PERMANENT PUMP STATION B
CONSTRUCTION PERMIT APPLICATION
RESPONSES TO THE FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
LETTER DATED NOVEMBER 25, 1997

Prepared for:

Hillsborough County
Solid Waste Management Department
601 E. Kennedy Blvd, 24th Floor
Tampa, Florida 33601

Prepared by:

SCS Engineers
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December 24, 1997
File No. 0995029.13

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SCS ENGINEERS

December 24, 1997
File No. 0995029.13

Mr. Kim B. Ford, P.E.
Florida Department of Environmental Protection
Southwest District
3804 Coconut Palm Drive
Tampa, Florida 33619

Subject: Response to Florida Department of Environmental Protection's letter dated November 25, 1997, regarding the Southeast County Landfill (SCLF), Pump Station B Construction, Pending Permit No. 35435-0001-SC, Hillsborough County, Florida

Dear Mr. Ford:

On behalf of the Hillsborough County Solid Waste Management Department (HCSWMD), SCS Engineers (SCS) has reviewed the referenced letter from the Florida Department of Environmental Protection (FDEP). We believe the following responses address the questions raised by the FDEP. Each of the FDEP's comments is restated in bold below, followed by our response.

1. <u>FDEP Statement 1</u> - **Proof of Publication of notice of application pursuant to Rule 62-103.150, see attached notice.**

   <u>Response</u> - A proof of publication notice will be submitted by the HCSWMD.

2. <u>FDEP Statement 2</u> - **Please provide a brief discussion on how the potential "well point" system would be installed and operated in case of vault or pipe system failure, and its expected performance for removing leachate as required.**

   <u>Response</u> - The well point system is a contingency system which may never be necessary. If, in the case where both access pipes to the leachate vault are rendered unusable, the coordinates and depth of the concrete vault would be used to locate and install a vertical extraction well. The system would be designed to remove leachate as required and the layout would be similar to the cross-section approved by the FDEP on Drawing D-14 in the original Permit Application by Camp, Dresser, and McKee Inc. dated February 1983.

3. <u>FDEP Statement 3</u> - **Please discuss the scenario where the 18 inch HDPE pipes may be required to be "slip lined". If this process were required, what would the diameter of the inner pipe be and could a pump(s) be located that would provide the necessary design leachate removal rate?**

   <u>Response</u> - Slip lining the access pipes is a contingency which may never be necessary. The scenario where either of the two 18-inch diameter access pipes would be slip lined would occur if routine visual inspections showed that the

pipes are either slowly deforming or separating. The size of the slip line will be dictated by the severity of the deformation. The diameter of the access pipes (i.e. 18-inch) was chosen to be larger than needed to provide the HCSWMD with adequate access and time to implement corrective actions if the pipes begin to deform. Submersible pumps are available that could be inserted in pipes as little as 8-inches in diameter with the capacity needed at the SCLF. The slip lined option with the smallest pipe size would to insert a 3-inch diameter suction hose into the access pipe to reach the concrete vault. The 3-inch diameter suction hose could be used to extract leachate using a vacuum assisted pump located at the perimeter of the SCLF. In any of the systems described above, the systems would be designed to remove leachate as required.

4. **FDEP Statement 4 - A minimum design pump cycle of 13 minutes is included apparently based on a 75 gallon per minute design flow. What is the maximum expected design flow and maximum projected pumping cycle? Could there be a high enough flow where continuous pumping and excess depth (head) on the liner system would exist? The department requests the design to include two pumps continuously operational in the vault to provide adequate removal in event of pump damage and maintenance, or excessive leachate production.**

Response - The maximum expected design flow is 93,800 gallons per day (65 gallons per minute), as described in the SCLF Leachate Management Plan (LMP) dated August 4, 1995. The proposed pump was selected to provide a best efficiency point at 75 gpm. As shown on the pump performance curve in Attachment E of the Construction Permit Application, the selected pump is capable of removing up to a maximum of 200 gpm. Therefore, two pumps operating simultaneously is not necessary. However, as stated in Section 2.4.3 of the Construction Permit Application, the HCSWMD will have two pumps available which will allow for one pump to be operational at all times.

5. **FDEP Statement 5 - When will the referenced report for the existing leachate collection system performance for Phases V and VI be completed and submitted?**

Response - The report is estimated to be submitted to the FDEP in April 1998. The Permanent Pump Station "B" (PPS-B) was designed to maximize the performance of the Leachate Collection and Removal System (LCRS). Therefore, any future lateral additions into the LCRS of Phases V and VI will not have an adverse impact on the performance of PPS-B.

6. **FDEP Statement 6 - According to the supporting information (Attachment F) the underlying clay will not provide sufficient support to hold the vault without an underlying geogrid. How will the geogrid be anchored during construction to ensure stability of the vault and underlying geogrid. How will the geogrid be**

anchored during construction to ensure stability of the vault and underlying clay liner prior to placement of backfill?

Response - As presented in Attachment G of the Construction Permit Application (Section 03410, Part 3.03 (C)), the vault shall be suspended in-place with a crane and not allowed to transmit a dead load onto the excavated sub-grade until all pipe connections are completed and the backfill is placed up to the elevation corresponding to the top of the surrounding phosphatic clay. The geogrid has been designed to provide sufficient runout length to support the vault during and immediately after construction. During construction, the geogrid will be anchored by the weight of the backfill soils. In addition, although not needed, a 1 foot deep anchor trench will be included for the lower geogrid layer. Section A on Drawing No. 6 of the Construction Permit Application has been modified to show the anchor trench (Attachment 1).

7. FDEP Statement 7 - **Upon evaluation of the vault dimensions it appears that the first point of allowable infiltration of leachate into the vault is at least two feet and four inches above the bottom of the excavation. Based on this, it appears that the liner surrounding the sump will have at least this amount of standing leachate at all times. Please provide an evaluation of the impacts of this design regarding hydraulic gradient, soil conditions and stability and the basis for allowing it. The Department requests a clear access point(s) for leachate to enter the vault directly from the granite rock backfill.**

Response - The 8-inch diameter HDPE pipes entering the vault are perforated to allow for the leachate to enter the vault. The performance of the bottom liner system with respect to the depth of leachate has been addressed in the Operation Permit Renewal Application by SCS dated August 22, 1994, Sections 3.3.4 and associated addendum and revisions. Issues concerning the depth of leachate in a sump area are understood by SCS to be exempt by Rule 62-701.400(3)(b)(1), Florida Administrative Codes.

8. FDEP Statement 8 - **According to Drawing No. 5, B/3/5, the sump will not initially be placed at the lowest point of the bottom clay liner. When will the sump be at the lowest point? Please discuss hydraulic head over the liner in the areas lower than the sump.**

Response - Although the top of phosphatic clay elevation is settling as projected in the Hydrogeological Investigation by Ardaman and Associates, Inc. dated February 22, 1983, precise dates for elevations cannot be made. The settlement plates for the SCLF will continue to be recorded and the top of phosphatic clay elevations will be reported to the FDEP. The hydraulic head over the liner will continue to be managed as presented in the LMP. The HCSWMD will continue to use the dewatering system in Phase IV to provide supplemental leachate removal from the current low area.

9. **FDEP Statement 9 - The design plans show filter fabric entirely surrounds the vault and gravel sump which could become clogged. Please provide an evaluation of a graded filter media rather than fabric that could be used for a portion of the sump design to allow direct leachate collection in the sump in event of fabric clogging.**

Response - The geotextile over gravel sump has been replaced with graded filter materials. Drawing No. 6 of the Construction Permit Application has been modified and is included in Attachment 1.

10. **FDEP Statement 10 - Please explain the need for the internal berm liner boot detail shown on Drawing No. 5 and the reason for delaying the construction of components identified as "not in contract". The Department requests the sump and all related systems be completed and operational for a sufficient period of time to evaluate performance prior to disposal in Phases V and VI.**

Response - As you know, the operation of the site is conducted in phases. Although PPS-B is located in Phase VI, Phase V will receive waste prior to Phase VI, and the 18-inch diameter main access pipe will pass through the separation berm between Phases V and VI. The berms are lined with a geomembrane to allow for separation of stormwater and leachate when Phase V becomes active. Therefore, the liner boot will be necessary to allow for the separation of stormwater and leachate between Phases V and VI.

Items labeled as "not in contract" are related to the 18-inch access pipe, and are delayed in order to allow for improvements to the existing LCRS in Phases V and VI, if required. As shown in the Construction Permit Application Section B on Drawing 5, the existing LCRS pipes are typically located deeper than the 18-inch access pipes. We have recommended the installation of the 18-inch diameter access pipes after the improvements to the LCRS are made in order to minimize construction conflicts.

As requested by the FDEP in our meeting on November 25, 1997, the vault has been modified to include an opening at the top, as shown on Drawing No. 7 of the Construction Permit Application (Attachment 1) to allow the HCSWMD to evaluate the performance of the vault before waste is placed in Phase VI. In addition, as we discussed, Drawing No. 4 was revised to eliminate the 90 degree connection from the eastern LCRS pipe (Attachment 1).

11. FDEP Statement 11 - **Please provide an evaluation for use of a sleeve (outer pipe) around each pipe that enters the vault to allow for the inner pipe to move due to settlement while the outer pipe remains in place as an extension to convey leachate into the vault and minimize forces on the inner pipe along the vault wall.**

Response - The pipe calculation for estimating settlement in the 18-inch diameter access pipe in Attachment D of the Construction Permit Application indicates that the estimated settlement in the vault to be 3.64 feet. On Drawing 3 of the Construction Permit Application, the 18-inch diameter access pipe is estimated to be 1,250 feet in length. The resulting increase in pipe length after the phosphatic clay settles is estimated to be less than 0.1 feet. The movement of the pipe at the vault is anticipated to be small enough that an outer sleeve to accommodate movement would not be necessary.

12. FDEP Statement 12 - **Please provide calculations for the vertical loading and horizontal pressure of 9,800 psf used as the basis for the vault and pipe calculations which should be based on and worst case conditions including maximum percent moisture, initial and intermediate cover soil, and at least 150 feet of fill. Please provide the basis for the assumption of no more than one foot of leachate above the pipes and an unsaturated soil condition as used for the vault calculations. Is the pump control designed to allow a full vault of leachate? Please provide the structural calculations based on worst case conditions.**

Response - The calculations which demonstrates the resulting vertical load on the vault to be 9,800 pounds per square foot (psf) are presented in Attachment 2. The calculated value of 9,800 psf represents the worst case scenario where the entire static load is acting on the vault, which is a conservative design when considering that soil arching will reduce the effective force exerted on the vault when the waste fill is over 30 feet high. As stated in Attachment D of the Construction Permit Application, the waste unit weight was obtained from test pits information at the SCLF. The test pits were representative of the in-place waste layers at the SCLF and included cover soils.

The design calculations for the concrete vault were re-evaluated to account for a submerged condition and a submerged condition was found to have no impact on the vault dimensions (see Attachment 3). As described in Section 2.4.3 of the Construction Permit Application, the pump controls were designed to allow for 20 inches of leachate inside the vault under normal operating conditions.

13. FDEP Statement 13 - **What is the safety factor for pipe ring deflection under worst case conditions? Please provide a copy of the entire Driscopipe Design Manual and a manufacturers list of projects with contacts for sites using the pipe for similar uses and loading conditions.**

<u>Response</u> - The pipe calculation for estimating the Standard Dimension Ratio (SDR) for the 18-inch diameter access pipe in Attachment D of the Construction Permit Application estimates that approximately 3.2 percent ring deflection will occur. The pipe is manufactured to provide a maximum safe ring deflection of 3.4 percent (including a safety factor of 2). Mr. Ross Carter representing FifePipe which distributes Driscopipe has been contacted (at 813-681-3765) and will submit their design manual to the FDEP under a separate cover to these responses.

14. <u>FDEP Statement 14</u> - **There appears to be an abrupt change in the slope of each pipe from invert elevation of 119.0 to the end of the pipe in the vault. How does this affect the pipe placement and would the system be better served by laying the pipe slightly into the underlying clay if necessary and maintaining a constant slope? Is geogrid required to provide support for these pipes?**

<u>Response</u> - The approximate bending radius of the HDPE pipes from elevation 119 to the vault is 200 feet. HDPE pipe manufacturer's recommendations allow for as little as a 30-foot diameter radius for an 18-inch pipe. The change in slope shown on the Construction Permit Application Drawings (Drawings) appears to be "abrupt" because of the exaggerated scale used. The actual change in slope is only 4 percent. The HDPE pipes will not be affected when installed as shown on the Drawings. Other than the gravel trench, no additional foundational support for the pipes are needed.

15. **FDEP Statement 15 - Please provide the geogrid design and calculations required for worst case conditions after loading of each maximum waste disposal lift and the earliest subsequent lift. Please explain the geogrid layout shown as it relates to the orientation of the vault. If appears the corners of the vault may damage the geogrid.**

<u>Response</u> - The worst case condition for which the geogrid is needed is when the bearing capacity of the phosphatic clay is at its lowest value, which is during the initial construction phase. The geogrid is included to provide temporary support for the vault while the bearing capacity of the phosphatic clay increases over time.

Subsequent waste lifts will be supported by the phosphatic clay not the geogrid. Phase VI will receive waste lifts in accordance with the operations plan for the site, which requires a 7 year period between lifts to allow for the phosphatic clays to further consolidate and be of sufficient strength to allow for additional waste lifts.

The geogrid is placed in a manner which allows for ease of construction for the incoming leachate pipes to the vault (i.e. no geogrid penetration). The geogrid will be protected from potential damage by the concrete vault with 6 inches of gravel as shown on the Drawings.

Please do not hesitate to call if you have any questions.

Very truly yours,

Larry E. Ruiz
Senior Project Engineer

Robert B. Gardner, P.E.
Vice President
SCS ENGINEERS

LER/RBG:kas
attachments

cc: Patricia V. Berry, HCSWMD
Paul Schipfer, Hillsborough County Environmental Protection Commission

Attachment 1

Drawing Nos. 4, 6 and 7

Attachment 2

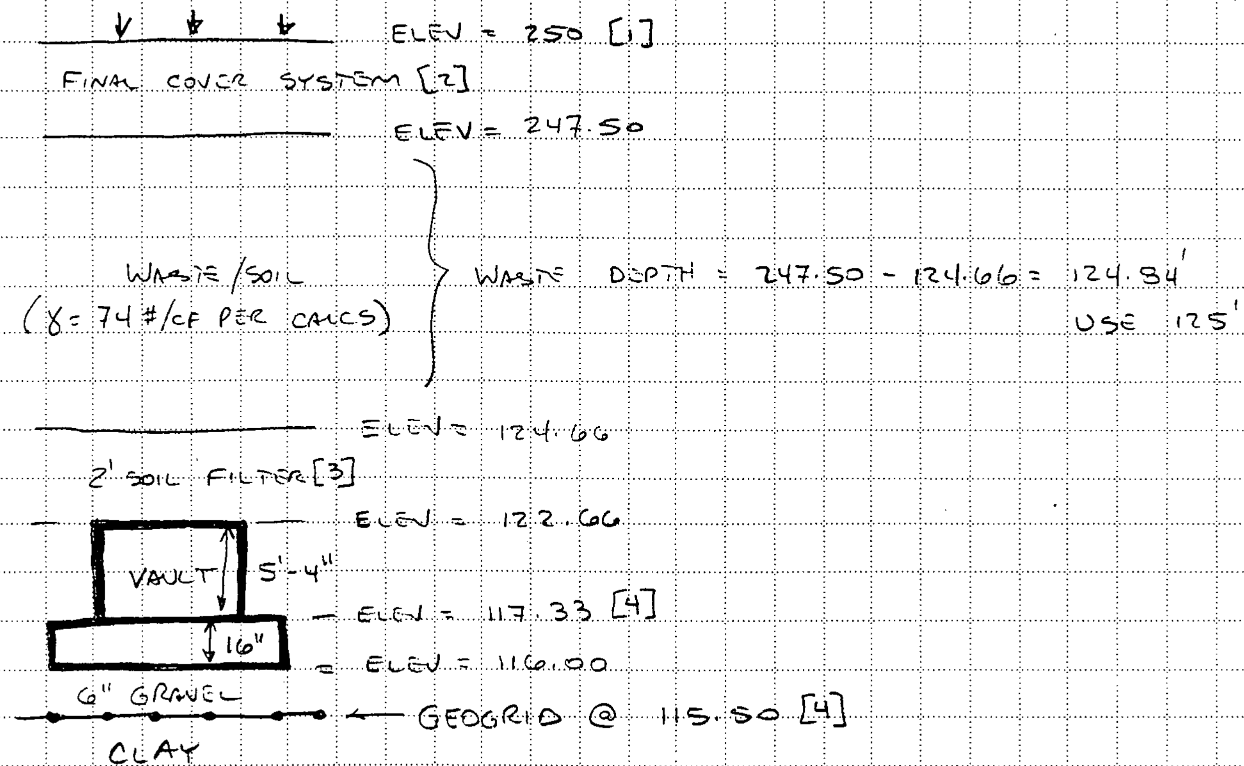
Pressure Calculation

SCS ENGINEERS

SHEET 1 OF 1

CLIENT	PROJECT	JOB NO.
HILLS. CNTY	PPS-B	0995029.13

SUBJECT	BY	DATE
RESPONSES TO FDEP	KAS	12-22-97
— VAULT VERTICAL LOADING CALCULATION	CHECKED JGR	DATE 12/22/97



NOTES:

[1] ATTACHMENT "D" OF CONSTRUCTION PERMIT APPLICATION, CLAY SETTLEMENT CALCULATION, FINAL ELEV. COLUMN IN SPREADSHEET. (CONSERVATIVE ESTIMATE. ELEV. MAY BE LOWER DUE TO SETTLEMENT).

[2] INCLUDES 2' PROTECTIVE SOIL LAYER OVER 40 MIL GEOMEMBRANE WHICH LIES OVER 6" SOIL BEDDING LAYER. γ = 110 #/CF

[3] CONSISTS OF SAND/GRAVEL MIX. USE γ = 135 #/CF PER CALCS.

[4] PER DRAWING NO. 6 OF 7.

ACTING FORCE ON VAULT TOP = SOIL FILTER + WASTE + COVER SYSTEM

= 2' * 135 #/CF + 125' * 74 #/CF + 2.5' * 110 #/CF

= 270 PSF + 9,250 PSF + 275 PSF

= 9,795 PSF

USE 9,800 PSF

Attachment 3

Tondelli Response

TONDELLI ENGINEERING, P.A.
CIVIL, MECHANICAL, STRUCTURAL AND BUILDING DESIGN

December 18, 1997

RECEIVED
DEC 22 1997
SCS-TAMPA

Mr. Karl Schmit
SCS ENGINEERS
3012 U.S. Hwy 301 N, Ste. 700
Tampa, FL 33619

Your Ref: Southeast Landfill Concrete Vault for Dewatering FDEP Comments
Our Ref: TE-1674

Dear Karl:

I have reviewed the structurally related comments from FDEP in regards to the above referenced vault.

In item #7, the vault will not be affected in any way if the leachate is 2 ft. or more above the bottom of the excavation. This goes in hand with comment #12, which requests the effect of the vault under complete submersion of leachate. The only structural considerations for this condition would be buoyancy and corrosion. Buoyancy would be most critical when the vault is empty, not completely covered by fill and under leachate. The buoyancy, due to the interior volume of the vault, would be a maximum of 24,000 lbs. of uplift. However, the vault, as can be seen on the calculations, weighs over 90,000 lbs. Therefore, we do not foresee any structural problems if the vault is completely submerged under leachate. The lateral loading would not change to any detrimental extent.

For corrosion problems, it is recommended that the reinforcement for the vault be epoxy coated with rust inhibiting epoxies such as Master Builders Concresive 1170. This is in addition to using type II cement and sealing the concrete surfaces with epoxy coating as per the specifications.

For observation prior to backfilling the vault, placing a 3' diameter hole on the top of the vault is possible. Covering the opening with a future precast slab is acceptable. Enclosed are sketches for the reinforcement that is required for this opening and the future slab.

If you need additional information, please do not hesitate to contact me at your convenience.

Sincerely,

TONDELLI ENGINEERING, P.A.

Juan B. Tondelli, P.E.
President

Encl.

1674-1.rpt

3606 West Swann Avenue • Tampa, Florida 33609 • Phone 813/875-2929 • *Fax 813/874-3001*

TONDELLI ENGINEERING, P.A.
3606 W. Swann Avenue
Tampa, FL 33609
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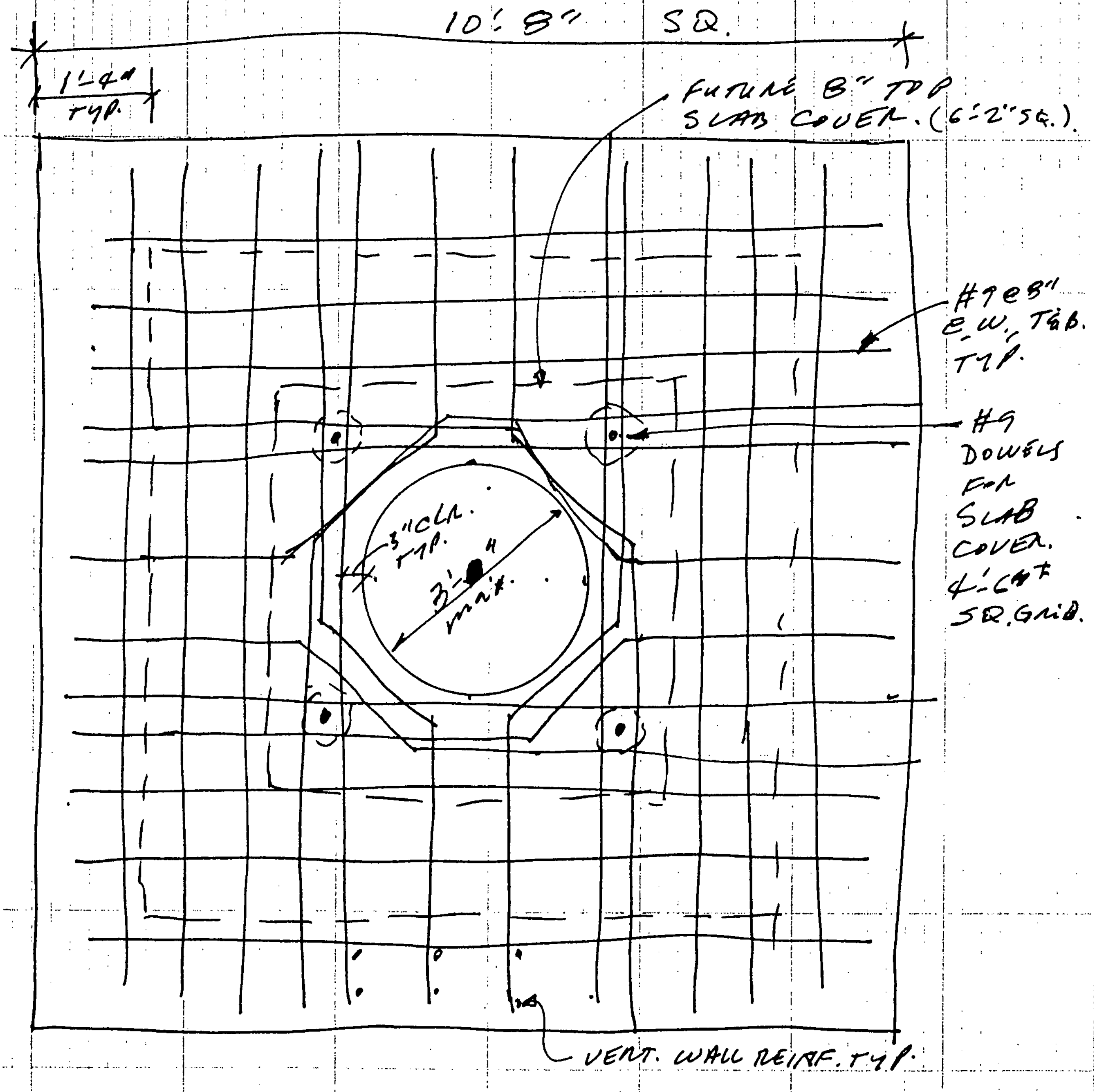
Fax 813/874-3001

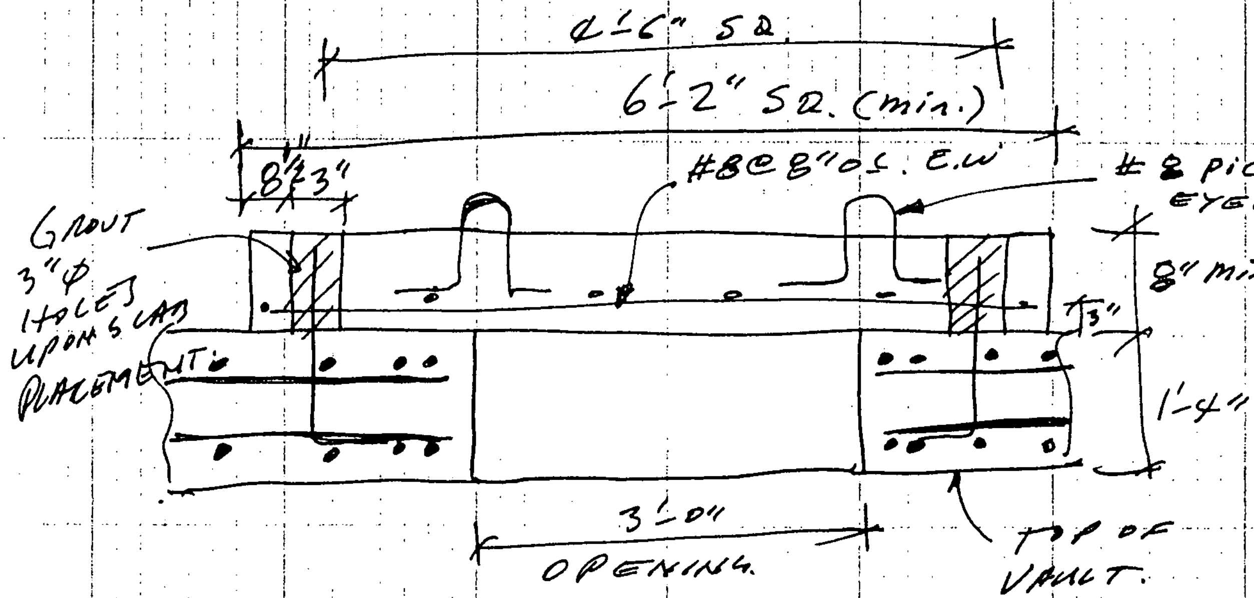
Customer: SCS		Page: 1X of
H.C. S.E. LANDFILL CONCR. VAULT		Job: TE-1674
Description: TOP SLAB OPENING.		Date: 12/18/97
		By: J. TONDELLI



TOP VAULT OPENING

TONDELLI ENGINEERING, P.A.
3606 W. Swann Avenue
Tampa, FL 33609
813/875-2929
Fax 813/874-3001

Customer: SCS	Page: 2x of
H.C. LANDFILL CONC. VAULT	Job: TE-1674
Description: TOP SLAB COVER.	Date: 12/18/97
	By: J. TONDELLI



NOTE: ALL STEEL REINFORCEMENT BARS SHALL BE EPOXY COATED WITH MASTERBUILDERS CONCRESIVE 1170.

CONCRESIVE® 1170

Protective Coating

MASTER BUILDERS
Epoxy Coating Systems

TECH DATA

DESCRIPTION

CONCRESIVE 1170 is a rigid, moisture-insensitive, epoxy coating. This general purpose coating can be used for both vertical and horizontal surfaces.

Typical Uses

- Coating concrete, cinder block, masonry and wood to provide a waterproof, chemical-resistant barrier
- Coating steel for corrosion protection

Advantages

- USDA approved, accepted by the Canadian Dept. of Agriculture
- High solids
- Provides a tough, tile-like finish
- Resistant to moisture
- Good chemical resistance
- Can be applied on both dry and damp surfaces[1]

Colors

Available in gray only.

PHYSICAL PROPERTIES[2]

Mix Ratio, by volume		2:1
Density, lb/gal		
Part A		12.6
Part B		8.1
Mixed		11.5
Viscosity, poise		
Part A		40
Part B		55
Mixed		45
	50°F 10°C	**77°F 25°C**
Pot Life, min		
1 quart	85	30
1 gallon	60	25
Thin Film Hard Dry Time, hr	24	6.5
Full Cure Time, day	14	7
Tensile Strength, psi (ASTM D 638)		6,000
MPa		41.4
Elongation @ Break, %. (ASTM D 638)		2.5
Compressive Strength, psi (ASTM D 695)		7,500
MPa		51.7
Compressive Modulus, psi (ASTM D 695)		3.0×10^5
Heat Deflection Temperature, °F (ASTM D 648)		100
°C		38

Flexural Adhesive Strength, psi	
Dry Concrete	> 210
Water Saturated Concrete (ASTM C 293[3])	> 160
Abrasion Resistance, mg (ASTM D 4060)	110

[1] Use on damp surfaces or in very humid weather may result in some color variation, but will not otherwise affect adhesion or cured properties.
[2] The properties listed on this data sheet are typical and descriptive. Cure time 7 days; Test and cure temperature 77°F (25°C).
[3] Bonded broken beam test.

LIMITATIONS

- Surface and air temperature should be at least 40 °F (4 °C) during installation and initial cure.
- Do not apply when free-standing water is present on surface to be top coated.
- Movement of sub-floor cracks may transmit through the coating.
- Not recommended for continuous immersion in organic acids such as acetic, in strong solutions of mineral acids, bleaches and other highly corrosive chemicals or in hot water above 140°F (60°C).

APPLICATION

Coverage Rates

175 ft²/gal. (4.29 m²/liter)

Packaging

1, 3, 15, 150 gallon (3.8, 11, 58, 568 liter) units

Surface Preparation Procedures

Concrete Surfaces
Substrate to receive CONCRESIVE 1170 should be clean, sound and dry and free of all contaminants detrimental to proper bonding. Surface should be checked for soundness and any "hollow" areas should be removed. All depressions or spalled areas; and cracks 1/16 inch (1.6 mm) or more wide should be pre-filled. Concrete substrate should have laitance removed by shot blast method. Detailing work such as injection, patching, and treatment of control and expansion joints, shall be specified per manufacturer's recommendation.

Steel Surfaces
Remove dirt, grease, and oil with suitable industrial grade cleaning or degreasing compounds.

Remove rust and mill scale by gritblasting. Blast steel to white metal. Follow gritblasting with vacuuming or oil free, dry air blast.

Product Application

Measure the components carefully and mix each component thoroughly. Add Part B to Part A. Mix thoroughly using an electric drill-powered paint mixer. Carefully scrape the sides and bottom of the container while mixing. Proper mixing will take about three to five minutes.

Master Builders

Apply by stiff brush, short-nap roller, squeegee or airless spray gun.

To avoid pinholing, apply two or more thin, 8 to 10 mil coats, rather than one thick coat. The second coat may be applied as soon as the first is touch dry. To ensure proper adhesion between coats, the maximum time between coats should be:

72 hours @ 60°F (16°C)
36 hours @ 77°F (25°C)
24 hours @ 90°F (32°C)

CLEAN UP

Mixed epoxy is much easier to clean up before it hardens - solvents such as acetone, methyl ethyl ketone (MEK) or toluene may be used. Commercial epoxy strippers such as CONCRESIVE 6003 or commercial solvents are recommended for hardened epoxy. Consult solvent manufacturer's usage recommendations.

SAFETY

Ensure adequate ventilation. Wash thoroughly after handling. The use of barrier creams is recommended. Clean rubber gloves or disposable polyethylene gloves should always be worn.

For detailed safety guidelines, please refer to the product Material Safety Data Sheet (MSDS).

TECHNICAL ASSISTANCE

For technical assistance, please contact your local Master Builders Representative.

ment during the curing period and to prevent formation of surface cracks due to rapid loss of water while the concrete is plastic. Detailed recommendations are given in ACI 308.

When surfaces are cured with membrane curing compound, all finishing operations, except grinding, chipping, bushhammering, and sandblasting, should be completed prior to application of the membrane.

Curing should commence as soon as possible following initial set or completion of surface finishing, and as soon as marring of the concrete surface will not occur. Various methods commonly used include sprinkling, ponding, using moisture retaining covers, or applying a liquid membrane-forming curing compound seal coat to form a thin water-impervious membrane.

Leaving wall forms in place provides an excellent means of retaining moisture. However, in hot, dry weather, the dry forms tend to absorb moisture from the concrete and inhibit dissipation of the heat of hydration. Therefore, in hot, dry weather, the forms should be kept moist or removed as soon as the concrete has hardened sufficiently to prevent damage to the concrete. Moist or membrane curing should be commenced immediately after removal of the forms.

The membrane curing compound should cover the entire surface to be cured with a uniform film that will remain in place without gaps or omissions for the full duration of the curing period. Exposed steel, keyways, or concrete to be surfaced should be protected from the curing compound unless tests show that satisfactory adherence of the surface is obtained.

Membrane curing compounds should conform to ASTM C 309 and should have a minimum of 18 percent solids, be nonyellowing, and have a unit moisture loss of less than 0.039 gm/cm^2 maximum at 72 hr. Rate of application of curing compounds should follow manufacturer's recommendation or be in the range of 150 to 200 ft^2/gal. [See Section 2.3.3 of ACI 308-81 (Revised 1986)]. Polyethylene film for curing concrete should conform to ASTM C 171. Curing compounds used in water treatment plant construction must be nontoxic and free of taste and odor.

4.7 — Leakage testing

It is normal practice to test liquid-retaining structures for water tightness. The leakage test should be performed while the tank walls are exposed so that leaks can be easily found and repaired. Thus, leakage tests usually are performed prior to backfilling or cladding the tank. For potable water facilities, the leakage test is often done in conjunction with the disinfection in order to save water.

The acceptance leakage criteria and method of test should be specified in the construction contract. Tanks generally are filled to full overflow level. If the structure has dried out, the water should be left standing for a period to allow for absorption. Tanks are usually considered acceptable if:

a. There are no visible leakage or visible damp areas, and

b. The volume of leakage in a given time period (after correcting for evaporation losses) is less than a specified amount.

Acceptable leakage volumes will vary depending on the specific application. Leakage rates of $\frac{1}{10}$ of 1 percent of the tank volume in any 24 hr period (after absorption and stabilization) would be generally acceptable for a water reservoir where the consequences of leakage would not be significant.

CHAPTER 5 — PROTECTION AGAINST CHEMICALS

5.1 — Resistance of concrete and reinforcing steel

Concrete made with the proper type of cement, which has been properly proportioned, batched, mixed, placed, consolidated, and cured, will be dense, strong, watertight, and resistant to most chemical attack; therefore, under ordinary service conditions, quality concrete does not require protection against chemical deterioration or corrosion. Likewise, reinforcement embedded in quality concrete normally is well-protected against corrosive chemicals.

Quality concrete, properly air entrained, is also resistant to freeze-thaw deterioration, which in many locations may be more severe than chemical action.

5.2 — Need for protection

The corrosive conditions that require concrete surface protection can range from comparatively mild to very severe, depending on the chemicals used and the domestic and industrial wastes encountered.

The type of protection employed against chemical attack will also vary according to the kind and concentration of the chemical, frequency of contact, and physical conditions such as temperature, pressure, mechanical wear or abrasion, and freeze-thaw cycles.

Where conditions exist that may be expected to deteriorate, remove, or otherwise destroy the concrete immediately around the reinforcing steel, direct protection of the reinforcing steel, such as epoxy coating as specified in ASTM A 775, may be desirable.

5.3 — Types of protection

Many types of protective coatings or barriers will prevent contact with the concrete surfaces. To be successful, such coatings should exhibit good adhesion to the concrete and be completely impervious.

Among these are various coatings of thermoplastic and thermosetting types, ceramics, chemical-resistant mortars, sheet or linear materials, and composite barriers.

If conditions are severe enough to deteriorate good-quality concrete, it is difficult to provide complete and lasting protection, even with the best of these types of protection. Consideration should be given to neutralizing severely aggressive liquid wastes.

When special protection is required for the reinforcing bars, epoxy-coated bars are preferable. Specifications for such coatings should be patterned upon ASTM A 775.

5.4 — Recommended coatings

5.4.1 *Water treatment plants* — In general, normal concentrations of the chemicals used in water treatment plants for coagulation, taste and color control, and disinfection do not affect concrete, except for liquid alum, which requires a continuous, inert barrier, such as PVC or rubber, at least 20 mils (0.508 mm) in thickness.

5.4.2 *Domestic sewage plants* — Concrete in domestic sewage treatment plants seldom requires special protection, although the mechanical equipment in such environments generally is provided with a protective coating of coal-tar-based paint or some type of epoxy due to its much greater susceptibility to damage from mildly corrosive conditions.

In exceptional cases, for example, where hydrogen sulfide evolves in a stagnant, unventilated environment that is difficult or uneconomical to correct or clean regularly, a coating such as that normally provided for metal may be necessary. Care should be exercised in using such coatings, and they should be fully tested to insure their suitability for the proposed application.

5.4.3 *Industrial wastewater treatment plants* — Industrial wastewater treatment may at times involve acid waste with pH as low as 1.0. The type of protection generally used is chemical-resistant mortar, acid proof brick or tile, thick bituminous coatings, epoxies, and heavy sheets or liners of rubber or plastic.

5.4.4 *Protection of floors in treatment plants* — Concrete floors, where occasional spillage of acids may occur, should be protected with vinyl lacquer, epoxy, chlorinated rubber, or phenolic coatings.

5.5 — Selection of protection system

Each project should be considered individually because various materials and techniques used from time to time cause new problems of chemical attack. Detailed recommendations are given in ACI 515.1R.

Manufacturers of protective materials should be consulted for information on the best preparation of concrete surfaces and the proper mixing and application of their coating products. It is important that the surfaces be clean, dry, and sound in order to obtain proper coverage and bond. Generally, muriatic acid washing and/or sandblasting are recommended for cleaning.

5.6 — Safety precautions

The toxicity of any product should be investigated. When applying coatings, the need for ventilation should be checked. Required protective equipment such as gloves, goggles, and masks should also be checked before application.

5.7 — Chemicals used in treatment plants

Chemicals sometimes encountered in water and wastewater treatment were previously listed in Table 2.3.2. Some type of protection may be required where some of these materials contact concrete surfaces. Table 2.5.2 of ACI 515.1R provides additional information on the effect of chemicals on concrete.

Group 1

These chemicals are not considered harmful to concrete but are listed because in some instances treatment is desired to prevent staining or the absorption of liquid into the concrete which may react with other chemicals in the future.

Activated carbon (except when agitated, then in Group 3)
Activated silica (except when agitated, then in Group 3)
Calcium hydroxide
Calcium oxide
Potassium permanganate
Sodium bicarbonate*
Sodium carbonate
Sodium fluoride
Sodium hydroxide (except over 20 percent concentration, then in Group 3)
Sodium silicate
Sodium siliconfluoride
Trisodium phosphate

Group 2

Concrete exposed to the chemicals listed in this group should be made with sulfate-resistant cement (see Section 3.1) or should be given a protective coating, as described in Section 5.4.
Copper sulfate
Ferric sulfate

(Type II, V or "K" Cement,

Group 3

Concrete should be protected against these chemicals with a protective coating, as described in Section 5.4.

Activated carbon (when not agitated, then in Group 1)
Activated silica (when not agitated, then in Group 1)
Alum, liquid
Aluminum ammonium sulfate
Aluminum chloride solution
Aluminum potassium sulfate
Aluminum sulfate
Ammonium sulfate
Calcium hypochloride
Chlorine
Ferric chloride
Fluosilicic acid
Sodium bisulfite
Sodium hydroxide (except less than 20 percent concentration, then in Group 1)
Sulfuric acid

Use epoxy coated rebars & epoxy sealant.

CHAPTER 6 — REFERENCES

6.1 — Recommended references

The documents of the various standards-producing organizations referred to in this document are listed below with their serial designation, including year of adoption or revision. The documents listed were the

*Caution with respect to alkali-reactive aggregate.