBS AND PAVEMENT IN UNPAVED AREAS.
11. CONTRACTOR SHALL COORDINATE WITH THE OWNER A SCHEDULE FOR REMOVAL AND ERECTION OF NEW FENCE TO PROVIDE CONTINUOUS SECURITY FOR THE FACILITY.
12. REFER TO GAGE PRODUCTS COMPANY, MICHIGAN - WATERMAIN IMPROVEMENTS SILMAN ROAD CONTRACT DRAWINGS FOR DETAILS REGARDING THE 8" WATERMAIN AND 2" SERVICE LEADS. COPIES AVAILABLE UPON REQUEST OF ENGINEER.
13. COORDINATE PAVEMENT REMOVAL AND REPLACEMENT FOR ELECTRICAL CONDUITS WITH ELECTRICAL CONTRACTOR, REFERENCE SHEET NUMBER E1.
14. SOILS AND GROUND WATER IN VICINITY OF THE PROPOSED LIMITED HAZARDOUS STORAGE WASTE FACILITY MAY POSSESS UNKNOWN QUANTITIES OF ORGANIC COMPOUNDS. SOIL REMOVED FROM THIS AREA SHOULD BE SEGREGATED AND CHARACTERIZED FOR PROPER DISPOSAL, AND NOT USED AS BACKFILL MATERIAL. SUBSURFACE WATER REMOVED FROM AREA SHOULD BE CONTAINED, CHARACTERIZED, AND DISPOSED OF PROPERLY. SUBSURFACE CONTRACTORS ARE RESPONSIBLE FOR PROVIDING APPROPRIATE HEALTH AND SAFETY MEASURES TO MINIMIZE WORKER EXPOSURE TO AIR, SOIL, AND GROUND WATER POTENTIALLY IMPACTED BY ORGANIC COMPOUNDS IN THIS AREA.

BORING #1



BORING #2



NOTES:
1. THE SOIL BORING LOGS REPRESENT POINT INFORMATION. PRESENTATION OF THIS INFORMATION IN NO WAY IMPLIES THAT SUBSURFACE CONDITIONS ARE THE SAME AT ALL LOCATIONS OTHER THAN THE EXACT LOCATION OF THE SOIL BORING.

W.W. Engineering & Science
A Summit Company
Suite 210 · 14988 Sheldon Road · Plymouth, MI 48170 · (313) 416-3676

NO.	DATE	BY	REVISIONS
1	8/89	GLW	ADDED EXISTING BUILDING
2	10/89	GLW	ASBUILTS 5/95

REVISED IN ACCORDANCE WITH CONSTRUCTION RECORDS

HAZARDOUS WASTE UNLOADING & LIMITED STORAGE FACILITY

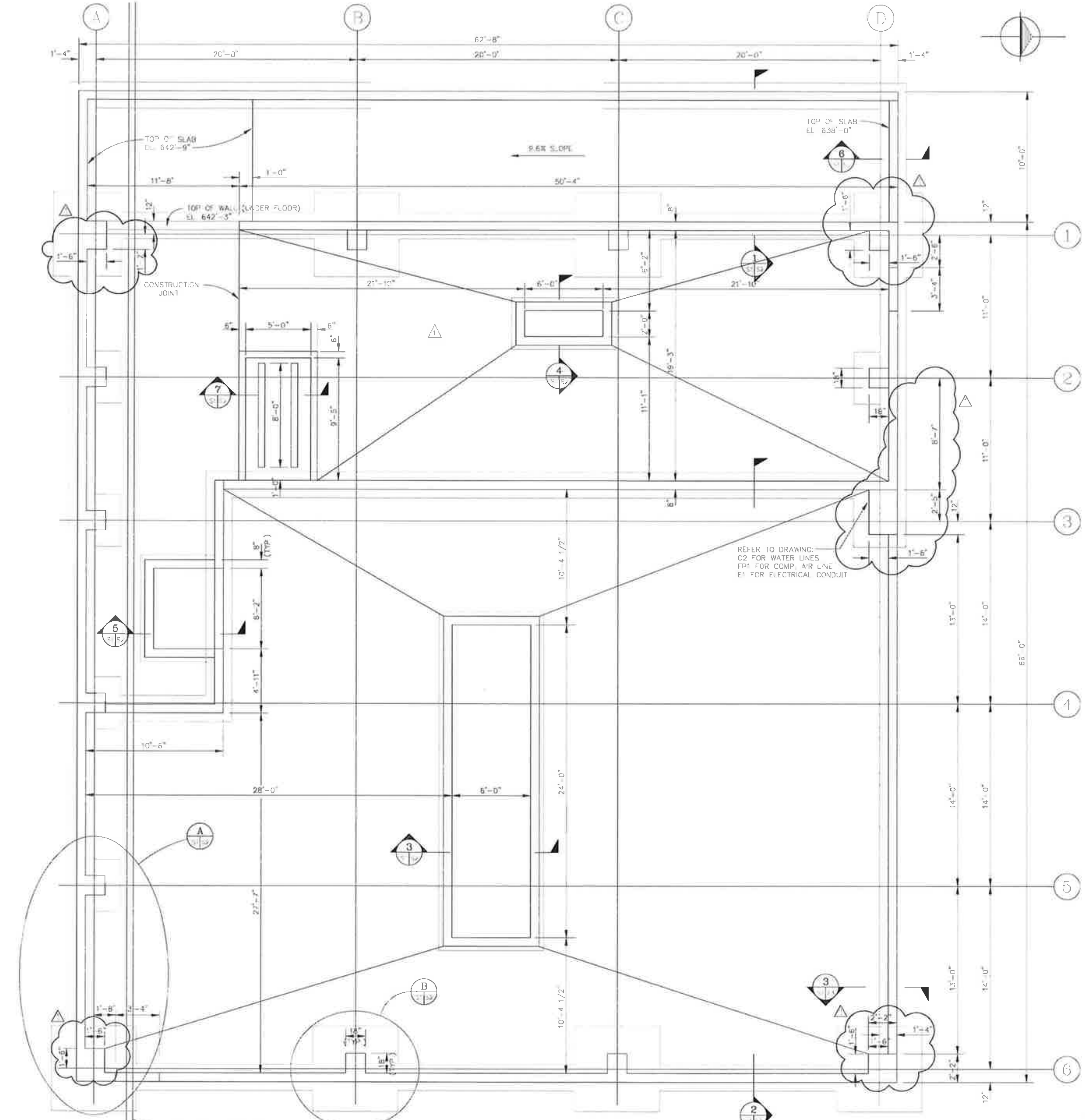
SITE PLAN - CIVIL

GAGE PRODUCTS, CO. FERNDALE, MICHIGAN

DESIGNED BY WDW	DATE AUG '89
DRAWN BY PRD	DATE AUG '89
CHECKED BY GLW	DATE DEC '89
FILE 8365I-C2	EDIT C:\FORD\95
SCALE 1"=20'	
DRAWING 1:240	
PLOT	
PROJECT 8365I	

C2

SHEET NO



FLOOR / FOUNDATION PLAN

SCALE 1/4" = 1'-0"

GENERAL NOTES

1. ELEVATIONS AND DIMENSIONS OF EXISTING STRUCTURES AND PLANT UTILITIES HAVE BEEN BASED ON THE BEST INFORMATION AVAILABLE AT THE TIME OF DESIGN AND MUST BE VERIFIED IN THE FIELD BY THE CONTRACTOR. THE CONTRACTOR WILL BE RESPONSIBLE TO VERIFY ALL DIMENSIONS AND ELEVATIONS BEFORE PROCEEDING WITH ANY WORK. IMMEDIATELY NOTIFY THE OWNER OF ANY CONFLICTS WHICH WILL EFFECT THE PROGRESS OF THE WORK.
2. FOUNDATIONS SHALL BE PLACED ON UNDISTURBED NATURAL SOIL WITH AN ALLOWABLE SOIL BEARING PRESSURE OF 2000 PSF. IF UNACCEPTABLE SOIL CONDITIONS ARE ENCOUNTERED, THE ENGINEER SHALL BE CONSULTED FOR DIRECTION WITH REGARD TO FOUNDATION CONSTRUCTION.
3. THE SLAB SUB-BASE SHALL BE PLACED ON NATURAL SUBGRADE MATERIAL AFTER THE CONCRETE HAS BEEN STRIPPED AND THE SUBGRADE PROOFROLLED. IF UNDERCUTTING IS REQUIRED TO REMOVE UNSUITABLE SUBGRADE MATERIAL OR IF THE NATURAL SUBGRADE IS BELOW THE DESIGN LEVEL, COMPACTED GRANULAR FILL SHALL BE USED TO ACHIEVE THE DESIRED SUBGRADE ELEVATION. MATERIAL MEETING THE GRADATIONAL REQUIREMENTS FOR MDOT CLASS II MATERIAL SHALL BE USED FOR FILL AND SHALL BE COMPACTED TO 95% OF THE MAXIMUM DRY DENSITY AS DETERMINED IN ACCORDANCE WITH ASTM STANDARD D-1557 (MODIFIED PROCTOR).
4. TESTING OF FOUNDATION SUBGRADE, FOUNDATION AND FLOOR SLAB CONCRETE, GRANULAR BACKFILL, AND OTHER TESTING REQUIRED WILL BE BY A CONSULTANT SELECTED BY, THE OWNER.
5. COORDINATE ALL BUILDING DIMENSIONS WITH PRE-ENGINEERED BUILDING SUPPLY. COORDINATE ALL WALL AND ROOF OPENING DIMENSIONS WITH MECHANICAL AND ELECTRICAL CONTRACTORS.

CAST-IN-PLACE CONCRETE NOTES

6. ALL REINFORCING IN CONCRETE WALLS FOOTINGS SHALL BE CONTINUOUS UNLESS DETAILED OTHERWISE. LAP SPLICES SHALL MEET THE REQUIREMENTS OF ACI CLASS "B" TOP SPLICES EXCEPT AS DETAILED OTHERWISED.
7. ALL CONSTRUCTION JOINTS SHALL HAVE CONTINUOUS KEYWAYS AS DETAILED. REINFORCING SPLICED AT THESE LOCATIONS SHALL HAVE ACI CLASS "C" TOP SPLICES UNLESS APPROVED OR DETAILED OTHERWISE. ALL CONSTRUCTION JOINTS EXCEPT THOSE DETAILED SHALL HAVE ENGINEER APPROVAL. SEE SPECIFICATIONS FOR OTHER CONSTRUCTION JOINT REQUIREMENTS.
8. ALL REINFORCING IN FOOTINGS AND WALLS SHALL BE CONTINUOUS AROUND CORNERS AND INTERSECTIONS.
9. PROVIDE 2-#5 BARS EXTRA AT TOP, BOTTOM AND SIDES OF ALL OPENINGS IN CONCRETE WALLS UNLESS OTHERWISE NOTED. EXTEND BARS 30 BAR DIAMETERS BEYOND EACH SIDE OF OPENING WHERE POSSIBLE.
10. PROVIDE 3/4" BEVELED EDGES ON ALL PERMANENTLY EXPOSED CONCRETE CORNERS.
11. COORDINATE WITH PRE-ENGINEERED BUILDING SUPPLIER ALL FOOTING AND ANCHORAGE DETAILS AND SPECIAL EMBEDMENTS.

DESIGN DATA:

CONCRETE 28-DAY STRENGTH	
GROUT AND FILL	f'c = 6000 PSI
SLABS ON GRADE	f'c = 4000 PSI
ALL OTHER CONCRETE	f'c = 3500 PSI
STRUCTURAL STEEL	fy = 36,000 PSI
REINFORCING STEEL	fy = 60,000 PSI
SUPERIMPOSED DESIGN LOADS	
BUILDING ROOF	
SNOW L.L.	20.0* PSF
ROOF D.L.	5.0 PSF
MISC. MECH. & ELEC. D.L.	20.0 PSF
TOTAL	45.0 PSF
ALLOWABLE SOIL BEARING CAPACITY	
Q'S	2,000 PSF

* SEE SHT. A2 "EAST ELEVATION" FOR DRIFT CONDITION

EXCAVATION NOTE:

1. SOILS AND GROUND WATER IN VICINITY OF THE PROPOSED LIMITED HAZARDOUS STORAGE WASTE FACILILTLY MAY POSSESS UNKNOWN QUANTITIES OF ORGANIC COMPOUNDS. SOIL REMOVED FROM THIS AREA SHOULD BE SEGREATED AND CHARACTERIZED FOR PROPER DISPOSAL, AND NOT USED AS BACKFILL MATERIAL. SUBSURFACE WATER REMOVED FROM AREA SHOULD BE CONTAINED, CHARACTERIZED, AND DISPOSED OF PROPERLY. SUBSURFACE CONTRACTORS ARE RESPONSIBLE FOR PROVIDING APPROPRIATE HEALTH AND SAFETY MEASURES TO MINIMIZE WORKER EXPOSURE TO AIR, SOIL, AND GROUND WATER POTENTIALLY IMPACTED BY ORGANIC COMPOUNDS IN THIS AREA.

WW Facilities Group
Engineering and Construction Management
5555 Glenwood Hills Parkway, SE • Grand Rapids, MI 49508 • (616) 942-9600

NO	REVISIONS	BY	DATE
	ASBUILTS		03/05
	REVISIONS		09/04
	BIDS		11/29/03

REVISED IN ACCORDANCE WITH CONSTRUCTION RECORDS

HAZARDOUS WASTE UNLOADING & LIMITED STORAGE FACILITY

FOUNDATION PLAN

GAGE PRODUCTS, CO. FERNDALE, MICHIGAN

SCALE: AS NOTED

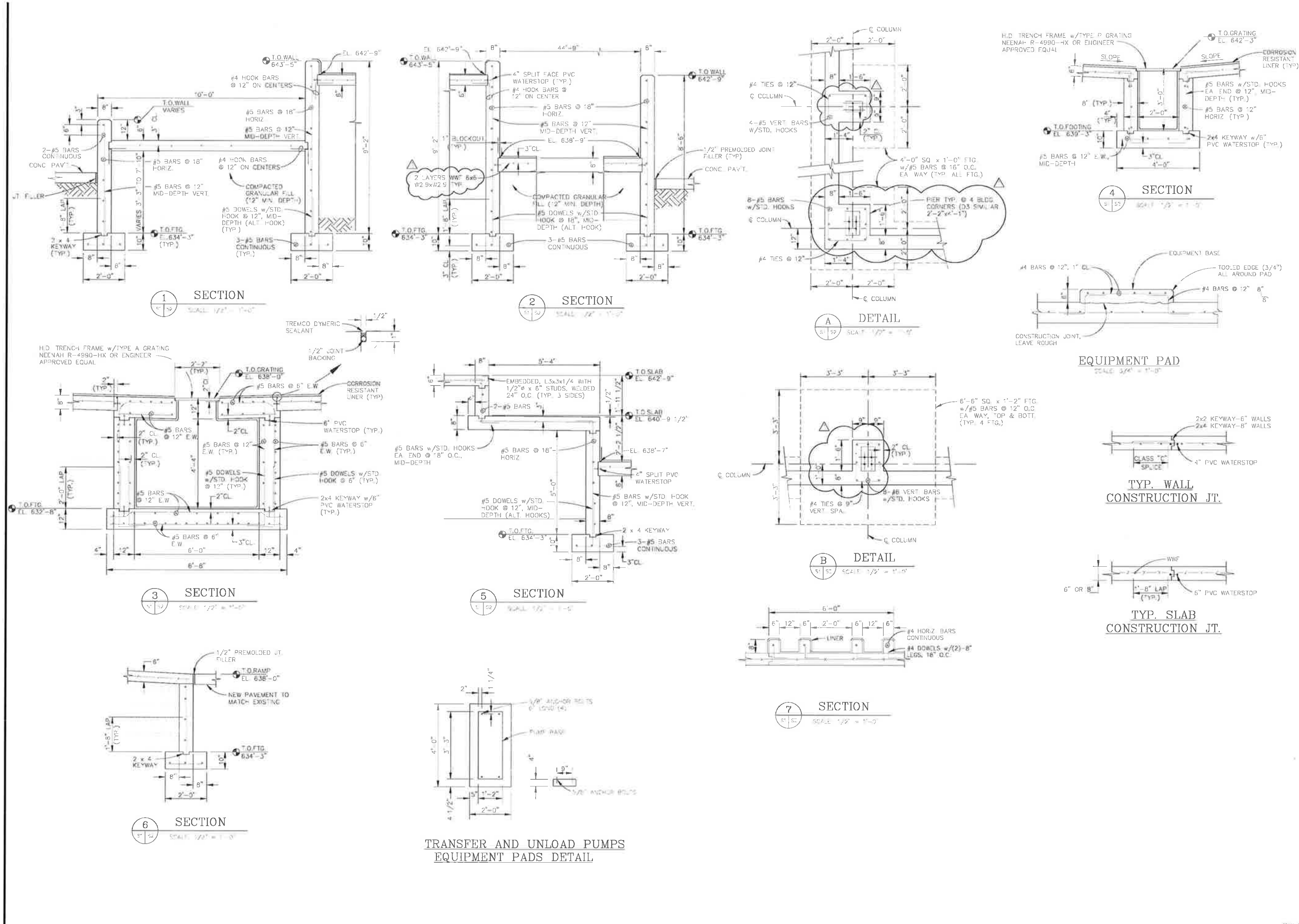
HORIZONTAL N.A.

VERTICAL

PROJECT 83551

SHEET NO. S1

83551-s1
C.F052295



WW Facilities Group
Engineering and Construction Management

HAZARDOUS WASTE UNLOADING & LIMITED STORAGE FACILITY

SECTIONS & DETAILS

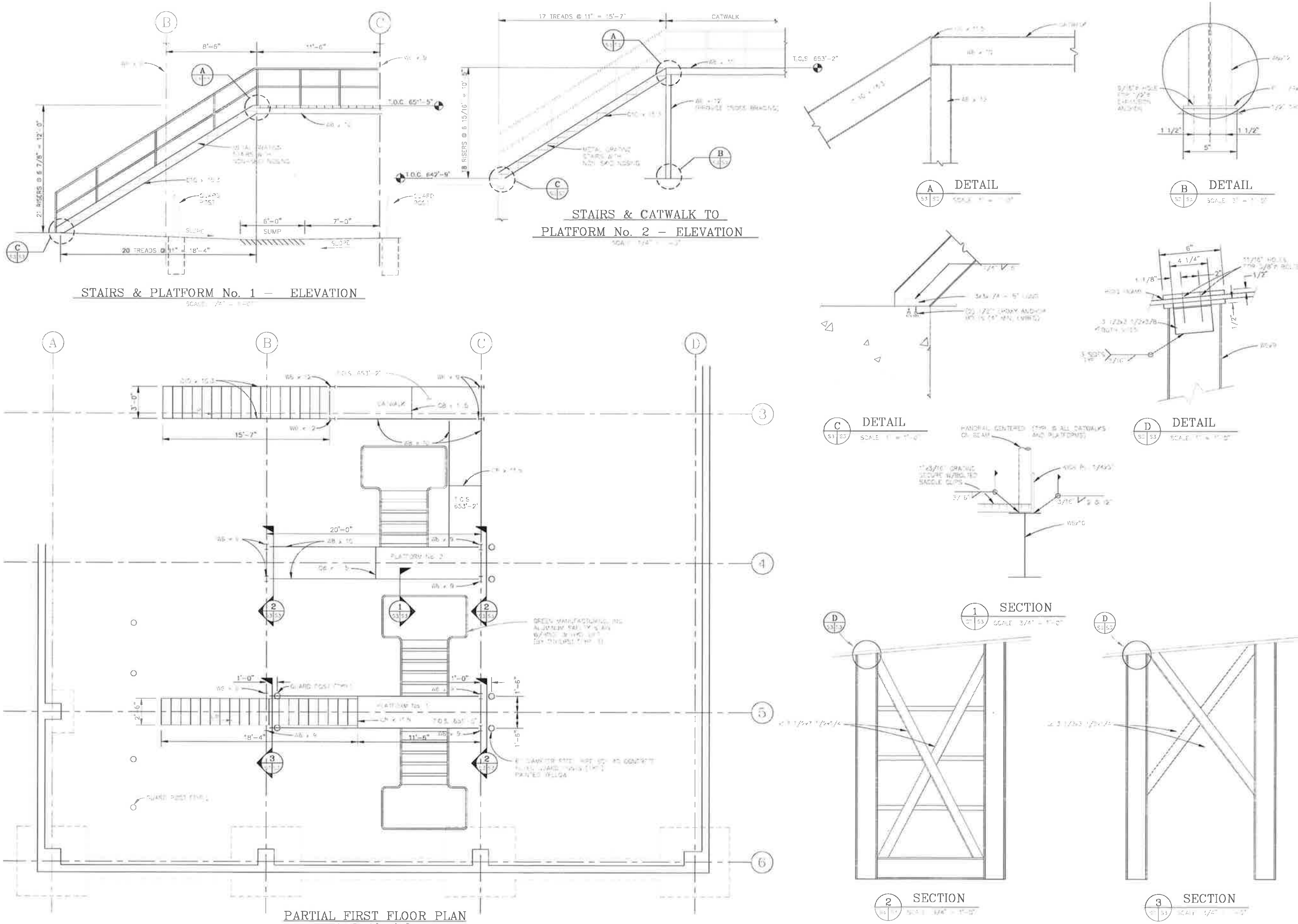
GAGE PRODUCTS, CO. FERNDALE, MICHIGAN

REVISED IN ACCORDANCE WITH CONSTRUCTION RECORDS

DESIGNED BY	DATE
DRAWN BY	DATE
CHECKED BY	DATE
SCALE	AS NOTED
HORIZONTAL	AS NOTED
VERTICAL	
PROJECT	

S2

SHEET NO.



WW Facilities Group
Engineering and Construction Management

HAZARDOUS WASTE UNLOADING & LIMITED STORAGE FACILITY

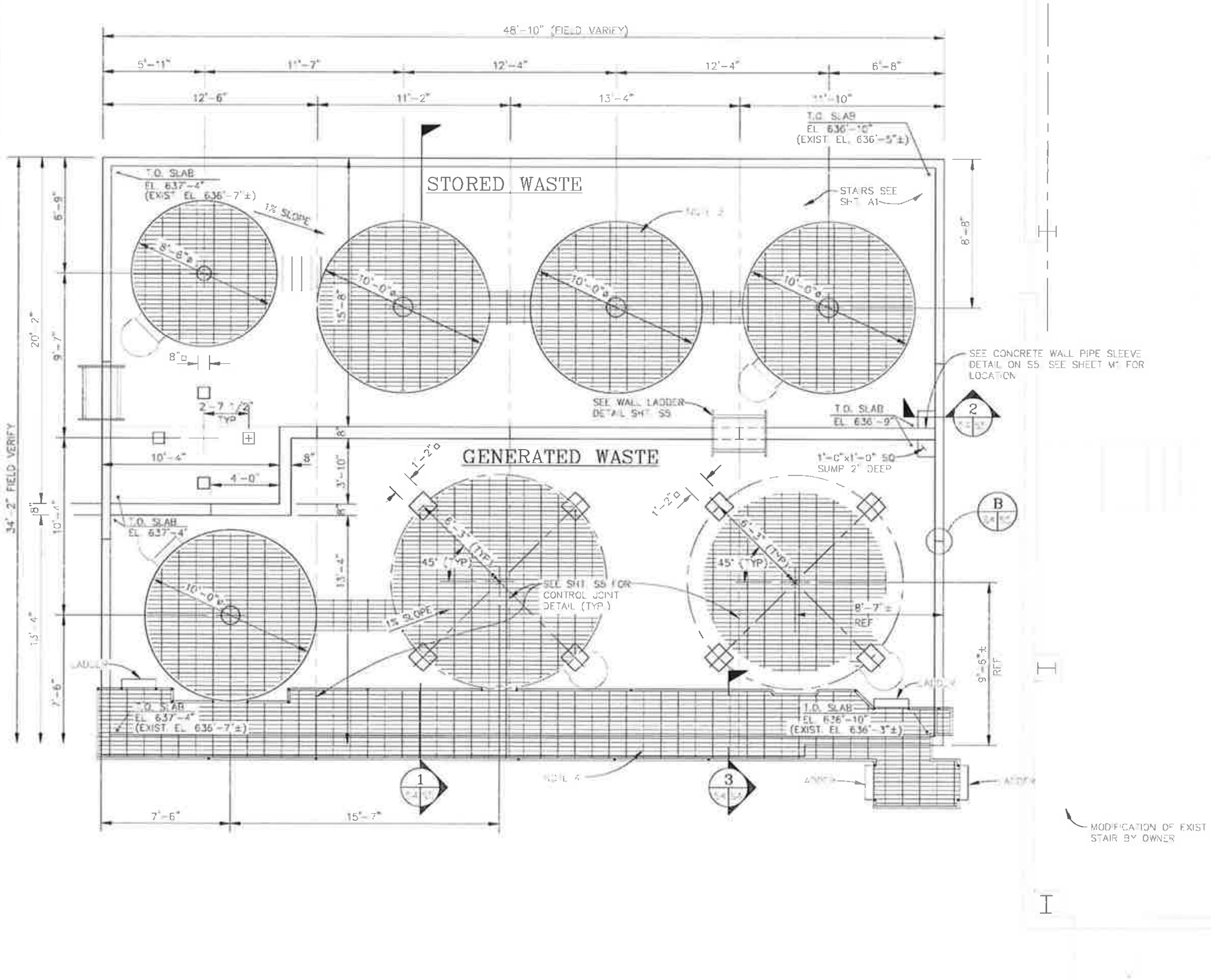
CATWALK PLAN & DETAILS

GAGE PRODUCTS, CO. FERNDALE, MICHIGAN

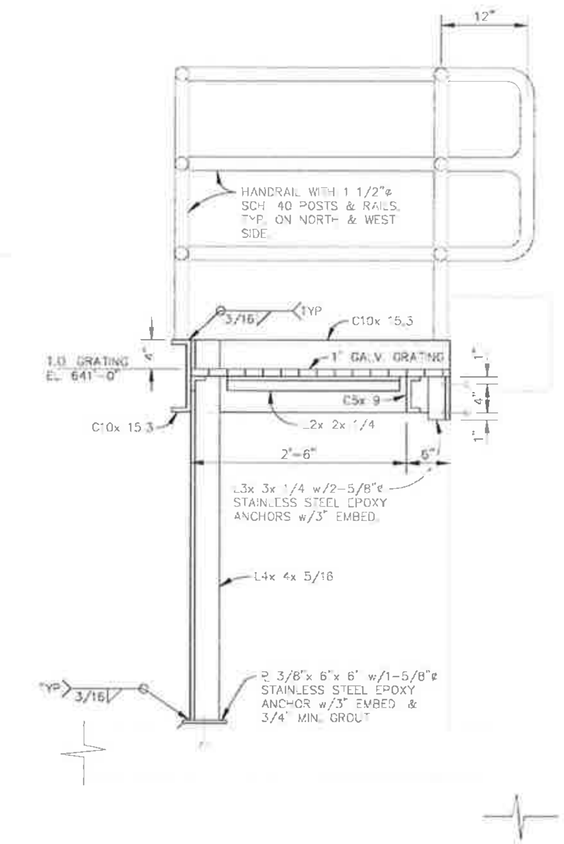
DESIGNED BY	DATE
DRAWN BY	DATE
CHECKED BY	DATE
SCALE	HORIZONTAL / VERTICAL
PROJECT	

S3

SHEET NO



TANK FARM PLAN



3 SECTION

NOTES:

WW Facilities Group
Engineering and Construction Management

HAZARDOUS WASTE UNLOADING & LIMITED STORAGE FACILITY

TANK FARM PLAN

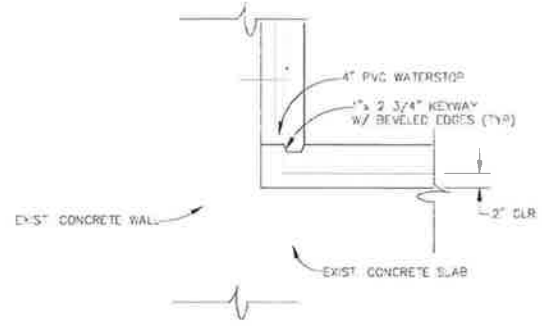
GAGE PRODUCTS, CO. FERNDALE, MICHIGAN

DESIGNED BY	DATE
DRAWN BY	DATE
CHECKED BY	DATE
SCALE	HORIZONTAL / VERTICAL
PROJECT	

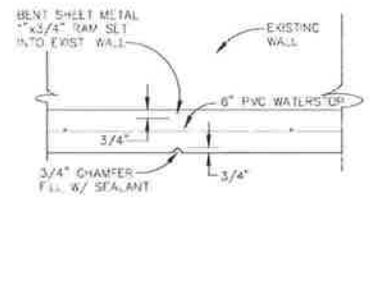
S4

SHEET NO.

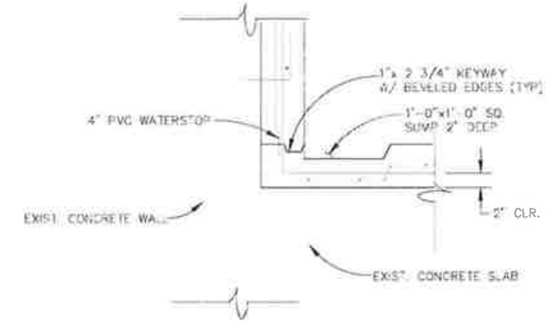
83651-S4



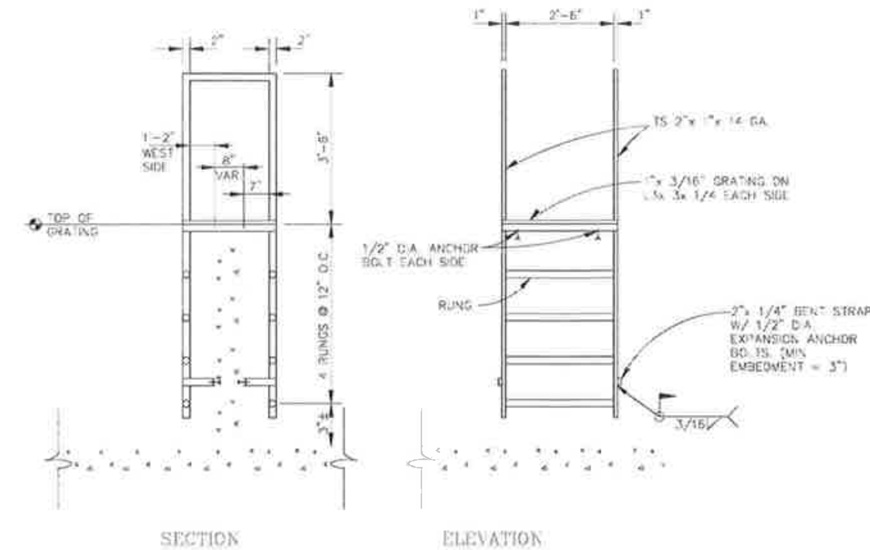
A DETAIL
SCALE: 1" = 1'-0"



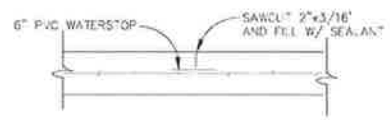
B DETAIL (TYPICAL 14 LOCATIONS)



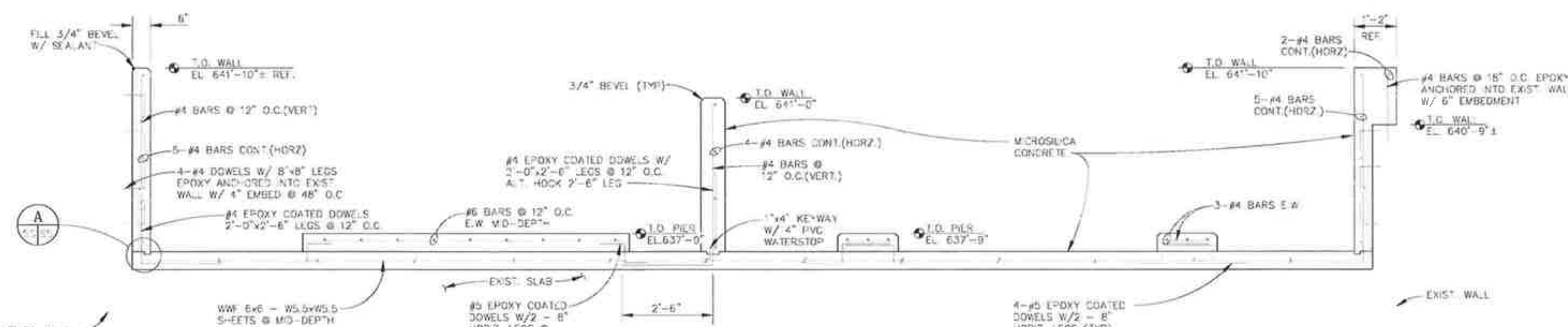
2 SECTION



WALL LADDER DETAILS



CONTROL JOINT DETAIL



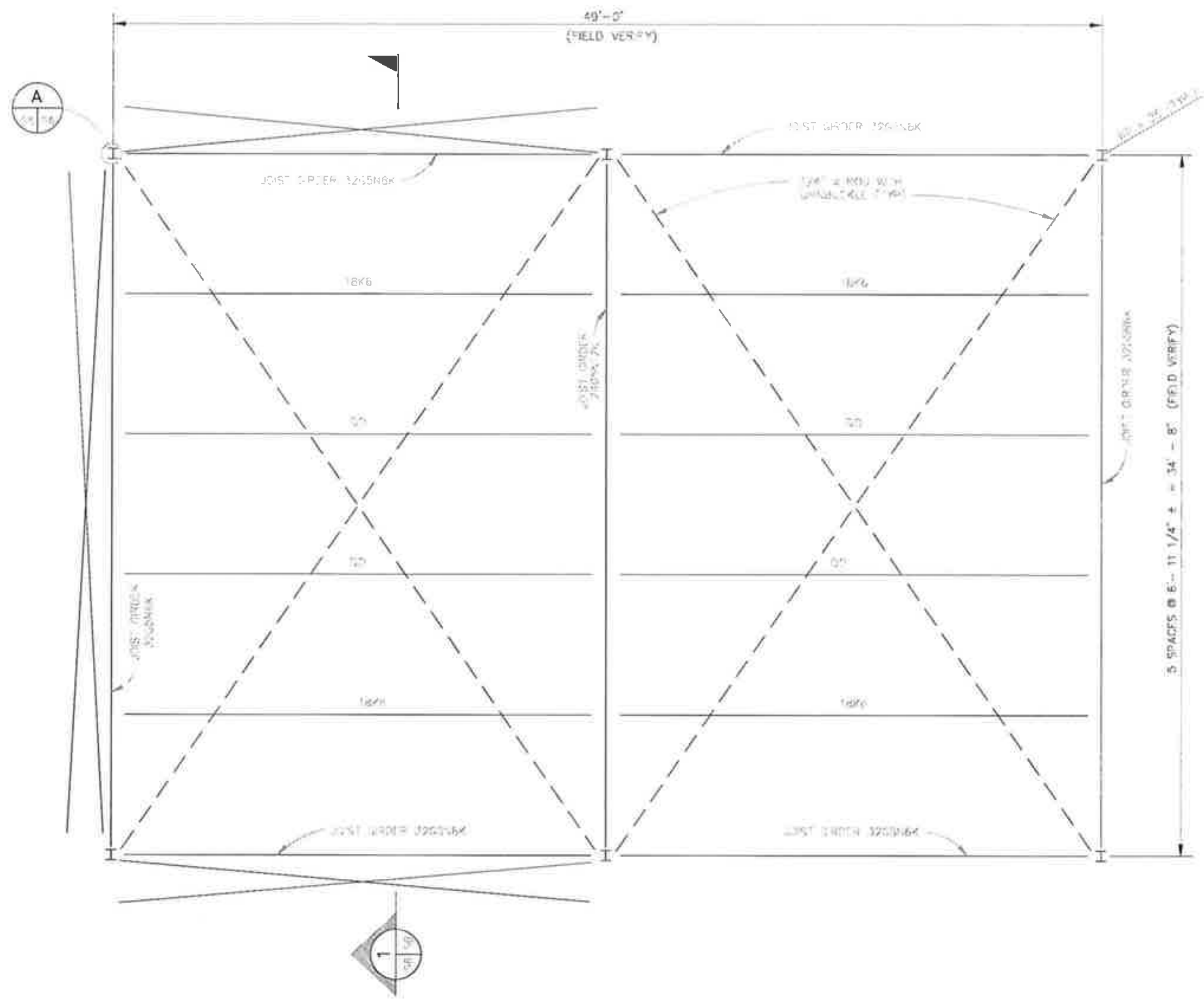
1 SECTION

WW Facilities Group
Engineering and Construction Management

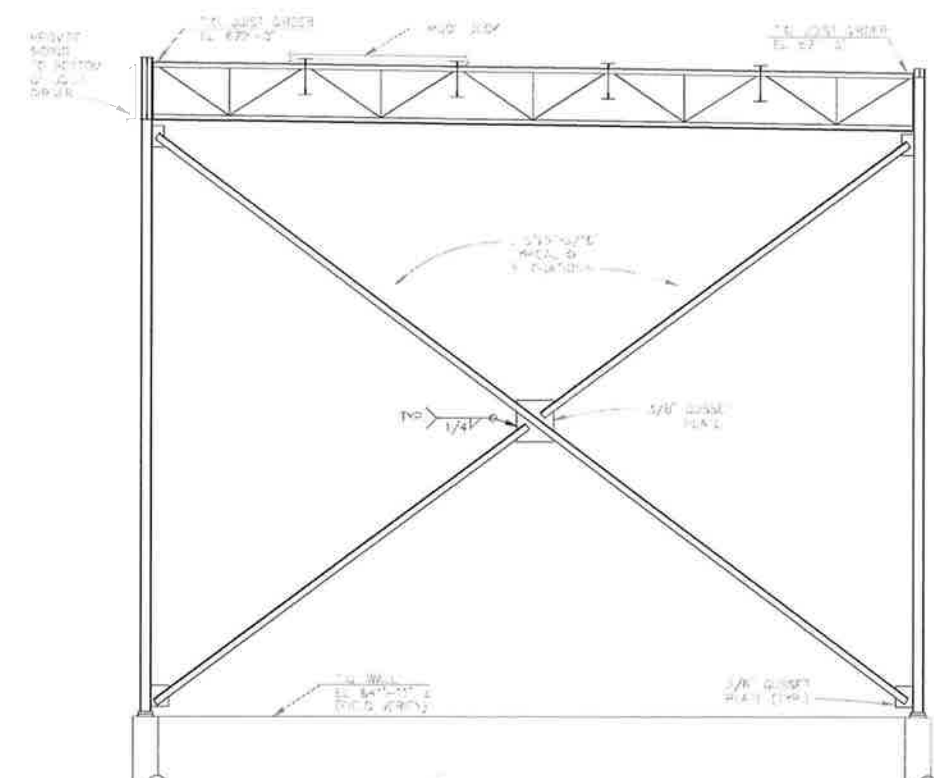
HAZARDOUS WASTE UNLOADING & LIMITED STORAGE FACILITY
TANK FARM CONC. DETAILS
GAGE PRODUCTS, CO. FERNDALE, MICHIGAN

DESIGNED BY	DATE
DRAWN BY	DATE
CHECKED BY	DATE
SCALE	AS NOTED
PROJECT	

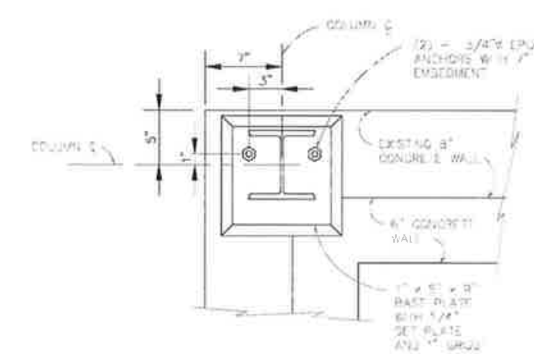
S5



TANK FARM ROOF FRAMING PLAN



SECTION



DETAIL

WW Facilities Group
Engineering and Construction Management

HAZARDOUS WASTE UNLOADING & LIMITED STORAGE FACILITY

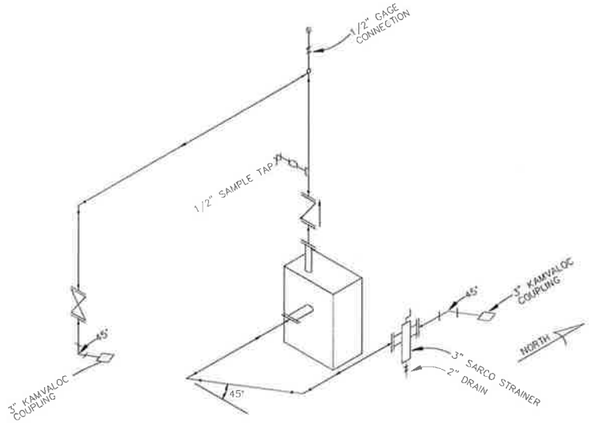
ROOF FRAMING PLAN DETAILS

GAGE PRODUCTS, CO. FERNDALE, MICHIGAN

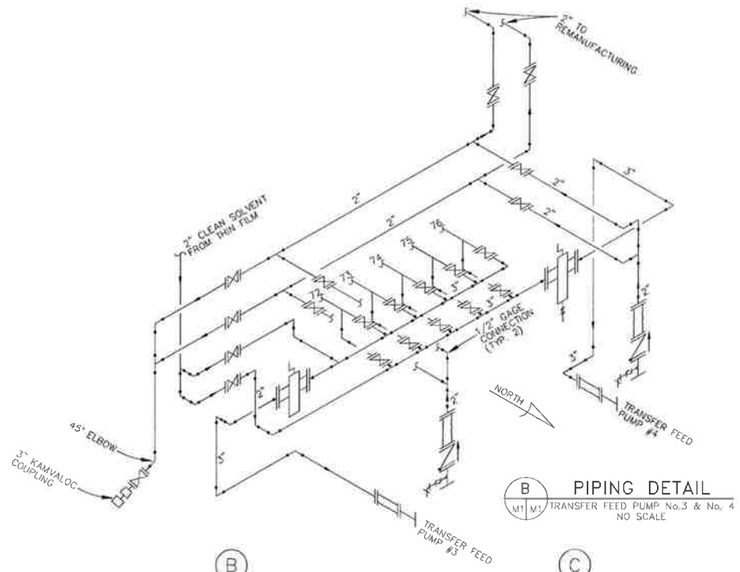
S6

GENERAL NOTES

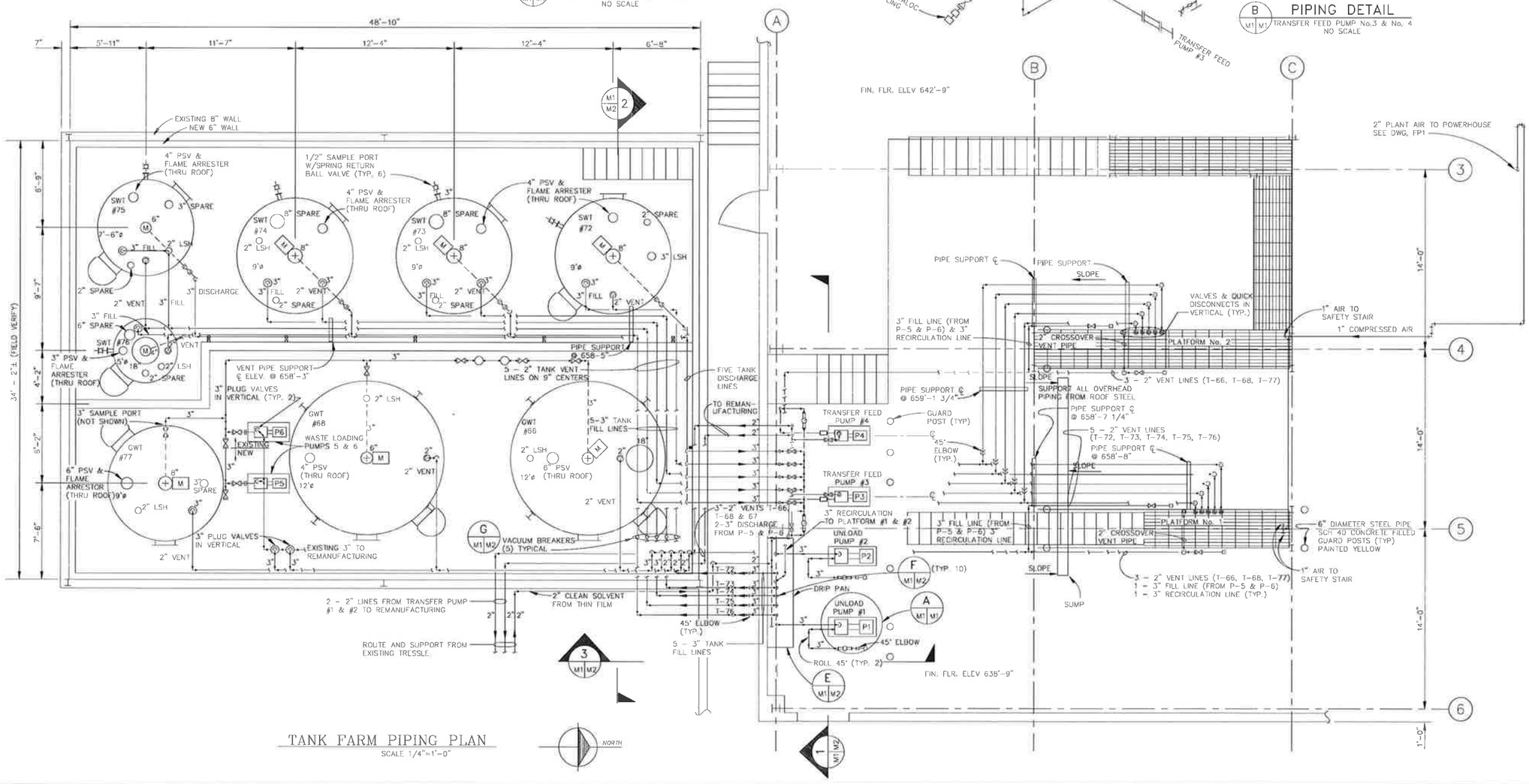
1. ALL TANKS TO BE PURCHASED AND SET BY OWNER.
2. OWNER HAS PRE-PURCHASED TRANSFER PUMP NO. 1.
3. CONTRACTOR TO FURNISH ALL OTHER EQUIPMENT, MATERIALS PIPE, VALVES, AND MISC. FITTINGS.
4. CONTRACTOR TO VERIFY ALL PROPOSED PIPE ROUTINGS AND DIMENSIONS PRIOR TO ANY FABRICATION OR INSTALLATION. IMMEDIATELY NOTIFY OWNER OF ANY CONFLICTS.
5. ALL EQUIPMENT AND MATERIALS SHALL BE COMPATABLE AND SUITABLE FOR INTENDED SERVICE.
6. ALL EQUIPMENT AND MATERIALS SHALL BE INSTALLED AND/OR APPLIED IN ACCORDANCE WITH MANUFACTURER'S RECOMENDATIONS.
7. SUBSTITUTION OF ANY EQUIPMENT AND/OR MATERIALS SHALL NOT BE ALLOWED, UNLESS PRIOR APPROVAL IS OBTAINED FROM OWNER.
8. CONTRACTOR SHALL ENSURE SAFE PASSAGE OF PERSONS AROUND THE AREA OF CONSTRUCTION.
9. INSTALLATION AND ERECTION TO BE PREFORMED IN A MANNER THAT WILL NOT DAMAGE EXISTING EQUIPMENT, STRUCTURES, AND/OR UTILITIES.
10. INSTALLATION SHALL BE IN ACCORDANCE WITH ALL GOVERNING LOCAL, STATE, AND FEDERAL CODES.
11. CONTRACTOR TO FURNISH AND INSTALL EMERGENCY VENTS ON STORED WASTE TANKS #72 THROUGH #76. VENT LINES SHALL BE ADEQUATELY BRACED, SUPPORTED AND FLASHED AT ROOF PENETRATION. VENT PIPES TO EXTEND TO ELEVATION 672'-0". FIVE 6" VENTS, ONE 4" VENT ARE REQUIRED.



A M1 M1 PIPING DETAIL
UNLOAD PUMPS 1 & 2 (2 REQ'D)
NO SCALE



B M1 M1 PIPING DETAIL
TRANSFER FEED PUMP No.3 & No. 4
NO SCALE



TANK FARM PIPING PLAN
SCALE 1/4"=1'-0"

WW Facilities Group
Engineering and Construction Management
1555 Glenwood Hills Parkway, SE • Grand Rapids, MI 49508 • (616) 942-5500

NO.	REVISIONS	BY	DATE
	AS-BUILTS	S/MS	
	BIDS	11/26/93	

REVISED IN ACCORDANCE WITH CONSTRUCTION RECORDS

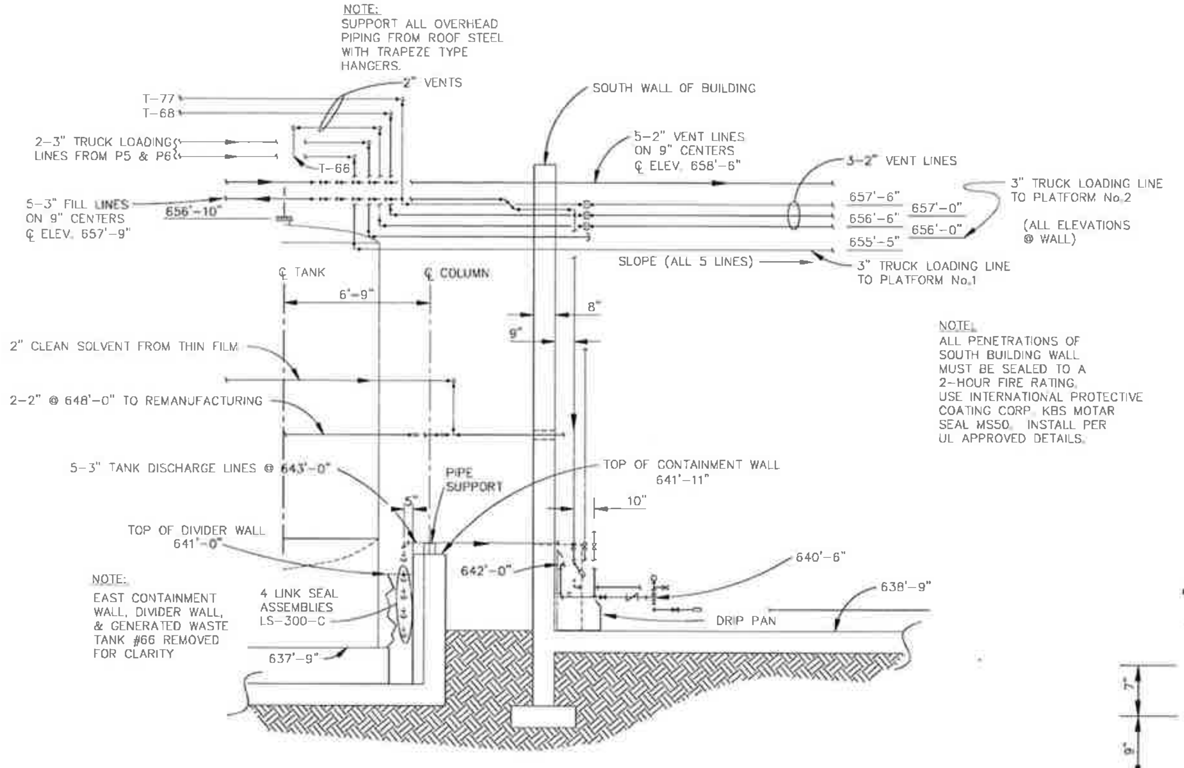
HAZARDOUS WASTE UNLOADING & LIMITED STORAGE FACILITY

TANK FARM PIPING PLAN

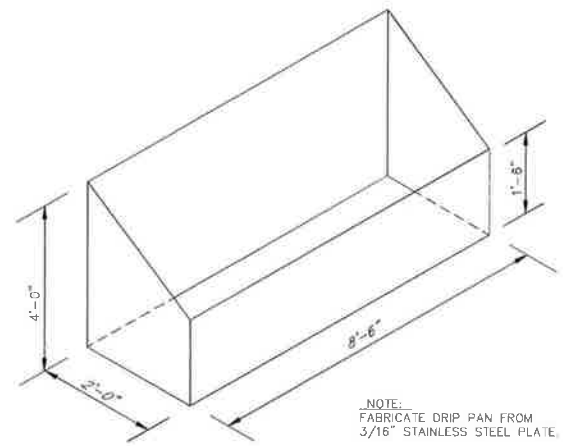
CAGE PRODUCTS, CO. FERNDALE, MICHIGAN

DESIGNED BY CLW	DATE MAR '91
DRAWN BY ALK	DATE MAR '91
CHECKED BY RJO	DATE JUN '91
SCALE	1/4=1'-0"
HORIZONTAL	NA
VERTICAL	
PROJECT	83651
SHEET NO.	M1

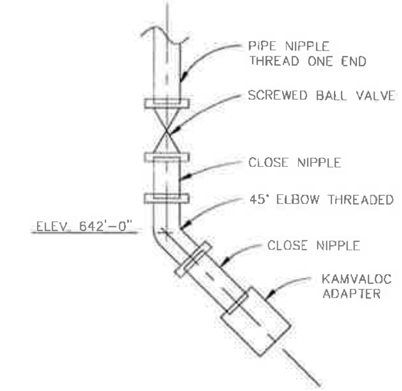
83651-M1
CJT052295



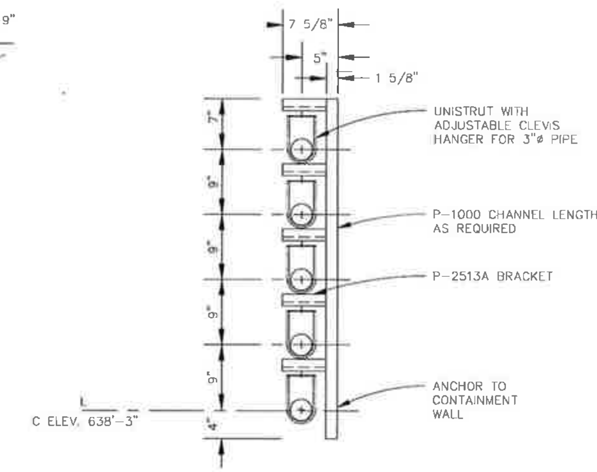
3 M1 M2 SECTION
SCALE: 1/4" = 1'-0"



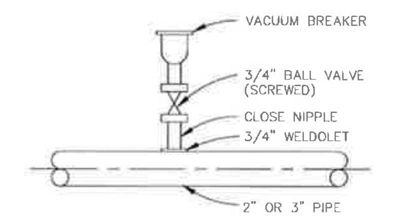
E M1 M2 DRIP PAN DETAIL
NO SCALE



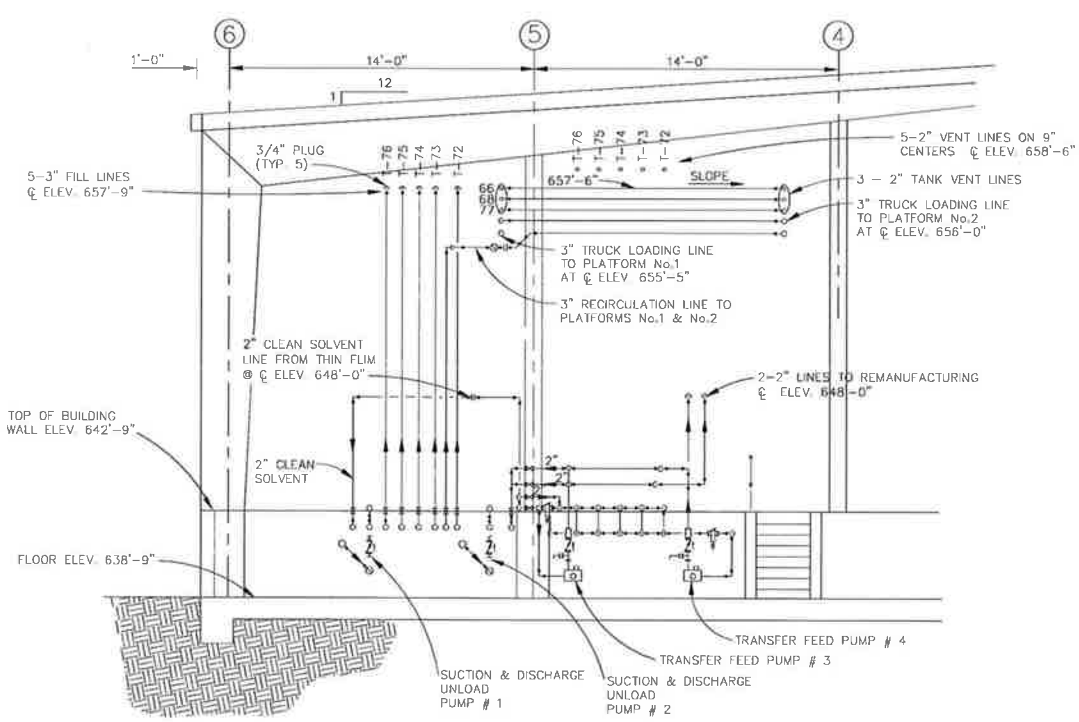
F M1 M2 QUICK DISCONNECT DETAIL
NO SCALE
13 REQUIRED
11-3"
2-2"



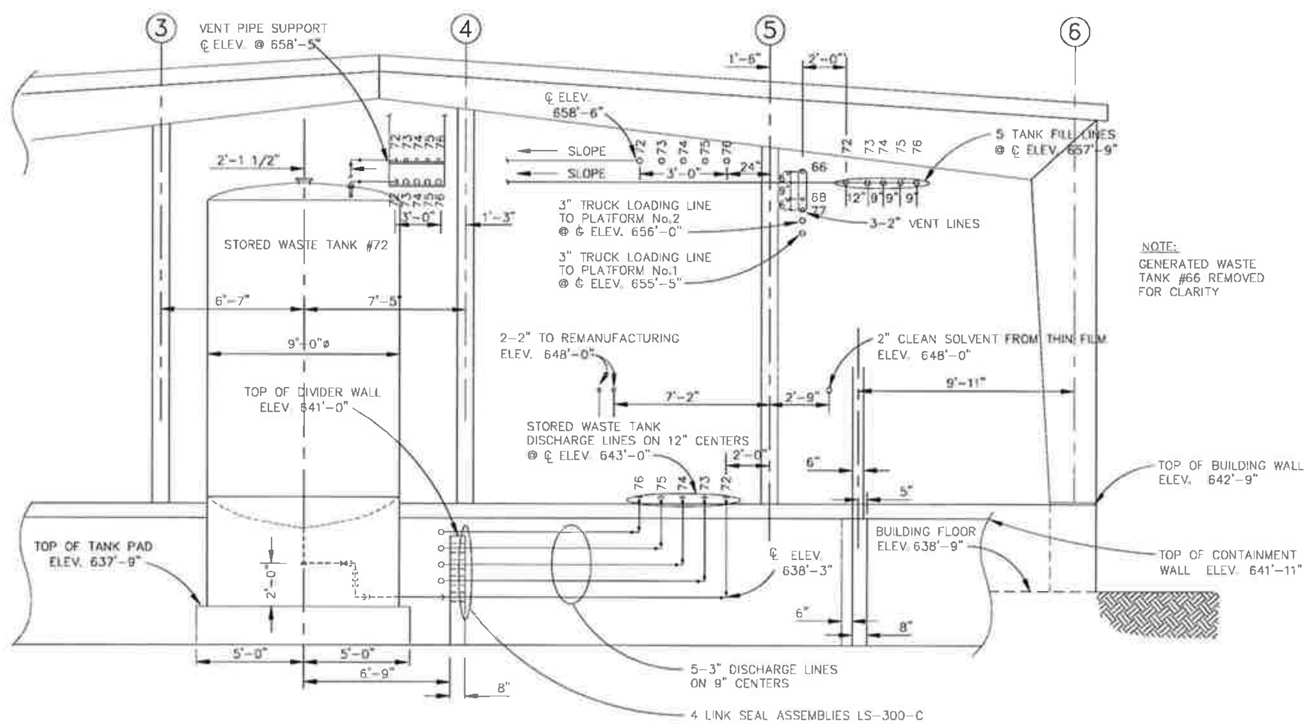
D M1 M2 PIPE SUPPORT DETAIL
(6 REQUIRED)
SCALE: 1" = 1'-0"



G M1 M2 VACUUM BREAKER DETAIL
NO SCALE
(9 REQUIRED)



1 M1 M2 SECTION
SCALE: 1/4" = 1'-0"



2 M1 M2 SECTION
SCALE: 1/4" = 1'-0"

WW Engineering & Science
Facilities Engineering Division

HAZARDOUS WASTE UNLOADING & LIMITED STORAGE FACILITY

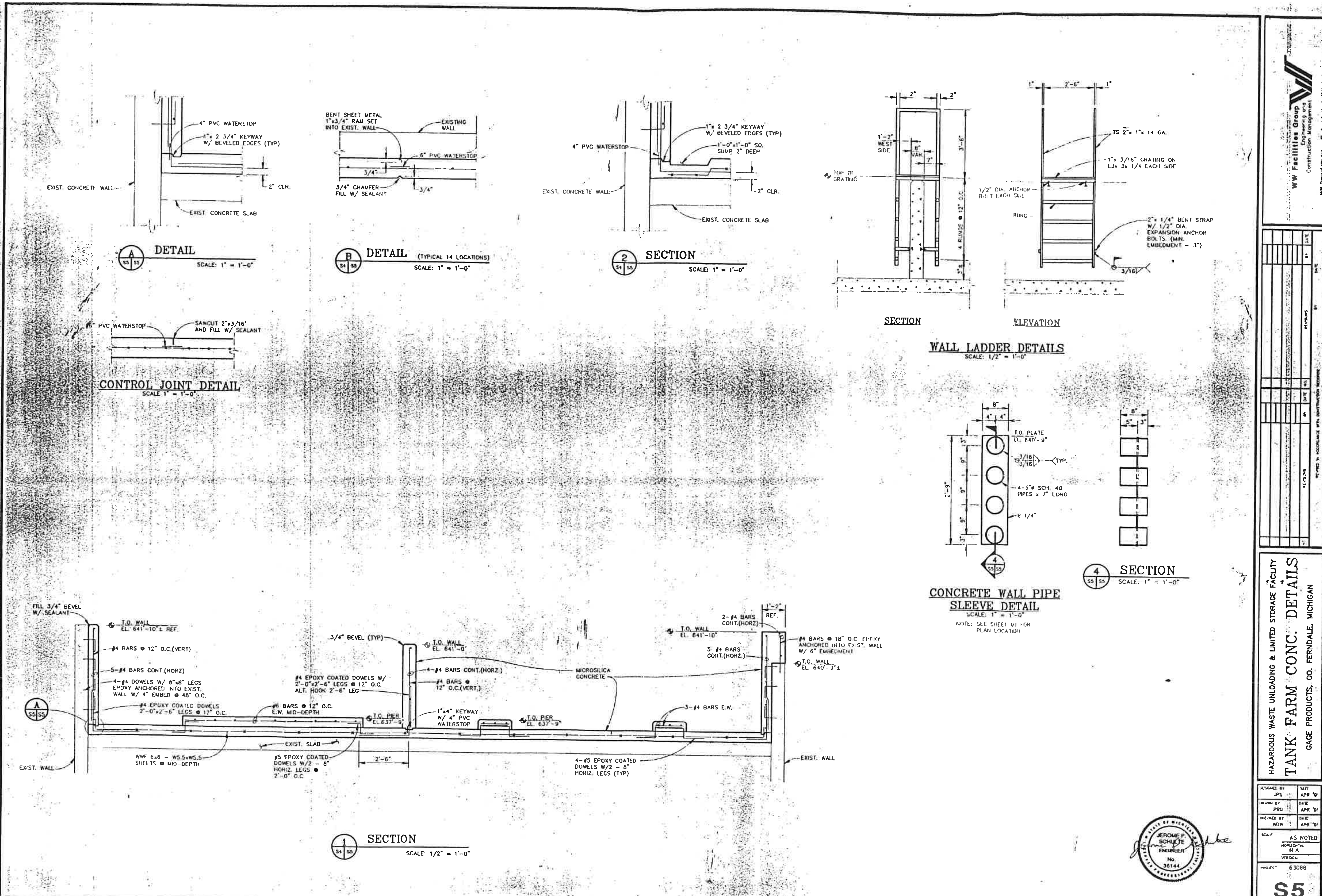
TANK FARM PIPING DETAILS

GAGE PRODUCTS, CO. FERNDALE, MICHIGAN

DESIGNED BY GLW	DATE MAR '91
DRAWN BY MPM	DATE MAY '91
CHECKED BY RJO	DATE JUN '91
SCALE HORIZONTAL 1/4"=1'-0"	VERTICAL NA

PROJECT 83651

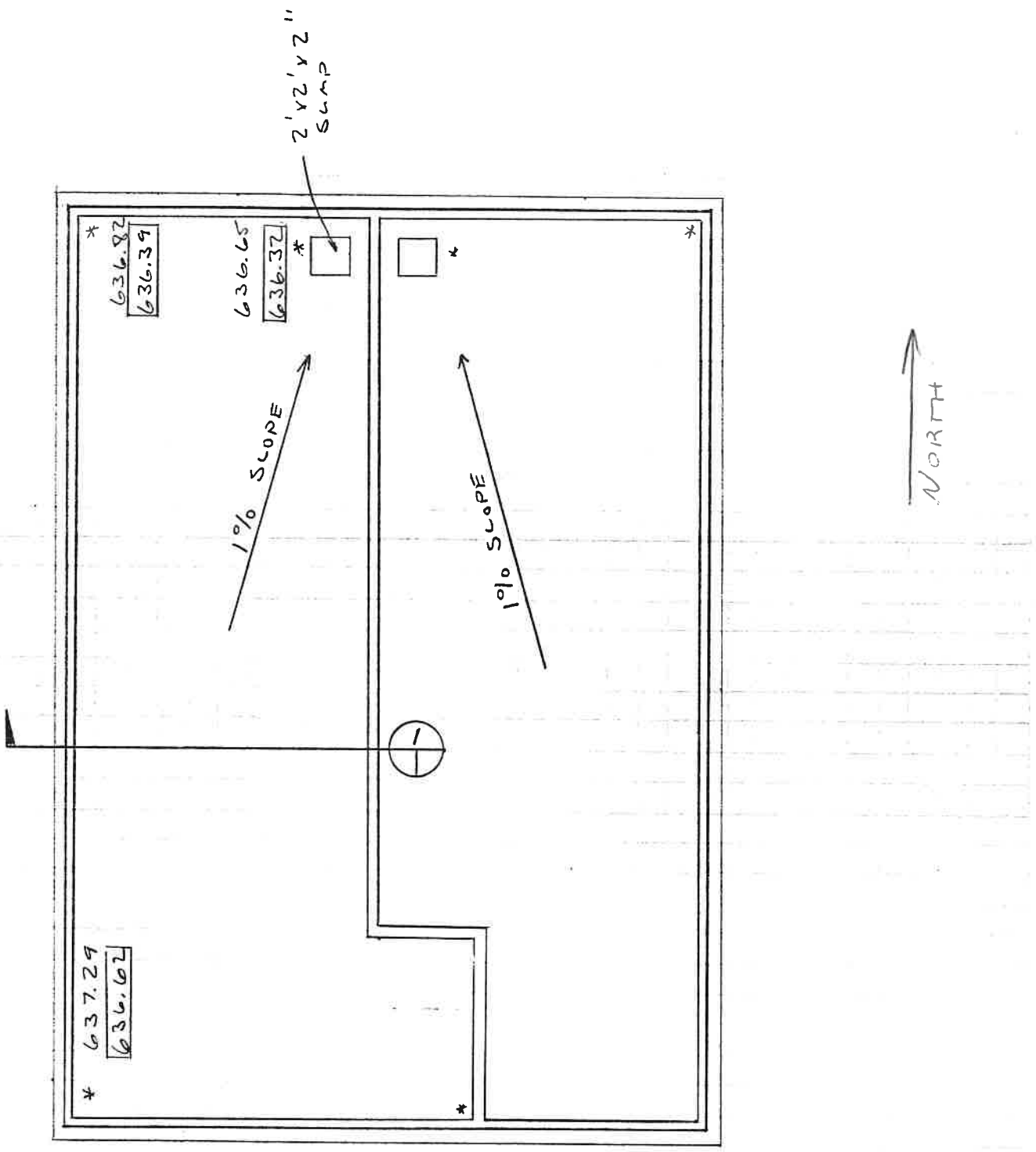
SHEET NO. M2



DETAIL A
SCALE: 1" = 1'-0"
4" PVC WATERSTOP
1"x 2 3/4" KEYWAY W/ BEVELED EDGES (TYP)
EXIST. CONCRETE WALL
2" CLR.
EXIST. CONCRETE SLAB
DETAIL B (TYPICAL 14 LOCATIONS)
SCALE: 1" = 1'-0"
BENT SHEET METAL 1"x3/4" RAM SET INTO EXIST. WALL
EXISTING WALL
6" PVC WATERSTOP
3/4" CHAMFER FILL W/ SEALANT
SECTION 2
SCALE: 1" = 1'-0"
1"x 2 3/4" KEYWAY W/ BEVELED EDGES (TYP)
1'-0"x1'-0" SQ. SUMP 2" DEEP
EXIST. CONCRETE SLAB
CONTROL JOINT DETAIL
SCALE 1" = 1'-0"
SAWCUT 2"x3/16" AND FILL W/ SEALANT
WALL LADDER DETAILS
SCALE: 1/2" = 1'-0"
SECTION
ELEVATION
TOP OF GRATING
TS 2"x 1"x 14 GA.
1"x 3/16" GRATING ON L3x 3x 1/4 EACH SIDE
1/2" DIA. ANCHOR BOLT EACH SIDE
RUNG
2"x 1/4" BENT STRAP W/ 1/2" DIA. EXPANSION ANCHOR BOLTS. (MIN. EMBEDMENT - 3")
4 RUNGS @ 12" O.C.
CONCRETE WALL PIPE SLEEVE DETAIL
SCALE: 1" = 1'-0"
NOTE: SEE SHEET M1 FOR PLAN LOCATION
T.O. PLATE EL. 640'-9"
4-5"ø SCH. 40 PIPES x 7" LONG
PL 1/4"
SECTION 4
SCALE: 1" = 1'-0"
SECTION 1
SCALE: 1/2" = 1'-0"
FILL 3/4" BEVEL W/ SEALANT
T.O. WALL EL. 641'-10"± REF.
#4 BARS @ 12" O.C.(VERT)
5-#4 BARS CONT.(HORZ)
4-#4 DOWELS W/ 8"x8" LEGS EPOXY ANCHORED INTO EXIST. WALL W/ 4" EMBED @ 48" O.C.
#4 EPOXY COATED DOWELS 2'-0"x2'-6" LEGS @ 12" O.C.
#5 BARS @ 12" O.C. E.W. MID-DEPTH
3/4" BEVEL (TYP)
T.O. WALL EL. 641'-0"
4-#4 BARS CONT.(HORZ.)
#4 BARS @ 12" O.C.(VERT.)
#4 EPOXY COATED DOWELS W/ 2'-0"x2'-6" LEGS @ 12" O.C. ALT. HOOK 2'-6" LEG
T.O. PIER EL. 637'-9"
1"x4" KEYWAY W/ 4" PVC WATERSTOP
MICROSILICA CONCRETE
2-#4 BARS CONT.(HORZ)
5 #4 BARS CONT.(HORZ.)
#4 BARS @ 18" O.C. EPOXY ANCHORED INTO EXIST. WALL W/ 6" EMBEDMENT
T.O. WALL EL. 640'-9"±
3-#4 BARS E.W.
EXIST. SLAB
EXIST. WALL
WWF 6x6 - W5.5xW5.5 SHEETS @ MID-DEPTH
#5 EPOXY COATED DOWELS W/2 - 8" HORIZ. LEGS @ 2'-0" O.C.
4-#5 EPOXY COATED DOWELS W/2 - 8" HORIZ. LEGS (TYP)
WW Facilities Group
Engineering and Construction Management
HAZARDOUS WASTE UNLOADING & LIMITED STORAGE FACILITY
TANK FARM CONC. DETAILS
GAGE PRODUCTS, CO. FERNDALE, MICHIGAN
DESIGNED BY JPS DATE APR '91
DRAWN BY PRO DATE APR '91
CHECKED BY WDW DATE APR '91
SCALE AS NOTED
PROJECT 63088
S5
JEROME P. SCHULTE ENGINEER No. 36144

Calculation Sheet

Computed by JPS Subject TANK Sheet 1 of 2
Checked by _____ FARM Job No. 85002
Client GAGE Date 3-12-91



Not Reinforced
Not Enough Slope (1/2%)

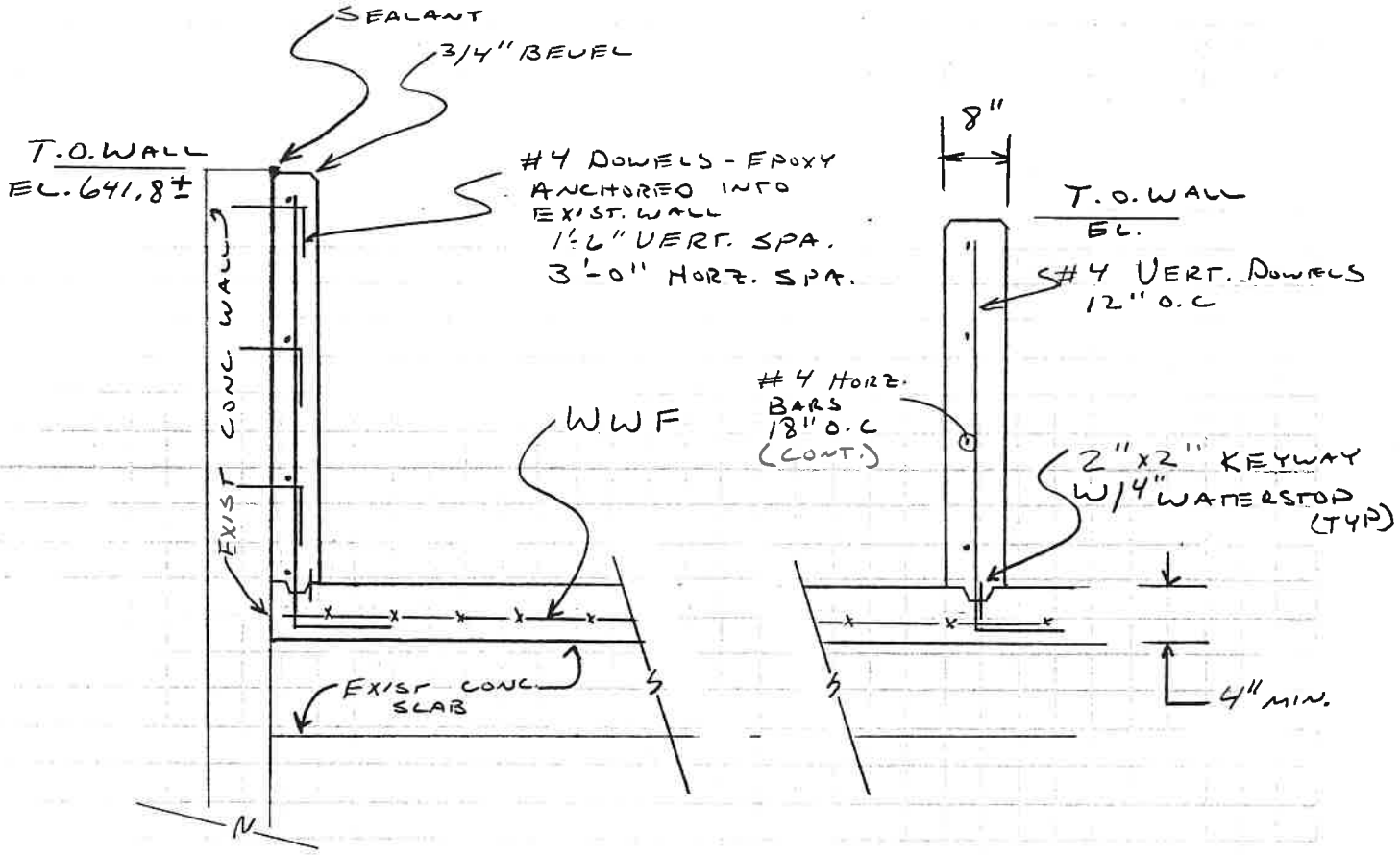
Proposing Liner – Cielcote
$14/sq. ft

Microsilica Concrete?

Liners Compatible with Waste Stored?

Calculation Sheet

Computed by JPS Subject TANK Sheet 2 of 2
Checked by _____ FARM Job No. 85002
Client GAGE Date 3-12-91



Appendix A1-6

Records Procedures

APPENDIX A1-6

RECORDING PROCEDURES

This section summarizes the record keeping procedures that are implemented by Gage Products Company as required under 40 CFR 264.73 and Appendix I and Michigan Act 451 Rule 299.9609. All records are maintained by Gage Products Company for a minimum of three years or longer as specified by the regulations.

TABLE OF CONTENTS

1 INTRODUCTION

All records and plans required by 40 CFR 264.73 and Appendix I and Michigan Act 451 Rule 299.9609 and other records required under the facility's permit or license are retained at the facility and are available, at reasonable times, for inspection by designated representatives of the U.S. EPA and EGLE. All records are retained for a period of at least three years or longer as specified by the regulations. The following records are retained at the facility:

2 GENERAL FACILTY RECORDS

- Daily operating record which includes, for each waste received by Gage Products Company, a description, the quantity, the method of storage, and the location of the waste in the facility cross-referenced to specific manifest document numbers.

- Records and results of analyses of wastes from each generator, including initial analyses and any follow up analyses.

- Michigan Limited Storage Facility Operating License application, plus any modifications.

- Generator notification letter of appropriate permits and willingness to accept the generator's waste at Gage Products Company.

- Notice of EPA ID number

- Inspection reports and any other including all reports prepared routinely by plant employees (see Attachment A6) and all inspection reports performed by outside inspection or testing services.

- Results of Subpart BB and Subpart CC air monitoring.

- Copies of the Procedures to Prevent hazards

- Copies of the Contingency Plan (Attachment A7) plus a summary of all incidents that required the implementation of the contingency plan.

- Personnel training records including the job titles for each position having hazardous waste management responsibilities; the name of each employee filling each job title; and the written job description for each hazardous waste management position listed, as outlined in Attachment A10.

- Documentation that the required training has been successfully completed by each employee with hazardous waste management responsibilities.

- Copies of any written reports required to be submitted to the EPA or EGLE after incidents occur at the facility that require implementation of the Contingency Plan per 40 CFR 265.56 (j).

- The facility copy of the manifest for each hazardous waste that has been received by Gage Products Company.

- Copies of the Closure Plan (Attachment A11).

- Closure cost estimates and any annual adjustments.

- Any revisions to the Closure Plan and closure cost estimates.
- Annual certification of Gage Products Company's hazardous waste volume and toxicity reduction program for generated wastes.
- Certificate of liability insurance as required by the U.S.EPA and EGLE.
- Copy of each biennial report as submitted to the U.S EPA
- The Limited Storage Facility Operating License as issued by the EGLE and any modifications to the permit.
- Permits that may be required.
- Copies of any reports, data, and information (etc.) requested by and submitted to any federal, state county, and city agency having authority.
- The detection of groundwater contaminants.
- Record of waste shipments rejected.
- Land disposal records.
- Generator records (regarding waste material shipped from this facility);

- Copy of the test results, analyses and any other determination made on the waste shipped off-site.
- Generator manifest copy signed by the initial transporter.
- Generator manifest copy signed by and returned by the disposal facility.
- Exception reports, as necessary, per 40 CFR 262.42.

3 LAND DISPOSAL RESTRICTION RECORDKEEPING REQUIREMENTS

All facilities that receive or generate restricted wastes are subject to land disposal restriction recordkeeping requirements. Generators are required to provide Gage Products Company with the first shipment of the waste a written notice that describes the appropriate treatment standards set forth in 40 CFR 268 Subpart D and any applicable prohibition levels set forth in 40 CFR 268.32 or RCRA 3004 (d), respectively. These recordkeeping requirements are discussed further in the waste analysis plan, Attachment A3.

For generated process wastes that will be managed at an off-site disposal facility, Gage Products Company will comply with the same generator notice and certification requirements.

Gage Products Company will maintain copies of all generator notices and certification and copies of notices and certification sent by Gage Products Company to off-site disposal facilities for a minimum of three years or more as required by regulations.

Appendix A1-7

Photographs of Units

Photo 1 **LSF Building Looking East 1**

Photo 2 **LSF Building Looking South 1**

Photo 3 **LSF Drum Storage 1**

Photo 4 **LSF Drum Storage 2**

Photo 5 **LSF Tanker Ship-Receive 1**

Photo 6 **LSF Tanker Ship-Receive 2**

Photo 7 LSF Waste Tanks 1

Photo 8 Solvent Awning Load Unload 1

Photo 9 Solvent Awning Load Unload 2

Appendix A1-8

Insurance and Letter of Credit

CERTIFICATE OF LIABILITY INSURANCE

DATE(MM/DD/YYYY)
02/09/2024

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must have ADDITIONAL INSURED provisions or be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER
Aon Risk Services Central, Inc.
MSC# 17385
Aon
PO Box 1447
Lincolnshire IL 60069 USA

CONTACT NAME:
PHONE (A/C. No. Ext): (866) 283-7122 **FAX (A/C. No.):** (800) 363-0105
E-MAIL ADDRESS:

INSURER(S) AFFORDING COVERAGE		NAIC #
INSURER A:	Lloyd's Syndicate No. 2623	AA1128623
INSURER B:	Accident Fund Insurance Co of America	10166
INSURER C:	Illinois Union Insurance Company	27960
INSURER D:	ACE American Insurance Company	22667
INSURER E:		
INSURER F:		

INSURED
GAGE PRODUCTS COMPANY
821 Wanda Avenue
Ferndale MI 48220 USA

COVERAGES **CERTIFICATE NUMBER:** 570103897765 **REVISION NUMBER:**

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

Limits shown are as requested

INSR LTR	TYPE OF INSURANCE	ADDL INSD	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS	
C	X **COMMERCIAL GENERAL LIABILITY** CLAIMS-MADE / X OCCUR GEN'L AGGREGATE LIMIT APPLIES PER: X POLICY / PRO-JECT / LOC OTHER:			APCG47443301001	12/31/2023	12/31/2024	EACH OCCURRENCE DAMAGE TO RENTED PREMISES (Ea occurrence) MED EXP (Any one person) PERSONAL & ADV INJURY GENERAL AGGREGATE PRODUCTS - COMP/OP AGG	$1,000,000 $1,000,000 $25,000 $1,000,000 $2,000,000 $2,000,000
D	**AUTOMOBILE LIABILITY** X ANY AUTO OWNED AUTOS ONLY / SCHEDULED AUTOS HIRED AUTOS ONLY / NON-OWNED AUTOS ONLY			PMU H08885400	12/31/2023	12/31/2024	COMBINED SINGLE LIMIT (Ea accident) BODILY INJURY (Per person) BODILY INJURY (Per accident) PROPERTY DAMAGE (Per accident) Comp./Coll. Deductible	$1,000,000 $2,000
C	**UMBRELLA LIAB** X OCCUR X **EXCESS LIAB** CLAIMS-MADE DED / RETENTION			XOOG47443313001	12/31/2023	12/31/2024	EACH OCCURRENCE AGGREGATE	$20,000,000 $20,000,000
B	**WORKERS COMPENSATION AND EMPLOYERS' LIABILITY** ANY PROPRIETOR / PARTNER / EXECUTIVE OFFICER/MEMBER EXCLUDED? Y / N: N **(Mandatory in NH)** If yes, describe under DESCRIPTION OF OPERATIONS below	N / A		AFWCP10007519802	12/31/2023	12/31/2024	X PER STATUTE / OTH-ER E.L. EACH ACCIDENT E.L. DISEASE-EA EMPLOYEE E.L. DISEASE-POLICY LIMIT	 $1,000,000 $1,000,000 $1,000,000
A	Environmental Site Liability			W25940210201	12/31/2021	12/31/2024	Each Pollution Deductible	$1,000,000 $100,000

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (ACORD 101, Additional Remarks Schedule, may be attached if more space is required)
Evidence of Insurance.

CERTIFICATE HOLDER

Gage Products Company
821 Wanda Avenue
Ferndale MI 48220 USA

CANCELLATION

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS.

AUTHORIZED REPRESENTATIVE

Aon Risk Services Central, Inc.

Holder Identifier :

Certificate No : 570103897765

THE PRIVATE BANK

IRREVOCABLE STANDBY LETTER OF CREDIT
NO. 216120601 DATED MARCH 31, 2009

COPY

Director
Department of Environmental Quality
c/o Waste and Hazardous Materials Division
Hazardous Waste Section
P.O. Box 30241
Lansing, Michigan 48909-7741

Director, Department of Environmental Quality:

1. We hereby issue our Irrevocable Letter of Credit No.216120601 in your favor on behalf of Gage Products Company, Inc., hereinafter known as the Company, for a sum of $85,000.00 (Eighty Five Thousand and 00/100 United States Dollars), available by your drafts at sight drawn on our institution, The PrivateBank and Trust Company, marked "Drawn under The PrivateBank and Trust Company Letter of Credit No. 216120601 dated March 31, 2009." We are a bank or financial institution which has the authority to issue Letters of Credit. Our Letter of Credit operations are regulated and examined by The Federal Deposit Insurance Corporation.

2. This Letter of Credit is issued to provide financial assurance to the State of Michigan, Department of Environmental Quality for cost of closure, post-closure maintenance and monitoring of the hazardous waste management facility(ies): Gage Products Company, EPA ID MID005338801, located at 821 Wanda, Ferndale, MI

3. This Letter of Credit shall expire on March 31, 2010, but such expiration date shall be automatically extended for periods of one year, unless, not less than 120 days before the current expiration date, we notify both you and the Company by certified mail of our decision not to extend the current expiration date. We agree that the 120 day period shall begin on the date when both you and the Company have received the notice, as evidenced by the return receipts.

4. You may draw on this Letter of Credit in the event that you issue a notice of violation or other order in accordance with the Administrative Rules promulgated pursuant to Part 111 of 1994 PA 451, as amended, indicating that the Company has failed to properly execute its closure or post-closure corrective action responsibilities. You also may draw on this Letter of Credit in the event that the Company fails to provide you with an extension of this Letter of Credit, an acceptable replacement Letter of Credit, or another type of financial assurance acceptable to you, within 90 days after receipt by both you and the Company of a notice from us that we have decided not to extend this Letter of Credit beyond its current expiration date.

5. Partial drawings are permitted. This original Letter of Credit must be submitted to us together with any drawings hereunder for our endorsement of any payments effected by us and/or for cancellation.

6. This Letter of Credit is subject to the Uniform Customs and Practice for Documentary Credits (Publication No. 600 of the International Chamber of Commerce, 2007 Revision, with the exception of Article 38(c)) or by subsequent Uniform Customs fixed by subsequent Congresses of the International Chamber of Commerce. This Letter of Credit shall be deemed to be made under the laws of the State of Michigan, including Article 5 of the Michigan Uniform Commercial Code, and shall be governed by and construed in accordance with the laws of the State of Michigan. Where conflicts exist between the provisions of the Uniform Customs and the laws of the State of Michigan, the laws of the State of Michigan shall govern this Letter of Credit.

7. We shall honor drafts drawn under and in compliance with the terms of this Letter of Credit and these drafts will be duly honored upon presentation to us if presented on or after March 31, 2009, and on or before March 31, 2010, or any automatically extended date as provided in paragraph 3 above. The amount of each draft must be endorsed on the reverse of this Letter of Credit by us.

8. We certify that the wording of this Letter of Credit is identical to the wording provided by the Michigan Department of Environmental Quality as of the date shown immediately below.

THE PRIVATEBANK AND TRUST COMPANY

By: _____
Name: _____
Title: _____

By: _____
Name: Brad Nelson
Title: Associate Managing Director

The PrivateBank

February 5, 2014

BENEFICIARY:
Department of Environmental Quality
c/o Waste and Hazardous Materials Division
Hazardous Waste Section
P.O. Box 30241
Lansing, Michigan 48909-7741

APPLICANT:
Gage Products Company, Inc.
821 Wanda Avenue
Ferndale, MI 43220

We hereby amend our Irrevocable Standby Letter of Credit No. 216120601 as follows:

Amendment Sequence Number: **001**

This Letter of Credit Number has been amended from 216120601 to 30853-31979. Please always quote LC Number **30853-31979** in all future correspondence.

The Letter of Credit has auto extended to March 31, 2015 per its terms. The auto extension provision as stated in the LC remains in effect.

In paragraph 2 of the Letter of Credit delete "post-closure maintenance and monitoring".

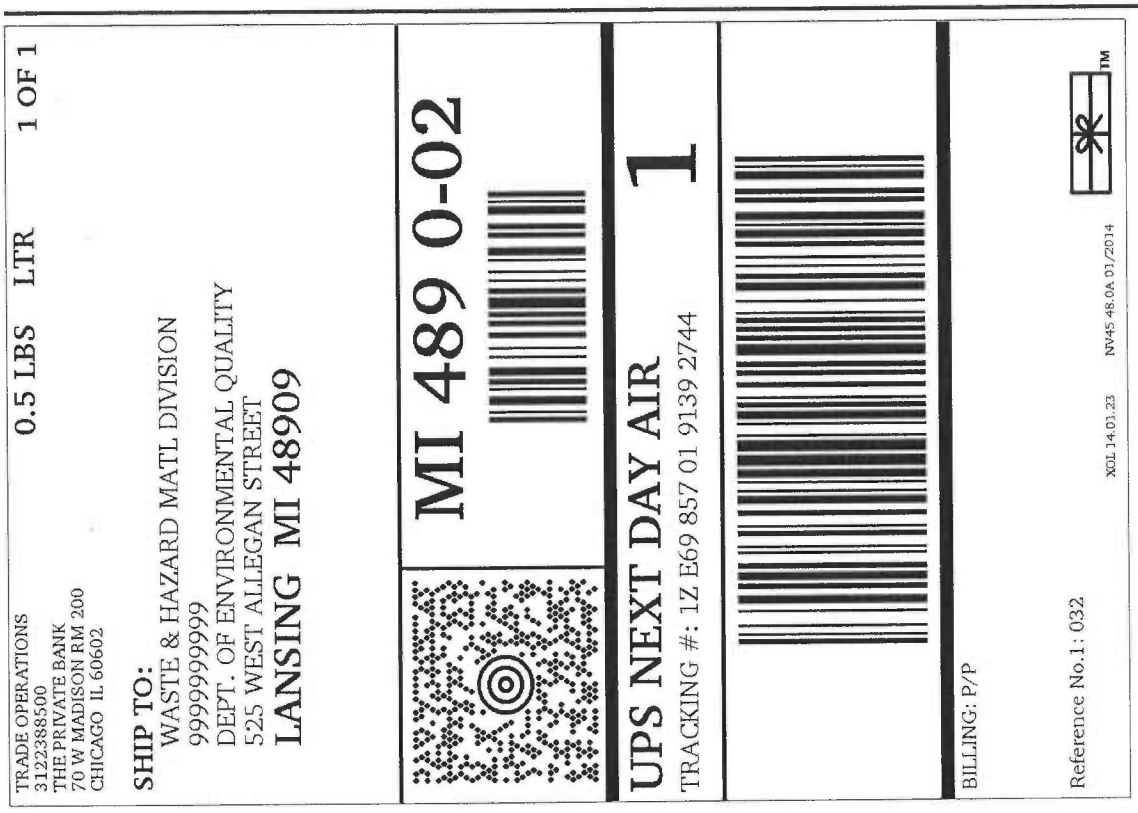
This amendment is subject to the Uniform Customs and Practice for Documentary Credits (2007 Revision), International Chamber of Commerce Publication No. 600.

This Amendment forms an integral part of the Letter of Credit and should be attached thereto. All other terms and conditions remain unchanged.

THE PRIVATEBANK AND TRUST COMPANY

By: _____
Name: _____
Title: CC MANAGER

By: _____
Name: JAMES J SATTLER
Title: LC OFFICER


TRADE OPERATIONS
3122388500
THE PRIVATE BANK
70 W MADISON RM 200
CHICAGO IL 60602
0.5 LBS LTR 1 OF 1
SHIP TO:
WASTE & HAZARD MATL DIVISION
9999999999
DEPT. OF ENVIRONMENTAL QUALITY
525 WEST ALLEGAN STREET
LANSING MI 48909
MI 489 0-02
UPS NEXT DAY AIR
1
TRACKING #: 1Z E69 857 01 9139 2744
BILLING: P/P
Reference No.1: 032
XOL 14.01.23
NV45 48.0A 01/2014

CIBC Bank USA
120 S. LaSalle Street
Chicago, Illinois 60603
Tel: 312 564-2000

MARCH 15, 2022

BENEFICIARY:
DEPARTMENT OF ENVIRONMENTAL QUALITY
C/O WASTE AND HAZARDOUS MATERIALS DIVISION
HAZARDOUS WASTE SECTION
P.O. BOX 30241
LANSING, MICHIGAN 48909-7741

APPLICANT:
GAGE PRODUCTS COMPANY, INC.
821 WANDA AVENUE
FERNDALE, MI 43220

WE HEREBY AMEND OUR IRREVOCABLE STANDBY LETTER OF CREDIT NO. **30853-31979 (FKA: 216120601)** AS FOLLOWS:

AMENDMENT SEQUENCE NUMBER: **002**

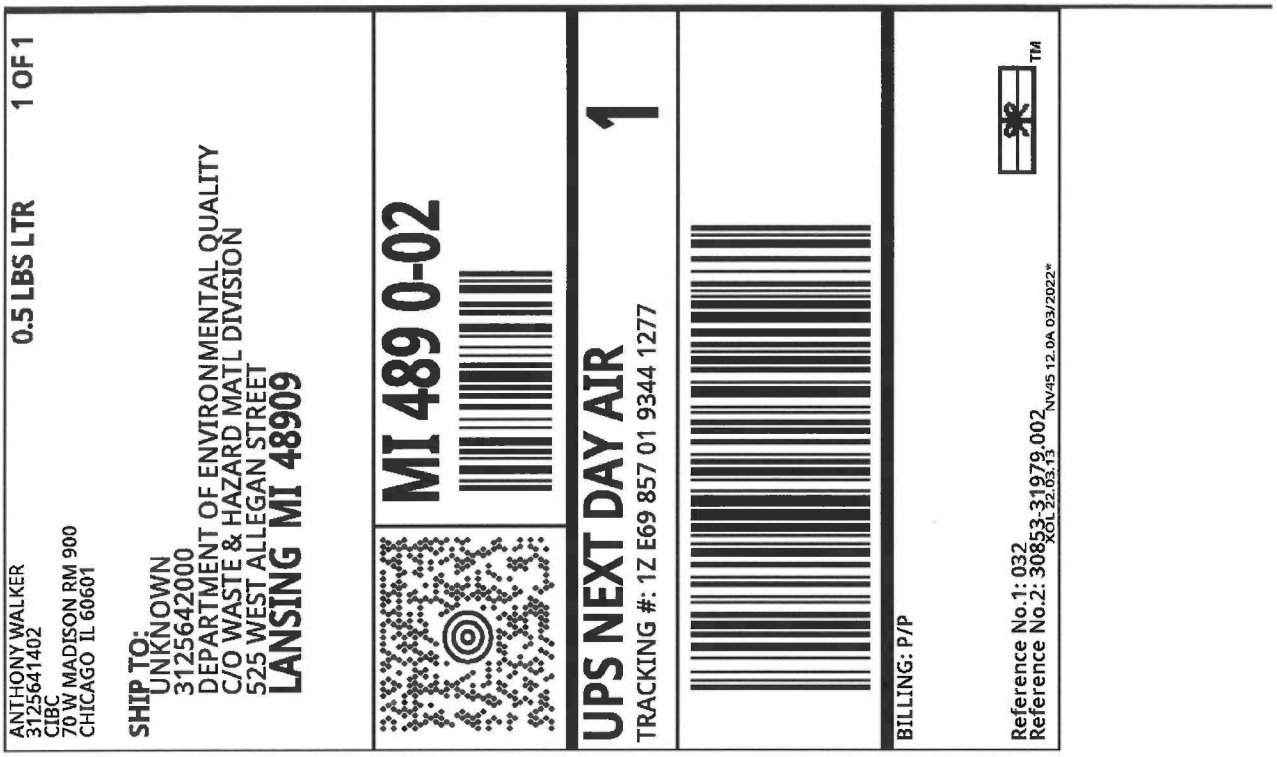
- AMOUNT INCREASED BY: $15,000.00
  TO A NEW AVAILABLE AMOUNT OF: $100,000.00

THIS AMENDMENT FORMS AN INTEGRAL PART OF THE LETTER OF CREDIT AND SHOULD BE ATTACHED THERETO. ALL OTHER TERMS AND CONDITIONS REMAIN UNCHANGED.

CIBC BANK USA F/K/A THE PRIVATE BANK AND TRUST COMPANY

BY: _____
CATHY HRUBECKY
LC MANAGER

BY: _____
ANTHONY WALKER
OFFICER


ANTHONY WALKER
3125641402
CIBC
70 W MADISON RM 900
CHICAGO IL 60601
0.5 LBS LTR
1 OF 1
SHIP TO:
UNKNOWN
3125642000
DEPARTMENT OF ENVIRONMENTAL QUALITY
C/O WASTE & HAZARD MATL DIVISION
525 WEST ALLEGAN STREET
LANSING MI 48909
MI 489 0-02
UPS NEXT DAY AIR
1
TRACKING #: 1Z E69 857 01 9344 1277
BILLING: P/P
Reference No.1: 032
Reference No.2: 30853-31979.002
XOL 22.03.13
NV45 12.0A 03/2022*
TM

Appendix A1-9

Owner Disclosure Statement

APPENDIX A1-9 OWNER

DISCLOSURE STATEMENT

The information provided in this section is submitted in accordance with the requirements of Michigan's Hazardous Waste Management Act; enacted by Public Act of 1994, Number 451, as amended, Rules 299.518 (4) and 299.522(2).

TABLE OF CONTENTS

GENERAL INFORMATION (299.518 (4))

This disclosure statement is prepared in accordance with the applicable requirements as stated in Michigan's Hazardous Waste Act; enacted by Public Act of 1994, Number 451, as amended. This disclosure statement is a component of Gage Products Company's Application for a Michigan Act 451-Limited Storage Facility Operating License.

1 FULL NAME AND BUSINESS ADDRESS (299.518 (4) (a))

1a Applicant

Gage Products Company
821Wanda Avenue
Ferndale, Michigan 48220

1b Five (5) persons holding the largest shares of the equity in or debt liability of Gage Products Company

Nancy Gage-Lindner
Eigerstrasse 5
Wiesbaden 65199 Germany

Raymond D. Gage
1270 Ginger Quill Dr.
Grayling, MI 49738

Joan Fetters
15682 Signal Hill Ct.
Granger, IN 46530

Susan A. McCoy
10113 Lake Dr.
Mecosta, MI 49332

James Gage
4285 Riverlands Ct. NE
Grand Rapids, MI 49525

1c Operator

Gage Products Company
821 Wanda Avenue
Ferndale, Michigan 48220

1d Three (3) employees with the most responsibility for day-to day operation of the facility.

Dan Finkiewicz
30320 LaBrea Court
Franklin, MI 48025

Matthew McCoy
229 Thalia Ave.
Rochester Hills, MI 48025

Brenna Harden
46701 Barrington Court
Plymouth, MI 48170

1e Other business entities in which persons listed above have or have had a twenty-five percent equity in or debt liability of that business entity.

None of those persons listed above have had a twenty five percent equity in or debt liability in any other business entity.

2 All convictions for criminal violations of any environmental statute enacted by a federal, state, Canadian, or provincial agency.

Gage Products Company has not had any convictions for criminal violations of any environmental statutes enacted by federal, state, Canadian, or provincial agency.

3 All environmental permits or licenses by a federal, state, Canadian, or provincial agency held by each person listed above which were permanently revoked because of noncompliance.

Gage Products Company has not had any environmental permits or licenses permanently revoked because of noncompliance.

4 All activities at property owned or operated by each person listed above, if the incident resulted in a threat or potential threat to the environment and public funds were used to finance an activity to mitigate the threat or potential threat to the environment, except if the public funds expended to facilitate the mitigation of the environmental contamination were voluntarily and expeditiously recovered the applicant or other listed person without litigation.

There have been no incidents or potential threats to the environment on any properties owned or operated by any of those persons listed above that required expenditure of public funds to mitigate a threat or potential threat to the environment.