

**CITY OF SAN ANGELO
SAN ANGELO LANDFILL
TOM GREEN COUNTY, TEXAS
TCEQ PERMIT NO. MSW 79**

**SITE DEVELOPMENT PLAN
AND
PERMIT MODIFICATIONS
(THROUGH DECEMBER 2013)**

Prepared for



City of San Angelo

Volume 1 of 3

Prepared by



BIGGS & MATHEWS ENVIRONMENTAL
1700 Robert Road, Suite 100 ♦ Mansfield, Texas 76063 ♦ 817-563-1144

**CITY OF SAN ANGELO
SAN ANGELO LANDFILL
TOM GREEN COUNTY, TEXAS
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**SITE DEVELOPMENT PLAN AND
PERMIT MODIFICATIONS
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VOLUME 1 OF 3

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(Issued January 27, 1984)

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Texas Department of Health

Robert Bernstein, M.D., F.A.C.P.
Commissioner

Robert A. MacLean, M.D.
Deputy Commissioner
Professional Services

Hermas L. Miller
Deputy Commissioner
Management and Administration

1100 West 49th Street
Austin, Texas 78756
(512) 458-7111

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Permit No. 79-A

Coordinates: N 31°30.35' W 100°23.25'

PERMIT FOR A MUNICIPAL SOLID WASTE FACILITY
issued under provisions of Article 4477-7, Vernon's
Texas Civil Statutes, and the Texas Department of Health's
"Municipal Solid Waste Management Regulations"

Permittee

City of San Angelo
P. O. Box 1751
San Angelo, Texas 76902

Tract No. 1

City of San Angelo
P. O. Box 1751
San Angelo, Texas 76902

Site Owners

Tract No. 2

Mr. Drew J. Wall
Route 1, Box SE-62
Palmer, Texas 75152

Legal Description of Site: The legal description as submitted with the
application is hereby made a part of this permit.

Size and Location of Site: The site consists of 257.7 acres of land and is located
northeast of San Angelo on the north side of Old U.S. Highway 67/277 (Old Ballinger Hwy.)
and the AT & SF Railroad, and approximately 1.8 miles northeast of the intersection of
Bell Street and Old U.S. Highway 67/277, in Tom Green County.

Operational Classification of Site: Type I

Waste Disposal Methods Used at Site: Trench and area methods of disposal with
compaction of solid waste and cover with a minimum of six (6) inches of compacted earth
not less often than once on each day of operation.

Description of Waste Materials Processed at Site: Solid waste under the
regulatory jurisdiction of the Texas Department of Health, when disposed of or
processed in accordance with the Department's "Municipal Solid Waste Management
Regulations."

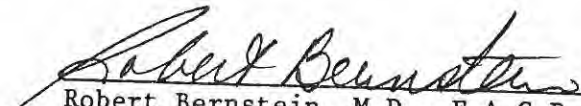
Findings of Fact and Conclusions of Law: Attached hereto and made a part hereof.

Standard Provision: Acceptance of this permit constitutes an acknowledgement that the
permittee will comply with all of the terms, provisions, conditions, limitations and
other restrictions embodied in this permit; with the "Municipal Solid Waste Management
Regulations" of the Texas Department of Health; and with the pertinent laws of the State
of Texas.

Special Provisions: None.

This permit will be valid until cancelled or revoked by the Commissioner of Health of the
Texas Department of Health or until the site is completely filled and rendered unusable,
whichever occurs first.

Given under my hand and Seal of Office at Austin, Texas, on the 27th day of
January 1984.


Robert Bernstein, M.D., F.A.C.P.

LEGAL DESCRIPTION OF TRACTS
OF LAND FOR USE BY
THE CITY OF SAN ANGELO
AS A SOLID WASTE DISPOSAL SITE

STATE OF TEXAS

Ø

COUNTY OF TOM GREEN

Ø

Tract No. 1

131 acres of land out of the middle part of Survey No. 179, Washington County Railroad Company, Certificate No. 28/45, Abstract No. 4032, Patent No. 47, Volume 1, dated July 8, 1974, described by metes and bounds as follows:

BEGINNING at a point in the south line of Old San Angelo and Robert Lee Road and being 2599.74' east and 25' south of the northwest corner of said Survey 179, a set rock;

THENCE with the south line of said road east 1169.32', a stake;

THENCE south 4444.0' a stake in a stone mound in the north line of G.C. & S.F.R. Company right-of-way;

THENCE with north line, south (53'30") west 1310.98';

THENCE west 119.43';

THENCE north 5277.25' to the place of BEGINNING, containing 131 acres of land, more or less, and being the land described in the deed from M. B. McCarroll, et al., to Emmett Wilson, dated March 26, 1928, and recorded in Volume 141, page 481 of the deed records of Tom Green County, Texas.

Tract No. 2

Being 137.449 acres of land including 2.359 acres in county roads on the North and East sides, 1.912 acres fenced out on the West side and 7.680 acres in Old U.S. Highway 67 (no easement found in abstract) and AT & SF Railroad right-of-way on the South side as described in deed from John Gaddis to The Gulf Colorado and Santa Fe Railway Co. dated June 2, 1888, and recorded in Volume Y at page 109 of the Deed Records of Tom Green County, Texas, and being subject to that certain 30 foot wide strip on the East side described in deed for road purposes from W. A. Gaddis to Oscar Frank, County Judge dated December 4, 1916, and recorded in Volume 78 at page 563 of said Deed Records. Said 137.449 acres also being subject to a right-of-way deed from S. A. McCarroll, et al to

Western Gas Service Co. dated August 9, 1927, and recorded in Volume 138 at page 13 of said Deed Records. Said 137.449 acres being all of that certain "131.7" acre tract conveyed from S. A. McCarroll, et ux to D. D. Wall by deed dated July 13, 1939, and recorded in Volume 201 at page 550 of said Deed Records except that certain "5" acres conveyed from D. D. Wall to I. J. Curtsinger, County Judge by deed dated March 8, 1948, and recorded in Volume 267 at page 77 of said Deed Records. Said 137.449 acres being out of the N.E. part of W. C. R.R. Co. Survey 179, Abstract 4032, Tom Green County, Texas, and being described by metes and bounds as follows:

Beginning at a 5/8" iron rod having coordinates on the Texas Coordinate System-Central Zone of Y=670, 976.79 feet and X=1, 982,335.25 feet set in pavement in an East-West county road, known as "50th Street" or "Dump Ground Road" for the N.W. corner of this tract from which a 5/8" iron rod set for the N.E. corner of that certain "131" acre tract conveyed from the First City National Bank of San Angelo to the City of San Angelo by deed dated January 10, 1978, and recorded in Volume 669 at page 562 of said Deed Records bears S. 00°15'02"W. 25.00 feet. Said beginning 5/8" iron rod being in the North line of said Survey 179 located 3770.16 feet S.89°40'11"E. from its N.W. corner.

Thence with the North line of said Survey 179 and the North line of said "131.7" acre tract, S.89°40'11"E., at 2.11 feet a N.W. fence corner post bears S.00°15'02"W. 28.67 feet, at 1162.93 feet cross gas line, at 1450.63 feet pass the West line of said 30 foot wide strip described in deed recorded in Volume 78 at page 563, at 1468.45 feet a N.E. fence corner post bears S. 00°07'24"W. 28.67 feet, in all 1485.63 feet to a 5/8" iron rod having coordinates of Y=670,968.23 feet and X=1,983,820.86 feet, set in a North-South county road for the N.E. corner of said Survey 179 and the N.E. corner of this tract in a West line of J. Poitevent Survey 1113 from which the N.W. corner of J. Pollan Survey 3 bears N. 00°07'24"E.

Thence with the East line of said Survey 179, the East line of said "131.7" acre tract, the East line of said 30-foot wide strip and the West line of said Survey 1113, S.00°07'24"W., at 3385.81 feet pass a 5/8" iron rod having coordinates of Y=667,582.44 feet and X=1,983,813.57 feet set in the N.W. right-of-way line of said A.T. & S.F. Railroad for the S.E. corner of said 30-foot wide strip from which its S.W. corner bears S.53°43'15"W. 37.29 feet and the point of intersection of said N.W. right-of-way with the fenced West line of said North-South county road bears S.53°43'15"W. 23.09 feet, in all 3609.45 feet to a point in the S.E. right-of-way line of said Old U.S. Highway No. 67 for the Deed call S.E. corner of said "131.7" acre tract from which a fence corner post for the S.E. corner of said Survey 179 bears S.00°07'24"W. 1657.71 feet. Said fence corner post for the S.E. corner of Survey 179 being the same one described in deed from John Gordon McGill, et al to Paul L. Gregory & wife dated May 21, 1975, and recorded in Volume 625 at page 873 of said Deed Records.

Thence with the S.E. right-of-way line of Old U.S. Highway 67 and the S.E. line of said "131.7" acre tract, S.53°43'15"W. 1858.81 feet to a point for the Deed call S.W. corner of said "131.7" acre tract.

Thence across said highway and railroad right-of-way, parallel to the West line of said Survey 179 with the West line of said "131.7" acre tract N.00°15'02"E. 224.01 feet to a 5/8" iron rod having coordinates of Y=666,482.91 feet and X=1,982,315.60 feet set in the N.W. right-of-way line of A.T. & S.F. Railroad for the S.E. corner of said "131" acre tract from which a 3/4" iron pipe found in road for the S.W. corner of said Survey 179 bears S.53°43'15"W. 1326.36 feet and N.89°51'58"W. 2704.36 feet.

Thence with said N.W. right-of-way line, to and with the S.E. line of said "5" acre tract, N.53°43'15"E., at 40.82 feet the S.W. corner of said "5" acre tract from which a found 3/4" iron pipe bears S.00°03'18"E. 0.96 feet, in all 536.35 feet to a point for the S.E. corner of said "5"-acre tract from which a Cedar corner post bears S.00°08'10"E. 0.48 feet.

Thence with the fenced East line of said "5" acre tract, N.00°08'10"W. 398.49 feet to a Cedar corner post for the N.E. corner of said "5" acre tract.

Thence with the fenced North line of said "5" acre tract S.89°55'40"W. 398.02 feet to a 2" iron pipe fence corner post in a North-South fence for the occupied N.W. corner of said "5" acre tract.

Thence with the fenced West line of said "5" acre tract S.00°03'18"W. 691.32 feet to the said S.W. corner of said "5" acre tract.

Thence with said N.W. right-of-way line of A.T. & S.F. Railroad, S.53°43'15"W. 40.82 feet to said 5/8" iron rod for the S.E. corner of said "131" acre tract.

Thence with the East line of said "131" acre tract and the West line of said "131.7" acre tract, parallel to the West line of said Survey 179, N.00°15'02"E., at 3625.46 feet cross said gas line, at 4465.26 feet pass 2.11 feet N.89°40'11"W. from first said N.W. fence corner post, at 4468.93 feet pass said 5/8" iron rod set for the N.E. corner of said "131" acre tract, in all 4493.93 feet to the place of beginning and containing 137.449 acres of land.

NOTE: Courses, distances and coordinates recited herein refer to the Texas Coordinate System-Central Zone.

cc: San Angelo-Tom Green County Health Department

FINDINGS OF FACT

(1) An application for a permit to operate a proposed municipal solid waste landfill, along with all necessary supporting data, was properly submitted by the applicant; due notice was given; and a public hearing was held at the Council Chambers, 4th Floor, City Hall, City Hall Plaza & College Street in San Angelo, Texas, on December 7, 1984; and all parties were given an opportunity to appear, be represented by counsel, and present testimony or other evidence either for or against the granting of a permit.

(2) The physical conditions existing at the subject site render the site suitable for use as a landfill.

(3) Use of the subject site as a Type I municipal solid waste landfill is compatible with the present uses being made of the surrounding land.

CONCLUSIONS OF LAW

(1) All procedural requirements relative to notice, hearing and process of law were met.

(2) The subject site, if operated in compliance with the Solid Waste Disposal Act (Article 4477-7, V.A.C.S.) the Texas Department of Health Municipal Solid Waste Management Regulations will not adversely affect the public health or create a public nuisance.

(3) Operation of a Type I municipal solid waste landfill is a proper land use of the property described in the attached permit.

CERTIFICATION OF DEMONSTRATION OF
LOCATION RESTRICTIONS

John Hall, *Chairman*
Pam Reed, *Commissioner*
Peggy Garner, *Commissioner*
Anthony Grigsby, *Executive Director*



TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

Protecting Texas by Reducing and Preventing Pollution

NOV 10 1993

W. H. Wilde
Public Works Director
City of San Angelo
P. O. Box 1751
San Angelo, Texas 76902

Re: City of San Angelo Landfill
MSW Permit No. 79
Location Restrictions

Dear Mr. Wilde:

On November 1, 1993, the Texas Natural Resource Conservation Commission (TNRCC) staff received the demonstration of compliance for the Subtitle D location (30 Texas Administrative Code Subchapter L) restrictions for wetlands and fault areas for the above-referenced facility.

Based on information provided in the documentation, it appears that this facility meets the requirements regarding the Subtitle D location restrictions for fault areas and wetlands. In addition, the site also meets the requirements regarding the Subtitle D location restrictions for airport safety, floodplains, and unstable areas. This was conveyed to you in a letter dated November 1, 1993. Please enter the supporting documentation and this letter into the Site Operating Record pursuant to 30 Texas Administrative Code Section 330.113.

If you have any questions regarding this letter, please contact Susan Janek, P.E. at (512) 908-6674 or Carol White at (512) 908-6677.

Sincerely,

A handwritten signature in cursive script that reads "Mary B. Adrian".

Mary B. Adrian, P.E.
Manager
Permits Section
Municipal Solid Waste Division

cc: TNRCC Regional Office - San Angelo
Kyle B. Combest
Combest Geoscience
7122 Wood Hollow No. 7
Austin, Texas 78731

John Hall, *Chairman*
Pam Reed, *Commissioner*
Peggy Garner, *Commissioner*
Anthony Grigsby, *Executive Director*



TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

Protecting Texas by Reducing and Preventing Pollution

NOV 01 1993

W. H. Wilde
Public Works Director
City of San Angelo
P. O. Box 1751
San Angelo, Texas 76902

Re: City of San Angelo Landfill
MSW Permit No. 79
Location Restrictions

Dear Mr. Wilde:

On September 29, 1993, the Texas Natural Resource Conservation Commission (TNRCC) staff received the demonstration of compliance for the Subtitle D location (30 Texas Administrative Code Subchapter L) restrictions for the above-referenced facility.

Based on information provided in the documentation, it appears that this facility meets the requirements regarding the Subtitle D location restrictions for airport safety, foodplains, and unstable areas. Please enter the supporting documentation and this letter into the Site Operating Record pursuant to 30 Texas Administrative Code Section 330.113.

If you have any questions regarding this letter, please contact Susan Janek, P.E. at (512) 908-6674 or Carol White at (512) 908-6677.

Sincerely,

A handwritten signature in cursive script, reading "Mary B. Adrian".

Mary B. Adrian, P.E.
Manager
Permits Section
Municipal Solid Waste Division

cc: TNRCC Regional Office - San Angelo
✓ Kyle B. Combest
Combest Geoscience
7122 Wood Hollow No. 7
Austin, Texas 78731

The City Of

San Angelo, Texas

P. O. Box 1751 - Zip 76902



November 1, 1993

Ms. Susan Janek
Texas Natural Resource Conservation Commission
Municipal Solid Waste Division
P. O. Box 13087
Austin, Texas 78711-3087

Re: Permit Modification, City of San Angelo Landfill, Permit No. 79

Dear Ms. Janek:

The City of San Angelo hereby submits for your consideration the following information in connection with the permit modification that was filed in September 1993 for the City landfill, Permit No. 79. This information is provided as certification that the facility meets the location restriction of the Subtitle "D" requirements.

1. Wetlands. See certification contained in Exhibit "A".
2. Fault Areas and Seismic Impact Zones. See certification contained in Exhibit "B".

Upon approval of these certifications, this information will be incorporated into the Site Operating Plan for the facility.

Please contact me at 915-657-4206 if you need any additional information or if you have any question.

Sincerely,

Will Wilde
Director of Public Works

xc: Stephen Brown, City Manager
Adam Hernandez, Texas Natural Resource Conservation
Commission, Region 8
Kyle Combest, Combest Geoscience
Lawrence Kennedy Jr., TrashAway, Inc.

EXHIBIT "A"

Soil Conservation Service
33 East Twohig Room 108
San Angelo, Texas 76903

October 29, 1993

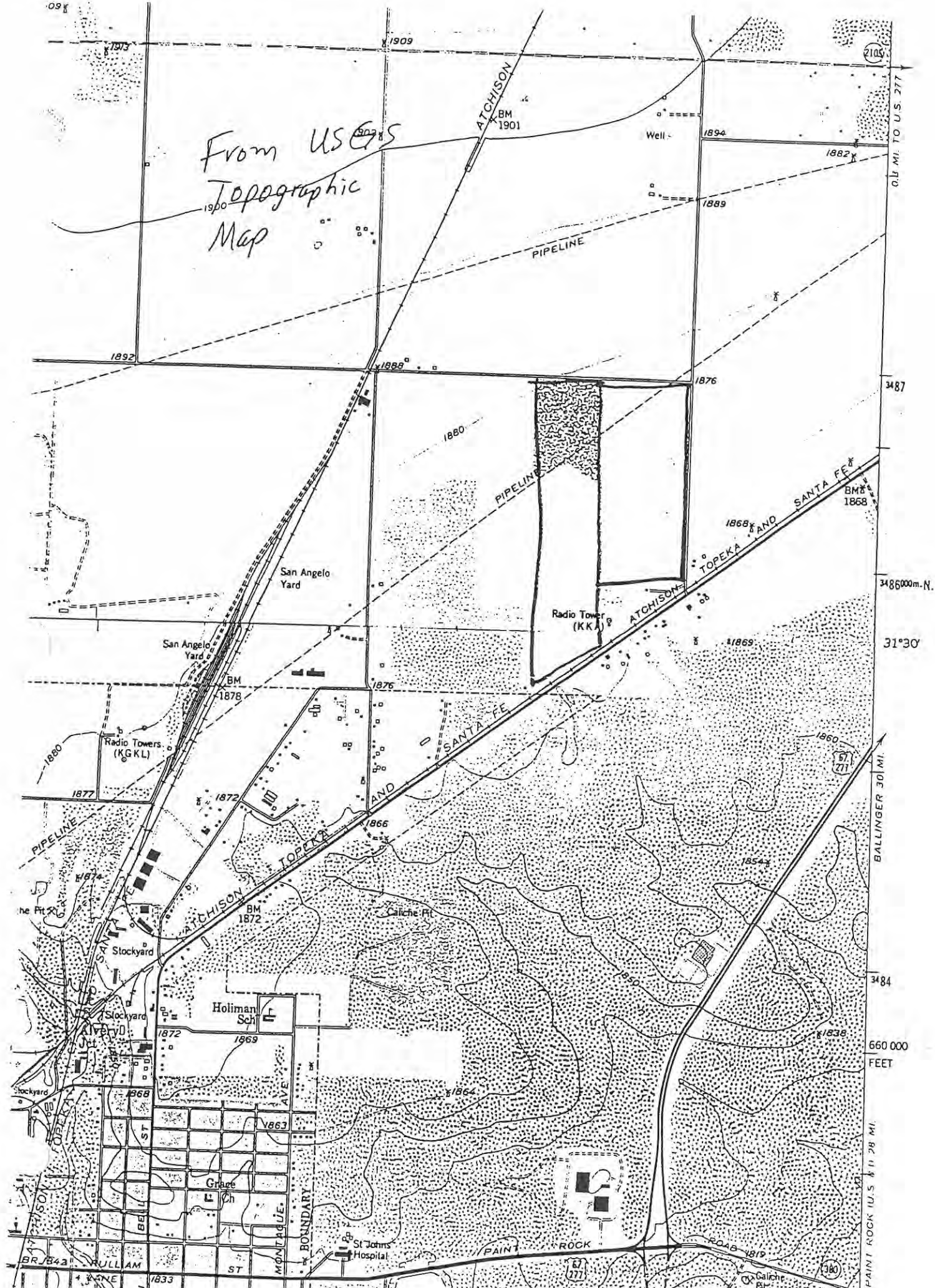
Will Wilde, Director
Public Works Department
P.O.Box 1751
San Angelo, Texas 76902

Re: Determination of Wetlands and Endangered Species
on landfill expansion site in Tom Green County

The area east of the existing landfill which is planned for expansion of the landfill does not contain any wetlands. None of the three essential wetland criteria (hydric soil, hydrology, and hydrophytic vegetation) are present on this tract of land.

Furthermore, this area is not inhabited by any federal or state listed threatened or endangered species and does not provide habitat for any such species.

Stephan A. Nelle
Stephan A. Nelle
Biologist



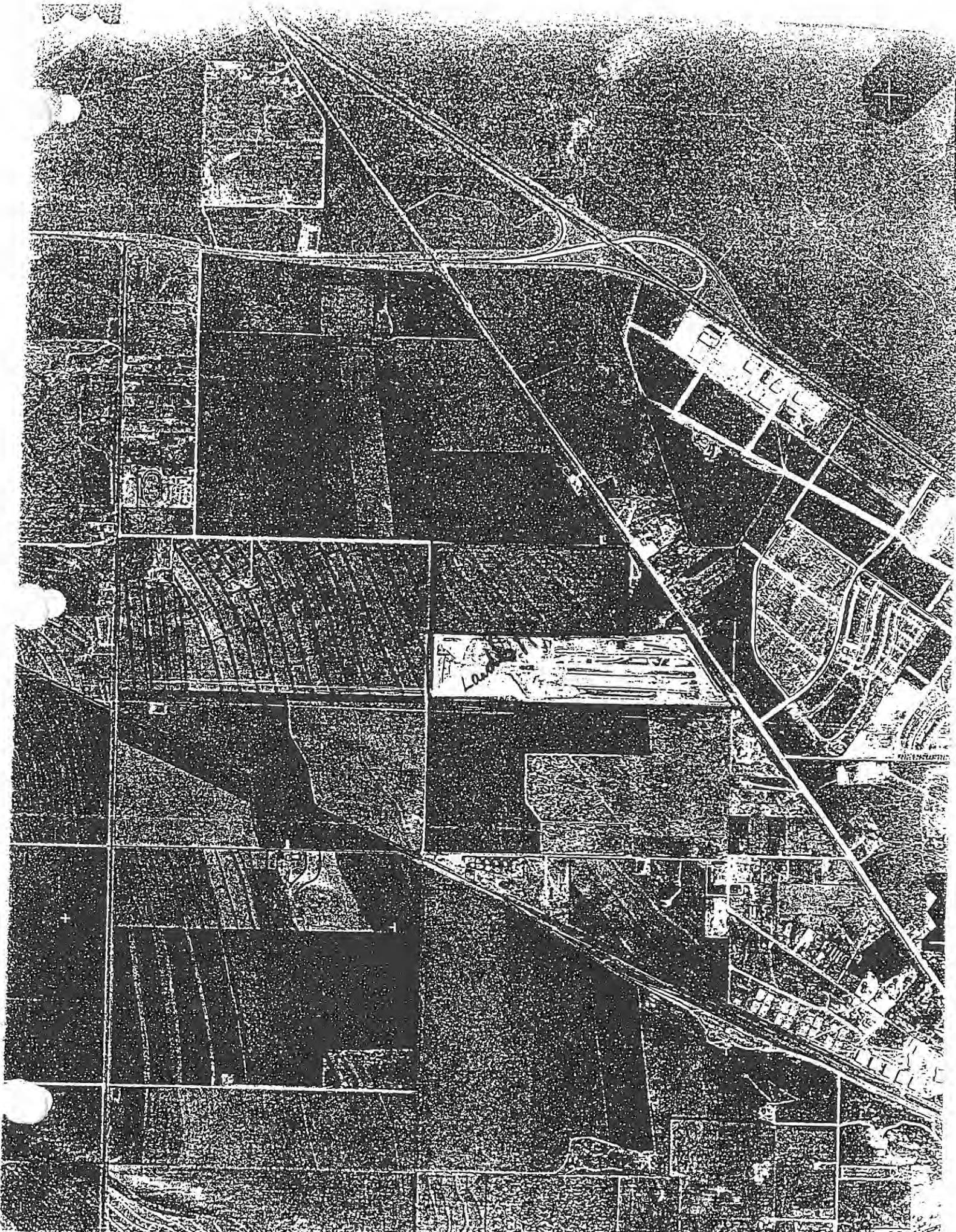


EXHIBIT "B"

20 October 1993

Ms. Susan Janek
TEXAS NATURAL RESOURCE CONSERVATION COMMISSION
Municipal Solid Waste Division
P.O. Box 13087 - Capitol Sta.
Austin, Texas 78711-3087

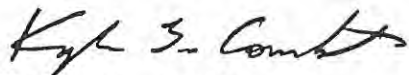
Re: Modifications to the San Angelo Municipal Landfill permit
(Permit No. #79-A).

Dear Ms. Janek:

For partial completion of modifications to the San Angelo Municipal Landfill permit, as required by the new Municipal Solid Waste Regulations, enclosed please find 3 copies of the certifications to demonstrate compliance with the "Fault Area" and "Seismic Impact Zone" location restrictions (31 TAC 330.303-304).

Once the certifications are approved, they will become part of the landfill's operating record. If you need additional information, please call me in Austin at 345-1063. Thank you.

Sincerely,



Kyle B. Combest
Environmental Geologist

cc: Mr. Will Wilde, Public Works Director
CITY OF SAN ANGELO

LOCATION RESTRICTIONS - FAULT AREAS (31 TAC 330.303)

The San Angelo Municipal Landfill has been examined in regard to the "Fault Area" location restriction which states that new units or lateral expansions shall not be located within 200-ft of a fault that has had displacement in Holocene time (31 TAC 330.303). As defined in this regulation, a fault is "a fracture or a zone of fractures in any material along which strata, rocks, or soils on one side have been displaced with respect to those on the other side" (31 TAC 330.2).

This evaluation has consisted of direct field observations of the area's soil conditions, geologic conditions, vegetation conditions, and human-made features. The evaluation also included a thorough literature review. Pertinent information was most importantly obtained from the following documents and maps:

- (1) Henderson, G.G., 1928, Geology of Tom Green County: University of Texas Bureau of Economic Geology, Bulletin 2807, 116 pp.
- (2) Texas Bureau of Economic Geology (TBEG), 1974, Geologic Atlas of Texas, San Angelo Sheet (1:250,000): Bureau of Economic Geology, Austin, Texas.

(3) Wiedenfeld, C.C. and P.H. Flores, 1971, Soil Survey of Tom Green County, Texas: United States Department of Agriculture, Soil Conservation Service, in cooperation with the Texas Agricultural Experiment Station.

(4) Willis, G.W., 1954, Ground-water resources of Tom Green County, Texas: Texas Board of Water Engineers, Bulletin 5411, prepared cooperatively by the Geological Survey, United States Department of the Interior.

A review of the landfill's soil conditions finds that the soil is almost entirely within the Angelo clay loam mapping unit (Figure 1, AnA). Only a very narrow strip along the landfill's southern boundary falls within the Slaughter-Kimbrough mapping unit (Figure 1, SkA). Throughout the area, there are no sudden soil changes that would indicate the occurrence of surface faulting. Also, there are no sudden vegetation changes in the area.

Topographically, the area's surface dips uniformly and very gradually to the southeast at approximately 20-ft/mi (Attachment 2 in Site Development Plan - USGS topographic map). There are no scarps, lineations, surface depressions, or abrupt changes in stream flow patterns that would indicate surface faulting in the area.

A published geologic map and cross section for the area indicate that nearby surface faults are not present (Figure 2).

Additionally, the aerial photograph for the landfill does not indicate any surface lineations (Attachment 4 in Site Development Plan).

No seismic activities or changes in benchmark elevations have been reported for the area. There are no nearby oil wells, gas wells, or water wells from which significant amounts of fluid are extracted that could lead to potential subsidence-faulting.

In summary, the soil conditions, geomorphic conditions, geologic conditions, vegetation patterns, and human-made features for the San Angelo Municipal Landfill area have been thoroughly reviewed for evidence of surface faulting. No evidence was found indicating the presence of surface faults within 1-mi of the facility.

Once approved by the TNRCC - Solid Waste Division, this document shall become part of the site's operating record.

Kyle B. Combest

Kyle B. Combest, CPG #8352

Environmental Geologist

Date: 20 Oct 93



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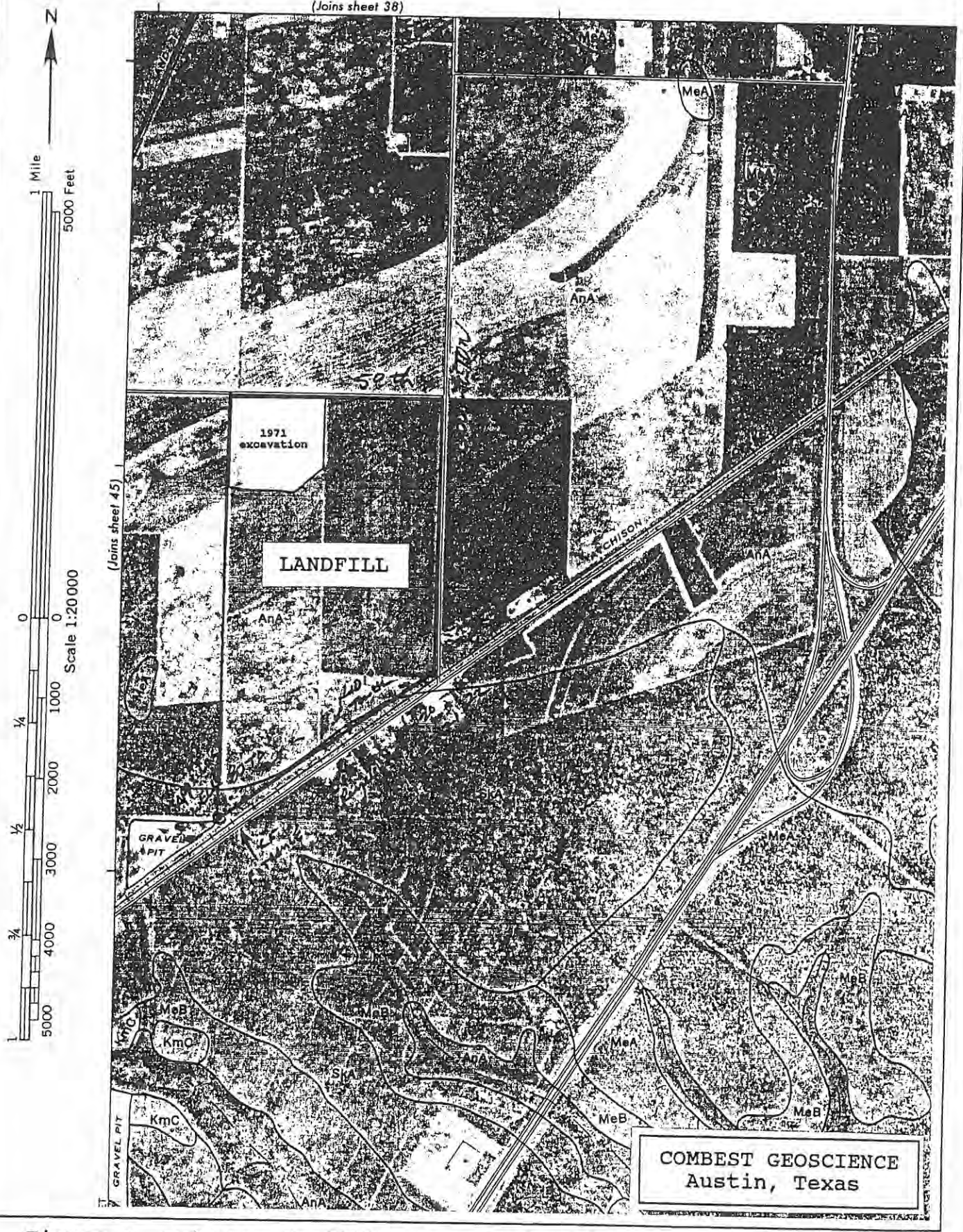


Figure 1. Soil map (modified from Wiedenfeld and Flores, 1971)

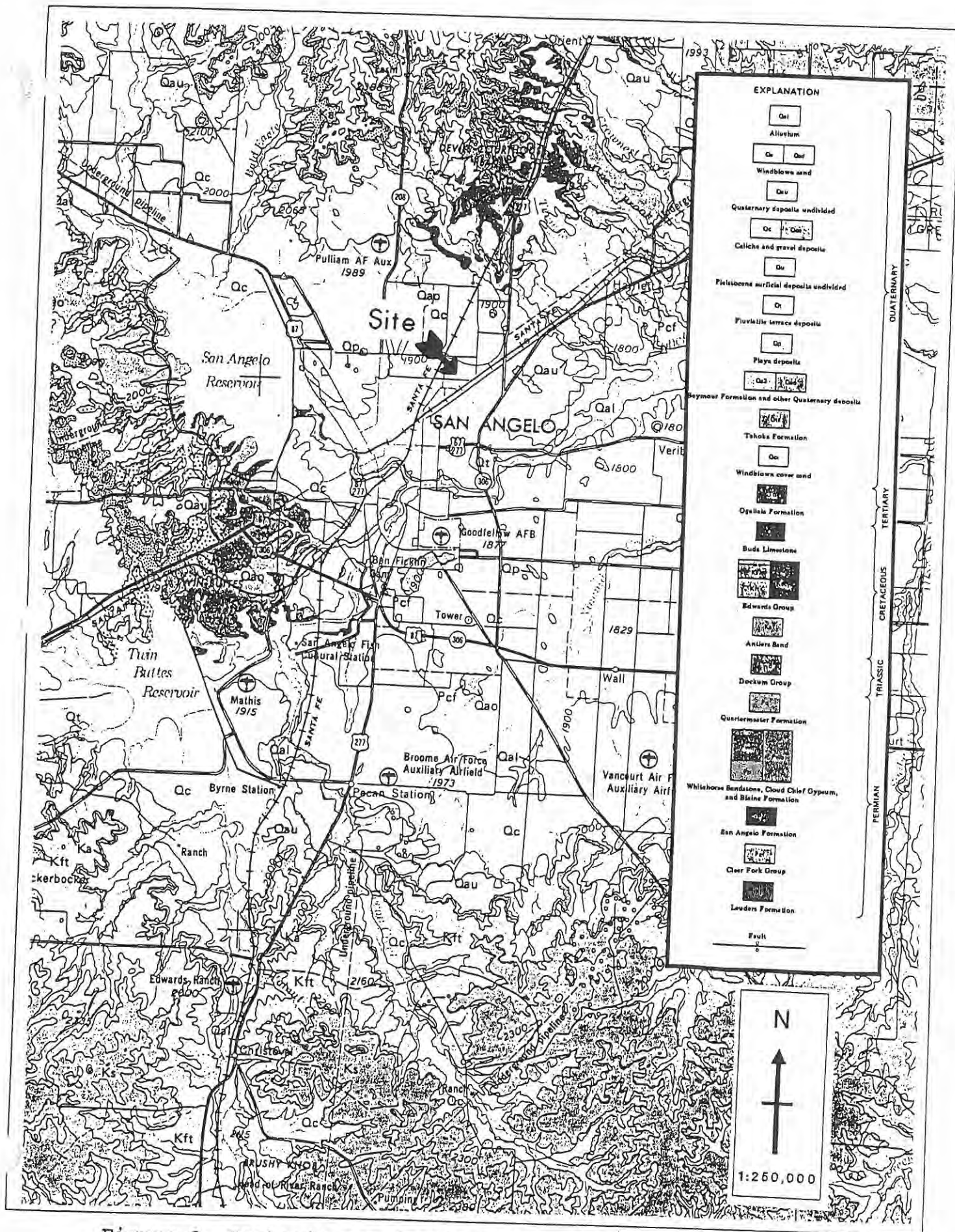


Figure 2. Geologic map (modified from Texas BEG, 1974)

LOCATION RESTRICTIONS - SEISMIC IMPACT ZONES (31 TAC 330.304)

The San Angelo Municipal Landfill has been examined in regard to the "Seismic Impact Zone" location restriction (31 TAC 330.304). As defined in this regulation, a seismic impact zone is "an area with a 10% or greater probability that the maximum horizontal acceleration in rock, expressed as a percentage of the earth's gravitational pull, will exceed 0.10g in 250 years". Maximum horizontal acceleration is defined as "the maximum expected horizontal acceleration depicted on a seismic hazard map, with a 90% or greater probability that the acceleration will not be exceeded in 250 years, or the maximum expected horizontal acceleration based on a site-specific risk assessment" (31 TAC 330.304).

This evaluation has consisted of a review of the document entitled:

Algermissen, S.T., D.M. Perkins, P.C. Thenhaus, S.L. Hanson, and B.L. Bender, 1982, Probabilistic estimates of maximum acceleration and velocity in rock in the contiguous United States: U.S. Dept. of the Interior, Geological Survey Open File Report 82-1033.

A review of the seismic zone map by Algermissen et al. (1982) indicates that there is a 90% probability that the maximum horizontal acceleration at the San Angelo MSWLF will not exceed 0.04g during a period of 250 years (Figure 1). The regulatory limit of 0.10g is therefore not exceeded.

Once approved by the TNRCC - Solid Waste Division, this document shall become part of the site's operating record.



Kyle B. Combest

Kyle B. Combest, CPG #8352

Environmental Geologist

Date: 20 Oct 93

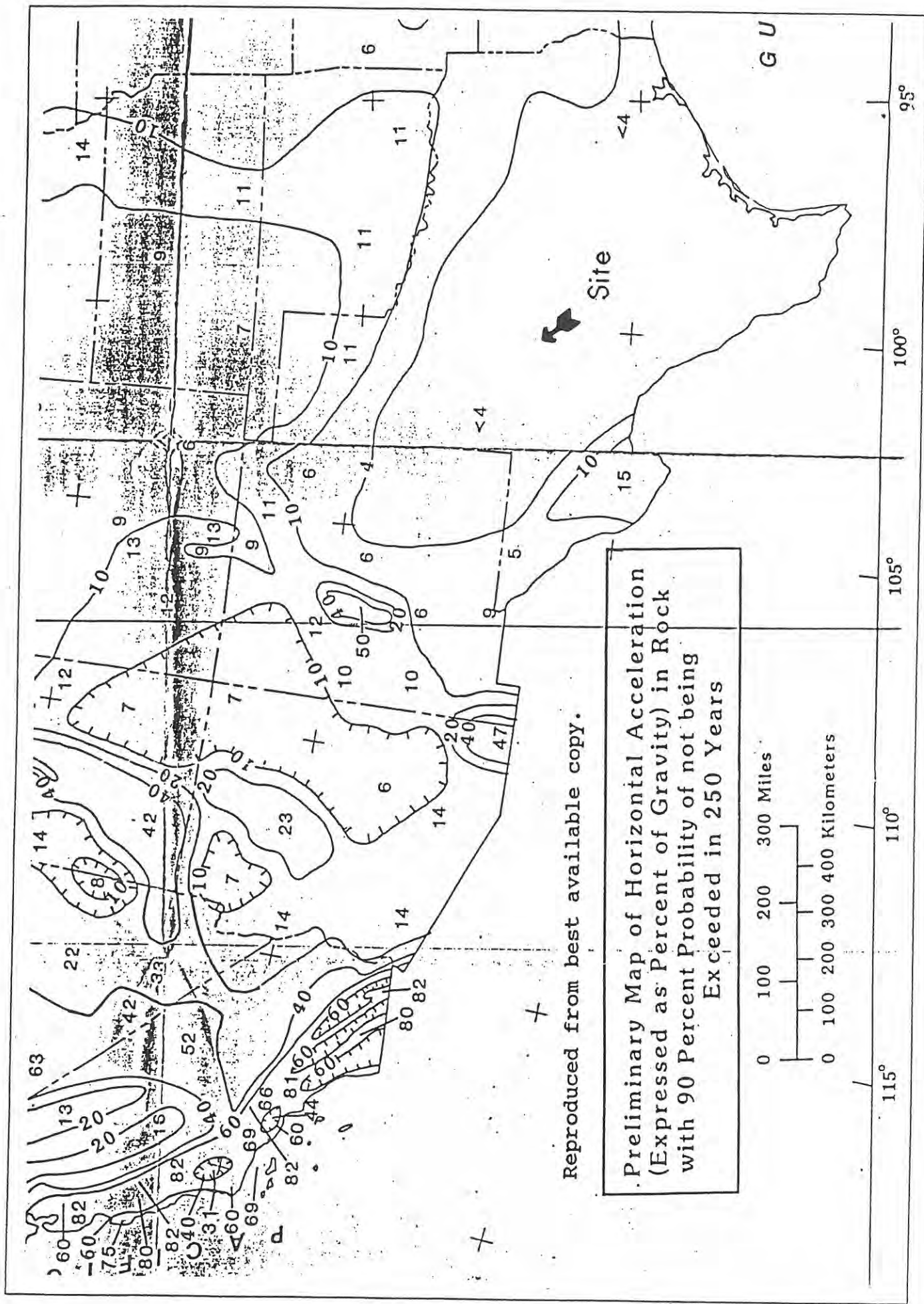


Figure 1. Seismic Impact Zone Map (Modified from Algermissen et al., 1982).

The City Of

San Angelo, Texas

P. O. Box 1751 - Zip 76902



September 29, 1993

Ms. Susan Janek, P.E.
Texas Natural Resource Conservation Committee
P.O. Box 13087, Capitol Station
Austin, TX 78711-3087

RE: City of San Angelo Landfill, Permit No. 79

Dear Ms. Janek:

The City of San Angelo hereby submits for your review the following items in reference to the City's landfill as required to comply with certification of location restrictions as set forth in the new Subtitle "D" regulations.

1. Airport Safety. As shown on the attached Exhibit "1", the landfill is more than 11 miles from the nearest airport used by turbojet or piston-type aircraft. This information is contained in Attachment #2 of the current permit for the facility.
2. Flood Plains. As shown on the attached Exhibit "2", the landfill is not located in a 100 year flood plain as defined by FEMA. This information is shown on Attachment #55A in the current permit and is hereby updated with a new Attachment #5A that incorporates flood plain information from the August 13, 1992 revised FEMA maps for Tom Green County, Texas.
3. Unstable Areas. Attached under Exhibit "3" is a report prepared by Kyle Combest, Combest Geoscience, which certifies that the landfill is not located in an unstable area. This is the same report submitted by Mr. Combest on September 27, 1993.

If you have any questions or need any additional information in regards to these items, please contact me at 915 657-4206.

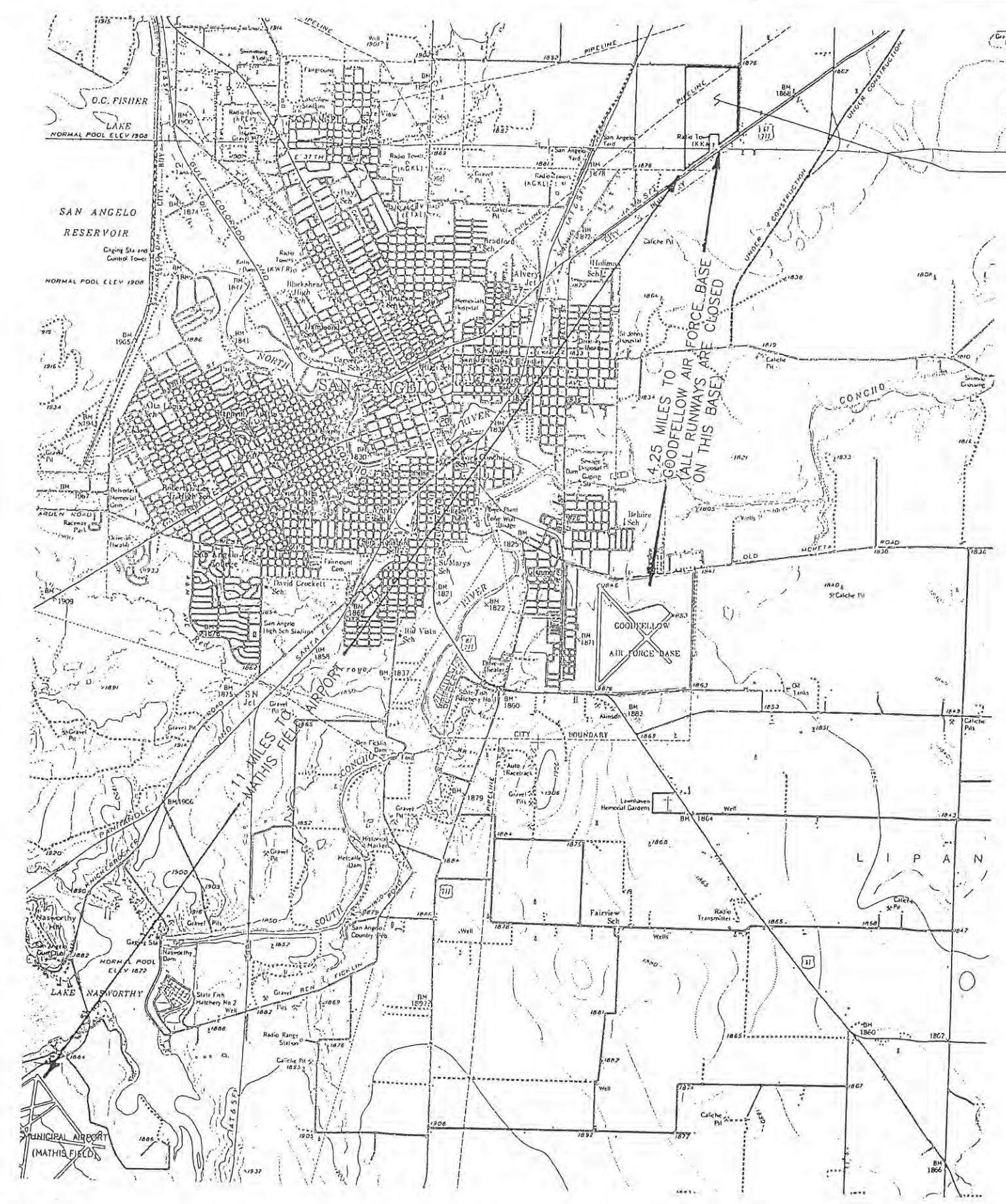
Sincerely,

W. H. Wilde
Public Works Director

xc: Stephen Brown, City Manager
Lawrence Kennedy, Jr., Trashaway, Inc.
Kyle Combest, Combest Geoscience
Adam Hernandez, TNRCC, Region 8

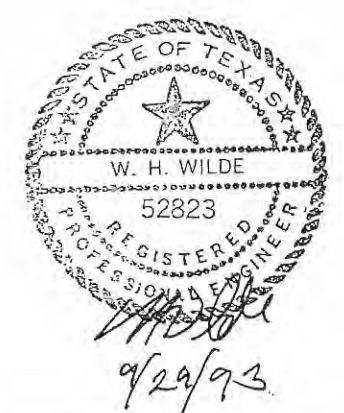
EXHIBIT "1"


 SCALE:
 1" = 5000'



CITY OF SAN ANGELO
 MUNICIPAL LANDFILL
 PERMIT NUMBER 79

PREVAILING WINDS
 OUT OF THE S - SE
 70% OF THE YEAR
 AVERAGE 11 MPH



CITY OF SAN ANGELO	
DEPARTMENT OF PUBLIC WORKS	
ATTACHMENT # 2	
TOPOGRAPHIC MAP	
CITY OF SAN ANGELO LANDFILL	
DRAWN BY: D.L.H.	DATE: 9/16/93
CHECKED: W.H.W.	SCALE: 1"=5000'

EXHIBIT "2"

1" = 2000'



EAST BOUNDARY LINE OF FEMA
FLOOD INSURANCE RATE MAP
COMMUNITY PANEL NUMBER
480622 0215B, TOM GREEN CO., TX.

WEST BOUNDARY LINE OF FEMA
FLOOD INSURANCE RATE MAP
COMMUNITY PANEL NUMBER
480622 0220B, TOM GREEN CO., TX.



CITY OF SAN ANGELO DEPARTMENT OF PUBLIC WORKS	
ATTACHMENT # 5A 100 YEAR FLOOD PLAIN LIMITS CITY OF SAN ANGELO LANDFILL	
DRAWN BY: D.L.H.	DATE: 9/16/93
CHECKED: W.H.W.	SCALE: 1"=2000'

EXHIBIT "3"

COMBEST GEOscience

Environmental Consulting and Testing

7122 Wood Hollow #7
Austin, Texas 78731
(512) 345-1063

27 September 1993

Ms. Susan Janek
TEXAS NATURAL RESOURCE CONSERVATION COMMISSION
Municipal Solid Waste Division
P.O. Box 13087 - Capitol Sta.
Austin, Texas 78711-3087

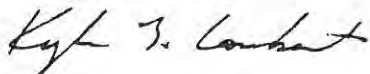
Re: Modifications to the San Angelo Municipal Landfill permit
(Permit No. #79-A).

Dear Ms. Janek:

For partial completion of modifications to the San Angelo Municipal Landfill permit, as required by the new Municipal Solid Waste Regulations (31 TAC 330), enclosed please find 3 copies of the certification to demonstrate compliance with the "Unstable Area" location restriction (31 TAC 330.305).

Once the certification is approved, it will become part of the landfill's operating record. If you need additional information, please call me in Austin at 345-1063. Thank you.

Sincerely,



Kyle B. Combest
Environmental Geologist

enclosures

cc: Mr. Will Wilde, Public Works Director
CITY OF SAN ANGELO

LOCATION RESTRICTIONS - UNSTABLE AREAS (31 TAC 330.305)

The location of the San Angelo Municipal Landfill has been examined in regard to the "Unstable Area" location restriction (31 TAC 330.305). As defined in this regulation, an unstable area is "a location that is susceptible to natural or human-induced events or forces capable of impairing the integrity of some or all of a landfill's structural components responsible for preventing releases from the landfill; unstable areas can include poor foundation conditions, areas susceptible to mass movement, and karst terrains".

This evaluation consisted of a thorough review of the area's soil conditions, geologic conditions, and human-made features.

Pertinent information was most importantly obtained from the following sources:

(1) Combest, K.B., 1992, Improvement of the ground-water monitoring system and further review of hydrogeology at the San Angelo Municipal Landfill (Permit 79-A): Report prepared for the City of San Angelo by Combest Geoscience, Austin, Texas.

(2) Texas Bureau of Economic Geology (TBEG), 1975, Geologic Atlas of Texas, San Angelo Sheet (1:250,000): Bureau of Economic Geology, Austin, Texas.

(3) Wiedenfeld, C.C. and P.H. Flores, 1971, Soil Survey of Tom Green County, Texas: United States Department of Agriculture, Soil Conservation Service, in cooperation with the Texas Agricultural Experiment Station.

(4) Willis, G.W., 1954, Ground-water resources of Tom Green County, Texas: Texas Board of Water Engineers, Bulletin 5411, prepared cooperatively by the Geological Survey, United States Department of the Interior.

A review of the landfill's soil conditions finds that the soil is almost entirely within the Angelo clay loam mapping unit (Figure 1, AnA). Only a very narrow strip along the landfill's southern boundary falls within the Slaughter-Kimbrough mapping unit (Figure 1, SkA). Throughout the area, there are no sudden soil changes that would indicate the occurrence of recent (Holocene) instability or karst development.

Topographically, the area's surface dips uniformly and very gradually to the southeast at approximately 20-ft/mi (Attachment 2 in Site Development Plan - USGS topographic map). Local topographic depressions that could indicate underlying karst features do not exist in the area. Additionally, there is not enough relief to create slope instability.

A geologic map and cross section for the area indicate that nearby surface faults do not exist (Figure 2). Additionally, the near-surface formations do not characteristically have karst development. More specifically, the uppermost formation is the Pleistocene-aged Leona Formation (Figure 2). The Leona consists of mixed caliche, clay, and gravel deposits with an average thickness of approximately 50-ft. Underlying the Leona is the Permian-aged Choza Formation which predominantly consists of shale with occasional, thin dolomite layers (Willis, 1954). The thickness of the Choza underneath the landfill is approximately 625-ft (Combest, 1992).

In regard to human-made features, no unusual activities or construction projects have been observed that would influence the landfill's stability. The landfill is located in an area that consists mostly of agricultural land (Attachment 3 in Site Development Plan - Land Use Map). A sparsely populated residential area, covering a much smaller area, is located to the south and southwest. Light industrial areas are located to the southwest and southeast (Attachment 3 in Site Development Plan - Land Use Map).

In summary, the soil conditions, geologic conditions, and human-made features for the San Angelo Municipal Landfill area have been thoroughly reviewed. No evidence was found suggesting that the area is unstable as defined in 31 TAC 330.305.

Once approved by the TNRCC - Solid Waste Division, this document shall become part of the site's operating record.

Kyle B. Combest

Kyle B. Combest, CPG #8352
Environmental Geologist

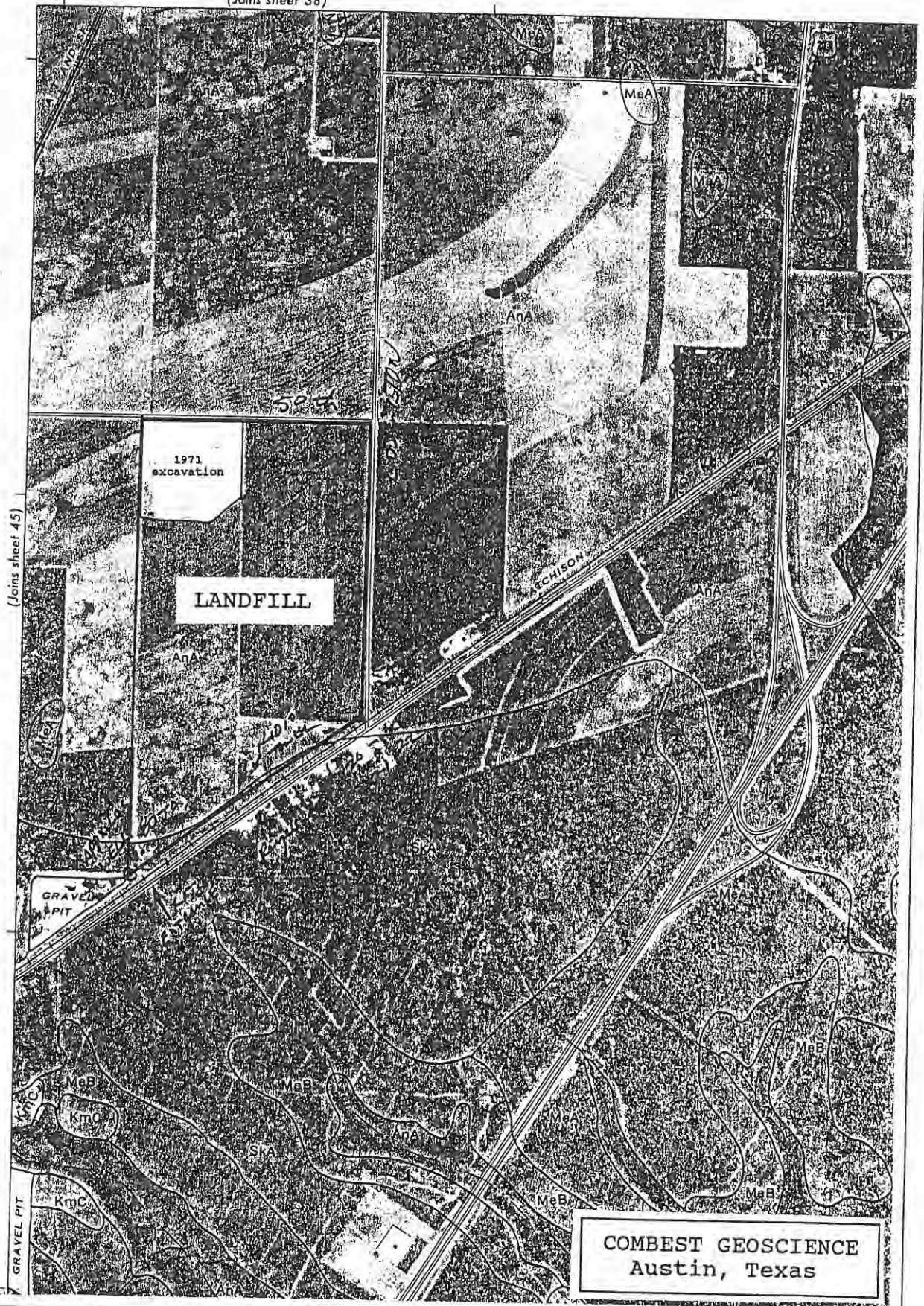
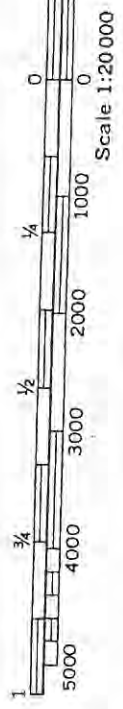
Date: 27 Sept. 1993



(Joins sheet 38)



1 Mile
5000 Feet



COMBEST GEOSCIENCE
Austin, Texas

Figure 1. Soil map (modified from Wiedenfeld and Flores, 1971)

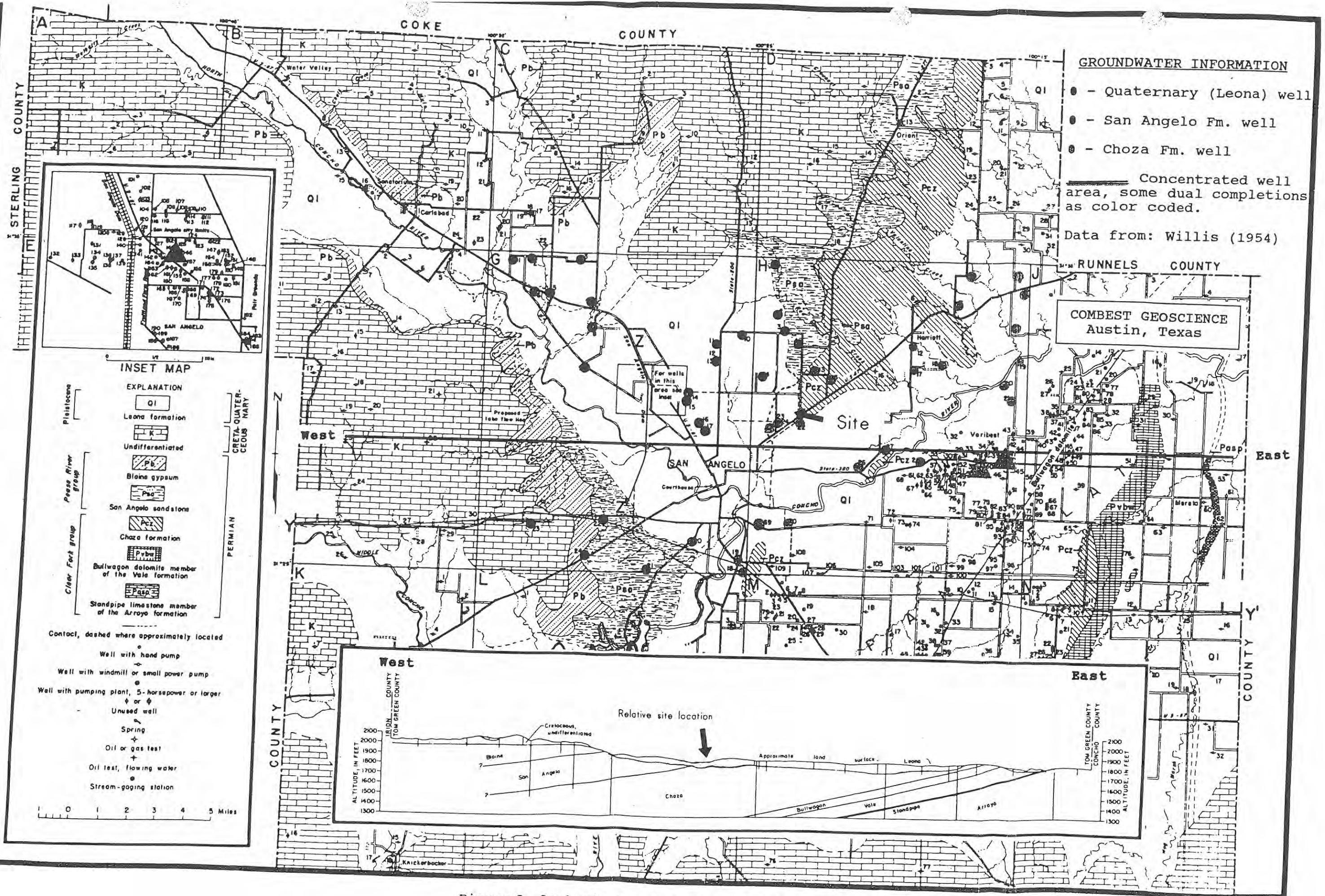


Figure 2. Geologic map and cross section (modified from Willis, 1954).

The City Of

San Angelo, Texas

P. O. Box 1751 - Zip 76902



September 15, 1993

Ms. Susan Janek, P.E.
Team Leader
Municipal Solid Waste Permits Section
Texas Natural Resource Conservation Commission
P.O. Box 13087, Capitol Station
Austin, TX 78711-3087

RE: City of San Angelo Landfill, Permit 79

Dear Ms. Janek:

Enclosed is a site plan that was inadvertently omitted from our letter of September 9 and the application for a modification on the City's landfill, Permit 79.

I apologize for any inconvenience, and if you have any questions, please contact me at 915 657-4206.

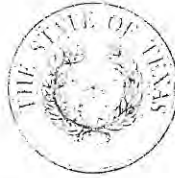
Sincerely,

W. H. Wilde
Public Works Director

xc: Adam Hernandez, TNRCC, District 9

Copy

Bryan W. Shaw, Ph.D., *Chairman*
Carlos Rubinstein, *Commissioner*
Toby Baker, *Commissioner*
Zak Covar, *Executive Director*



TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

January 4, 2013

Mr. Ricky Dickson
Director of Operations
San Angelo Landfill
City of San Angelo
P. O. Box 1751
San Angelo, Texas 76902

Re: San Angelo Landfill – Tom Green County
Municipal Solid Waste – Permit No. 79
Permit Modification – Leachate Chimney Details in Attachments 2, 3, and 10
Tracking No. 16562218; RN102289576/CN600251615

Dear Mr. Dickson:

We have reviewed your application for a municipal solid waste permit modification dated November 30, 2012, requesting modifications to Attachments 2, 3, and 10 of the referenced permit, to revise the minimum required width of leachate chimneys and to correct inconsistencies between attachments. The information presented is technically sufficient for a municipal solid waste permit modification.

Enclosed is a copy of the above referenced modification which is now part of your permit and should be attached thereto. The documentation prepared and submitted to support the modification request shall be considered as requirements of the permit.

If you have questions concerning this matter, please contact Mr. Arten Avakian at (512) 239-4419. When addressing written correspondence, please use mail code MC 124.

This action is taken under authority delegated by the Executive Director of the Texas Commission on Environmental Quality.

Sincerely,

A handwritten signature in black ink, appearing to read "C. Bergren".

f Christine M. Bergren, Manager
Municipal Solid Waste Permits Section
Waste Permits Division

CMB/AJA/sdm

cc: Mr. Todd E. Stiggins, P.E., Project Engineer, Biggs & Mathews Environmental, Mansfield

Enclosure

Texas Commission on Environmental Quality



Modification to Municipal Solid Waste Permit No. 79 San Angelo Landfill

Municipal Solid Waste Permit No. 79 is hereby modified as follows:

Description of Change:

This modification revises Attachments 2, 3, and 10 of the referenced permit, changing the minimum required width of leachate chimneys and correcting inconsistencies between attachments.

The details of this permit modification are contained in the application dated November 30, 2012.

Part of Permit Modified:

Part III of the Application

Attachment 2 (Site Development Plan)

Title page and table of contents

Drawing 94-11

Attachment 3 (Soils and Liner Quality Control Plan)

Title page and table of contents

Sections 8.2.3.1 and 8.2.3.2 revised and merged into Section 8.2.3

Sections 8.4.3, 8.5.1, and 8.5.2

Table 3-20

Appendix 3A (Liner and Leachate Collection System Details)

Attachment 3A.6 (drawing)

Attachment 10 (Leachate and Contaminated Water Plan)

Title page and table of contents

Appendix 10A (Leachate Collection System Plan and Details)

Attachment 10A.3 (drawing)

Appendix 10B (Leachate Collection System Design Calculations)

Pages 10B-2 and 10B-4

This modification is a part of Permit No. 79 and should be attached thereto.

Approved, Issued, and Effective in accordance with Title 30 Texas Administrative Code Chapter 305, Sections 305.70(j)(5), (17), and (19), and Chapter 330, Sections 330.333 and 330.339.

Issue Date:

JAN 04 2013


For the Commission

Buddy Garcia, *Chairman*
Larry R. Soward, *Commissioner*
Bryan W. Shaw, Ph.D., *Commissioner*
Mark R. Vickery, P.G., *Executive Director*



TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

May 11, 2009

The Honorable J. W. Lown
Mayor of San Angelo
City of San Angelo
P. O. Box 1751
San Angelo, Texas 76902-1751

Re: City of San Angelo Landfill - Tom Green County
Municipal Solid Waste (MSW) - Permit No. 79
Permit Modification - 10-foot Height Increase
Tracking No. 12592510; RN102289576 / CN600251615

Dear Mayor Lown:

We have reviewed your application for a municipal solid waste permit modification dated February 20, 2008, and the revisions dated May 21, August 15, October 3, November 25, 2008, and January 27, 2009 regarding the above referenced MSW facility requesting a one-time ten-foot height increase and reduction in the limits of waste area north of the gas pipeline from 41.5 acres to 31.9 acres, creating a total waste disposal footprint of 225.2 acres. A Technically Complete package was received on February 16, 2009. The information presented is technically sufficient for a municipal solid waste permit modification.

Enclosed is a copy of the above referenced modification which is now part of your permit and should be attached thereto. The documentation prepared and submitted to support the modification request shall be considered as requirements of the permit.

If you have questions concerning this matter, please contact Ms. Gulay Aki at (512) 239-2340. When addressing written correspondence, please use Mail Code 124 (MC 124).

This action is taken under authority delegated by the Executive Director of the Texas Commission on Environmental Quality.

Sincerely,


Richard C. Carmichael, Ph.D., P.E.
Manager, Municipal Solid Waste Permits Section
Waste Permits Division

RCC/GA/fp

cc: Mr. Kenneth J. Welch, P.E., Biggs & Mathews Environmental, Mansfield

Enclosure

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY



MODIFICATION TO MUNICIPAL SOLID WASTE PERMIT NO. 79 CITY OF SAN ANGELO LANDFILL

Municipal Solid Waste Permit No. 79 is hereby modified as follows:

Description of Change:

Modification of the Site Development Plan to revise the final contours and increase the maximum height of the landfill by 10 feet, from 1920 feet above mean sea level (ft-msl) to 1930 ft-msl, to improve surface water drainage and to reduce the limits of waste area north of the gas pipeline from 41.5 acres to 31.9 acres, creating a reduced total waste disposal footprint of 225.2 acres.

The details of this permit modification are contained in the application dated February 20, 2008, and the revisions dated May 21, August 15, October 3, November 25, 2008 and January 27, 2009. A Technically Complete package was received on February 16, 2009.

Part of Permit Modified:

Site Development Plan:

Attachment 2, Drawings 94-02, 94-03, 94-03A, 94-08, are revised.

Attachment 2, Drawings 94-03B, 94-03C, 94-03-D, 94-08A are added new.

Attachment 4, Run-on/Run-off Control Plan, Page 4-ii is revised.

Appendix 4A, Drainage Design Report is completely replaced. It contains the following:

Appendix 4A-A Drainage System Plans and Details

Appendix 4A-B Drainage Maps

Appendix 4A-C 10-foot Height Increase Hydrologic Calculations

Appendix 4A-D Final Cover Erosion Control Structure Design

Appendix 4A-E Perimeter Drainage Design

Attachment 5, Section 3.2.2, Estimate of Maximum Inventory Waste Ever on Site is revised.

Attachment 5.1, Landfill Completion Plan, Appendix 5D, Slope Stability Analysis is added new.

This modification is a part of Permit No. 79 and should be attached thereto.

APPROVED, ISSUED, AND EFFECTIVE in accordance with Title 30 Texas Administrative Code Chapter 305, Section (§)305.70(k)(2), §305.70(j)(13) and Chapter 330, §330.63(c), and §330.305 as effective prior to May 29, 2008.

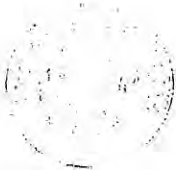
ISSUED DATE:

MAY 04 2009

A handwritten signature in cursive script, appearing to read "Mark V. Uecker".
For the Commission

Scanned

Buddy Garcia, *Chairman*
Larry R. Soward, *Commissioner*
Bryan W. Shaw, Ph.D., *Commissioner*
Glenn Shankle, *Executive Director*



TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

April 25, 2008

The Honorable J. W. Lown
Mayor of San Angelo
P. O. Box 1751
San Angelo, Texas 76902-1751

Re: City of San Angelo Landfill – Tom Green County
Municipal Solid Waste - Permit No. 79A
Permit Modification: Additional Leachate Collection Sumps
WWC No. 11992133; CN602718405 / RN102143294

Dear Mayor Lown:

We have reviewed your application for a municipal solid waste permit modification received February 27, 2008, requesting to install additional leachate collection sumps in the Phase II Area. The information presented is technically sufficient for a municipal solid waste permit modification.

Enclosed is a copy of the above referenced modification which is now part of your permit and should be attached thereto as Attachment 3, Soils and Liner Quality Control Plan. The documentation prepared and submitted to support the modification request shall be considered as requirements of the permit.

If you have questions concerning this matter, please contact Mr. Arthur Denny at (512) 239-6610. When addressing written correspondence, please use Mail Code 124 (MC 124).

This action is taken under authority delegated by the Executive Director of the Texas Commission on Environmental Quality.

Sincerely,

A handwritten signature in dark ink, appearing to read "Richard C. Carmichael", is written over the word "Sincerely,".

Richard C. Carmichael, Ph.D., P.E.
Manager, Municipal Solid Waste Permits Section
Waste Permits Division

RCC/ALD/fp

Enclosure

cc: Mr. Kenneth Welch, P.E., Biggs & Mathews Environmental, Mansfield
Mr. Ron Lewis, P.E., Public Works Director, City of San Angelo
Mr. Jason Quiton, Trashaway Services, Inc., San Angelo

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY



MODIFICATION TO MUNICIPAL SOLID WASTE PERMIT NO. 79A CITY OF SAN ANGELO LANDFILL

Municipal Solid Waste Permit No. 79A is hereby modified as follows:

Description of Change:

Provides minor revisions to the Site Development Plan, which includes changes to the Site Development Plan Drawings, Soil Liner Quality Control Plan and Leachate and Contaminated Water Plan. The details of this permit modification are contained in the application received February 27, 2008.

Parts of Permit Modified:

1. Part III, Site Development Plan, Attachment 2, Title Page.
2. Part III, Site Development Plan, Attachment 2, Table of Contents, Page ii.
3. Part III, Site Development Plan Drawing Nos. 94-05, 94-06A, 94-09, 94-09A, 94-10, 94-10A, 94-11.
4. Part III, Site Development Plan, Attachment 3, Appendix 3A, Attachments 3A.1, 3A.6, and 3A.7.
5. Part III, Site Development Plan, Attachment 10, Complete Replacement.

This modification is a part of Permit No. 79A and should be attached thereto.

APPROVED, ISSUED, AND EFFECTIVE in accordance with Title 30 Texas Administrative Code Chapter 305, Section 305.70(j)(18).

ISSUED DATE:

APR 25 2008

A handwritten signature in black ink, appearing to be "D. R. Smith", written over a horizontal line.

For the Commission

Kathleen Hartnett White, *Chairman*
Larry R. Soward, *Commissioner*
Glenn Shankle, *Executive Director*



TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

March 13, 2007

The Honorable J. W. Lown
Mayor of San Angelo
P. O. Box 1751
San Angelo, Texas 76902-1751

Re: Municipal Solid Waste (MSW) – Tom Green County
City of San Angelo Landfill - MSW Permit No. 79
Permit Modification – Leachate Sidewall Riser Pipe
WWC Tracking No. 11556995; RN102289576 / CN600320154

Dear Mayor Lown:

We have reviewed your application for a municipal solid waste permit modification dated January 8, 2007, received on January 11, 2007, requesting use of a leachate sidewall riser pipe for leachate collection pipe cleanout in each cell. The information presented is technically sufficient for a municipal solid waste permit modification.

Enclosed is a copy of the above referenced modification which is now part of your permit and should be attached thereto. The documentation prepared and submitted to support the modification request shall be considered as requirements of the permit.

If you have questions concerning this matter, please contact Mr. Arthur Denny at (512) 239-6610. When addressing written correspondence, please use Mail Code 124 (MC 124).

This action is taken under authority delegated by the Executive Director of the Texas Commission on Environmental Quality.

Sincerely,

A handwritten signature in cursive script that reads "Richard C. Carmichael".

Richard C. Carmichael, Ph.D., P.E.
Manager, Municipal Solid Waste Permits Section
Waste Permits Division

RCC/ALD/ff

cc: Mr. Mike Widner, Field Service Manager, Biggs & Mathews Environmental, Mansfield
Mr. Ron Lewis, P.E., Public Works Director, City of San Angelo

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY



MODIFICATION TO MUNICIPAL SOLID WASTE PERMIT NO. 79 SAN ANGELO LANDFILL

Municipal Solid Waste Permit No. 79 is hereby modified as follows:

Description of Changes:

The modification authorizes the use of a leachate sidewall riser pipe for leachate collection pipe cleanout in each cell, instead of the leachate manhole riser.

The details of this permit modification are contained in the application dated January 8, 2007 and received on January 11, 2007.

Parts of Permit Modified:

Attachment 2, Site Development Plan
Attachment 10, Leachate Contaminated Water Plan
Appendix C, Representative Leachate Collection System Cleanout Information
Appendix F, Leachate Collection System Details

This modification is a part of Permit No. 79 and should be attached thereto.

APPROVED, ISSUED, AND EFFECTIVE in accordance with Title 30 Texas Administrative Code Sections 305.70(j)(18).

ISSUED DATE:

MAR 13 2007


For the Commission

**SAN ANGELO LANDFILL
TOM GREEN COUNTY, TEXAS
TCEQ PERMIT NO. MSW 79**

PART III

**ATTACHMENT 2
SITE DEVELOPMENT PLAN**

Prepared for

CITY OF SAN ANGELO

Technically Complete February 2009

Revised November 2012



Prepared by

BIGGS & MATHEWS ENVIRONMENTAL

1700 Robert Road, Suite 100 • Mansfield, Texas 76063 • 817-563-1144

TEXAS BOARD OF PROFESSIONAL ENGINEERS
FIRM REGISTRATION NO. F-256

TEXAS BOARD OF PROFESSIONAL GEOSCIENTISTS
FIRM REGISTRATION NO. 50222



CONTENTS

2A – SITE DEVELOPMENT PLAN DRAWINGS

Drawing No.	Drawing Title	Latest Revision Date
	Cover Sheet	April 5, 1994
94-01	Site Layout	April 11, 1995
94-02	Final Grading Plan	January 27, 2009
94-03	Permitted Cross Sections	August 15, 2008
94-03A	Permitted Cross Sections	October 3, 2008
94-03B	Permitted Cross Sections	August 15, 2008
94-03C	Permitted Cross Sections	February 20, 2008
94-03D	Permitted Cross Sections	August 15, 2008
94-04	Leachate Collection Plan	March 1, 2000
94-05	Leachate Collection Plan Phase II Development Area	February 20, 2008
94-06	Sump and Riser Details	April 11, 1995
94-06A	Sump and Riser Details	February 20, 2008
94-07	Clean Out Details North Embankment	May 8, 2000
94-08	Miscellaneous Details and Specifications	February 20, 2008
94-08A	Miscellaneous Details and Specifications	February 20, 2008
94-09	Liner Details	February 20, 2008
94-09A	Liner Details	February 20, 2008
94-10	Liner Details	February 20, 2008
94-10A	Liner Details	February 20, 2008
94-11	Leachate Collection System Details	November 30, 2012
94-12	Leachate Collection Plan Riser Pipe Details	January 3, 2007

SITE DEVELOPMENT PLAN
CITY OF SAN ANGELO
MUNICIPAL LANDFILL
1994 PERMIT MODIFICATION

Owner:

City of San Angelo

Engineer:

San Angelo Public Works

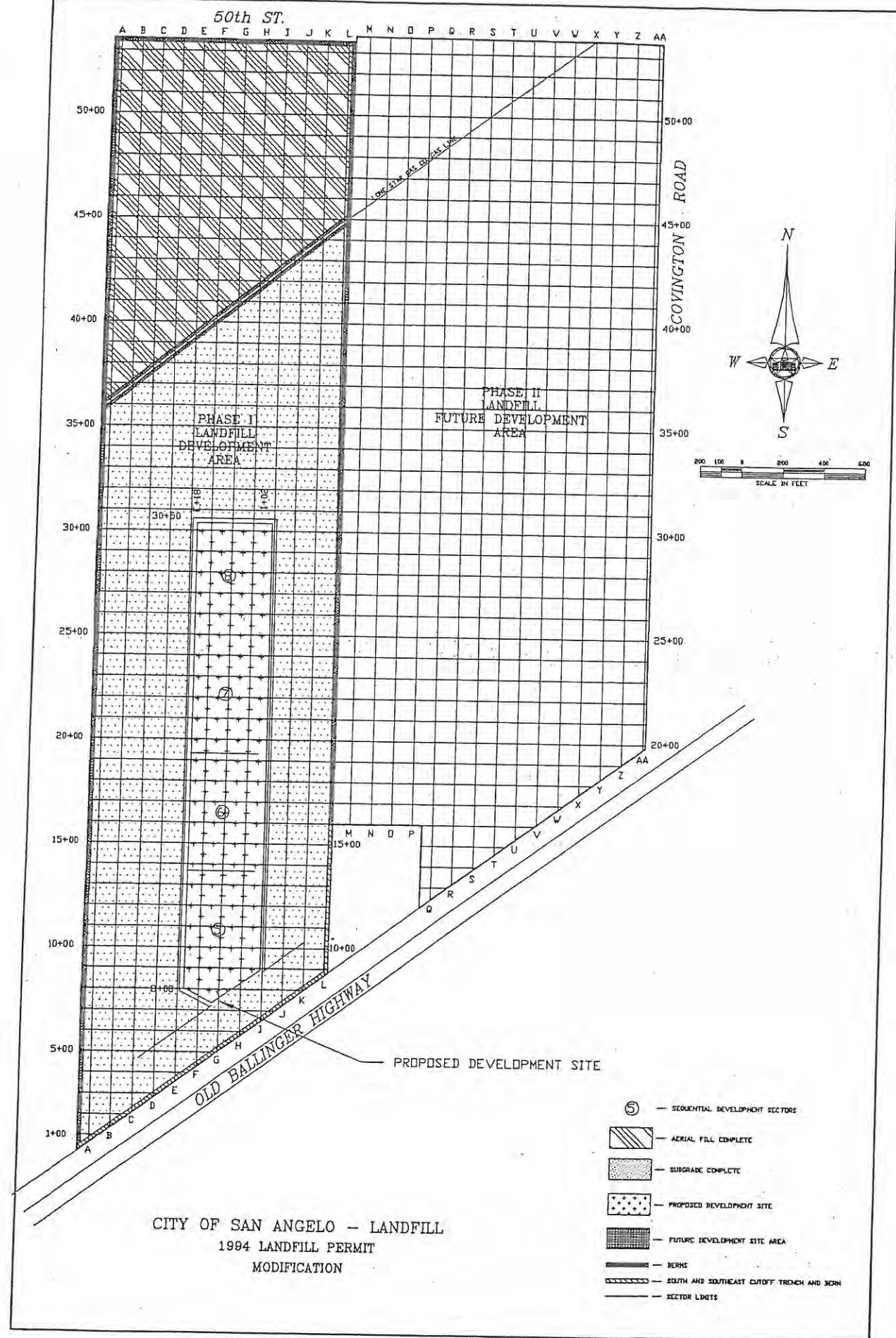
Governing Agency:

Texas Natural Resource Conservation Commission

April, 1994



APR 5, 1994



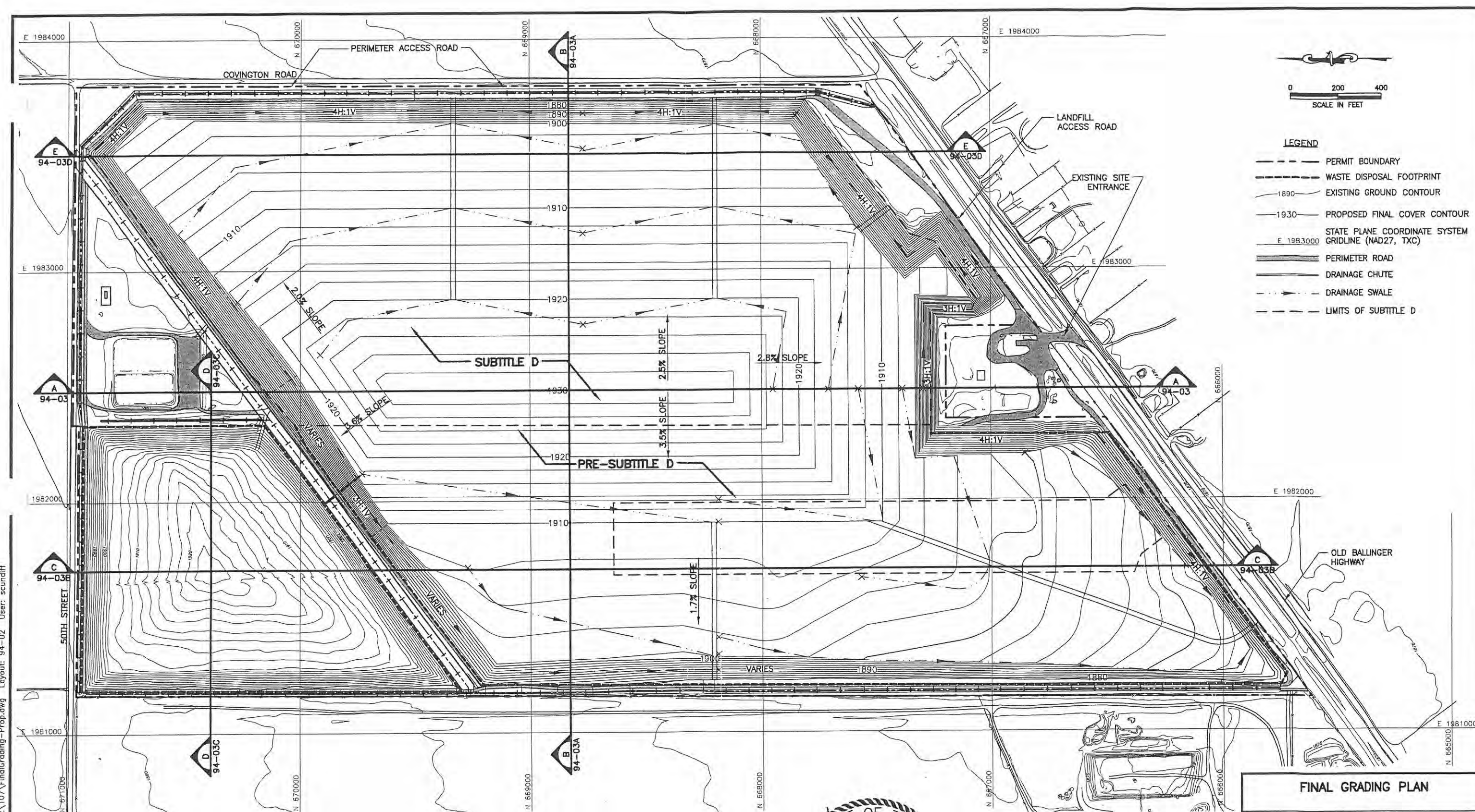
LIST OF DRAWINGS

DRAWING NO.	TITLE
94-01 M-489	SITE LAYOUT
94-02 M-490	PERMITTED FINAL GRADING PLAN
94-03 M-491	PERMITTED CROSS-SECTIONS
94-04 M-492	LEACHATE COLLECTION PLAN
94-05 M-493	LEACHATE COLLECTION PLAN - FUTURE DEVELOPMENT SITE
94-06 M-494	SUMP & RISER DETAILS
94-07 M-495	CLEAN OUT DETAILS NORTH EMBANKMENT
94-08 M-496	MISC. DETAILS AND SPECIFICATIONS
94-09 M-500	MISC. DETAILS AND SPECIFICATIONS



REVISION TABLE				CITY OF SAN ANGELO DEPARTMENT OF PUBLIC WORKS	
ITEM	DATE REVISED	DESCRIPTION	BY:	1994 LANDFILL PERMIT MODIFICATION	
①	07/07/94	REVISED BOUNDARY OF DEVELOPMENT SITE	W. H. WILD	SITE LAYOUT	
②	07/07/94	REVISED DWG. TITLES	W. H. WILD		
③	04/11/95	ADDED DETAIL PAGE 94-09 M-500	W. H. WILD		
				DWG. NO. 94-01 M-489	

J:\225\02\107\FinalGrading-Prop.dwg Layout: 94-02 User: scundiff



- NOTES:
- EXISTING CONTOURS COMPILED FROM AERIAL SURVEY FLOWN ON MAY 11, 2006 BY METROPOLITAN AERIAL SURVEYS.
 - REFER TO ATTACHMENT 9 FOR INFORMATION REGARDING LANDFILL GAS MANAGEMENT.



TEXAS BOARD OF PROFESSIONAL ENGINEERS
FIRM REGISTRATION NO. F-256

TEXAS BOARD OF PROFESSIONAL
GEOSCIENTISTS
FIRM REGISTRATION NO. 50222

ISSUED FOR PERMITTING PURPOSES ONLY

REVISIONS						
REV	DATE	DESCRIPTION	DWN BY	DES BY	CHK BY	APP BY
	02/09	TECHNICALLY COMPLETE	SRC	SAB	KJW	KJW

FINAL GRADING PLAN

SAN ANGELO LANDFILL
TCEQ PERMIT NO. MSW 79
10 FOOT HEIGHT INCREASE

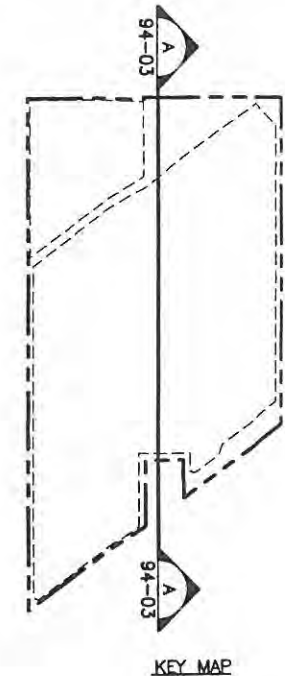
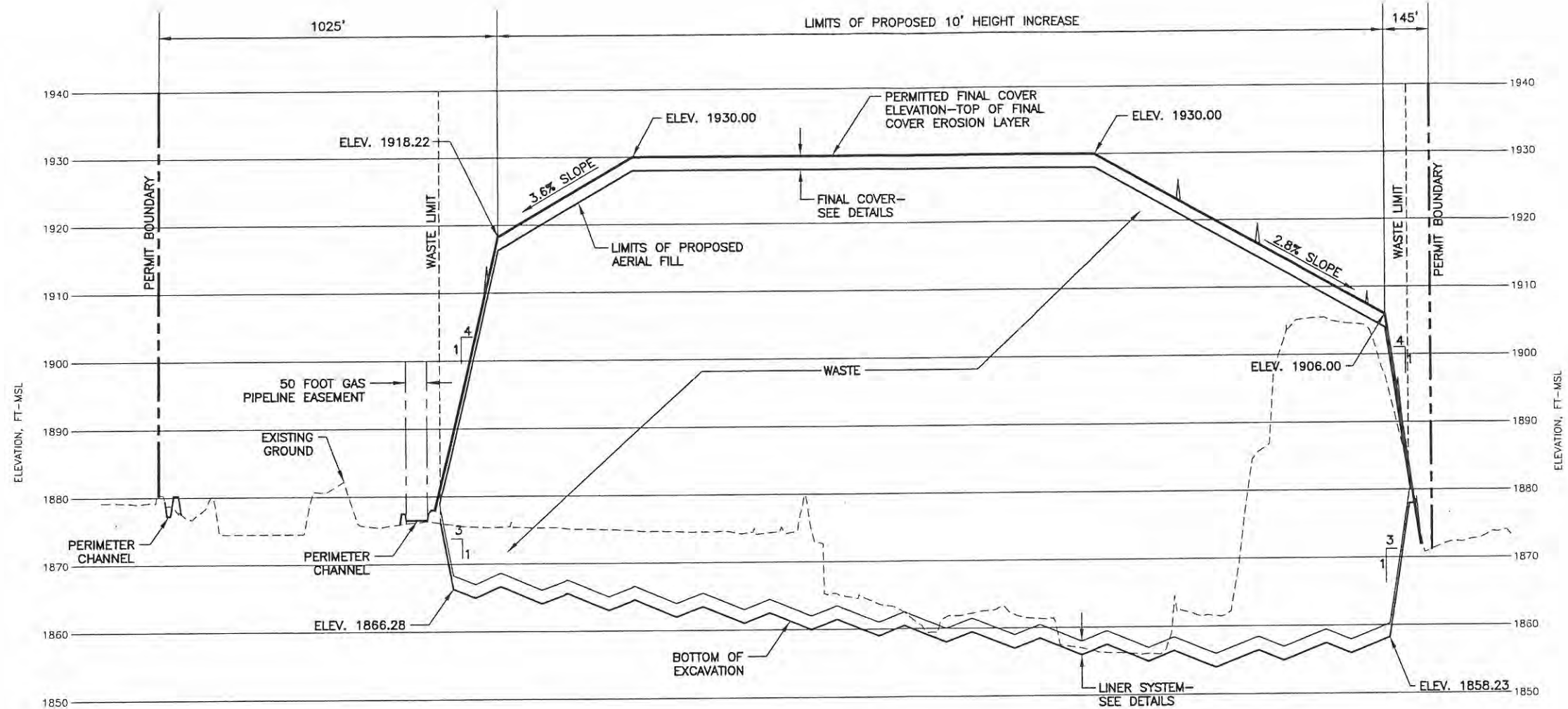
BIGGS & MATHEWS
ENVIRONMENTAL
CONSULTING ENGINEERS
MANSFIELD
DALLAS • WICHITA FALLS
B17-563-1144

DSN. SAB DATE : 01/09
DWN. SRC SCALE : GRAPHIC
CHK. KJW DWG : FinalGrading-Prop.dwg

DRAWING
94-02

J:\225\02\107\FinalGrading-Prop.dwg Layout: 94-02 User: scundiff

J:\225\02\107\FinalGrading-Sect.dwg Layout: 94-03 User: scundiff



NOTES:

1. 10' HEIGHT INCREASE WILL OCCUR ABOVE SUBTITLE D WASTE DISPOSAL AREA.
2. 10' HEIGHT INCREASE WILL NOT OCCUR WITHIN 125' BUFFER ZONE OF PERMIT BOUNDARY.

SECTION



0 200 400
HORIZONTAL SCALE IN FEET

0 10 20
VERTICAL SCALE IN FEET



ISSUED FOR PERMITTING PURPOSES ONLY

REVISIONS								DSN. ALN		DATE : 02/08		DRAWING
REV	DATE	DESCRIPTION	OWN BY	DES BY	CHK BY	APP BY	CHK.	ALN	DWG :	SCALE : GRAPHIC	FinalGrading-Sect.dwg	
02/09		TECHNICALLY COMPLETE	SRC	SAB	KJW	KJW						94-03

TEXAS BOARD OF PROFESSIONAL ENGINEERS
FIRM REGISTRATION NO. F-256

TEXAS BOARD OF PROFESSIONAL
GEOSCIENTISTS
FIRM REGISTRATION NO. 50222

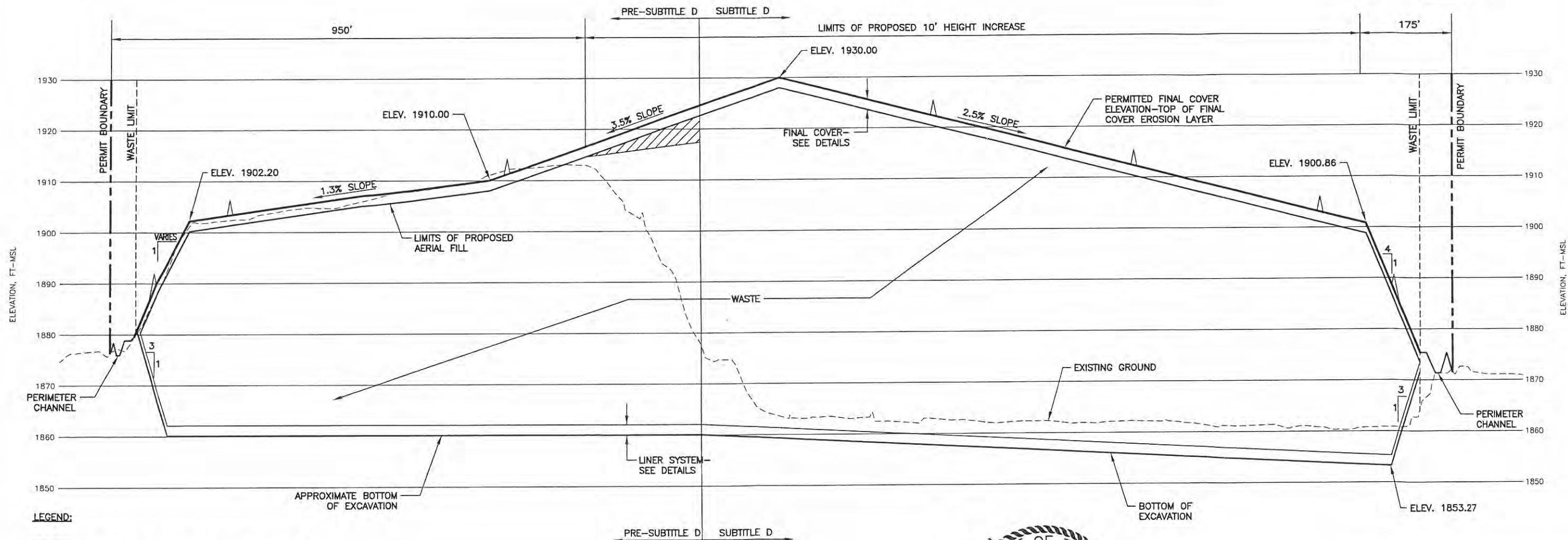
PERMITTED CROSS SECTIONS

SAN ANGELO LANDFILL
TCEQ PERMIT NO. MSW 79
10 FOOT HEIGHT INCREASE



BIGGS & MATHEWS
ENVIRONMENTAL
CONSULTING ENGINEERS
MANSFIELD
DALLAS • WICHITA FALLS
817-563-1144

DRAWING



LEGEND:

10' HEIGHT INCREASE ABOVE PRE-SUBTITLE D AREA

NOTES:

1. 10' HEIGHT INCREASE WILL NOT OCCUR WITHIN 125' BUFFER ZONE OF PERMIT BOUNDARY.
2. 10' HEIGHT INCREASE WILL OCCUR OVER PRE-SUBTITLE D AREA AND SUBTITLE D WASTE DISPOSAL AREAS.
3. INERT WASTE, WHICH IS DEFINED IN 30 TAC CHAPTER 330.3(67), WILL BE PLACED ABOVE THE CURRENTLY PERMITTED FINAL COVER AREA THAT IS LOCATED OVER PRE-SUBTITLE D LINED AREAS. INERT WASTE AS DEFINED CONSISTS OF "INERT MATERIAL IS A NATURAL OR MAN-MADE NON-PUTRESCIBLE, NON-HAZARDOUS MATERIAL THAT IS ESSENTIALLY INSOLUBLE, USUALLY INCLUDING, BUT NOT LIMITED TO, SOIL, DIRT, CLAY, SAND, GRAVEL, BRICK, GLASS, CONCRETE WITH REINFORCING STEEL, AND ROCK."

SECTION **B**
94-03A

0 100 200
HORIZONTAL SCALE IN FEET

0 10 20
VERTICAL SCALE IN FEET



TEXAS BOARD OF PROFESSIONAL ENGINEERS
FIRM REGISTRATION NO. F-255

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FIRM REGISTRATION NO. 50222

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REVISIONS						
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02/09		TECHNICALLY COMPLETE	SRC	SAB	KJW	KJW

PERMITTED CROSS SECTIONS

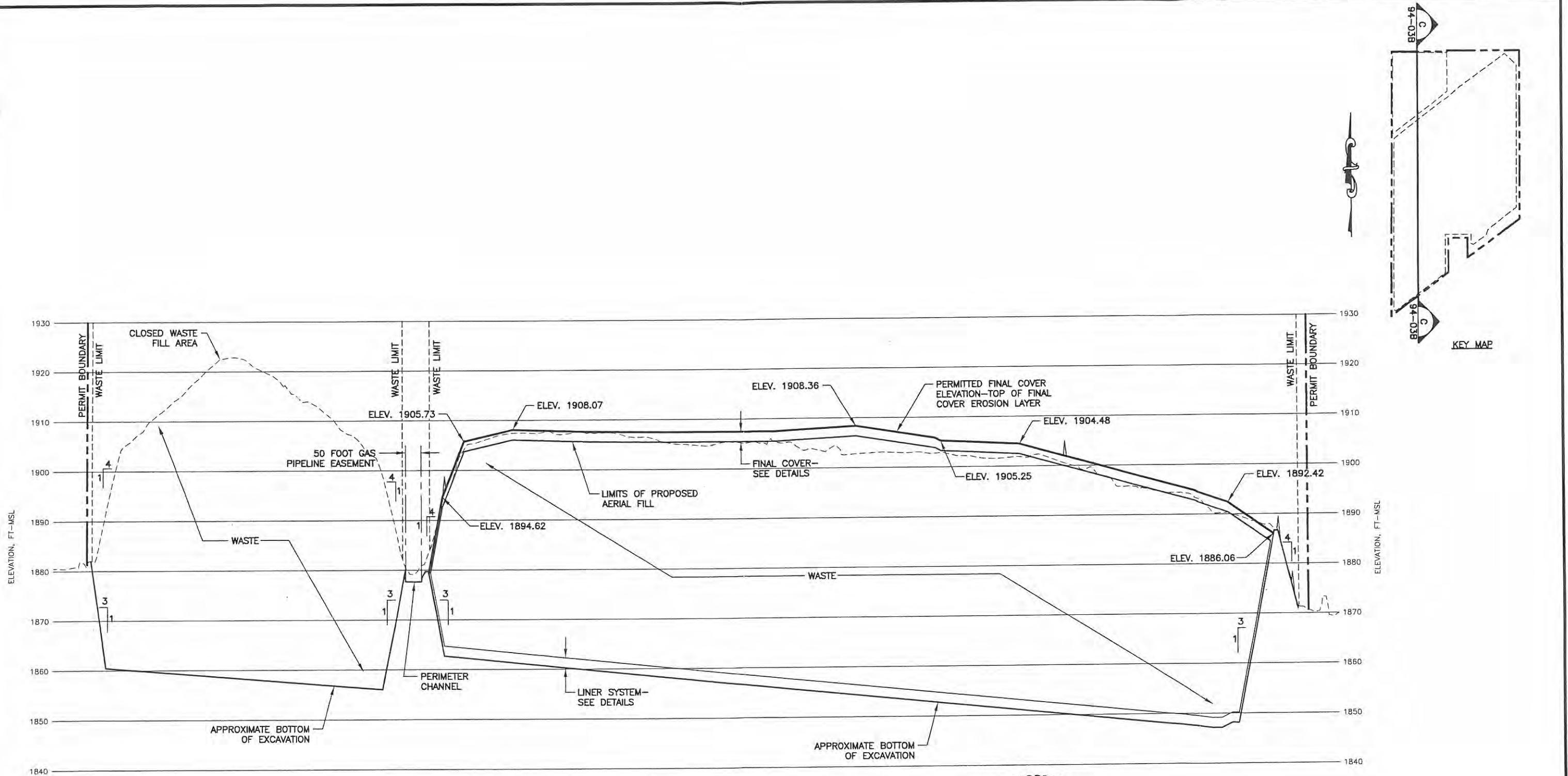
SAN ANGELO LANDFILL
TCEQ PERMIT NO. MSW 79
10 FOOT HEIGHT INCREASE



BIGGS & MATHEWS
ENVIRONMENTAL
CONSULTING ENGINEERS
MANSFIELD
DALLAS • WICHITA FALLS
817-563-1144

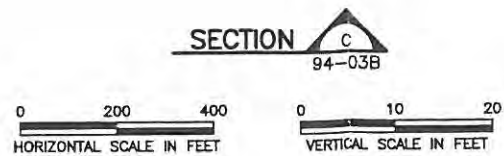
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CHK. KJW	DWG : FinalGrading-Sect.dwg	

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NOTES:

1. 10' HEIGHT INCREASE WILL NOT OCCUR WITHIN THIS CROSS-SECTIONAL AREA.



TEXAS BOARD OF PROFESSIONAL ENGINEERS
FIRM REGISTRATION NO. F-256

TEXAS BOARD OF PROFESSIONAL
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REVISIONS						
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PERMITTED CROSS SECTIONS

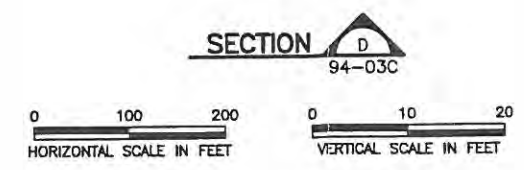
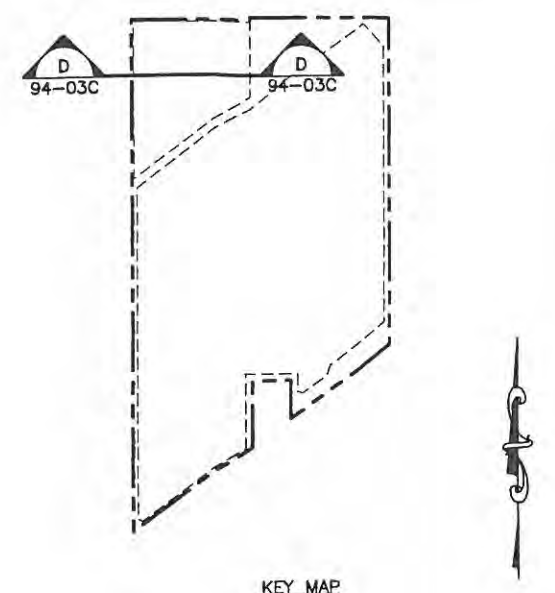
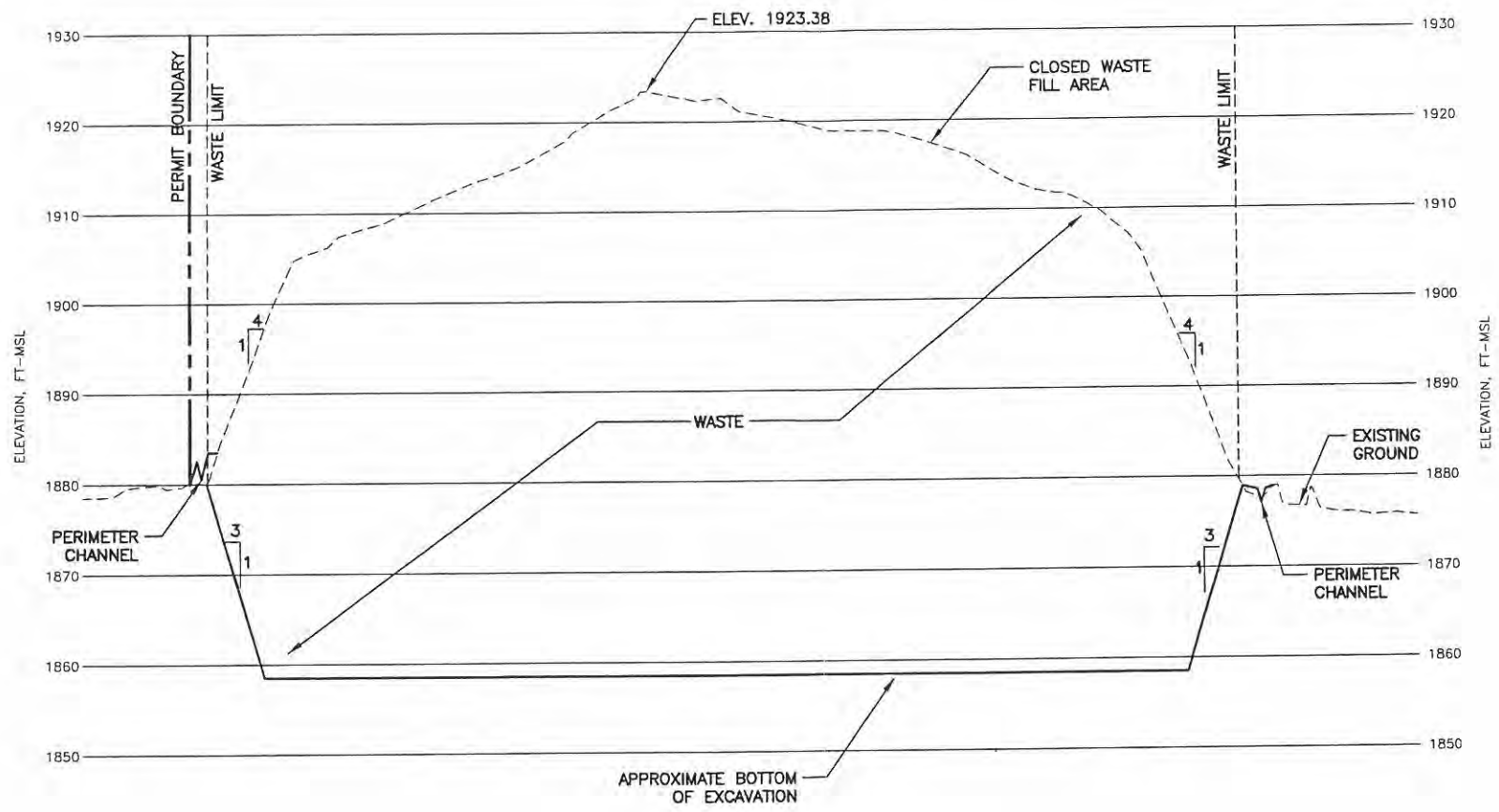
SAN ANGELO LANDFILL
TCEQ PERMIT NO. MSW 79
10 FOOT HEIGHT INCREASE



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CONSULTING ENGINEERS
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DSN.	ALN	DATE :	02/08	DRAWING 94-03B
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TEXAS BOARD OF PROFESSIONAL ENGINEERS
FIRM REGISTRATION NO. F-256

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FIRM REGISTRATION NO. 50222

PERMITTED CROSS SECTIONS

SAN ANGELO LANDFILL
TCEQ PERMIT NO. MSW 79
10 FOOT HEIGHT INCREASE

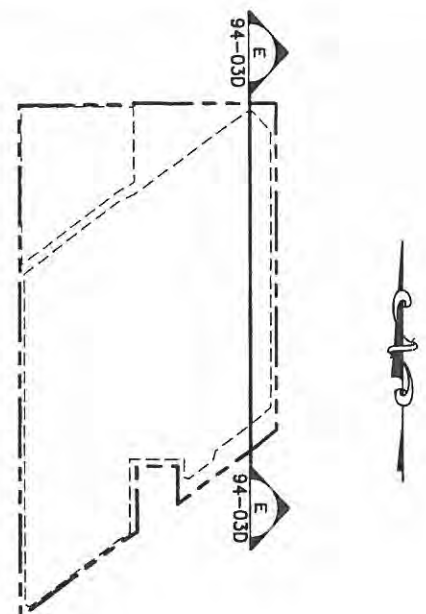
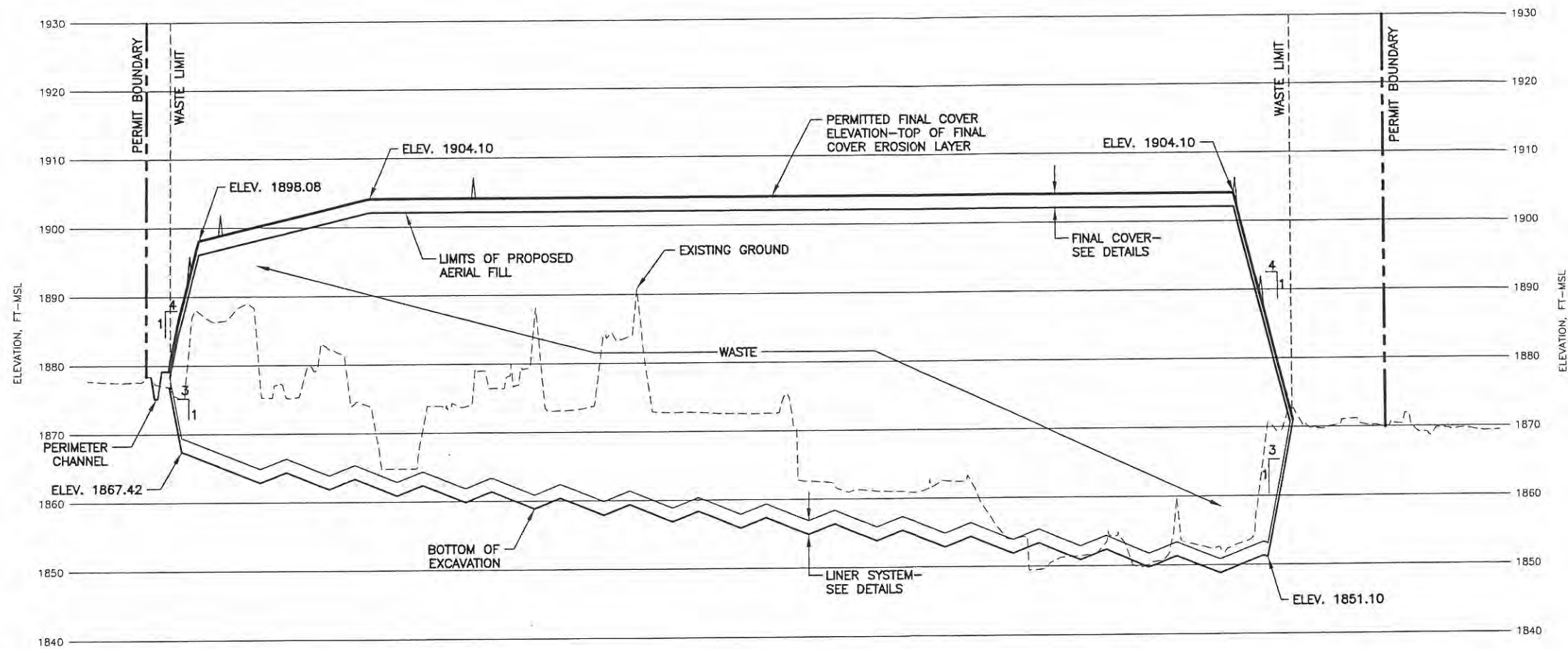


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REVISIONS								DSN.	ALN	DATE	02/08	DRAWING 94-03C
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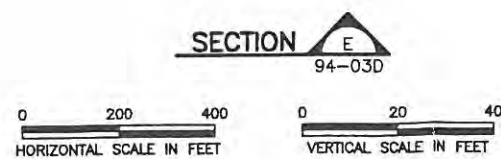
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KEY MAP

NOTES:

1. 10' HEIGHT INCREASE WILL NOT OCCUR WITHIN THIS CROSS-SECTIONAL AREA.



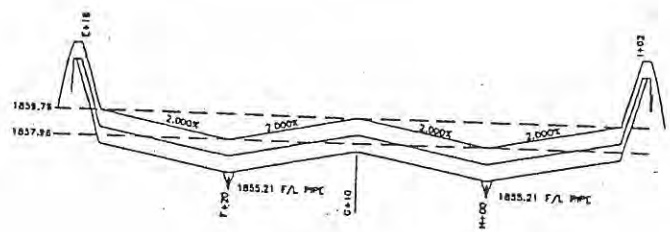
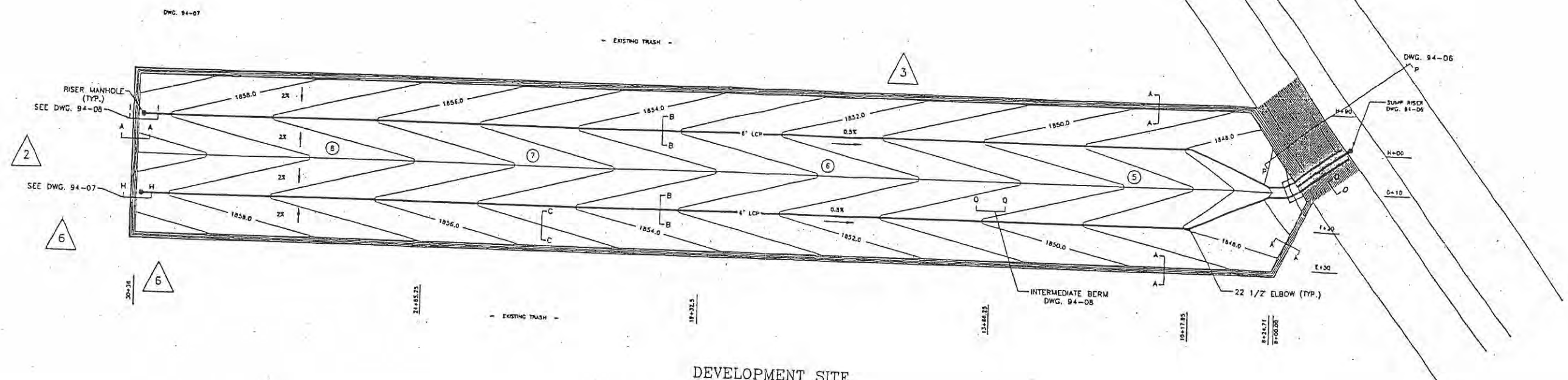
ISSUED FOR PERMITTING PURPOSES ONLY

REVISIONS						
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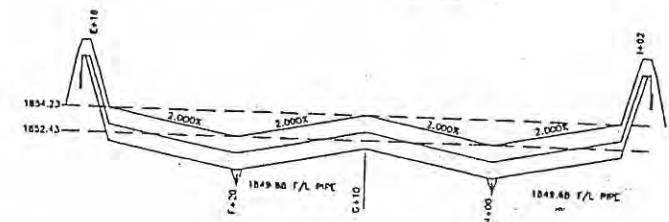
PERMITTED CROSS SECTION	
SAN ANGELO LANDFILL TCEQ PERMIT NO. MSW 79 10 FOOT HEIGHT INCREASE	
	BIGGS & MATHEWS ENVIRONMENTAL CONSULTING ENGINEERS MANSFIELD DALLAS • WICHITA FALLS 817-563-1144
DSN. ALN DATE : 02/08 DWN. SRC SCALE : GRAPHIC CHK. ALN DWG : FinalGrading-Sect.dwg	DRAWING 94-03D

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FIRM REGISTRATION NO. F-256

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FIRM REGISTRATION NO. 50222

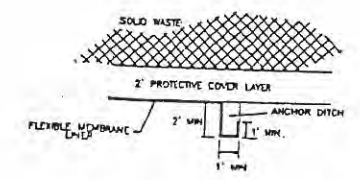
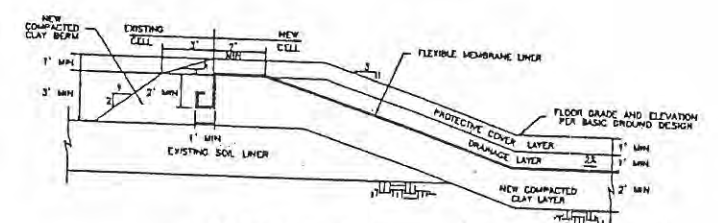


STA 30+38

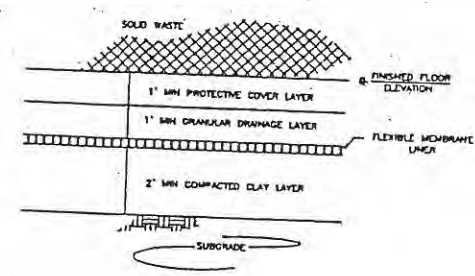


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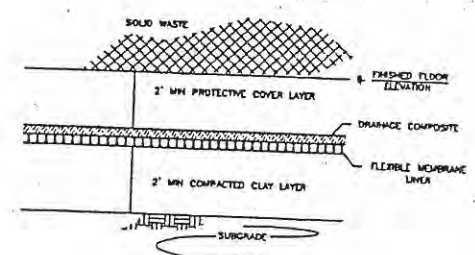
LANDFILL SECTORS TYPICAL SECTIONS



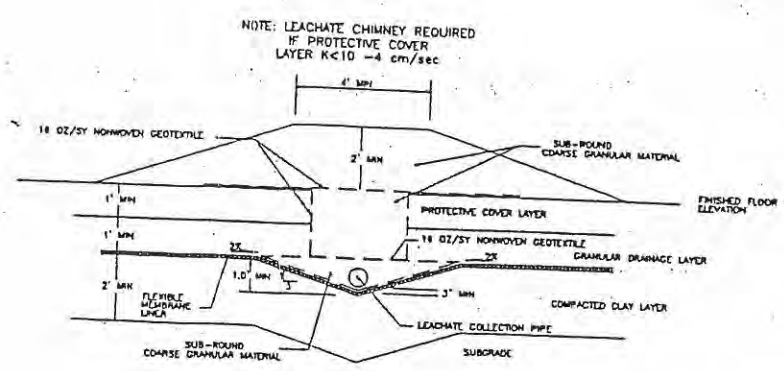
SECTION D-D



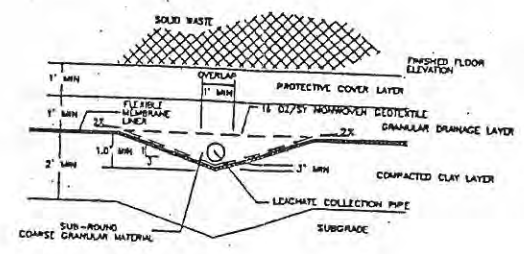
BASE DESIGN



ALTERNATE DESIGN



ALTERNATE :
LEACHATE COLLECTION TRENCH
WITH CHIMNEY



SECTION B-B
LEACHATE COLLECTION TRENCH

SECTION C-C
COMPOSITE LINER DETAIL

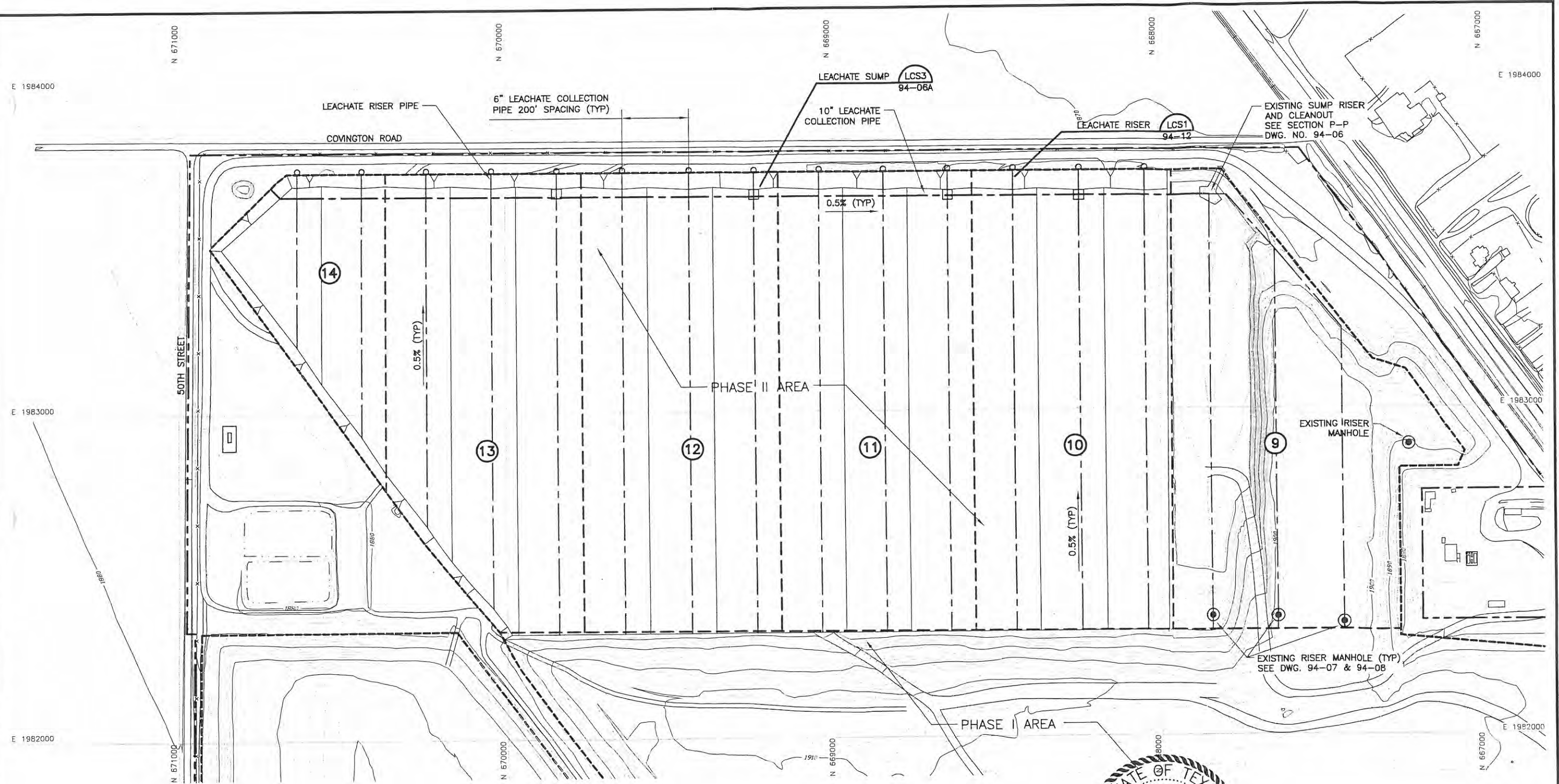
NOTE: SEE DWG. 94-08 FOR MATERIAL SPECIFICATIONS AND CONSTRUCTION NOTES.

REVISION TABLE			
ITEM	DATE REVISED	DESCRIPTION	BY:
1	07/07/94	REVISED STATION NUMBERS	W.H.W.
2	07/07/94	REVISED SECTIONS H-H, I-I & ADDED SEC. N-N	W.H.W.
3	07/07/94	MOVED EAST BOUNDARY OUT	W.H.W.
4	08/22/94	ADDED SECTION C-C ALTERNATE DESIGN	W.H.W.
5	04/11/95	ADDED SECTION D-D	W.H.W.
6	03/01/00	REVISED SECTION H-H, AND I-I, DELETED SECTION N-N	W.H.W.



CITY OF SAN ANGELO
DEPARTMENT OF PUBLIC WORKS
1994 LANDFILL PERMIT MODIFICATION
LEACHATE COLLECTION PLAN
DWG. NO. 94-04 M-492

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LEGEND

- PERMIT BOUNDARY
- WASTE DISPOSAL FOOTPRINT
- 1890- EXISTING GROUND CONTOUR
- E 1983000 STATE PLANE COORDINATE SYSTEM GRIDLINE (NAD27, TXC)
- SECTOR LIMITS
- LEACHATE PIPE LOCATION
- LEACHATE RISER PIPE
- EXISTING LEACHATE MANHOLE
- LEACHATE SUMP

NOTES:

- EXISTING CONTOURS COMPILED FROM AERIAL SURVEY FLOWN ON MAY 11, 2006 BY METROPOLITAN AERIAL SURVEYS.
- EXCAVATION CONTOURS ARE COMPILED FROM THE CITY OF SAN ANGELO, 1994 PERMIT MODIFICATION.



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REVISIONS					
REV	DATE	DESCRIPTION	DWN BY	DES BY	CHK BY
4	02/08	ADDED SUMPS	WCM	ALN	ALN
3	01/07	ADDED RISER PIPE CLEAN OUT	RMP	SAN	KJW
2	12/07/01	ADDED 10" LEACHATE COLLECTION PIPE	-	-	-
1	12/07/01	DELETED CLEAN OUT & ADDED RISER M.H.	-	-	-

**LEACHATE COLLECTION PLAN
PHASE II DEVELOPMENT AREA**

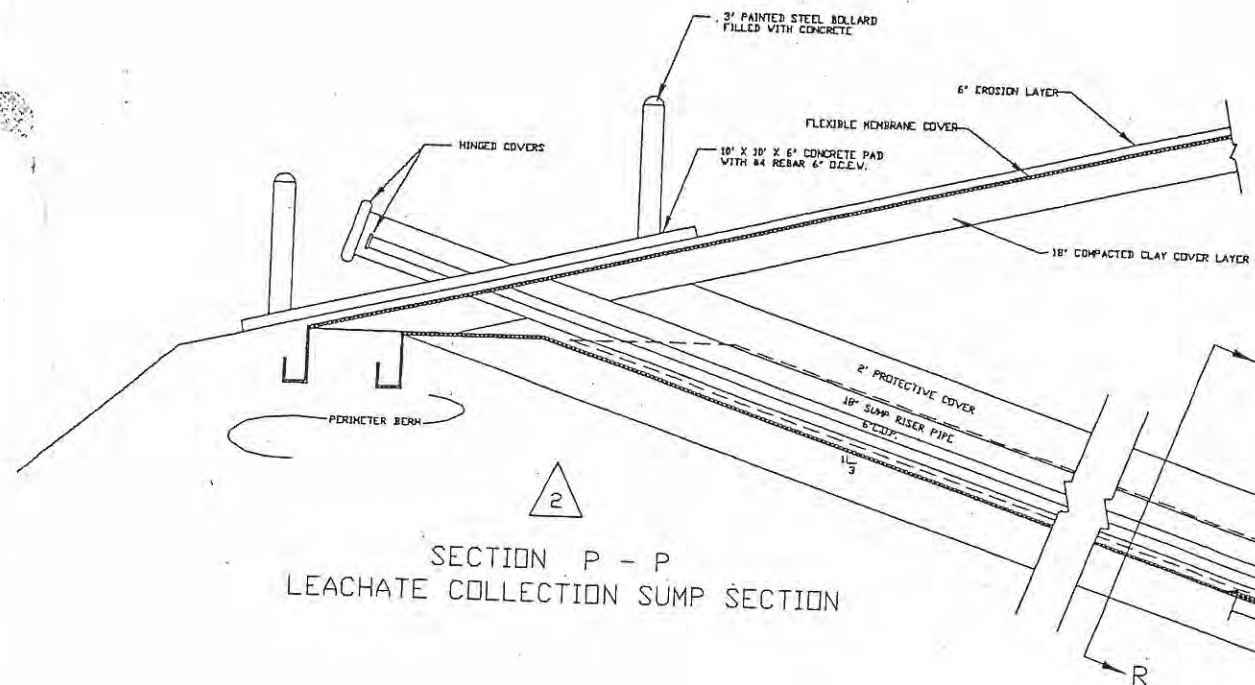
**SAN ANGELO LANDFILL
CITY OF SAN ANGELO
TCEQ PERMIT NO. MSW 79**

**BIGGS & MATHEWS
ENVIRONMENTAL
CONSULTING ENGINEERS**
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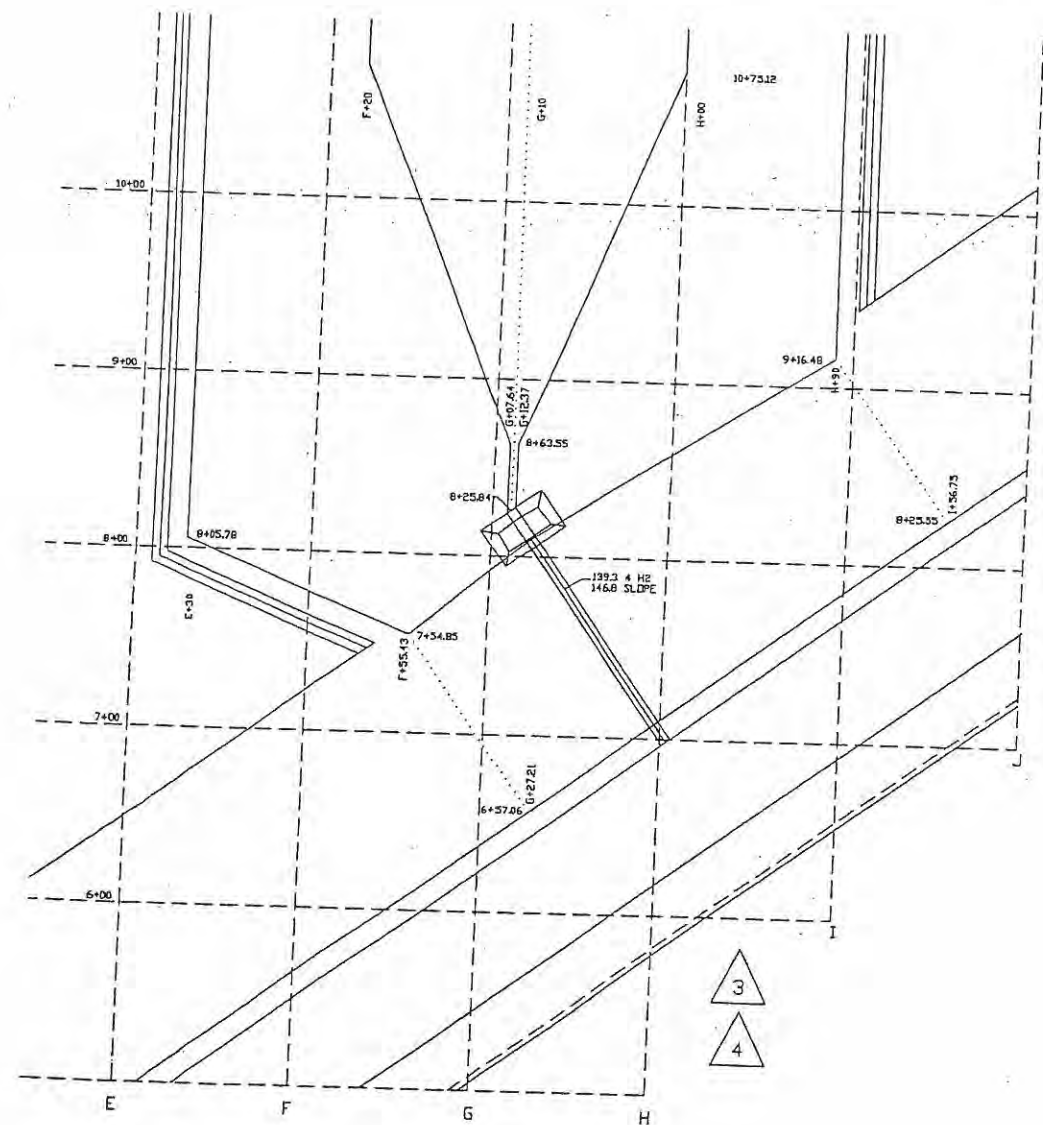
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DRAWING
94-05

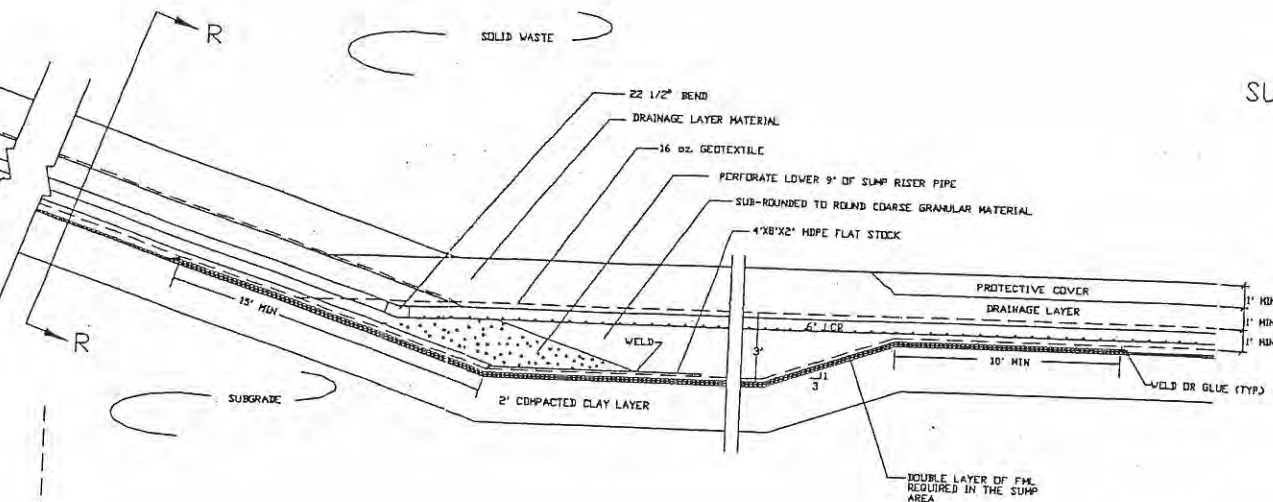
NOTE: SEE DWG. 94-08 FOR MATERIAL SPECIFICATIONS AND CONSTRUCTION NOTES.



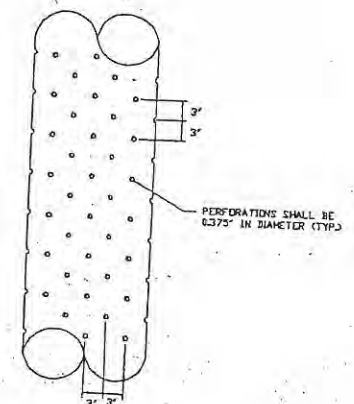
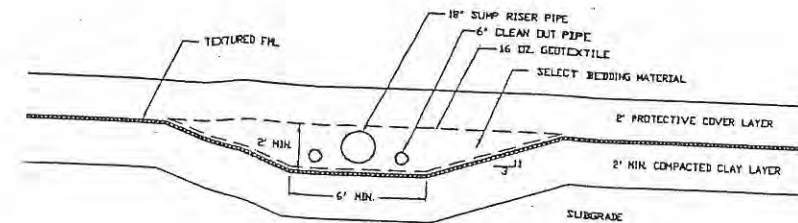
SECTION P - P
LEACHATE COLLECTION SUMP SECTION



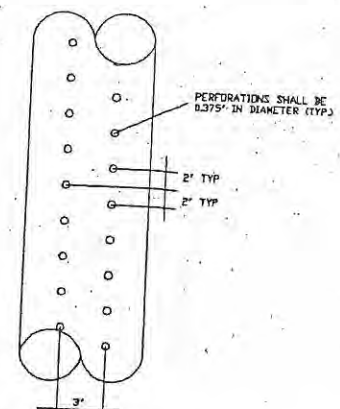
SUMP DETAIL
1"=50'



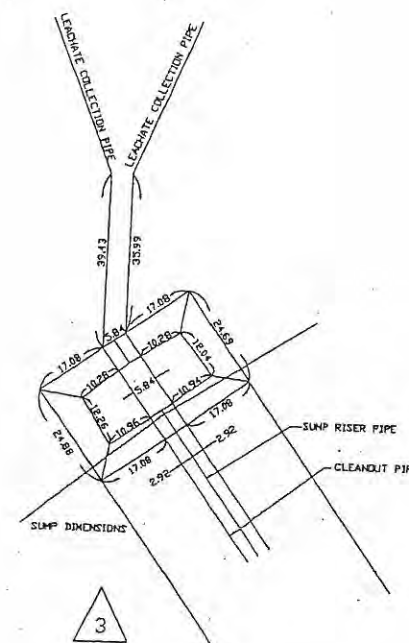
SECTION R - R
SUMP RISER TRENCH DETAIL



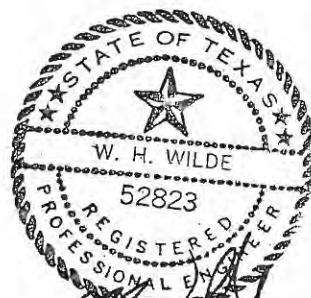
18" LEACHATE RISER
PIPE PERFORATION



6" LEACHATE COLLECTION PIPE
PERFORATION DETAIL

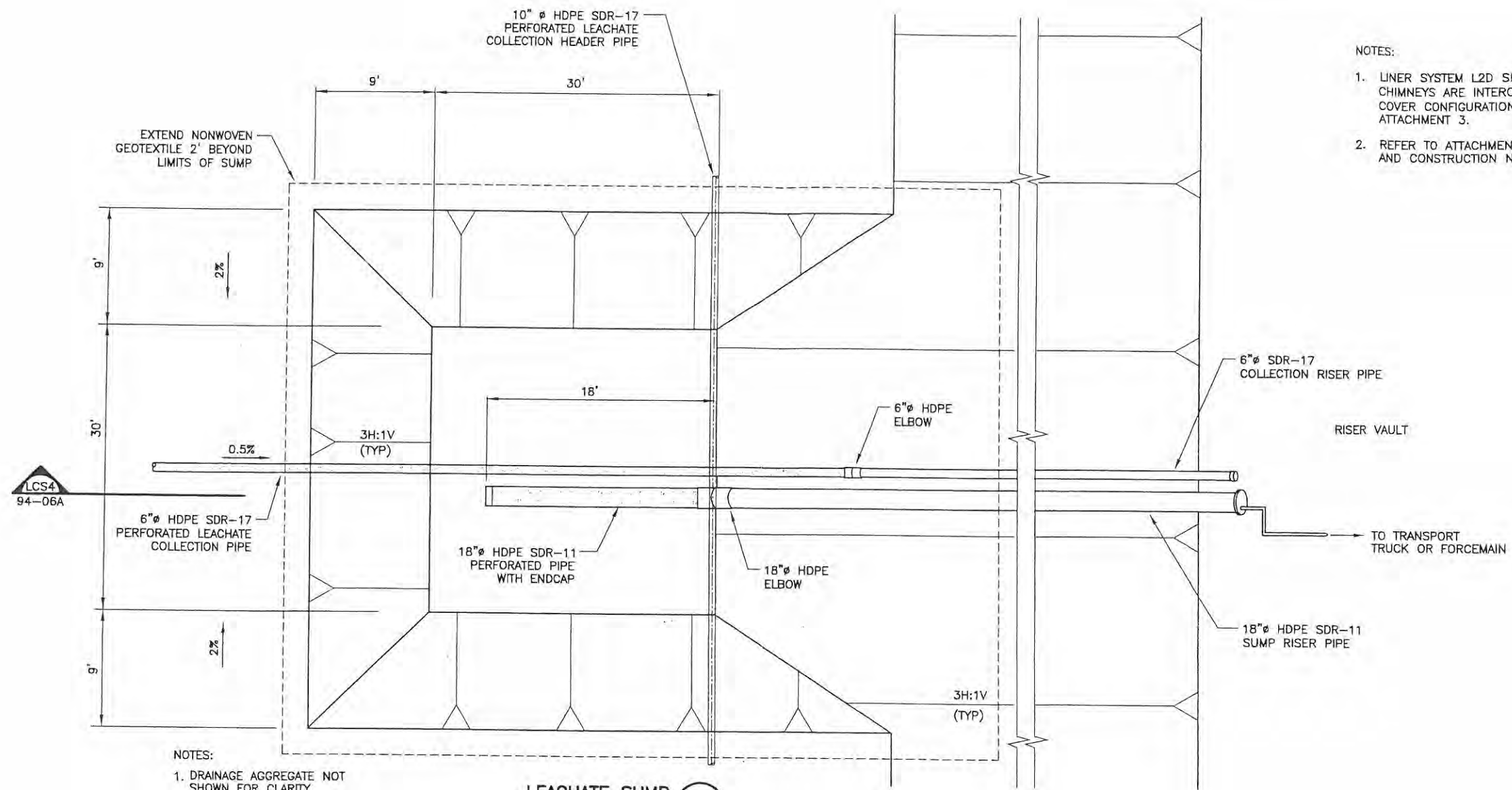


4. SUMP DIMENSIONS
1"=20'

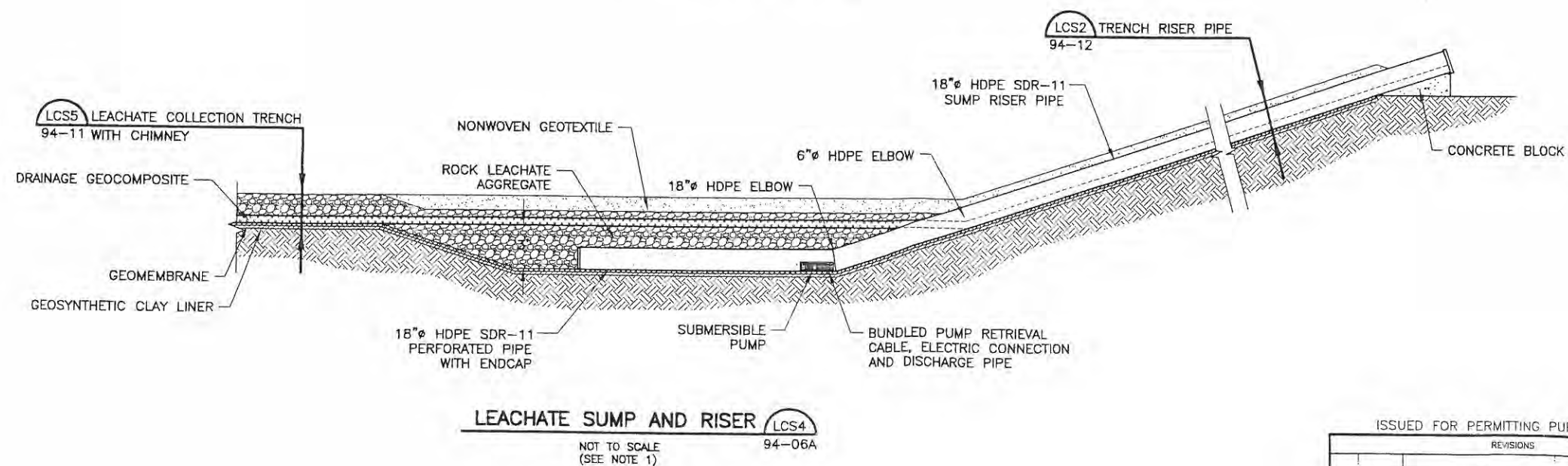


REVISION TABLE			
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1	07/07/94	ADDED 6" LEACHATE COLLECTION PIPE PERFORATION DETAIL	W. J. [Signature]
2	07/07/94	REVERSED VIEW DIRECTION OF SEC. R-R	W. J. [Signature]
3	8/10/94	ADDED SUMP DETAIL & DIMENSIONS	W. J. [Signature]
4	10/17/94	REVISED SUMP AREA	W. J. [Signature]
5	4/11/95	REVISED DETAIL TO CORRESPOND W/SECT P-P	W. J. [Signature]

CITY OF SAN ANGELO
DEPARTMENT OF PUBLIC WORKS
1994 LANDFILL PERMIT MODIFICATION
SUMP & RISER DETAILS
DWG. NO. 94-06 M-494



- NOTES:
1. LINER SYSTEM L2D SHOWN. LEACHATE COLLECTION SYSTEM CHIMNEYS ARE INTERCHANGEABLE WITH ANY LINER/PROTECTIVE COVER CONFIGURATION (WHEN REQUIRED), AS DISCUSSED IN ATTACHMENT 3.
 2. REFER TO ATTACHMENTS 3 AND 10 FOR MATERIAL SPECIFICATIONS AND CONSTRUCTION NOTES.



SUMP AND RISER DETAILS

SAN ANGELO LANDFILL

CITY OF SAN ANGELO

TCEQ PERMIT NO. MSW 79



BIGGS & MATHEWS

ENVIRONMENTAL

CONSULTING ENGINEERS

MANSFIELD

DALLAS • WICHITA FALLS

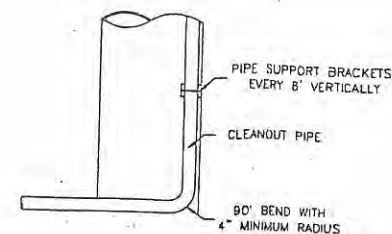
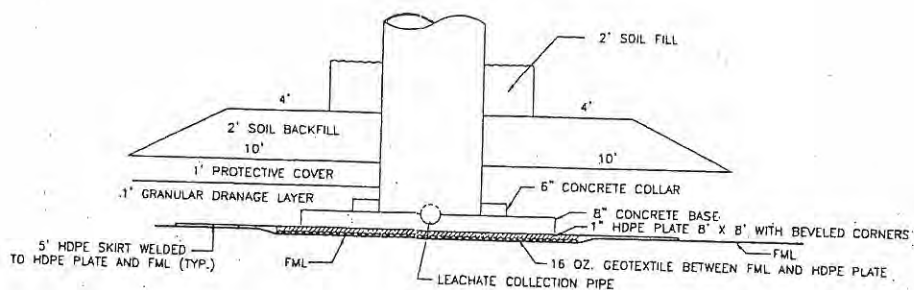
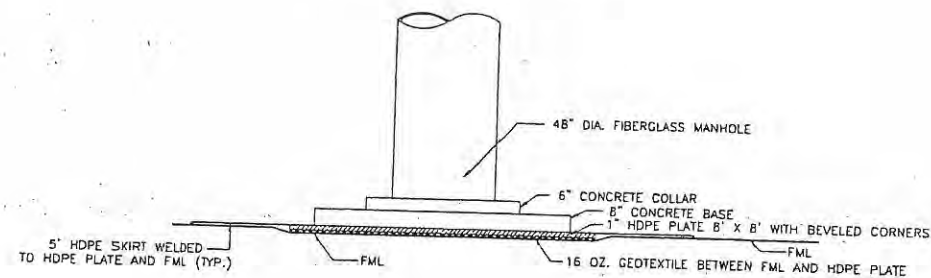
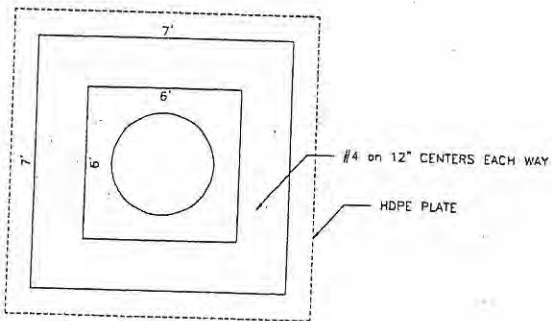
817-563-1144

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REVISIONS				
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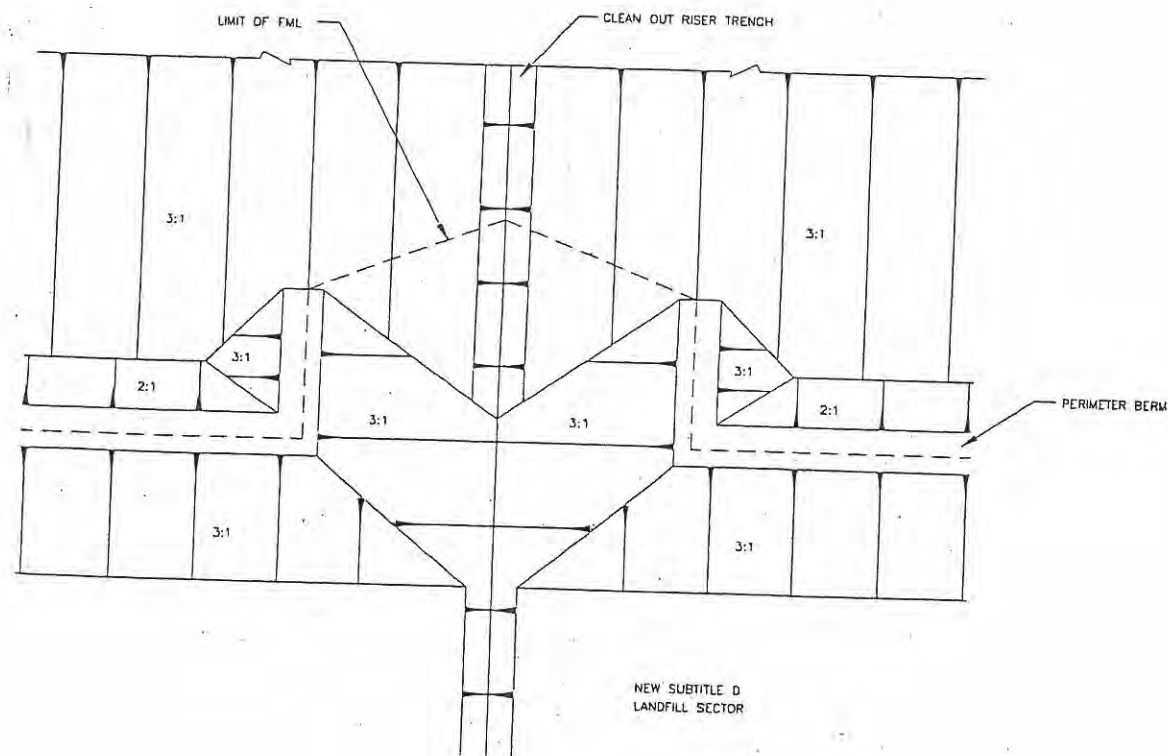
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94-06A



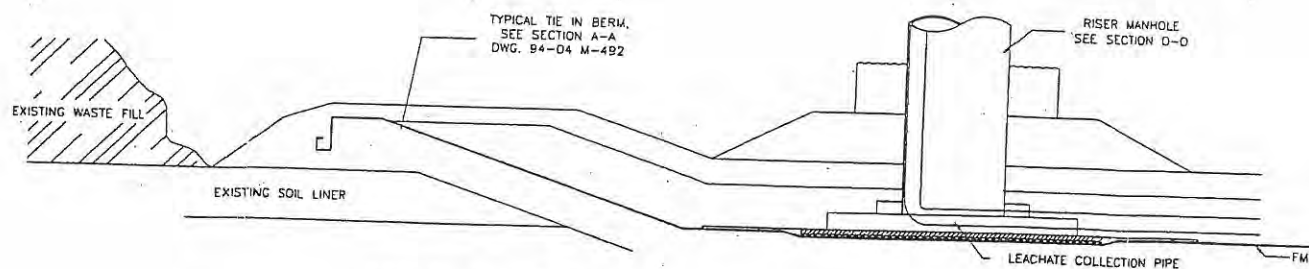
SEC 0-0 RISER MANHOLE DETAILS

7



CLEAN OUT GRADING PLAN DETAIL

SCALE: 1"=20'



SEC H-H: NORTH EMBANKMENT CLEAN OUT MANHOLE

NTS

3

6



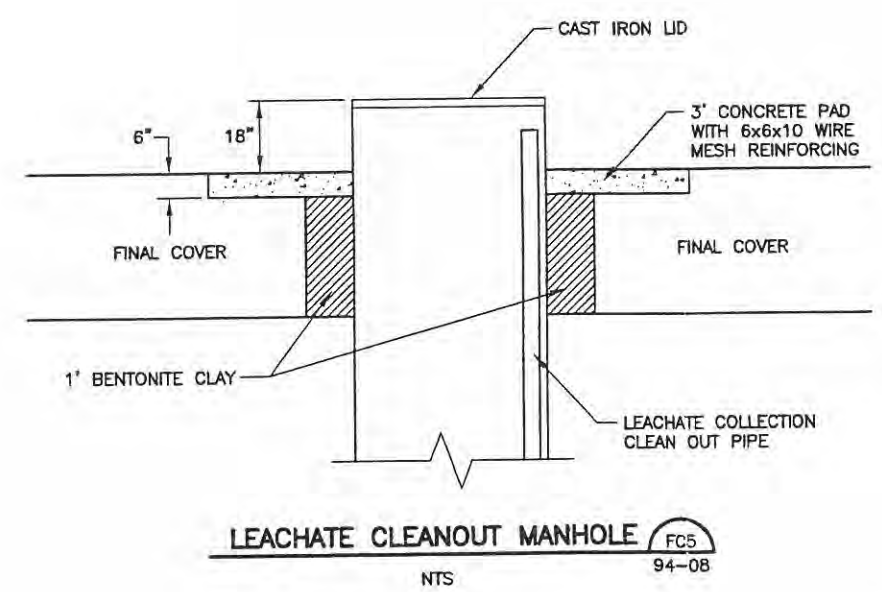
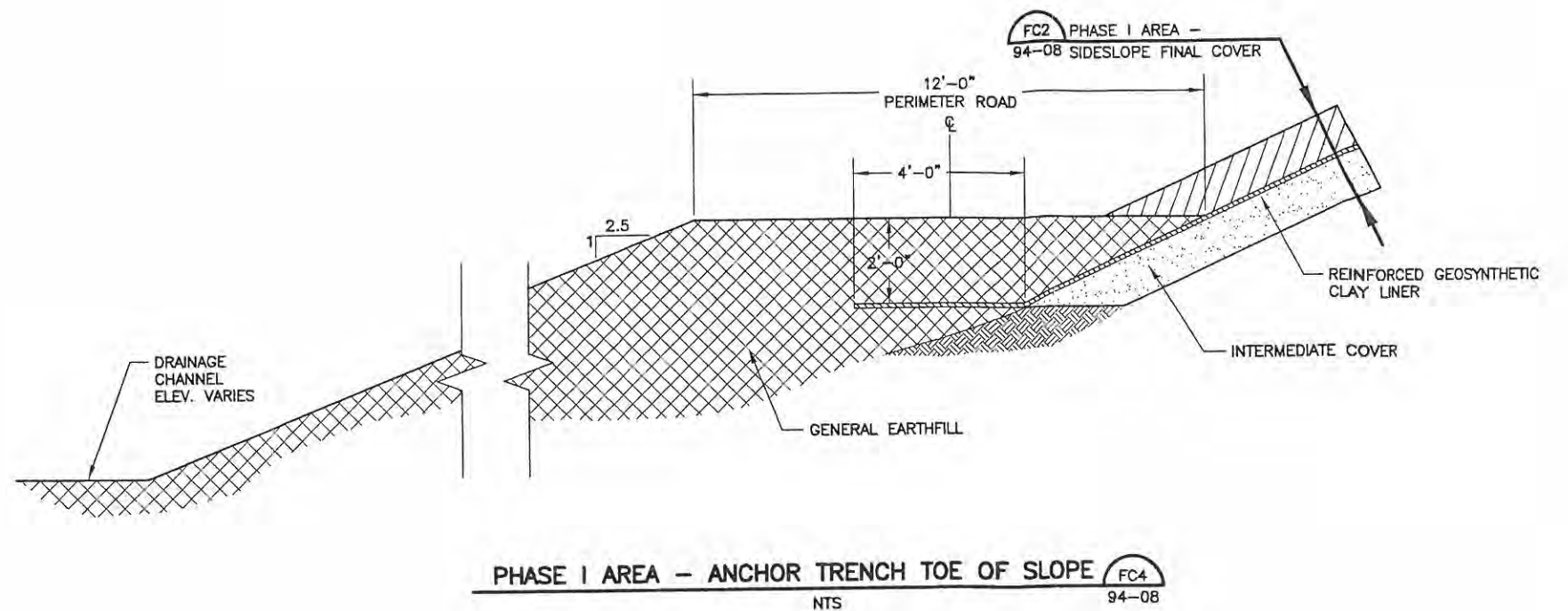
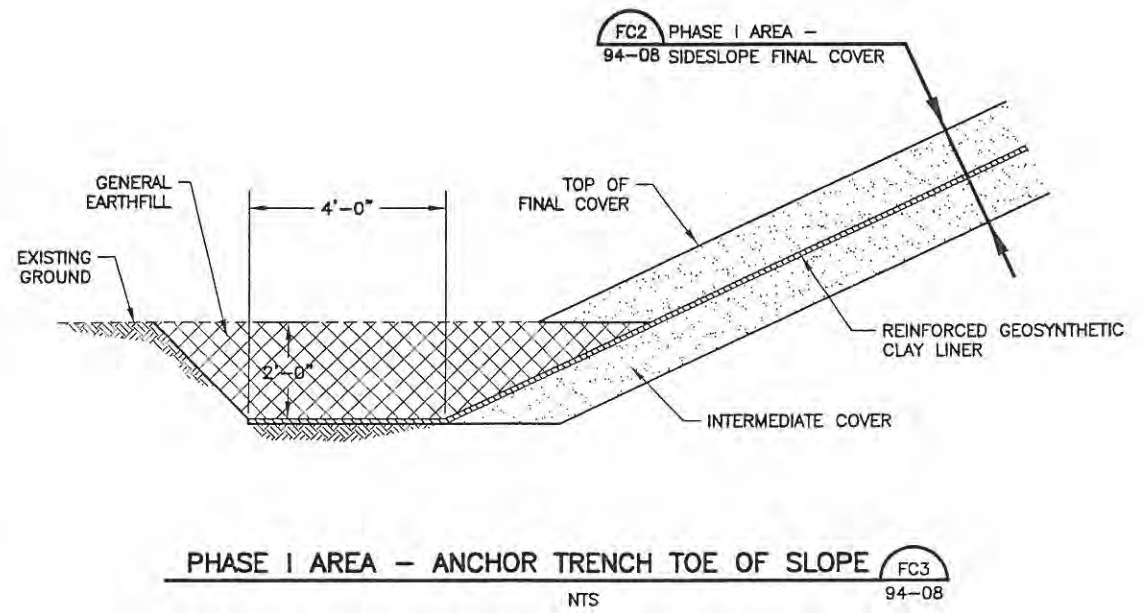
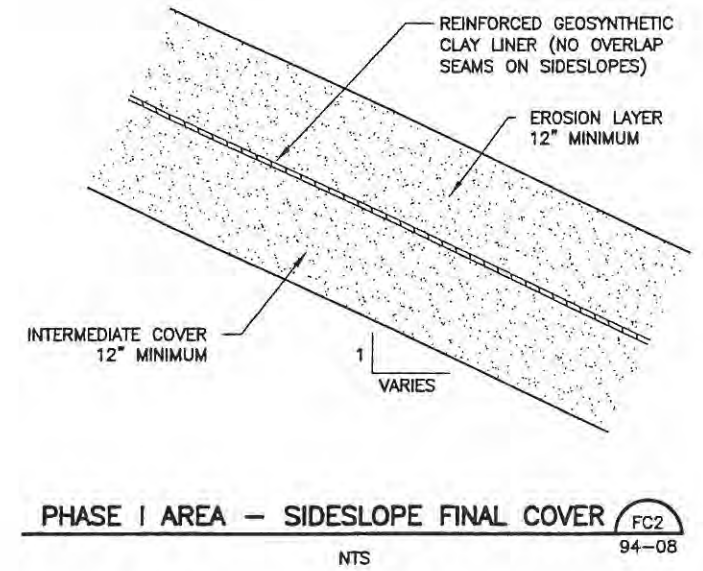
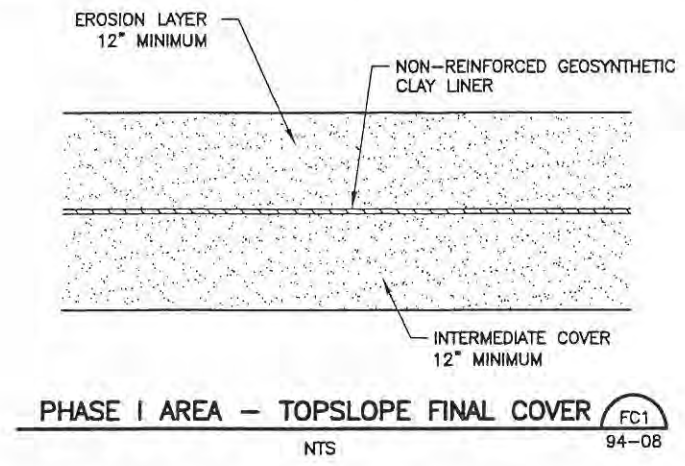
April 5, 1994

REVISION TABLE

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1	07/07/94	RENAMED DETAIL	LMV
2	07/07/94	ADDED STA. 30+38 DETAIL RENAMED SEC. N-N	LMV
3	07/07/94	REPLACED SECTION H-H	LMV
4	07/07/94	MOVED SECTION I-I, & E-E TO DWG. 94-08	LMV
5	07/07/94	REVISED DWG. TITLE	LMV
6	5/8/00	REVISED SECTION H-H AND DELETED SECTION N-N	LMV
7	5/8/00	ADDED SECTION 0-0	LMV

CITY OF SAN ANGELO
DEPARTMENT OF PUBLIC WORKS
1994 LANDFILL PERMIT MODIFICATION
CLEAN OUT DETAILS
NORTH EMBANKMENT
DWG. NO. 94-07 M-496

NOTE: SEE DWG. 94-08 FOR MATERIAL SPECIFICATIONS AND CONSTRUCTION NOTES.



NOTE:
1. REFER TO APPENDIX 5C FOR THE FINAL COVER QUALITY CONTROL PLAN.

TEXAS BOARD OF PROFESSIONAL ENGINEERS
FIRM REGISTRATION NO. F-256

TEXAS BOARD OF PROFESSIONAL
GEOSCIENTISTS
FIRM REGISTRATION NO. 50222

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REVISIONS									
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MISCELLANEOUS DETAILS AND SPECIFICATIONS

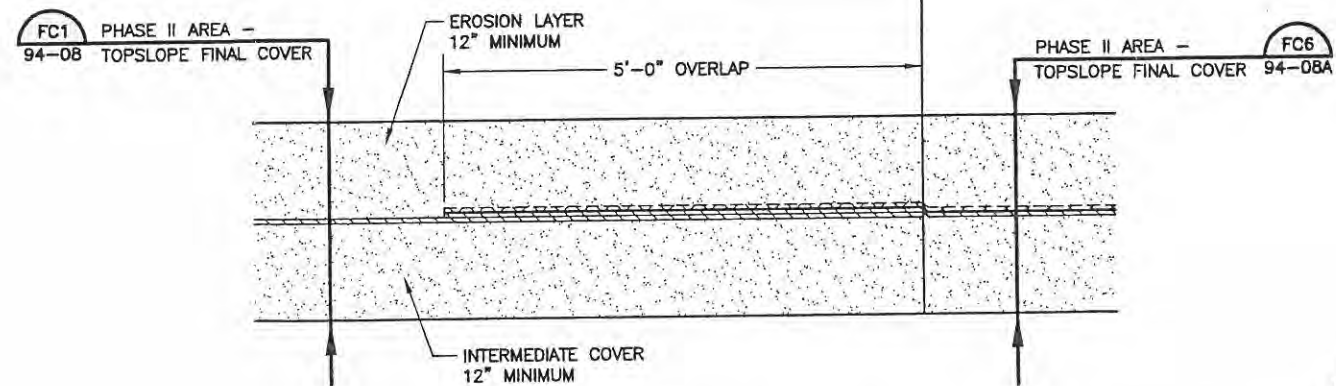
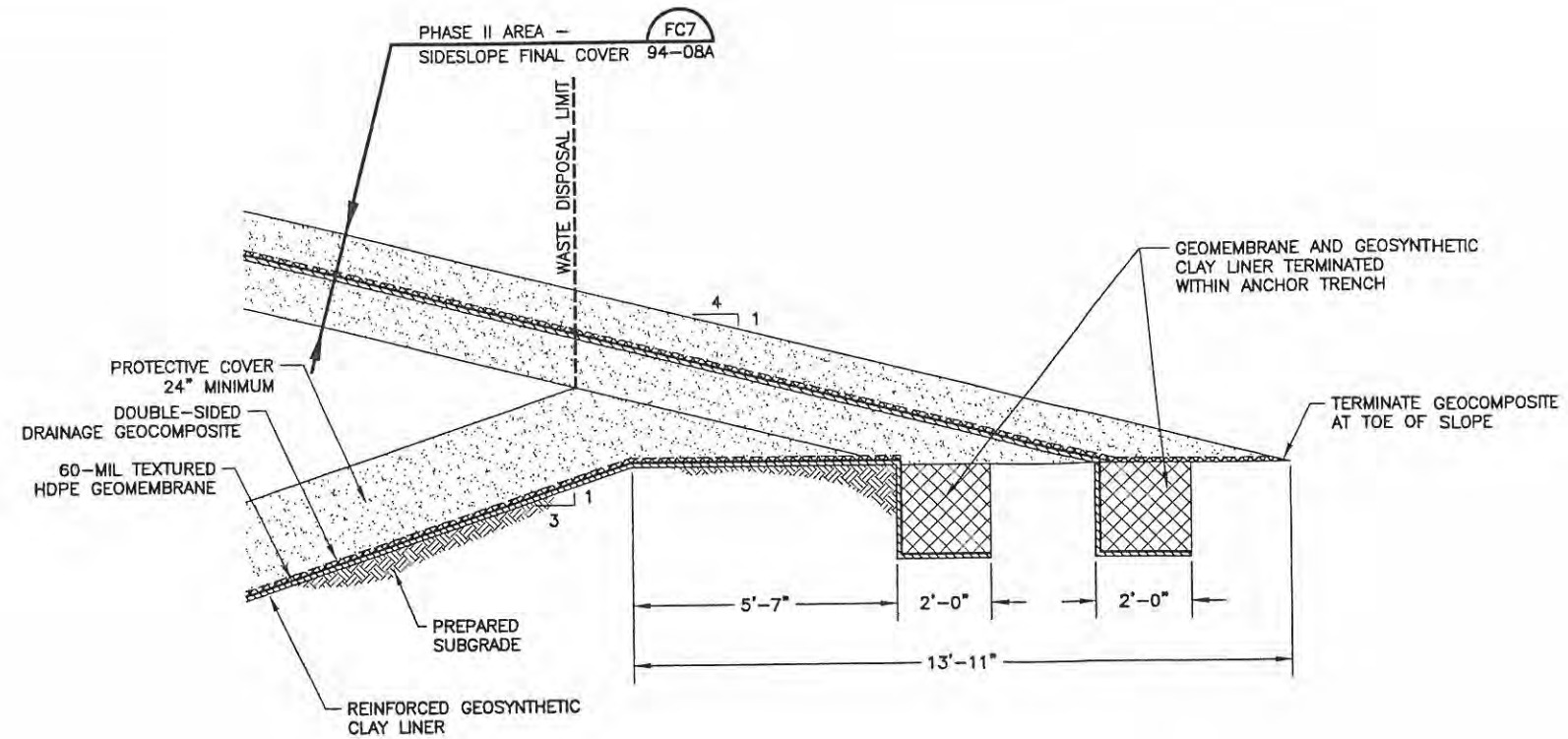
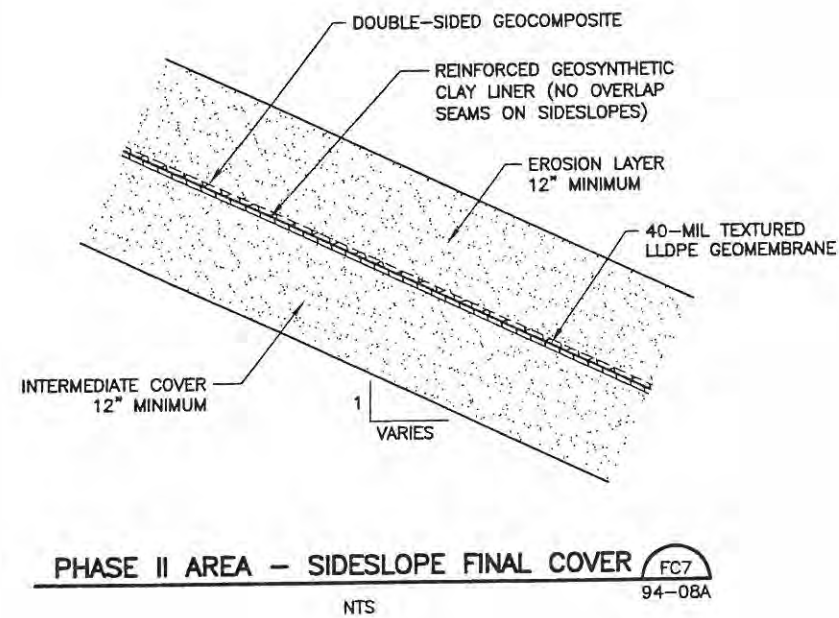
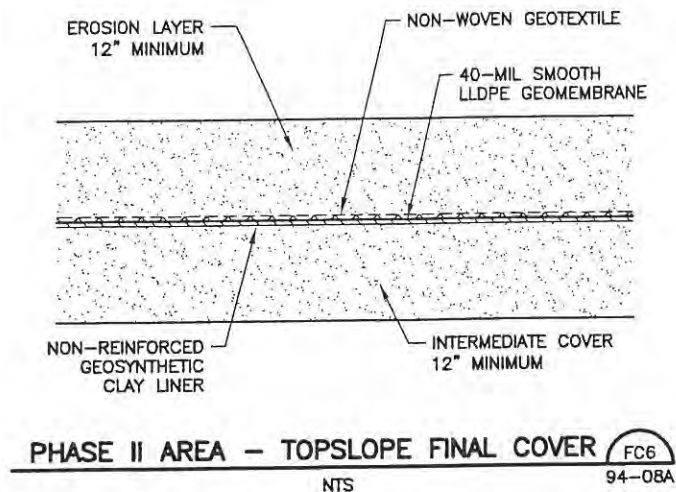
SAN ANGELO LANDFILL
TCEQ PERMIT NO. MSW 79
10 FOOT HEIGHT INCREASE

BIGGS & MATHEWS
ENVIRONMENTAL
CONSULTING ENGINEERS
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DRAWING
94-08

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NOTE:

1. REFER TO APPENDIX 5C FOR THE FINAL COVER QUALITY CONTROL PLAN.



TEXAS BOARD OF PROFESSIONAL ENGINEERS
FIRM REGISTRATION NO. F-256

TEXAS BOARD OF PROFESSIONAL
GEOSCIENTISTS
FIRM REGISTRATION NO. 50222

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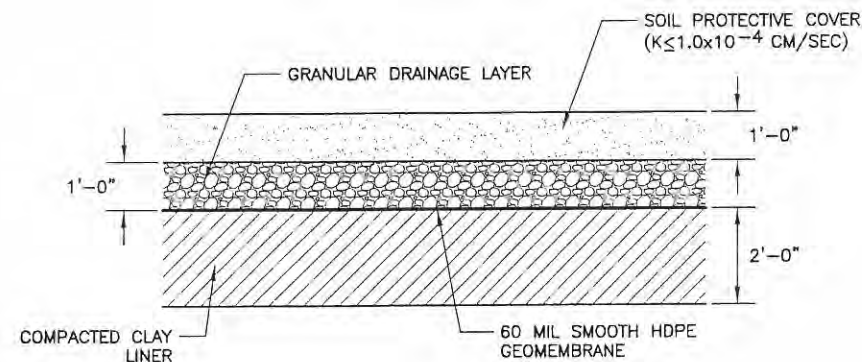
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MISCELLANEOUS DETAILS
AND SPECIFICATIONS

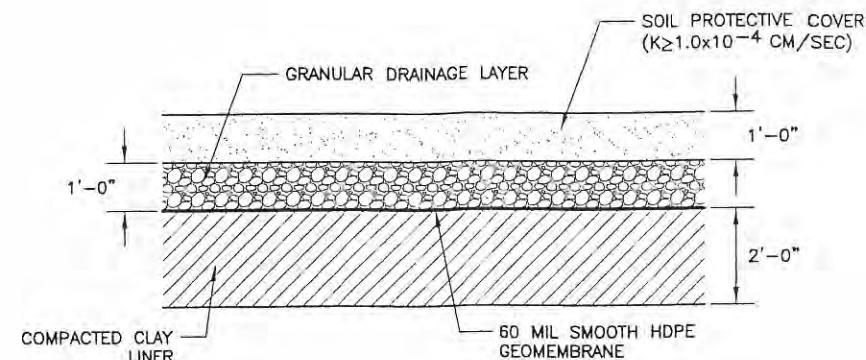
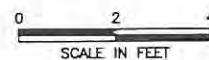
SAN ANGELO LANDFILL
TCEQ PERMIT NO. MSW 79
10 FOOT HEIGHT INCREASE



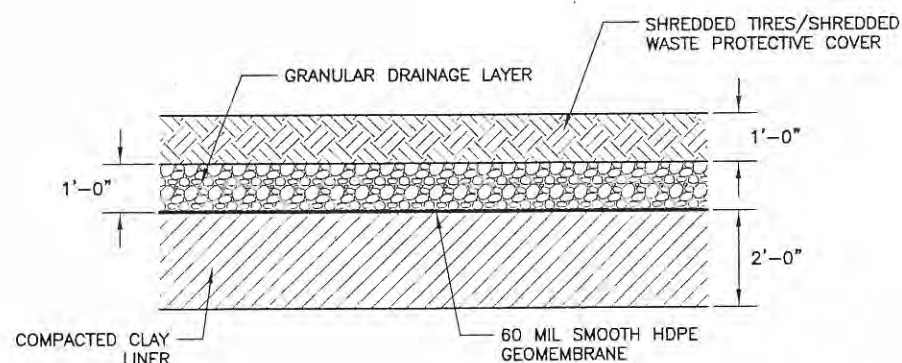
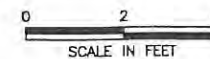
BIGGS & MATHEWS
ENVIRONMENTAL
CONSULTING ENGINEERS
MANSFIELD
DALLAS • WICHITA FALLS
817-563-1144



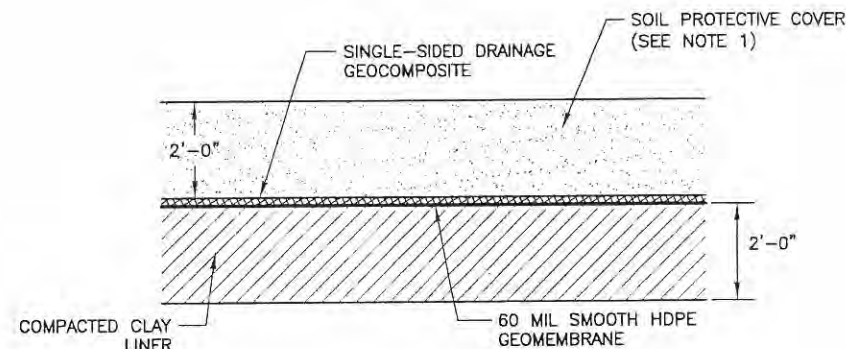
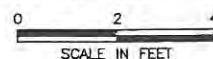
BOTTOM LINER L1A
CHIMNEYS REQUIRED 94-09



BOTTOM LINER L1B
CHIMNEYS NOT REQUIRED 94-09



BOTTOM LINER L1C
CHIMNEYS NOT REQUIRED 94-09



BOTTOM LINER L1D
CHIMNEY REQUIREMENTS VARY 94-09
(SEE NOTE 1)

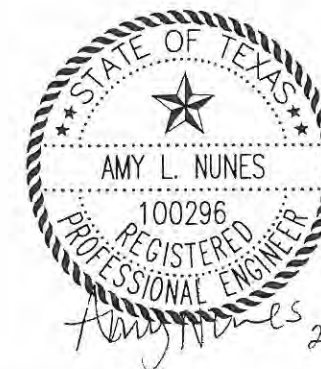


NOTES:

1. THE PROTECTIVE COVER HAS A COEFFICIENT OF PERMEABILITY GREATER THAN 1.0×10^{-4} CM/SEC, THEN CHIMNEYS ARE NOT REQUIRED. IF THE PROTECTIVE COVER HAS A MAXIMUM COEFFICIENT OF PERMEABILITY LESS THAN 1.0×10^{-4} CM/SEC, THEN CHIMNEYS ARE REQUIRED.

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REVISIONS					
REV	DATE	DESCRIPTION	OWN BY	DES BY	CHK BY



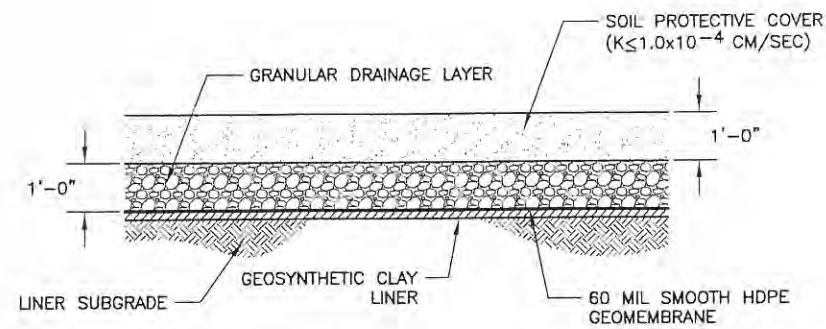
LINER DETAILS

**SAN ANGELO LANDFILL
PERMIT MODIFICATION**

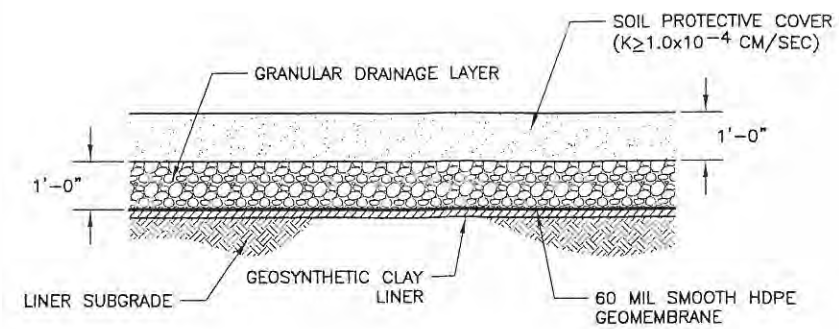
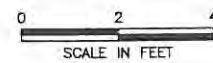


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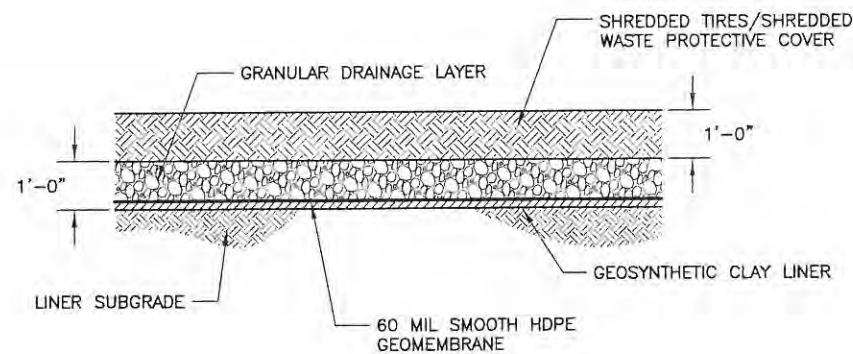
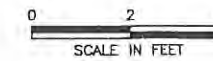
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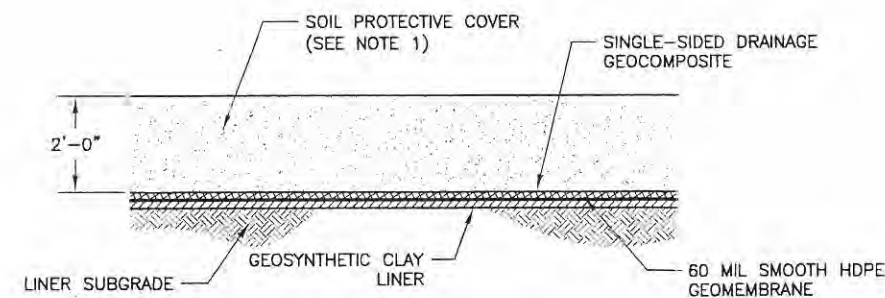
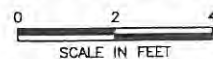
BOTTOM LINER L2A
CHIMNEYS REQUIRED 94-09A



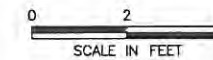
BOTTOM LINER L2B
CHIMNEYS NOT REQUIRED 94-09A



BOTTOM LINER L2C
CHIMNEYS NOT REQUIRED 94-09A



BOTTOM LINER L2D
CHIMNEY REQUIREMENTS VARY 94-09A
(SEE NOTE 1)



NOTES:

1. THE PROTECTIVE COVER HAS A COEFFICIENT OF PERMEABILITY GREATER THAN 1.0×10^{-4} CM/SEC, THEN CHIMNEYS ARE NOT REQUIRED. IF THE PROTECTIVE COVER HAS A MAXIMUM COEFFICIENT OF PERMEABILITY LESS THAN 1.0×10^{-4} CM/SEC, THEN CHIMNEYS ARE REQUIRED.



LINER DETAILS

**SAN ANGELO LANDFILL
PERMIT MODIFICATION**



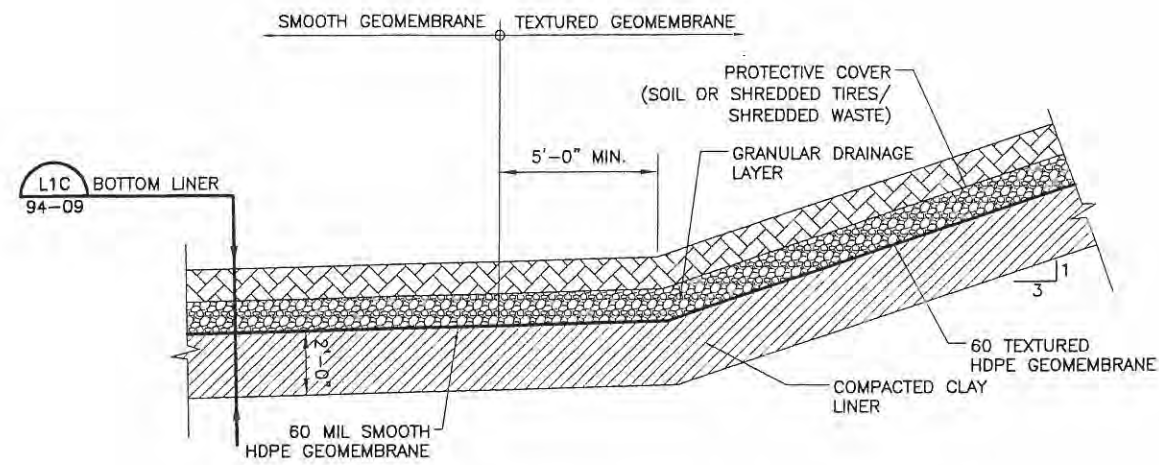
**BIGGS & MATHEWS
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CONSULTING ENGINEERS**
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DALLAS • WICHITA FALLS
817-563-1144

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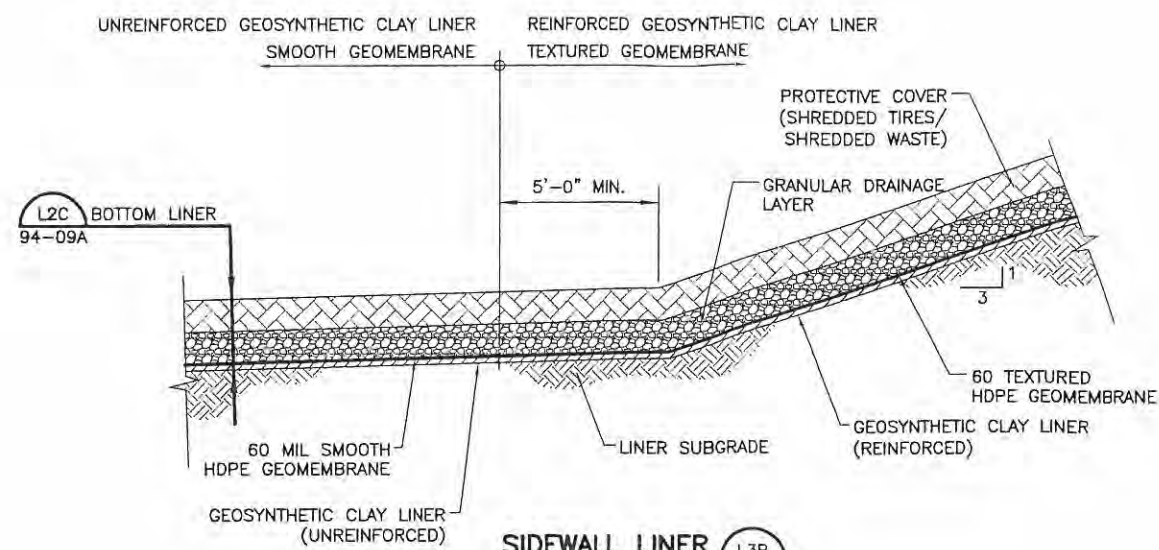
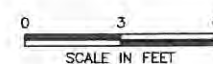
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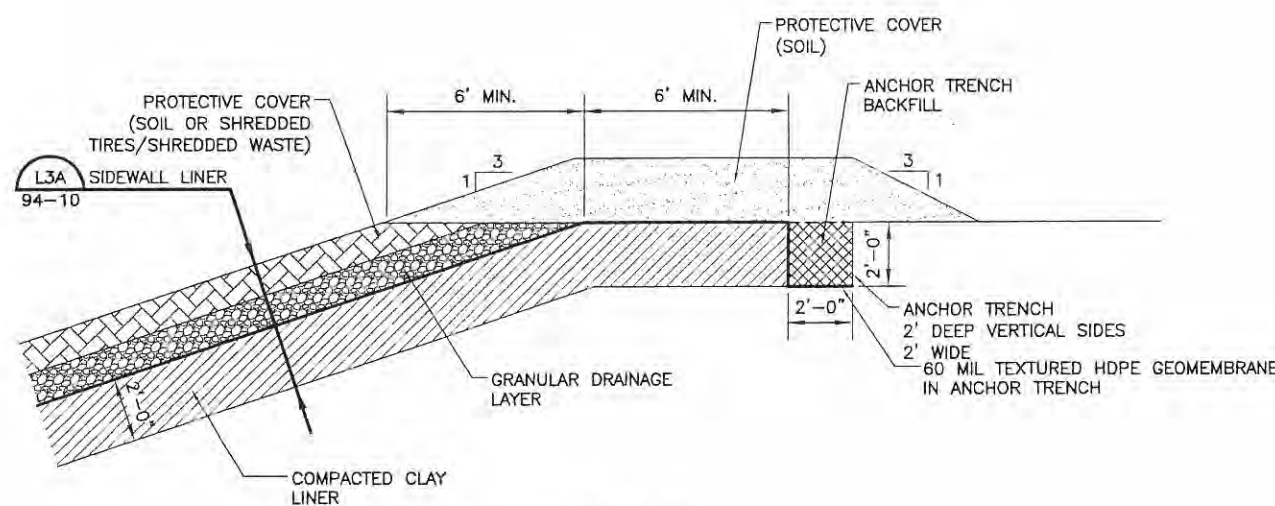
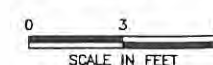
94-09A



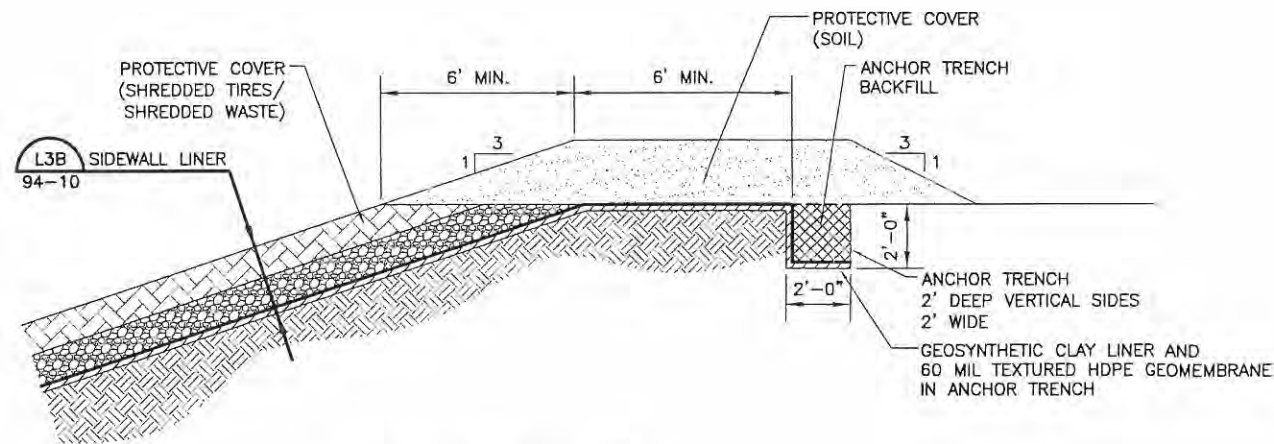
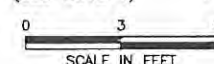
SIDEWALL LINER L3A
(SEE NOTE 1) 94-10



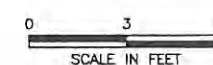
SIDEWALL LINER L3B
(SEE NOTE 1) 94-10



ANCHOR TRENCH L4A
(SEE NOTE 1) 94-10



ANCHOR TRENCH L4B
(SEE NOTE 1) 94-10



- NOTES:**
1. LEACHATE COLLECTION LAYERS L1C AND L2C ARE SHOWN. ALL LEACHATE COLLECTION LAYERS ARE INTERCHANGEABLE WITH BOTH LINER SYSTEMS.



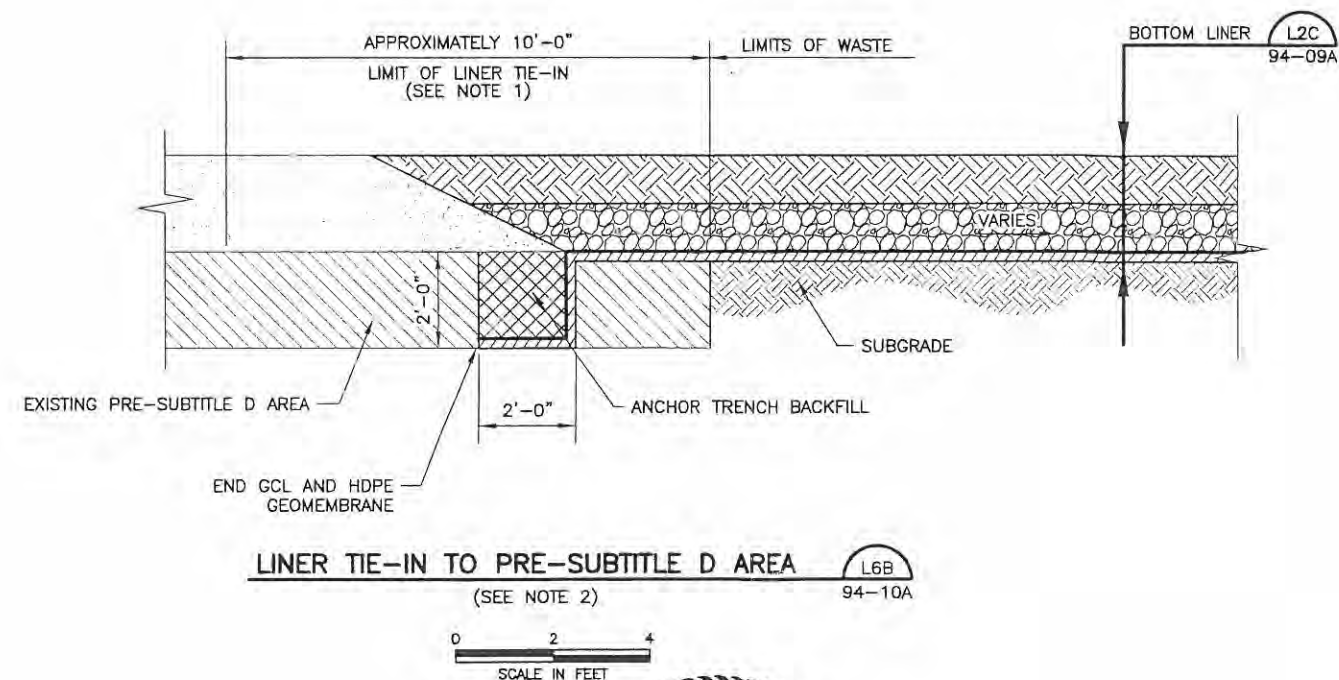
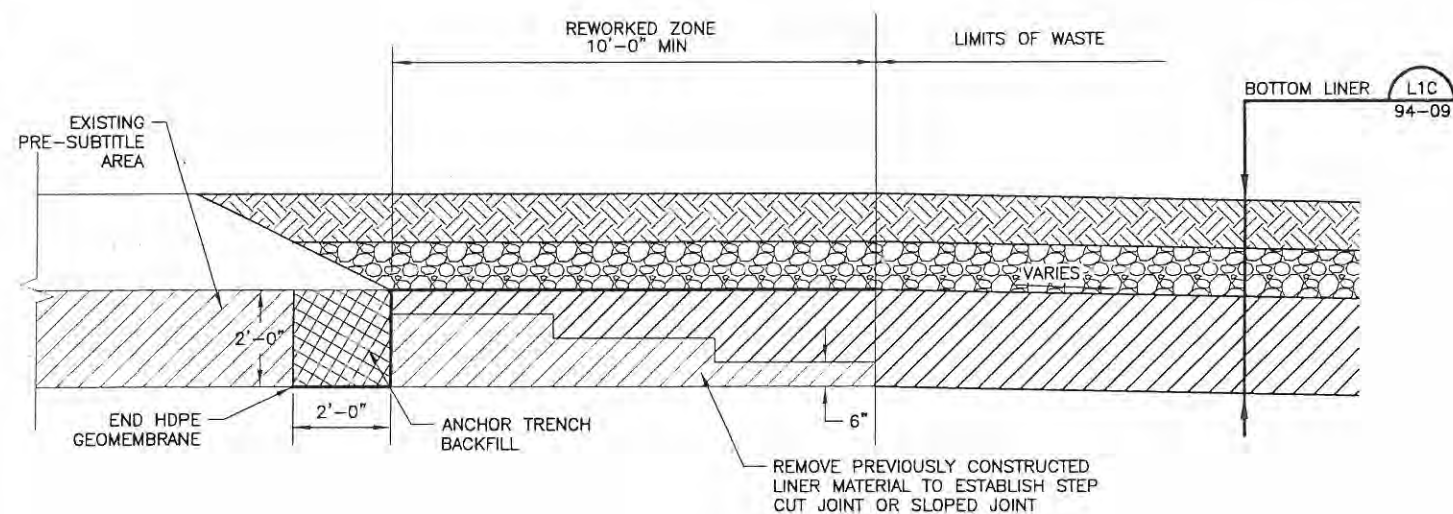
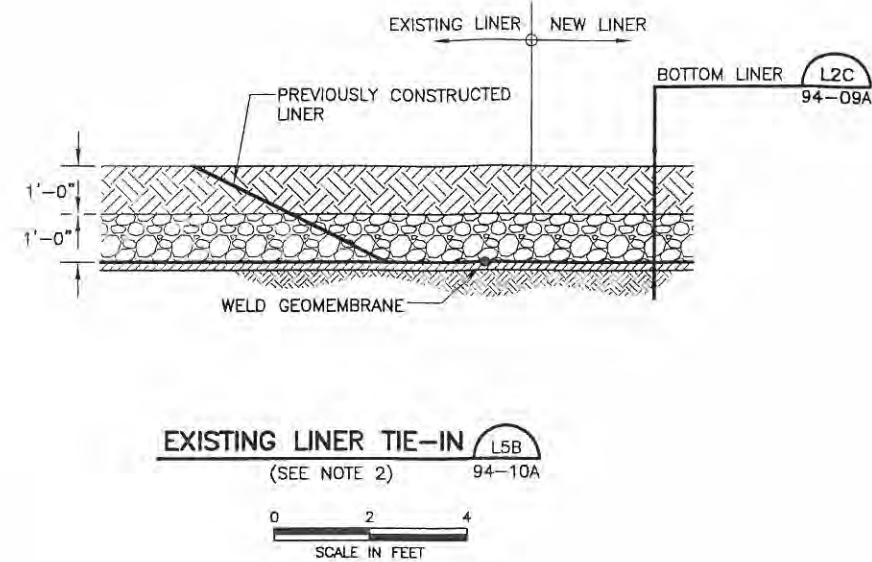
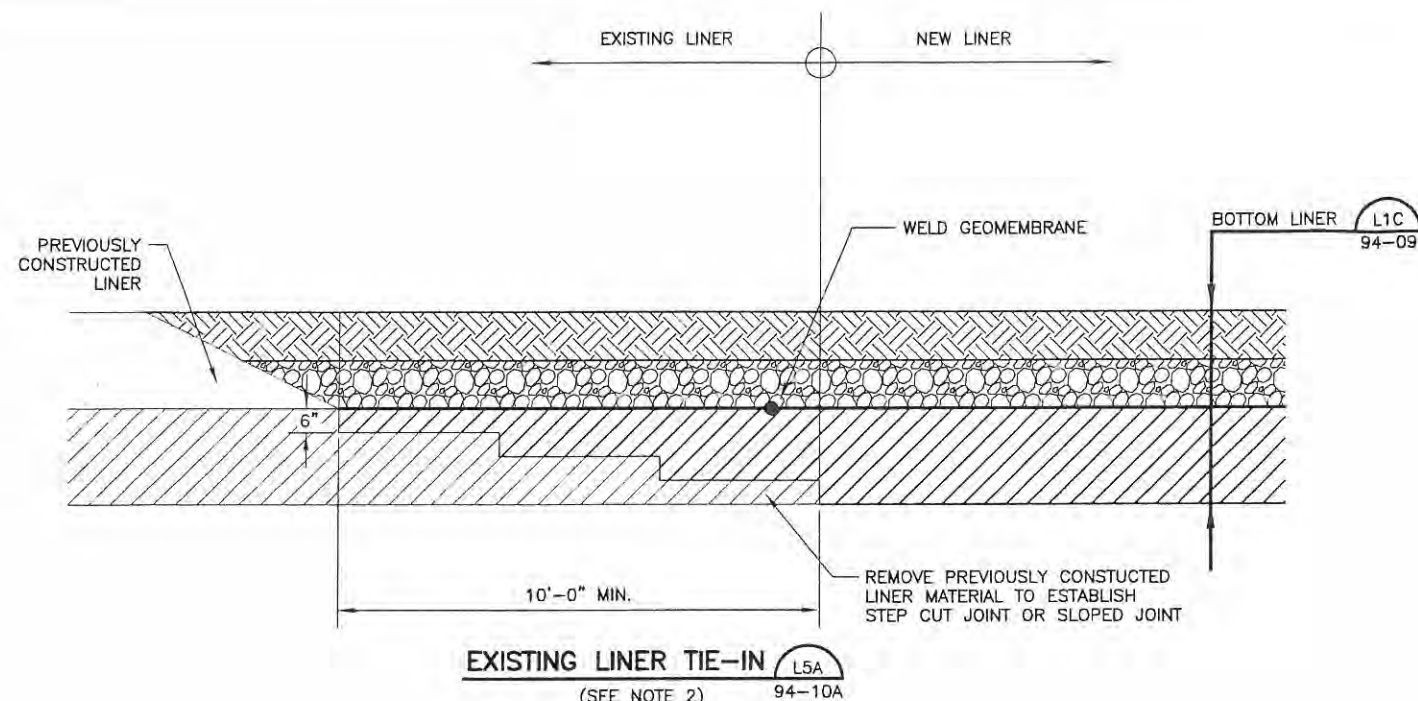
ISSUED FOR PERMITTING PURPOSES ONLY									
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							CHK	ALN	DWC

LINER DETAILS

SAN ANGELO LANDFILL PERMIT MODIFICATION

BIGGS & MATHEWS ENVIRONMENTAL CONSULTING ENGINEERS
MANFIELD
DALLAS • WICHITA FALLS
817-553-1144

DATE: 02/08
SCALE: GRAPHIC
DRAWING: 94-10



NOTES:

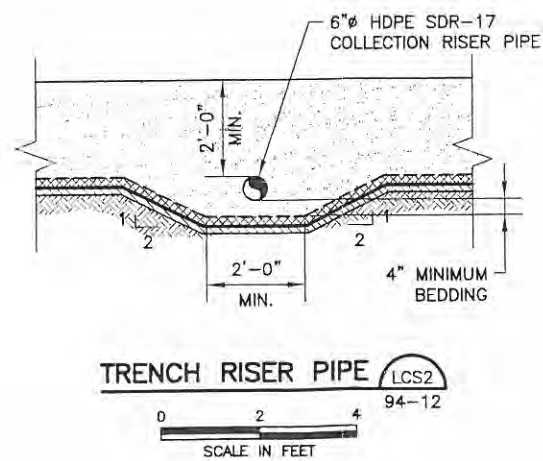
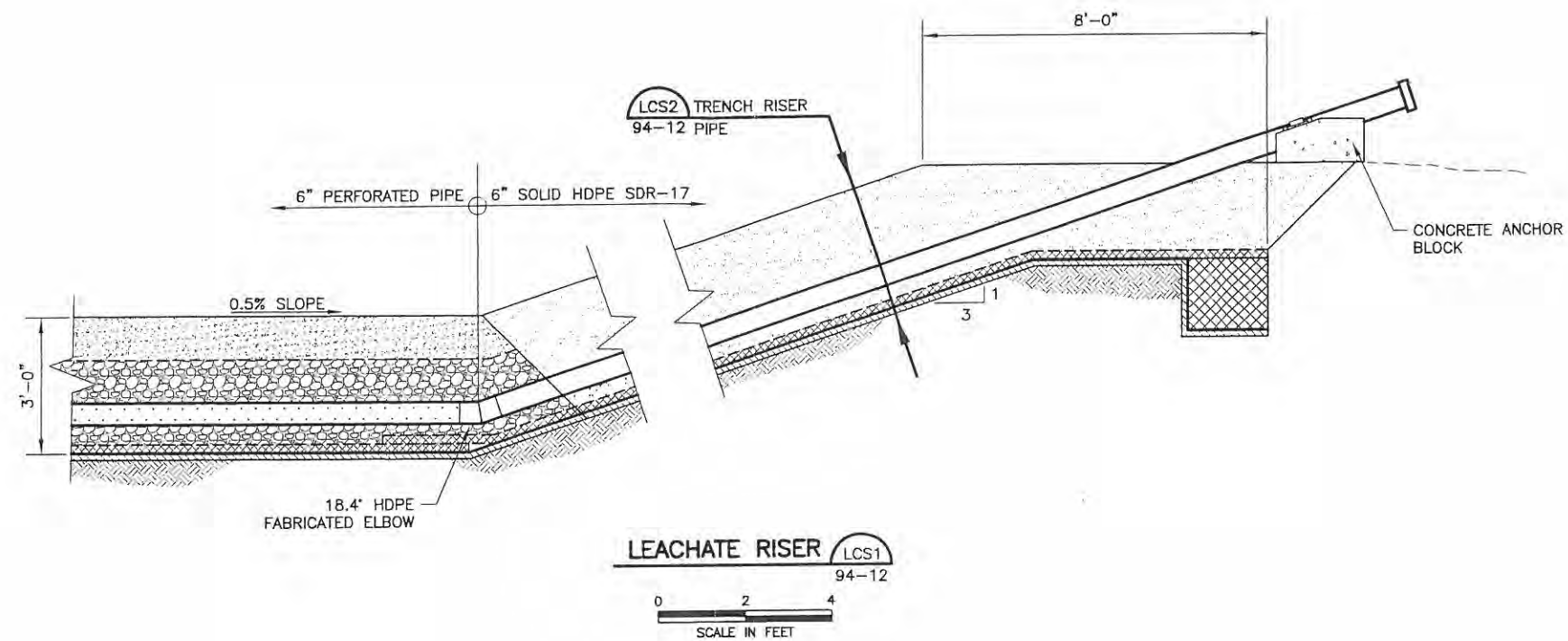
1. THE GCL LINER WILL EXTEND INTO THE PRE-SUBTITLE D AREAS TO PROVIDE A COMPLETELY LINED CELL.
2. LEACHATE COLLECTION LAYERS L1C AND L2C ARE SHOWN. ALL LEACHATE COLLECTION LAYERS ARE INTERCHANGEABLE WITH BOTH LINER SYSTEMS.



ISSUED FOR PERMITTING PURPOSES ONLY

REVISIONS				
REV	DATE	DESCRIPTION	OWN BY/DES BY/CHK BY	APP BY

LINER DETAILS			
SAN ANGELO LANDFILL PERMIT MODIFICATION			
		BIGGS & MATHEWS ENVIRONMENTAL CONSULTING ENGINEERS MANSFIELD DALLAS • WICHITA FALLS 817-563-1144	
DSN	ALN	DATE	02/08
DWN	WCI	SCALE	GRAPHIC
CHK	ALN	DWG	LinerDetails.dwg
DRAWING			94-10A



ISSUES FOR PERMITTING PURPOSES

REVISIONS						
REV	DATE	DESCRIPTION	DWN BY	DES BY	CHK BY	APP BY

LEACHATE COLECTION PLAN RISER PIPE DETAILS			
SAN ANGELO LANDFILL PERMIT MODIFICATION			
		BIGGS & MATHEWS ENVIRONMENTAL CONSULTING ENGINEERS MANFIELD DALLAS • WICHITA FALLS 817-563-1144	
DSN. SAN	DATE : 01/07	APPENDIX	
DWN. RMP	SCALE : GRAPHIC	94-12	
CHK. KJW	DWG : LinerDetails.dwg		

Copy

Bryan W. Shaw, Ph.D., *Chairman*
Carlos Rubinstein, *Commissioner*
Toby Baker, *Commissioner*
Zak Covar, *Executive Director*



TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

January 4, 2013

Mr. Ricky Dickson
Director of Operations
San Angelo Landfill
City of San Angelo
P. O. Box 1751
San Angelo, Texas 76902

Re: San Angelo Landfill – Tom Green County
Municipal Solid Waste – Permit No. 79
Permit Modification – Leachate Chimney Details in Attachments 2, 3, and 10
Tracking No. 16562218; RN102289576/CN600251615

Dear Mr. Dickson:

We have reviewed your application for a municipal solid waste permit modification dated November 30, 2012, requesting modifications to Attachments 2, 3, and 10 of the referenced permit, to revise the minimum required width of leachate chimneys and to correct inconsistencies between attachments. The information presented is technically sufficient for a municipal solid waste permit modification.

Enclosed is a copy of the above referenced modification which is now part of your permit and should be attached thereto. The documentation prepared and submitted to support the modification request shall be considered as requirements of the permit.

If you have questions concerning this matter, please contact Mr. Arten Avakian at (512) 239-4419. When addressing written correspondence, please use mail code MC 124.

This action is taken under authority delegated by the Executive Director of the Texas Commission on Environmental Quality.

Sincerely,

A handwritten signature in black ink, appearing to read "C. Bergren".

f Christine M. Bergren, Manager
Municipal Solid Waste Permits Section
Waste Permits Division

CMB/AJA/sdm

cc: Mr. Todd E. Stiggins, P.E., Project Engineer, Biggs & Mathews Environmental, Mansfield

Enclosure

Texas Commission on Environmental Quality



Modification to Municipal Solid Waste Permit No. 79 San Angelo Landfill

Municipal Solid Waste Permit No. 79 is hereby modified as follows:

Description of Change:

This modification revises Attachments 2, 3, and 10 of the referenced permit, changing the minimum required width of leachate chimneys and correcting inconsistencies between attachments.

The details of this permit modification are contained in the application dated November 30, 2012.

Part of Permit Modified:

Part III of the Application

Attachment 2 (Site Development Plan)

Title page and table of contents

Drawing 94-11

Attachment 3 (Soils and Liner Quality Control Plan)

Title page and table of contents

Sections 8.2.3.1 and 8.2.3.2 revised and merged into Section 8.2.3

Sections 8.4.3, 8.5.1, and 8.5.2

Table 3-20

Appendix 3A (Liner and Leachate Collection System Details)

Attachment 3A.6 (drawing)

Attachment 10 (Leachate and Contaminated Water Plan)

Title page and table of contents

Appendix 10A (Leachate Collection System Plan and Details)

Attachment 10A.3 (drawing)

Appendix 10B (Leachate Collection System Design Calculations)

Pages 10B-2 and 10B-4

This modification is a part of Permit No. 79 and should be attached thereto.

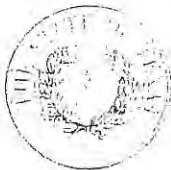
Approved, Issued, and Effective in accordance with Title 30 Texas Administrative Code Chapter 305, Sections 305.70(j)(5), (17), and (19), and Chapter 330, Sections 330.333 and 330.339.

Issue Date:

JAN 04 2013


For the Commission

Buddy Garcia, *Chairman*
Larry R. Soward, *Commissioner*
Bryan W. Shaw, Ph.D., *Commissioner*
Glenn Shankle, *Executive Director*



TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

April 25, 2008

The Honorable J. W. Lown
Mayor of San Angelo
P. O. Box 1751
San Angelo, Texas 76902-1751

Re: City of San Angelo Landfill – Tom Green County
Municipal Solid Waste - Permit No. 79A
Permit Modification: Additional Leachate Collection Sumps
WWC No. 11992133; CN602718405 / RN102143294

Dear Mayor Lown:

We have reviewed your application for a municipal solid waste permit modification received February 27, 2008, requesting to install additional leachate collection sumps in the Phase II Area. The information presented is technically sufficient for a municipal solid waste permit modification.

Enclosed is a copy of the above referenced modification which is now part of your permit and should be attached thereto as Attachment 3, Soils and Liner Quality Control Plan. The documentation prepared and submitted to support the modification request shall be considered as requirements of the permit.

If you have questions concerning this matter, please contact Mr. Arthur Denny at (512) 239-6610. When addressing written correspondence, please use Mail Code 124 (MC 124).

This action is taken under authority delegated by the Executive Director of the Texas Commission on Environmental Quality.

Sincerely,

A handwritten signature in dark ink, appearing to read "Richard C. Carmichael".

Richard C. Carmichael, Ph.D., P.E.
Manager, Municipal Solid Waste Permits Section
Waste Permits Division

RCC/ALD/fp

Enclosure

cc: Mr. Kenneth Welch, P.E., Biggs & Mathews Environmental, Mansfield
Mr. Ron Lewis, P.E., Public Works Director, City of San Angelo
Mr. Jason Quiton, Trashaway Services, Inc., San Angelo

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY



MODIFICATION TO MUNICIPAL SOLID WASTE PERMIT NO. 79A CITY OF SAN ANGELO LANDFILL

Municipal Solid Waste Permit No. 79A is hereby modified as follows:

Description of Change:

Provides minor revisions to the Site Development Plan, which includes changes to the Site Development Plan Drawings, Soil Liner Quality Control Plan and Leachate and Contaminated Water Plan. The details of this permit modification are contained in the application received February 27, 2008.

Parts of Permit Modified:

1. Part III, Site Development Plan, Attachment 2, Title Page.
2. Part III, Site Development Plan, Attachment 2, Table of Contents, Page ii.
3. Part III, Site Development Plan Drawing Nos. 94-05, 94-06A, 94-09, 94-09A, 94-10, 94-10A, 94-11.
4. Part III, Site Development Plan, Attachment 3, Appendix 3A, Attachments 3A.1, 3A.6, and 3A.7.
5. Part III, Site Development Plan, Attachment 10, Complete Replacement.

This modification is a part of Permit No. 79A and should be attached thereto.

APPROVED, ISSUED, AND EFFECTIVE in accordance with Title 30 Texas Administrative Code Chapter 305, Section 305.70(j)(18).

ISSUED DATE:

APR 25 2008

A handwritten signature in black ink, appearing to be "D. Smith", written over a horizontal line.
For the Commission

Buddy Garcia, *Chairman*
Larry R. Soward, *Commissioner*
Bryan W. Shaw, Ph.D., *Commissioner*
Glenn Shankle, *Executive Director*



TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

December 13, 2007

The Honorable J. W. Lown
Mayor of San Angelo
P. O. Box 1751
San Angelo, Texas 76902-1751

Re: Municipal Solid Waste (MSW) – Tom Green County
City of San Angelo - MSW Permit No. 79
Permit Modification: Soils and Liner Quality Control Plan
WWC Nos. 11914756 and 11947846, CN602718405 / RN102143294

Dear Mayor Lown:

We have reviewed your application for a municipal solid waste permit modification received October 11, 2007 and dated July 07, 2007, and the addendum drawing Attachment 3A.5 received November 20, 2007, requesting to replace the Soils and Liner Quality Control Plan (Attachment 3) of the Site Development Plan (Part III). The information presented is technically sufficient for a municipal solid waste permit modification.

Enclosed is a copy of the above referenced modification which is now part of your permit and should be attached thereto as Attachment 3, Soils and Liner Quality Control Plan. The documentation prepared and submitted to support the modification request shall be considered as requirements of the permit.

If you have questions concerning this matter, please contact Mr. Arthur Denny at (512) 239-6610. When addressing written correspondence, please use Mail Code 124 (MC 124).

This action is taken under authority delegated by the Executive Director of the Texas Commission on Environmental Quality.

Sincerely,

A handwritten signature in black ink, reading "Richard C. Carmichael".

Richard C. Carmichael, Ph.D., P.E.
Manager, Municipal Solid Waste Permits Section
Waste Permits Division

RCC/ALD/fp

Enclosure

cc: Mr. Kenneth Welch, P.E., Biggs & Mathews Environmental, Mansfield
Mr. Ron Lewis, P.E., Public Works Director, City of San Angelo
Mr. Jason Quiton, Trashaway Services, inc., San Angelo

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY



MODIFICATION TO MUNICIPAL SOLID WASTE PERMIT NO. 79 CITY OF SAN ANGELO LANDFILL

Municipal Solid Waste Permit No. 79 is hereby modified as follows:

Description of Change:

Part III (Site Development Plan), Attachment 3 (Soils and Liner Quality Control Plan (SLQCP)), has been completely revised and replaced. The details of this permit modification are contained in the application received October 11, 2007, and the addendum drawing received November 20, 2007.

Parts of Permit Modified:

Part III, Attachment 3 (SLQCP), complete replacement, received October 11, 2007, and November 20, 2007.

This modification is a part of Permit No. 79 and should be attached thereto.

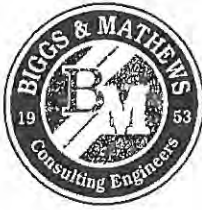
APPROVED, ISSUED, AND EFFECTIVE in accordance with Title 30 Texas Administrative Code Chapter 305, Section 305.70(j)(5).

ISSUED DATE:

DEC 13 2007

A handwritten signature in black ink, appearing to be "D. Shults", written over a horizontal line.

For the Commission



BIGGS & MATHEWS ENVIRONMENTAL

Consulting Engineers ♦ Hydrogeologists

Mansfield ♦ Arlington ♦ Dallas ♦ Wichita Falls

November 19, 2007

Mr. Arthur Denny
MC-124
MSW Permits Section, Waste Permits Division
Texas Commission on Environmental Quality
P.O. Box 13087
Austin, Texas 78711-3087

Re: San Angelo Landfill, City of San Angelo
Tom Green County, Texas
TCEQ Permit No. MSW 79
Addendum to Permit Modification – Soils and Liner Quality Control Plan
RN: 102289576; CN: 600251615

Dear Mr. Denny:

Per our telephone conversation on November 15, 2007, we are submitting an addendum to the Soils and Liner Quality Control Plan Permit Modification. The Soils and Liner Quality Control Plan Permit Modification was submitted to TCEQ on July 2, 2007. As requested, Detail L6A (Liner Tie-In to Pre-Subtitle D Area) on Attachment 3A.5 has been revised to provide additional callout descriptions and dimensions.

One original and two copies of this addendum are provided for your use and distribution. We are also providing a copy of this addendum to the TCEQ Region 8 office for their files. A copy of this submittal has been placed in the site operating record for this facility. If you have any questions or comments regarding this correspondence, please do not hesitate to contact me at (817) 563-1144.

Sincerely,

BIGGS & MATHEWS ENVIRONMENTAL

Kenneth J. Welch, P.E.
Senior Engineer

Attachments: Revised Attachment 3A.5 (3 copies)

cc: Mr. Ricky Dickson, City of San Angelo (2)
Mr. Jason Quinton, Trashaway Services, Inc. (1)
Mr. Ed Rhodes, Trashaway Services, Inc. (1)
Mr. Ricky Anderson, TCEQ Region 8 (1)

**SAN ANGELO LANDFILL
TOM GREEN COUNTY, TEXAS
TCEQ PERMIT NO. MSW 79**

PERMIT MODIFICATION

**PART III - SITE DEVELOPMENT PLAN
ATTACHMENT 3
SOILS AND LINER QUALITY CONTROL PLAN**

Prepared for

City of San Angelo

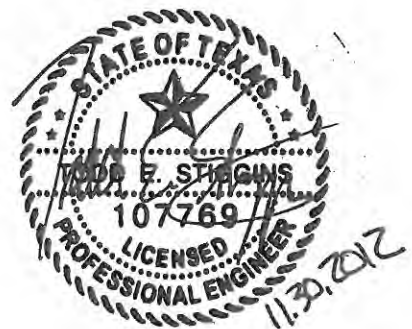
March 1994

July 1994

July 2007

February 2008

Revised November 2012



Prepared by

BIGGS & MATHEWS ENVIRONMENTAL
1700 Robert Road ♦ Mansfield, Texas 76063 ♦ 817-563-1144



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APPENDIX 3A

Liner and Leachate Collection System Details

APPENDIX 3B

Geosynthetic Research Institute Standard GM13

APPENDIX 3C

Geosynthetic Research Institute Standard GCL3

APPENDIX 3D

Alternate Liner Design Permit Modification
(Approved by TCEQ as Permit Modification January 1999)



1 INTRODUCTION

1.1 PURPOSE

This Soils and Liner Quality Control Plan (SLQCP) has been prepared in accordance with Chapter 330, Subchapter H: Liner System Design and Operation to establish procedures to assure compliance with Texas Commission on Environmental Quality (TCEQ) Municipal Solid Waste Rules (MSWR). This SLQCP also provides guidance for the design, construction, testing and documentation of the liner and leachate collection system construction.

1.2 DEFINITIONS

Specific terms and acronyms that are used in this SLQCP are defined below.

ASTM

This means the American Society for Testing and Material.

Construction Quality Assurance (CQA)

CQA is a planned system of activities that provides the owner and permitting agency assurance that the facility was constructed as specified in the design. CQA includes the observations, evaluations, and testing necessary to assess and document the quality of the constructed facility. CQA includes measures taken by the CQA organization to assess whether the work is in compliance with the plans, specifications, and permit requirements for a project.

Construction Quality Assurance (CQA) Monitors

CQA monitors are representatives of the GP who work under direct supervision of the GP. The CQA monitor is responsible for quality assurance monitoring and performing on-site tests and observations. The CQA monitor must be NICET-certified at level 2 for soils and geosynthetics, an engineering technician with a minimum of four years directly related experience, or a graduate engineer or geologist with one year of directly related experience.

Geomembrane Liner (GM)

This is an essentially impermeable geomembrane synthetic lining material, also referred to as geomembrane, membrane liner, or sheet.

Geomembrane Liner Evaluation Report (GLER)

This is a construction report for geomembrane liner that is submitted to the TCEQ for approval.

Geosynthetic Materials

Manufactured materials that include geomembranes, geogrids, geofilters, geocomposites, geodrainage nets, and geotextiles.

Geosynthetic Clay Liner (GCL)

A synthetic liner material that consists of bentonite encapsulated between two geotextiles.

Geosynthetic Clay Liner Evaluation Report (GCLER)

This is a construction report for geosynthetic clay liner that is submitted to the TCEQ for approval.

Geotechnical Professional (GP)

The GP is the authorized representative of the owner who is responsible for all CQA activities for the project. The GP must be registered as a professional engineer in Texas. Experience and education should include geotechnical engineering, engineering geology, soil mechanics, geotechnical laboratory testing, construction quality assurance and quality control testing, and hydrogeology. The GP must also have competency and experience in certifying similar projects. The GP may also be known in applicable regulations and guidelines as the CQA engineer, resident project representative, geotechnical quality control/quality assurance professional (GQCP), or professional of record (POR).

Geotechnical Professional's (GP's) Representative

The GP's Representative is a person who works under the supervision of the GP. The GP's Representative may include the CQA Monitor and third party testing laboratory, but excludes employees of the manufacturer and contractor.

Panel

This is a unit area of the GM or GCL, which will be seamed in the field.

Quality Assurance

Quality assurance is a planned program, or system of activities that is designed to assure that the work meets the requirements of plans, specifications, and permit for a construction project. Quality assurance includes procedures, quality control activities and documentation that are performed by the GP and CQA monitor.

Quality Control

Quality control is a planned system of inspections and activities that implement, monitor and control the quality of a construction project. The GP, CQA monitor, and contractor will perform quality control.

1.3 SITE CONDITIONS

1.3.1 Geology

The site geology and subsurface conditions are summarized below.

The San Angelo Landfill is located on the western edge of the Eastern Shelf of the Permian Basin. Permian age formations dip westerly into the Midland Basin at about 50 feet per mile. The Permian formations occur as redbeds and consist of silty and clayey clastic deposits with thin interbeds of limestone, dolomite, and sandstone. The Concho River valley occurs in a southeast–northwest trend across the area and is the erosional edge of the Edwards Plateau. The Edwards Plateau consists of Lower Cretaceous limestones and sandstones.

Quaternary aged alluvial and colluvial sediments shed from the Edwards Plateau and fill the Concho River valleys and lowland areas. Thicknesses of these sediments range from 0 to 150 feet and consist of caliche, clay, silt, sand, gravel, and conglomerate. The gravel is typically found at the base of the unit.

Quaternary sediments occur at the surface of the site. These sediments are alluvial in nature and consist of various lithologies of sand, silt, and clay and range in thickness from about 27 feet on the west side of the site to 55 feet on the far northeast corner of the site. Off-site to the south and southeast, the Quaternary alluvial strata occur in similar thicknesses, ranging from about 70 feet to about 62 feet. Occasional uncorrelatable lenses of limestone and caliche also occur within the alluvial section.

At the base of the alluvial section is a unit that consists of basal gravels and gravelly clays in communication with cemented fractured conglomerates and fractured limestones and dolomites from the upper portions of the Choza Formation. The conglomerate, limestone, and dolomite sections appear to be the same lithologic variation. The conglomerate is likely to be made up of eroded Paleozoic limestone and dolomite deposited as part of the Leona alluvial depositional event. In any event, the limestone, dolomite and conglomerates, which appear to be cemented, are fractured and in communication with the gravel and sandy portions of the overlying Leona. This assemblage of lithologies is identified collectively as the Leona Gravel and serves as the uppermost aquifer. The combined lithologies of the Leona Gravel interval range in thickness, where present on the site, from 2 feet to 32 feet. Clean gravel materials appear more frequently on the western side of the site. Over most of the site, the gravel occurs as clayey gravel. Occasional isolated and uncorrelatable, relatively thin interbeds of clay occur within the Leona Gravel interval. The unit occurs over most of the site but is absent from the north central portion of the site.

Beneath the Leona Formation is the Permian-aged Choza Formation. The Choza in the area is primarily a shale to clayey shale red-bed formation that contains occasional isolated and uncorrelatable interbeds of limestone and/or dolomite. The Choza dolomites that occur more than 10 feet into the Choza shale are not immediately hydraulically connected to the Leona Gravel interval. Where dolomite, limestone, and conglomerates of limestone and dolomite occur near the top of the Choza, they are often in communication with the overlying Leona and are considered to be a part of the

Leona unit. The Choza shale is a widespread correlateable unit that underlies the Leona Gravel throughout the area. The Choza shale serves as the aquiclude beneath the uppermost aquifer beneath the site, which is the Leona Gravel.

1.3.2 Hydrogeology

The major aquifer of the region is found in the basal gravels of the Quaternary alluvium and is known as the Leona Aquifer. Maximum yields have been reported in the Lipan Flats area, about 20 miles south of the site, of 500 gallons per minute (gpm). Typical yields in the area of the site range from a few gpm up to about 100 gpm. Typical well depths range from 30 to about 100 feet. The Leona Aquifer is occasionally commingled with the underlying Permian aquifers. The regional gradient of the Leona Aquifer is toward the Concho River.

There are minor Permian age aquifers underlying the Leona which produce highly mineralized groundwater. Almost all of the groundwater producing wells located in Tom Green County, regardless of which zone, are completed above 300 feet because of the poor water quality (brine conditions) found below that depth.

2 LINER SYSTEM

2.1 LINER AND LEACHATE COLLECTION SYSTEMS

Two liner systems are permitted for installation at the San Angelo Landfill. An alternate liner design permit modification was approved by TCEQ on January 15, 1999 and is included as Appendix 3D. The components for the two liner systems are listed from bottom to top in Table 3-1.

Table 3-1
Components of the Liner Systems

	Liner System Component	Description	Thickness
Option 1	Compacted Clay Liner	Compacted soil with a maximum coefficient of permeability of less than 1×10^{-7} cm/sec.	24 inches
	Geomembrane Liner (GM)	Smooth HDPE geomembrane on floor. Textured HDPE geomembrane on sidewalls.	60 mils
Option 2	Geosynthetic Clay Liner (GCL)	Unreinforced GCL on the floor. Reinforced GCL on the sidewalls. GCL with a maximum coefficient of permeability of less than 5.0×10^{-9} cm/sec.	Varies
	Geomembrane Liner (GM)	Smooth HDPE geomembrane on floor. Textured HDPE geomembrane on sidewalls.	60 mils

In addition to the two liner system options, there are several leachate collection system configurations permitted for use at the San Angelo Landfill. The components of the leachate collection systems are listed from bottom to top in Table 3-2.

**Table 3-2
Components of the Leachate Collection Systems**

	Leachate Collection System Component	Description	Thickness	Chimneys
Option A	Granular Drainage Layer	Granular drainage layer consisting of rock drainage aggregate with a permeability of 1×10^{-2} cm/sec or greater.	12 inches	Chimneys required
	Soil Protective Cover	Soil protective cover with a maximum coefficient of permeability of less than 1×10^{-4} cm/sec.	12 inches	
Option B	Granular Drainage Layer	Granular drainage layer consisting of rock drainage aggregate with a permeability of 1×10^{-2} cm/sec or greater.	12 inches	Chimneys not required
	Soil Protective Cover	Soil protective cover with a maximum coefficient of permeability of greater than 1×10^{-4} cm/sec.	12 inches	
Option C	Granular Drainage Layer	Granular drainage layer consisting of rock drainage aggregate with a permeability of 1×10^{-2} cm/sec or greater.	12 inches	Chimneys not required
	Shredded Tires or Shredded Waste Protective Cover	Shredded tires or shredded waste protective cover consisting of tires or waste shredded to pieces having a nominal size of 2 to 4 inches with a permeability of 1×10^{-2} cm/sec or greater.	12 inches	
Option D	Drainage Layer	Single-sided drainage geocomposite on the floor, and double-sided drainage geocomposite on the sidewalls.	Varies	If the protective cover has a coefficient of permeability greater than 1×10^{-4} cm/sec, then chimneys are not required. If the protective cover has a maximum coefficient of permeability less than 1×10^{-4} cm/sec, then chimneys are required.
	Soil Protective Cover	Soil protective cover with a maximum coefficient of permeability of less than 1×10^{-4} cm/sec.	24 inches	

As shown in Table 3-1, there are two liner systems currently permitted for use at the San Angelo Landfill. The two liner system options are permitted to be interchangeable with the leachate collection system options shown in Table 3-2.

The leachate collection layer will drain to collection trenches along the centerline of each cell. The leachate collection trenches will consist of perforated HDPE pipes encased in aggregate filled trenches. The leachate collection trenches will convey leachate to sumps located along the toe of the sideslopes. Details of the leachate collection system are provided in Appendix 3A.

2.2 CONSTRUCTION MONITORING

Continuous on-site monitoring is necessary to assure that all the components of the liner and leachate collection system are constructed in accordance with this SLQCP. At a minimum, the CQA monitor shall provide continuous on-site observation during all construction activities including the following:

- Subgrade preparation
- Compacted clay liner placement, compaction, and testing (if required)
- Geosynthetic clay liner (GCL) deployment, seaming, and repairing (if required)
- Geomembrane liner deployment, trial welds, seaming, testing, and repairing
- Anchor trench backfill
- Leachate collection layer deployment and seaming
- Protective cover layer placement
- Any work that could damage the installed components of the liner system

The GP will document and certify that the liner system was constructed in accordance with this SLQCP. The GP will generally be on site once weekly during periods when construction activities are occurring and the GP will be on site for all extraordinary construction events to provide adequate direct observation of the installation and testing of the liner system.

3 CONSTRUCTION QUALITY ASSURANCE FOR EARTHWORK

3.1 GENERAL

The top of liner plan for the San Angelo Landfill (see Appendix 3A, Attachment 3A.1) provides for the landfill floor to slope at 0.5 percent to the perimeter sidewalls, which will slope at 3H:1V. The landfill floor will be divided into approximate 200-foot wide areas, which will each have a 2 percent cross slope from the ridge of each cell to a leachate collection trench along the centerline of the cell. Collection trenches will slope at 0.5 percent to sumps located along the east perimeter of the landfill. The excavation will range from ground surface to about 20 feet deep. Earthwork activities and testing will be documented in the SLER or GCLER and the GLER in accordance with Section 9.

3.2 MATERIALS

The following material classifications will be encountered in excavations, or will be required for landfill construction.

General Fill and Liner Subgrade

General fill consists of soil that is free from debris, rubbish, solid waste, organic matter, and particles larger than 4 inches in diameter. The top 6 inches of liner subgrade will consist of soil that is free from debris, rubbish, solid waste, organic matter, and particles larger than $\frac{3}{4}$ -inch in diameter.

Protective Cover

Protective cover materials shall consist of soil that is free from debris, rubbish, frozen materials, foreign objects, solid waste, organic materials, and meets the requirements of Section 7.2.4.

Daily and Intermediate Cover

Daily and intermediate cover materials consist of soils that have not been previously mixed with solid waste.

Topsoil

Topsoil consists of soil that is capable of sustaining vegetation and is free of debris, rubbish, and solid waste.

Drainage Aggregate

Drainage aggregate consists of natural or manufactured granular material meeting the gradation that is required by the specifications. Drainage aggregate shall have a

coefficient of permeability of 1.0×10^{-2} cm/sec or greater. Additional requirements for drainage aggregate that is used in the leachate collection system are provided in Section 7.2.1.

Anchor Trench Backfill

Anchor trench backfill consists of general fill that is free of particles larger than 1 inch in diameter.

Unsuitable Materials

Unsuitable materials consist of any material that is determined by the Engineer to not be suitable for use as classified above.

3.3 EXCAVATION

Based on the subsurface exploration, it is anticipated that the excavation can be achieved with excavation equipment such as dozers with rippers and trackhoes.

3.4 GENERAL FILL AND LINER SUBGRADE

Areas to receive general fill shall be stripped of vegetation and debris. Prior to placement of general fill, either the GP or the CQA monitor shall observe the subgrade. Soft areas shall be undercut to firm material then be backfilled with compacted general fill. General fill consists of soil that is free from debris, rubbish, solid waste, organic matter, and particles larger than 4 inches in diameter. The top 6 inches of liner subgrade will consist of soil that is free from debris, rubbish, solid waste, organic matter, and particles larger than $\frac{3}{4}$ -inch in diameter.

3.5 TESTING AND VERIFICATION

A minimum of one standard Proctor test (ASTM D 698) shall be performed on each representative soil used as general fill material. Atterberg limits tests (ASTM D 4318) and percent passing the 1-inch and No. 200 sieve (ASTM D 422) shall be performed with each Proctor test. Moisture-density testing shall be performed by the CQA monitor at a rate of one field density test per lift for each 20,000 square feet of lift area.

4 CONSTRUCTION QUALITY ASSURANCE FOR COMPACTED CLAY LINER

4.1 GENERAL

The compacted clay liner layer consists of a 24-inch-thick layer of compacted, relatively homogeneous, cohesive material. The CQA monitor shall generally be on site during compacted clay liner layer placement, processing, compaction, and testing. The GP shall make sufficient site visits during compacted clay liner layer construction to document the construction activities, testing, and thickness verification in the Soils and Liner Evaluation Report (SLER), in accordance with Section 9.

4.2 MATERIALS

Compacted clay liner layer material shall consist of soil that is free from debris, rubbish, frozen materials, foreign objects, and organic material. The required compacted clay liner layer material properties are summarized in Table 3-3.

Table 3-3
Compacted Clay Liner Material Properties

Test	Standard	Required Property
Plasticity Index	ASTM D 4318	15 or greater
Liquid Limit	ASTM D 4318	30 or greater
Percent Passing No. 200 Mesh Sieve	ASTM D 1140	30 or greater
Percent Passing 1-inch Sieve	ASTM D 422	100
Coefficient of Permeability	ASTM D 5084 or COE EM 1110-2-1906 Appendix VII	1×10^{-7} cm/sec or less

Preconstruction testing procedures and frequencies for compacted clay liner layer materials are listed in Section 4.8.1.

4.3 SUBGRADE PREPARATION

Prior to placing compacted clay liner layer material, the subgrade should be proofrolled with heavy, rubber-tired construction equipment to detect soft areas. The GP or CQA monitor must observe the proof-rolling operation. Soft areas should be undercut to firm

material then be backfilled with compacted general fill in accordance with the requirements for general fill.

The subgrade elevations shall be verified in accordance with the requirements of Section 4.8.3 prior to the placement of compacted clay liner layer. Low areas should be brought to the design grades with general fill that is placed in accordance with the requirements of Section 3.4.

4.4 PLACEMENT AND PROCESSING

The compacted clay liner subgrade and surface of each lift should be scarified prior to placement of the next lift of compacted clay liner. The compacted clay liner layer material should be placed in maximum 8-inch loose lifts to produce compacted lift thickness of approximately 6 inches. The material should be processed to a maximum particle size of 1 inch or less before water is added. Rocks and clods less than 1 inch in diameter should not total more than about 10 percent by weight. The surface of the top lift shall contain no material larger than $\frac{3}{8}$ inch. Compacted clay liner material should be processed with a disc or soil pulverizer.

If additional water is necessary to adjust the moisture content, it should be applied after initial processing, but prior to compaction. Water should be applied evenly across the lift and be worked into the material. Water used for the clay liner compaction must not be contaminated by waste or any objectionable material.

4.5 COMPACTION

The compacted clay liner layer shall be compacted with a pad/tamping-foot or prong-foot roller. A footed roller is necessary to bond the lifts, to distribute the water, and to blend the soil matrix through kneading action. The compacted clay liner layer shall not be compacted with a bulldozer, rubber-tired roller, flat-wheel roller, scrapers, or any track equipment unless it is used to pull a footed roller. The compactor should weigh at least 40,000 pounds. The Caterpillar 815 and 825 are examples of equipment typically used to achieve satisfactory results. The lift thickness shall be controlled to achieve total penetration into the top of the previously compacted lift; therefore, the lift thickness must not be greater than the pad or prong length. Cleaning devices on the roller must be in place and be maintained to prevent the prongs or pad feet from becoming clogged to the point that they cannot achieve full penetration.

The compactor shall make approximately four passes across the area being compacted. A pass is defined as one pass of the compactor, front and rear drums. The material should be compacted to a minimum of 95 percent of the maximum dry density determined by standard Proctor (ASTM D 698) at a moisture content at or above optimum moisture. Areas with failing tests shall be reworked and recompact, and then retested with passing tests before another lift is added.

After a lift is compacted, it must be watered to prevent drying and desiccation until the next lift can be placed. If desiccation occurs, the GP must determine if the lift can be

rehydrated by surface application of water or if the lift must be scarified, watered, and then recompact. Following compaction and fine grading of the final lift, the surface of the compacted clay liner layer shall be smooth drum rolled.

4.6 PROTECTION

The completed compacted clay liner layer must be protected from drying, desiccation, rutting, erosion and ponded water until the geomembrane liner is installed. Areas that undergo excessive desiccation or damage shall be reworked, recompact and retested as directed by the GP.

4.7 TIE-IN TO EXISTING LINERS

The edge of existing compacted clay liner layers shall be cut back on either a slope or stair steps to prevent the formation of a vertical joint. Details of approved tie-in methods to existing liners are shown in Appendix 3A.

4.8 TESTING AND VERIFICATION

4.8.1 Preconstruction Testing

Table 3-4 lists the minimum testing required for material proposed for use as the compacted clay liner layer.

Table 3-4
Compacted Clay Liner Layer Material Preconstruction Tests

Test	Standard	Frequency
Plasticity Index	ASTM D 4318	1 per material type
Liquid Limit	ASTM D 4318	1 per material type
Percent Passing No. 200 Mesh Sieve	ASTM D 1140	1 per material type
Percent Passing 1-inch Sieve	ASTM D 422	1 per material type
Standard Proctor Test	ASTM D 698	1 per material type
Coefficient of Permeability	ASTM D 5084 or COE EM 1110-2-1906 Appendix VII	1 per material type

After the moisture density relationship has been determined for a material type, a soil sample should be remolded to about 95 percent of the maximum dry density at the optimum moisture content. This sample will be tested to determine if the soil can be compacted to achieve a suitable coefficient of permeability. Either falling head or constant head laboratory permeability tests may be performed to determine the coefficient of permeability. The permeant fluid for testing must be tap water or

0.005N calcium sulfate solution. Distilled or deionized water shall not be used as the permeant fluid.

4.8.2 Construction Testing

All quality control testing will be performed during construction of the liner, except for testing which is required after individual lifts are constructed. Table 3-5 lists the minimum testing required for material used as the compacted clay liner layer.

Table 3-5
Compacted Clay Liner Layer Material Construction Tests

Test	Standard	Frequency
Field Density	ASTM D 2922 ASTM D 3017	1/8,000 sf per 6-inch lift
Plasticity Index	ASTM D 4318	1/100,000 sf per 6-inch lift
Liquid Limit	ASTM D 4318	1/100,000 sf per 6-inch lift
Percent Passing 1-inch and No. 200 Mesh Sieve	ASTM D 1140 ASTM D 422	1/100,000 sf per 6-inch lift
Standard Proctor Test	ASTM D 698	1 per material type
Coefficient of Permeability	ASTM D 5084 or COE EM 1110-2-1906 Appendix VII	1/100,000 sf per 6-inch lift

The Atterberg limits of the in-place compacted clay liner layer must be continually compared to the Atterberg limits of the Proctor curve sample to assure that the proctor curve accurately represents the in place material. Any variance of more than 10 points between the liquid limit or plasticity index of the in-place soil and those of the Proctor curve sample will require that a new Proctor curve be developed. Permeability testing will be performed as described in Section 4.8.1 and all test data will be reported.

4.8.3 Thickness Verification

The as-built thickness of the compacted clay liner layer shall be determined by standard survey methods. Prior to the placement of compacted clay liner layer material the subgrade elevations will be determined at a minimum rate of 1 survey point per 5,000 square feet of lined area. After the compacted clay liner layer is completed, the top of compacted clay liner layer elevations will be determined at the same locations as the subgrade elevations. The as-built thickness will be the difference between the subgrade elevations and the top of compacted clay liner layer elevations, reported to the nearest 0.1 foot, and shall not be less than 2 feet.

5 CONSTRUCTION QUALITY ASSURANCE FOR GEOSYNTHETIC CLAY LINER

5.1 GENERAL

The geosynthetic clay liner (GCL) consists of a sodium bentonite contained between two geotextiles that is placed over the liner subgrade. Reinforced GCL will be placed over the sidewalls, and nonreinforced GCL will be placed on the landfill floor. The CQA monitor shall provide continuous on-site observation during GCL deployment, seaming, and repairing. The GP shall make sufficient site visits during the GCL installation to document the installation in the GCLER, in accordance with Section 9.

5.2 MATERIALS

5.2.1 Properties

The GCL shall consist of sodium bentonite contained between two geotextiles. A certificate of analysis for each clay lot shall be submitted as part of the quality control documentation. The finished GCL must have a permeability no greater than 5×10^{-9} cm/sec (test method ASTM D 5084 or GRI GCL-2), have a free swell (test method ASTM D 5890) of at least 24 mL/2g, and a fluid loss (test method ASTM D 5891) no greater than 18 mL. The manufacturer shall provide recommended seaming procedures.

Manufacturer quality control testing procedures and frequencies for GCL are listed in Section 5.5.1. Conformance samples may be taken at the manufacturing plant or at the project site by the GP or his representative and will be forwarded to a third party laboratory for testing. Third party conformance testing procedures and frequencies for GCL are listed in Section 5.5.2.

5.2.2 Delivery and Storage

The GCL shall be shipped in rolls, which are wrapped individually in relatively impermeable and opaque protective covers. The rolls may be stacked only as allowed by manufacturer's recommendations. The GCL rolls must be stored above ground and protected from moisture.

Upon delivery of the GCL, the CQA monitor will observe that:

- Equipment used to unload and store the rolls or pallets does not damage the GCL.
- The GCL is stored in an acceptable location and not stacked more than five rolls high.

- The GCL is protected from puncture, dirt, grease, water, moisture, and excessive heat, or other damage.
- All manufacturing documentation required by the specifications has been received and reviewed for compliance with the specifications.

5.3 PREPARATION

Prior to installation of the GCL, the liner subgrade shall be surveyed and verified. Surveying will be performed to verify that the finished subgrade is to the lines and grades specified in the design with a vertical tolerance of ± 0.1 feet.

Before installation of GCL, the CQA monitor or geosynthetics contractor will observe the following:

- All lines and grades of the prepared subgrade have been verified.
- The prepared subgrade is free of irregularities and protrusions.
- The top six inches of prepared subgrade shall be free of particles larger than $\frac{3}{4}$ -inch in diameter.
- The prepared subgrade has been smooth-drum rolled.
- The prepared subgrade is not saturated and no standing water is present.
- The geosynthetics contractor has certified in writing that the prepared subgrade on which the GCL will be installed is acceptable.

5.4 INSTALLATION

5.4.1 Deployment and Placement

Equipment used to deploy GCL over soil shall not cause rutting of the subgrade. The GCL should be unrolled, not dragged, across the subgrade. Where the GCL cannot be unrolled, a geosynthetic rub sheet must be placed under the GCL to protect it during deployment. Deployed GCL panels shall contain no folds or excessive slack. Generators, gasoline or solvent cans, tools, or supplies shall not be placed directly on GCL. Installation personnel shall not smoke or wear damaging shoes when working on GCL.

GCL on sideslopes shall not be unrolled perpendicular (across) to the slope. No horizontal seams will be allowed on side slopes unless the full roll length is too short to extend from the anchor trench to 5 feet past the toe of the slope. If horizontal seams are necessary, they will be constructed only in the lower half of the slope with a minimum end lap of 3 feet, shingled in the down slope direction, and staggered at least 20 feet apart vertically. GCL will be temporarily anchored at the top of the slope and then be unrolled downslope with appropriate construction equipment to prevent wrinkles and folds.

During GCL placement, the CQA monitor must:

- Provide full time observation.
- Record weather conditions.
- Observe the condition of the liner subgrade and note any deficiencies. All deficiencies shall be repaired and be approved by the CQA monitor.
- Observe the condition of the GCL and note any defects. All defects must be repaired in accordance with the requirements of Section 5.4.4.
- Observe that people working on the GCL do not smoke, wear shoes that could damage the GCL, or engage in activities that could damage the GCL.
- Observe that no more panels are deployed than can be covered on the same day.
- Observe that overlaps are constructed in accordance with the manufacturer's recommendations, but in no case will the overlaps be less than 6 inches on the edges (longitudinal) and 2 feet on the ends.
- Observe that seams are constructed per manufacturer's recommendations. Horizontal and vertical seams for reinforced and unreinforced GCLs will be amended with granular dry bentonite between the overlapped panels in accordance with the manufacturer's recommendations. In absence of other guidelines, a rate of ¼ pound per linear foot will be used where bentonite amendment is required.
- Observe that defects are patched and overlapped properly.
- Observe that on sideslopes, the GCL is anchored at the top and then unrolled.
- Observe the GCL for premature hydration. All GCL that has prematurely hydrated shall be removed and replaced with new GCL.

Any panels that are not deployed in accordance with this section shall be marked by the CQA monitor and be repaired in accordance with Section 5.4.4 or be removed and replaced by the installer.

5.4.2 Protection

Construction equipment on the GCL shall be minimized to reduce the potential for damage or puncture. Small equipment such as generators shall be placed on scrap GM material (rub sheets). Vehicle and equipment traffic other than only low contact pressure vehicles must not be allowed on the deployed GCL. The CQA monitor will verify that GCL (or overlying geosynthetics) are not displaced or damaged while overlying materials are being placed. Drainage aggregates and protective cover shall be placed in lifts using low ground pressure equipment.

5.4.3 Anchor Trenches

The top corner of the anchor trenches shall be rounded to prevent crimping the GCL. The bottom of the anchor trench shall be dry, stable and be free of loose particles and rocks. Anchor trenches shall be backfilled with compacted general fill that is free of particles larger than 1 inch in diameter. General fill material placed in anchor trenches will be placed in uniform lifts, which do not exceed 12 inches in loose thickness and are compacted. In-place moisture density tests will be taken at the discretion of the CQA monitor to evaluate the quality of the backfill.

5.4.4 Repairs

Repairs shall be constructed in accordance with the manufacturer's recommendations. Damaged unreinforced GCL (landfill floor) will be repaired by completely exposing the affected area, removing all foreign objects or soil, and placing a patch cut from unused GCL over the damaged area with a minimum overlap of 12 inches on all edges. Dry bentonite will be placed between the patch edges and the repair material at a rate of a quarter pound per linear foot. Reinforced GCL material damaged on the side slopes will be repaired by the same procedure as the unreinforced GCL.

5.5 TESTING AND VERIFICATION

5.5.1 Manufacturer's Quality Control Testing

The manufacturer shall test the GCL and raw materials in accordance with the most current GRI Standard GCL3 and Table 3-6 to assure the quality of the GCL. The current GRI Standard GCL3 (as of the date of this SLQCP) is provided in Appendix 3C.

Table 3-6
GCL Manufacturer Tests

Test	Type of Test	Standard Test Method	Frequency of Testing
Bentonite ¹	Free Swell	ASTM D 5890	per 50 tons and every truck or railcar
	Fluid Loss	ASTM D 5891	
Geotextile	Mass Unit/Unit Area	ASTM D 5261	per 200,000 ft ²
	Grab Tensile Strength	ASTM D 4632	
GCL Product	Clay Mass/Unit Area @0% moisture	ASTM D 5993	per 40,000 ft ²
	Bentonite Moisture Content	ASTM D 5993	
	Grab Tensile Strength	ASTM D 4632	per 200,000 ft ²
	Permeability ²	GRI GCL-2 or ASTM D 5084	per week for each production line
	Lap Joint Permeability	Flow box or other suitable device	per GCL adjoining material and lap type

¹ Tests to be performed on bentonite before incorporation into GCL.

² Report last 20 permeability values, ending on production date of supplied GCL.

5.5.2 Conformance Testing

Conformance testing requirements are provided in Table 3-7.

Table 3-7
GCL Conformance Tests

Property	Standard Test Method	Frequency of Testing
Clay Mass/Unit Area @ 0% moisture	ASTM D 5993	per 40,000 ft ²
Permeability ¹	GRI GCL-2 or ASTM D 5084	per 100,000 ft ²
Internal Shear Strength	ASTM D 6243	per 100,000 ft ²

¹Test at confining/consolidating pressures simulating field conditions for ASTM D 5084.

5.5.3 Required Manufacturer's Specifications

Table 3-8
Manufacturer's Specifications for Unreinforced and Reinforced GCL Materials

Property	Required Values	
	Unreinforced GCL	Reinforced GCL
Free Swell (millimeters)	24 (minimum)	24 (minimum)
Fluid Loss (millimeters)	18 (minimum)	18 (minimum)
Bentonite Mass per Unit Area (lb/sf)	0.75 (minimum)	0.75 (minimum)
Grab Tensile Strength (lbs)	80 (minimum)	90 (minimum)
GCL Hydrated Internal Shear Strength (psf)	50 (minimum)	500 (minimum)
GCL Permeability (cm/s)	5×10^{-9} (maximum)	5×10^{-9} (maximum)
Lap Joint Permeability (cm/s)	5×10^{-9} (maximum)	5×10^{-9} (maximum)

6 CONSTRUCTION QUALITY ASSURANCE FOR GEOMEMBRANE LINER

6.1 GENERAL

The geomembrane liner (GM) consists of a 60-mil-thick HDPE geomembrane placed over the geosynthetic clay liner or the compacted clay liner. Smooth GM will be placed on the floor and GM that is textured on both sides will be placed over the sidewalls. The CQA monitor shall provide continuous on-site observation during GM deployment, trial welds, seaming, testing, and repairing. The GP shall make sufficient site visits during the GM installation to document the installation and testing in the GLER, in accordance with Section 9.

6.2 MATERIALS

6.2.1 Properties

GM shall consist of smooth and textured high-density polyethylene (HDPE) geomembrane produced from virgin raw materials. Recycled materials are not acceptable. The GM shall not be manufactured from resin from differing suppliers. The GM shall meet the requirements of the Geosynthetics Research Institute (GRI) Standard GM13. A copy of GRI Standard GM13 (as of the date of this SLQCP) is included in Appendix 3B for informational purposes and will be superseded as newer versions are adopted. This SLQCP incorporates the most current version of GRI Standard GM13.

Third party conformance testing procedures and frequencies for GM are listed in Section 6.5.2.

6.2.2 Delivery and Storage

GM shall be shipped in rolls labeled with the manufacturer's name, roll number, and lot or batch number. The CQA monitor shall inspect the rolls for shipping damage and complete a geosynthetics receipt log for all materials delivered to the site.

Upon delivery of the geomembrane, the CQA monitor will observe that:

- Equipment used to unload and store the rolls or pallets does not damage the geomembrane.
- The geomembrane is stored in an acceptable location and not stacked more than five rolls high.
- The geomembrane is protected from puncture, dirt, grease, water, moisture, and excessive heat, or other damage.

- All manufacturing documentation required by the specifications has been received and reviewed for compliance with the specifications.
- The geomembrane receipt log form has been completed for all materials received.

Damaged geomembrane may be rejected and removed from the site or stored at a location separate from accepted geomembrane.

6.3 PREPARATION

The surface of the compacted clay liner or the GCL shall be protected in accordance with Section 5.4.2 until the GM is installed. Prior to installation of any geomembrane, the installed GCL or compacted clay liner surface shall be inspected by the CQA monitor and the geosynthetics contractor. Before installation of the GM, the GP or CQA monitor will observe the following:

- The GCL or compacted clay liner surface is free of surface irregularities and protrusions.
- The anchor trenches are free of sharp objects and stones.
- The GCL is not saturated, and no water is present above the GCL (if required).
- The geosynthetics contractor has certified in writing that the GCL or compacted clay liner surface on which geomembrane will be installed is acceptable.

6.4 INSTALLATION

6.4.1 Deployment and Placement

The following activities must take place prior to GM deployment:

- The manufacturer's quality control and third party conformance tests will be completed and approved by the GP in accordance with the requirements of Section 6.5.
- The GP and geosynthetics installer shall approve the subgrade in accordance with the requirements of Section 6.3.
- The geosynthetic installer shall sign the subgrade acceptance form.

GM shall be deployed by equipment that will unroll the GM without damaging, crimping or stretching it and deployment equipment must not damage the underlying geosynthetic clay liner (GCL) or compacted clay liner. Only low contact pressure equipment shall be allowed on the GCL or compacted clay liner. GM must not be deployed during periods

of rain, freezing temperatures, or high winds. The installer must only deploy the amount of GM that can be seamed on the same day.

Upon deployment, each panel shall be assigned a unique identification number. All panels must be anchored with adequate ballast to prevent uplift from wind. Smoking and damaging shoes shall not be permitted on the GM and only low-ground pressure supporting equipment shall be allowed on the GM. Textured GM shall be placed on sideslopes and shall extend to a minimum of 5 feet beyond the toe of the slope.

During GM placement, the CQA monitor must:

- Provide full-time observation.
- Record panel numbers, panel dimensions, and roll numbers on the panel layout drawing.
- Record weather conditions.
- Observe the condition of the GM and note any defects. All defects must be repaired in accordance with the requirements of Section 6.4.4.
- Observe that people working on the GM do not smoke, wear shoes that could damage the GM, or engage in activities that could damage the GM.
- Observe that the deployment method minimizes wrinkles and that the GM is anchored to prevent movement from wind.
- Observe that no more panels are deployed than can be seamed on the same day.
- Observe that there are no horizontal seams on sideslopes and that the textured material extends a minimum of 5 feet past the toe of the slope.
- Observe that the underlain GCL or compacted clay liner is not damaged by geomembrane installation equipment or activities. These observations will be visual and when the GM deems it necessary other testing methods may be used.
- Observe that the geomembrane panels are deployed only by low ground pressure equipment to prevent damage to the underlain GCL or compacted clay liner.
- Observe that the geomembrane is not dragged across a surface that could damage the geomembrane.
- Observe that the geomembrane panel is placed in a manner to ensure direct and uniform contact between GM and GCL or compacted clay liner. The geomembrane panels will be observed for crimping, stretching, and wrinkling to ensure uniform contact.

Any panels that are not deployed in accordance with this section shall be marked by the CQA monitor and be repaired in accordance with Section 6.4.4 or be removed and replaced by the installer.

6.4.2 Seaming

Only welding apparatus and operators that have completed approved trial welds, in accordance with Section 6.5.3, shall be allowed to weld panel seams. Each seam shall be assigned a unique number, which is preferably consistent with the panel numbering system. Sidewall seams shall be oriented downslope. Prior to welding, the proper panel overlap shall be provided. Dirt, grease, and free moisture shall be cleaned from the panel contact area, and wrinkles shall be removed as much as practical. For extrusion welds, oxidation shall be ground from the seam area within one hour of the welding operation and the extrudate shall be purged from the extrusion welding apparatus. Seaming operations shall not be allowed when the ambient temperature is below 40° F or above 104° F unless trial welds have demonstrated that adequate welds can be achieved outside these limits.

During GM seaming operations, the CQA monitor must:

- Provide full-time observation.
- Record seam numbers on the panel layout drawing.
- Record weather conditions.
- Observe that only approved welding apparatus and operators are allowed to weld seams.
- Observe the condition of the seams and note any defects. All defects must be repaired in accordance with the requirements of Section 6.4.4.
- Observe that people working on the GM do not smoke, wear shoes that could damage the GM, or engage in activities that could damage the GM.
- Observe that the seams are free of grease, dirt, moisture and wrinkles.
- Observe that welding operations take place within the approved ambient temperature range.
- Observe that seam grinding has been completed less than one hour before extrusion welding and the extrudate has been purged from extrusion welders.

6.4.3 Anchor Trenches

The GM anchor trench shall be left open until the seaming is completed. Expansion and contraction of the GM will be accounted for during deployment. The top corner of the anchor trenches shall be rounded to prevent crimping the GM. The bottom of the anchor trench shall be dry, stable and be free of loose particles and rocks. Anchor

trenches shall be backfilled with compacted general fill that is free of particles larger than 1 inch in diameter. The anchor trenches shall be backfilled and compacted in a manner that does not damage or induce stress to the GM.

6.4.4 Repairs

Defects in the GM, defects in seams, failing destructive tests, failing nondestructive tests, holes from nondestructive tests, and destructive test sample locations shall be repaired by one of the following repair techniques:

- Patching - used to repair large holes, tears, large GM defects, and destructive test locations.
- Extrusion - used to repair small GM defects, cuts, holes from nondestructive tests, and seam defects less than ½ inch long.
- Capping - used to repair failed seams or seams where nondestructive tests cannot be performed.
- Removal - used to replace areas with large defects where other repair techniques are not appropriate.

Repair procedures include the following:

- Abrade geomembrane surfaces to be repaired (extrusion welds only) no more than one hour prior to the repair.
- Clean and dry all surfaces at the time of repair.
- Extend patches or caps at least 6 inches beyond the edge of the defect, and round all corners of material to be patched and the patches to a radius of at least 3 inches. Bevel the top edges of patches prior to extrusion welding.

Destructive and non-destructive testing will be performed on all repairs in accordance with Section 6.5.4.

6.5 TESTING AND VERIFICATION

6.5.1 Manufacturer's Quality Control Testing

The GM manufacturer shall test the geomembrane and raw materials in accordance with the most current GRI Standard GM13 to assure the quality of the GM. The GRI Standard GM13 (as of the date of this SLQCP) is provided in Appendix 3B.

6.5.2 Conformance Testing

Conformance samples of the GM shall be cut across the full width of selected rolls in accordance with the test frequency specified in Table 3-9. Conformance samples may

be taken at the manufacturing plant or at the project site by the GP or his representative and will be forwarded to a third party laboratory for testing. Minimum conformance testing requirements are provided in Table 3-9 and criteria are provided in GRI GM13.

**Table 3-9
GM Conformance Tests**

Test	Standard	Frequency
Sheet Thickness ¹	ASTM D 5199 (smooth) ASTM D 5994 (textured)	1 per 50,000 sf and every resin lot
Specific Gravity	ASTM D 1505	1 per 100,000 sf and every resin lot
Carbon Black Content	ASTM D 1603	1 per 100,000 sf and every resin lot
Carbon Black Dispersion	ASTM D 3015 ASTM D 5596	1 per 100,000 sf and every resin lot
Tensile Properties	ASTM D 638/GRI GM13	1 per 100,000 sf and every resin lot
Direct Shear	ASTM D 5321	Per GM/adjoining material type

¹The average thickness shall be no less than the specified thickness and no individual measurement shall be less than 90 percent of the specified thickness.

6.5.3 Trial Welds

Each operator and welding apparatus must be tested to verify that seam welds that meet the specifications can be achieved under the site conditions. Trial welds, must be performed at the beginning and midpoint of each day for each operator and apparatus used that day. If welding continues past 6:00 p.m., additional trial welds may be required.

The trial weld samples shall be 3-feet long and 12-inches wide, with the seam centered lengthwise. At least four one-inch wide coupons will be cut from each trial weld sample.

Two coupons from each sample will be tested for shear and two samples will be tested for peel. Peel test coupons for dual-track welds shall be tested on both sides of the air channel. Each coupon must meet the minimum strength requirements listed in Table 3-10 and exhibit a Film Tear Bond (FTB). If the trial weld fails, two more trial seams must be welded and tested. This process will continue until passing trial welds are achieved.

The CQA monitor must observe the trial welding operations and document the operator's initials, apparatus number, time, date, air temperature, apparatus temperature, and peel and shear test results. If the CQA monitor believes that an operator or apparatus is not functioning properly, or if the weather conditions have substantially changed since the trial welds were performed, new trial welds must be performed.

6.5.4 Construction Testing

Nondestructive Tests

Nondestructive seam tests include vacuum testing and air pressure testing. Nondestructive testing shall be performed for the entire length of each seam by the GM installer.

Vacuum testing shall be used to test extrusion-welded seams and fusion welded seams that cannot be tested by air pressure methods. The vacuum box shall be placed over a seam section, which has been thoroughly saturated with a soapy water solution. The rubber gasket on the bottom of the vacuum box must seal against the GM to prevent leaks. The vacuum box pressure shall be reduced to about 3 to 5 inches of Hg. Soap bubbles will indicate the presence of holes or non-bonded seams. The vacuum box dwell time shall be at least 10 seconds.

Air pressure testing shall be used to test fusion-welded seams that have an air channel. Both ends of the air channel shall be sealed and air shall be pumped into the channel to at least 30 psi or $\frac{1}{2}$ psi per mil of thickness, whichever is greater. With the air pump shut off, the air channel must sustain the pressure for at least five minutes, without more than a 4-psi pressure drop. Following a passing pressure test, the pressure shall be released from the end of the seam that is opposite of the pressure gauge. The pressure gauge must return to zero, if not, the seam is probably blocked. After the blockage has been located, the seam shall be pressure tested on both sides of the blockage. If the pressure drop is greater than 4 psi after 5 minutes this indicates a seam leak which must be isolated and repaired. All penetration holes shall be sealed after the air pressure testing is completed.

During the nondestructive testing, the CQA monitor must:

- Observe that equipment and operators are performing the tests properly.
- Observe that the entire length of each seam is tested and record the results of the test on the appropriate log.
- Identify failed seams and inform the installer of any required repairs.
- Record all completed and tested repairs on the repair log.

Destructive Tests

Destructive testing shall be performed at a frequency of one test location per 500 linear feet of seam. Repairs over 10-feet long shall be included in the total seam length. Destructive test samples will be 45-inches long by 12-inches wide with the seam centered along the length of the sample. At a minimum, a destructive test must be done for each welding machine used for seaming or repair.

Two coupons will be cut from each end of the sample and the installer must test these coupons with a tensiometer capable of measuring the seam strength. The installer shall

test two coupons in shear and two coupons in peel. For double wedge-welded seams, both sides of the air channel shall be tested in peel. The CQA monitor must observe the tests and record the results on the destructive testing log. The minimum requirements for destructive testing are provided in Table 3-10. If one of the coupons fails in either peel or shear, the installer shall reconstruct the entire seam between passed test locations, or take additional samples 10 feet in both directions of the failed test. If the additional tests pass, the contractor shall reconstruct or cap the seam between the passing test locations. If the additional tests fail, the sampling and testing procedure shall be repeated until the length of the faulty seam is established.

If the field test results are satisfactory, the remaining sample shall be divided into three parts: one third for the installer, one third for third party laboratory testing, and one third for the owner to archive. The laboratory shall test five coupons from each sample in shear and test five coupons from each sample in peel (10 when testing both inner and outer welds of dual-track fusion welds). The minimum requirements for destructive testing are provided in Table 3-10. If the laboratory test fails in either peel or shear, the installer shall reconstruct the entire seam between passed test locations, or take additional samples 10 feet in both directions of the failed test. If the additional tests pass, the contractor shall reconstruct or cap the seam between the passing test locations. If the additional tests fail, the sampling and testing procedure shall be repeated until the length of the faulty seam is established. All seams shall be bracketed by passing laboratory tests; field tests results shall not be used for final acceptance.

**Table 3-10
Geomembrane Seam Properties**

Test	Standard	Frequency	Minimum Criteria
Shear	ASTM D 4437/ NSF 54 or ASTM D 6392/ GRI-GM19	1 sample per 500 feet of seam	4 of 5 specimens from each sample must have a shear strength greater than or equal to 95% of sheet strength but not less than 120 ppi. The average shear strength value of all 5 specimens must be greater than or equal to 95% of sheet strength but not less than 120 ppi. 4 of 5 specimens shall exhibit Film Tear Bond.
Peel	ASTM D 4437/ NSF 54 or ASTM D 6392/ GRI-GM19	1 sample per 500 feet of seam	4 of 5 specimens from each sample must have a peel strength greater than or equal to 62% of sheet strength but not less than 78 ppi. The average peel strength value of all 5 specimens must be greater than or equal to 62% of sheet strength but not less than 78 ppi. Both sides of dual track seams shall meet the minimum criteria. Each track is considered a separate sample. 4 of 5 specimens shall exhibit Film Tear Bond.

¹ The manufacturer's sheet strength values must be provided in order to determine if the test result is adequate.

During destructive seam testing, the CQA monitor must:

- Select sample locations and observe sample cutting.
- Assign sample numbers and label samples.
- Observe installer-performed tests.
- Record sample locations, sample number, sample purpose, and field test results.

7 CONSTRUCTION QUALITY ASSURANCE FOR THE LEACHATE COLLECTION LAYER AND PROTECTIVE COVER

7.1 GENERAL

As detailed in Table 3-2, the San Angelo Landfill is permitted for several leachate collection system configurations. The leachate collection system consists of the leachate collection layer, collection trenches, piping, and the sumps. This section includes information regarding the leachate collection layer (granular drainage layer, geocomposite) and protective cover (shredded tires/shredded waste protective cover, soil protective cover). Section 8 discusses the leachate collection system (geotextiles, pipes, aggregates). Details of the leachate collection layer design are provided in Appendix 3A. Material properties are described in Section 7.2. The CQA monitor shall provide on-site observation during leachate collection layer installation. The GP shall make sufficient site visits during the leachate collection layer installation to document the installation in the GLER, in accordance with Section 9.

The protective cover consists of either a 12-inch or 24-inch-thick layer of soils or a 12-inch-thick layer of shredded tires/shredded waste. Where leachate chimneys are provided, the drainage aggregate or shredded tires/shredded waste around the leachate collection pipes will extend through the protective cover to form a chimney drain for the leachate collection system. The CQA monitor shall provide continuous on-site observation during protective cover placement to assure that protective cover placement does not damage underlying geosynthetics. The GP shall make sufficient site visits during protective cover placement to document the construction activities, testing, and thickness verification in the GLER in accordance with Section 9.

7.2 MATERIALS

7.2.1 Granular Drainage Layer

The leachate collection layer may consist of 12 inches of granular soils installed above the liner system. The granular soils are selected on the basis of grain size and permeability. The permeability of the granular soils will be 1×10^{-2} cm/sec or greater. The granular drainage layer shall have the minimum properties listed in Table 3-11.

**Table 3-11
Granular Drainage Layer Properties**

Test	Standard	Required Property	
Gradation	ASTM D 422	<u>Sieve</u>	<u>% Passing</u>
		2"	100
		1 1/2"	90 – 100
		3/4"	10 – 70
		3/8"	0 – 10
		No. 4	0 – 5
Hydraulic Conductivity	ASTM D 2434	$\geq 1.0 \times 10^{-2}$ cm/sec	
Carbonate Content	JLT-S-105-89 or ASTM D 3042 ^a	Maximum 15% or less	

^aUse an HCL solution having a pH of 5 or lower.

Conformance testing procedures and frequencies for granular drainage layer are listed in Section 7.5.1.

7.2.2 Geocomposite (Drainage Layer)

The leachate collection layer may consist of a drainage geocomposite installed above the liner system. Single-sided geocomposite (nonwoven geotextile bonded to the top of HDPE drainage net) will be installed on the floor, and double-sided geocomposite (nonwoven geotextile bonded to the top and bottom of HDPE drainage net) will be installed on the sidewalls. The geocomposite shall have the minimum properties listed in Table 3-12.

**Table 3-12
Geocomposite Properties**

Material	Test	Standard	Required Property
Geotextile	Material		Nonwoven polypropylene or polyester
	Apparent Opening Size	ASTM D 4751	70 sieve maximum
	Unit Weight	ASTM D 5261	6 oz/yd ²
	Grab Strength	ASTM D 4632	160 lb
HDPE Drainage Net	Specific Gravity	ASTM D 1505	0.935 g/cm ³
	Thickness	ASTM D 5199	0.20 inch
	Carbon Black	ASTM D 1603	Minimum 2%; Maximum 3%
Geocomposite	Transmissivity	ASTM D 4716	5.0×10^{-4} m ² /sec

Manufacturer quality control testing procedures and frequencies for geocomposite are listed in Section 7.5.1.

7.2.2.1 Delivery and Storage

Geocomposite shall be shipped in rolls labeled with the manufacturer's name, roll number, and lot or batch number. The CQA monitor shall inspect the rolls for shipping

damage and complete a geosynthetics receipt log for all materials delivered to the site. Damaged rolls shall be rejected.

The geocomposite shall be unloaded and handled with equipment that does not cause damage. Rolls will not be pushed, slid, or be dragged to the storage location. The geocomposite must not be stored on wet, soft, or rocky subgrade but must be stored on a stable subgrade. Geocomposite must not be stacked more than five rolls high to avoid crushing the roll cores. The stored geocomposite must be protected from puncture, grease, dirt, excessive heat, or other damage.

7.2.2.2 Preparation

Prior to installation of the leachate collection layer the GM shall be tested and verified in accordance with Section 6.5. The CQA monitor shall observe that the surface to receive the granular drainage layer or geocomposite is free of debris, stones and dirt. Also, the CQA monitor will verify that the geocomposite conformance documentation has been submitted and approved, if geocomposite is to be installed.

Prior to placing the protective cover material, the liner subgrade elevations shall be verified in accordance with the requirements of Section 4.3 and all testing on the underlying geosynthetics shall be completed.

7.2.3 Shredded Tires/Shredded Waste Protective Cover

Shredded tires/shredded waste may be used as a 12-inch leachate collection/protective cover layer. The 12-inch leachate collection/protective cover layer consisting of shredded tires/shredded waste will be placed over the 12-inch granular drainage layer in accordance with the project plans and specifications. The shredded tires/shredded waste shall have a nominal size of 2 to 4 inches and shall be free of organics, angular rocks, foreign objects, or other deleterious materials. The physical characteristics of the shredded tires/shredded waste shall be evaluated through visual observation before and during construction. The shredded tires/shredded waste will be placed using low ground pressure equipment. The shredded tires/shredded waste shall be placed by spreading in front of the spreading equipment with a minimum of 12 inches of granular drainage layer between the spreading equipment and the installed geosynthetics. Under no circumstances shall the construction equipment, or shredded tires/shredded waste come in direct contact with the installed geosynthetics.

The thickness of the shredded tires/shredded waste shall be verified with surveying procedures of a minimum of one survey point per 5,000 square feet of constructed area. A minimum of two survey points shall be used for all constructed areas regardless of size. Surveying will verify that the finished shredded tires/shredded waste layer minimum thickness is as specified in the SLQCP. The test results for the shredded tires/shredded waste layer will be included in the GLER.

7.2.4 Soil Protective Cover

Soil protective cover material shall consist of soil that is free from debris, rubbish, frozen materials, foreign objects, solid waste, and organic material, or any material that could

damage the underlying geosynthetics. If the protective cover has a maximum coefficient of permeability of greater than 1.0×10^{-4} cm/sec, then chimneys are not required. If the protective cover has a maximum coefficient of permeability of less than 1.0×10^{-4} cm/sec, then chimneys are required.

7.3 INSTALLATION/PLACEMENT

7.3.1 Granular Drainage Layer

A 12-inch-thick granular drainage layer shall be installed on the floors and sidewalls. The granular drainage layer shall be placed to the lines and grades shown on the plans. The granular drainage layer shall be placed in a manner that minimizes the potential to damage the underlying geosynthetics. Hauling equipment shall be restricted to haul roads of sufficient thickness to protect the underlying geosynthetics. The granular drainage layer material shall be dumped from the haul road and spread by low ground pressure equipment in a manner that minimizes wrinkles and stress in the geosynthetics. On sidewalls, the granular drainage layer shall be placed from the bottom to the top, not across or down. Bridge slope transitions occur when cold weather causes the geomembrane to contract. The granular drainage layer shall not be placed over geosynthetics until the geosynthetics expand to maintain contact with the liner subgrade. The minimum separation distance between construction equipment and the geosynthetics are listed in Table 3-13.

Table 3-13
Minimum Separation Distance

Equipment Ground Pressure (psi)	Minimum Separation Distance (in)
<4	10
4 – 8	18
8 – 16	24
>16	36

During the granular drainage layer placement, the CQA monitor must:

- Observe that the granular drainage layer is placed in accordance with the plans and specifications.
- Observe that the granular drainage layer is consistent with the conformance test samples.
- Observe that people working on the GM do not smoke, wear shoes that could damage the GM, or engage in activities that could damage the GM.
- Observe that the granular drainage material is spread in a way to minimize wrinkles in the GM.

Any geosynthetic material that in the opinion of the CQA monitor has been damaged by the granular drainage layer placement must be repaired and retested in accordance with Sections 5.4.4 and 6.4.4.

7.3.2 Geocomposite

Single-sided geocomposite shall be installed on the floor, and double-sided geocomposite shall be installed on the sidewalls. Geocomposite shall be deployed by equipment that will unroll the geocomposite without damaging, crimping or stretching it and deployment equipment must not damage the underlying GM. All panels must be anchored with adequate ballast to prevent uplift from wind. Smoking and damaging shoes shall not be permitted on the geocomposite and only low-ground pressure supporting equipment shall be allowed on the geocomposite or GM. Adjacent rolls of geocomposite shall be securely tied through the drainage net with plastic fasteners every 5 feet along the length of the panel and every 6 inches along the ends of the panels. The top geotextile of adjacent rolls shall be overlapped and be sewn or heat bonded together.

During geocomposite placement, the CQA monitor must:

- Provide full time observation.
- Record weather conditions.
- Observe the condition of the geocomposite and note any defects. All defects must be repaired or replaced.
- Observe that people working on the GM do not smoke, wear shoes that could damage the GM, or engage in activities that could damage the GM.
- Observe that the deployment method minimizes wrinkles in the GM and the geocomposite.
- Observe that the geocomposite panels have been properly tied and seamed.

Any panels that are not installed in accordance with this section shall be marked by the CQA monitor and be removed and replaced by the installer.

7.3.3 Shredded Tires/Shredded Waste Protective Cover

Shredded tires/shredded waste shall be placed in the collection trenches and sumps to the lines and grades shown on the plans. During shredded tires/shredded waste placement, the CQA monitor must:

- Observe that the shredded tires/shredded waste is placed in accordance with the plans and specifications.
- Verify that grade control construction staking is performed prior to work.

- Verify that the shredded tires/shredded waste have no protruding steel or metal components.
- Verify that underlying geosynthetic installations are not damaged during placement operations. Mark damaged geosynthetics and verify that damage is repaired.
- Monitor haul road thickness over geosynthetic installations and verify that equipment hauling and material placement meet equipment specifications.
- The GP will coordinate with the project surveyor to perform a thickness verification survey of the shredded tires/shredded waste materials upon completion of placement operations. Verify corrective action measures as determined by the verification survey.

7.3.4 Soil Protective Cover

The soil protective cover shall be placed in a manner that minimizes the potential to damage the underlying geosynthetics. Hauling equipment shall be restricted to haul roads of sufficient thickness to protect the underlying geosynthetics. The soil protective cover shall be dumped from the haul road and spread by low ground pressure equipment in a manner that minimizes wrinkles and stress in the geosynthetics. On sidewalls, soil protective cover shall be placed from the bottom to the top, not across or down. Bridge slope transitions occur when cold weather causes the geomembrane to contract. Soil protective cover shall not be placed over geosynthetics until the geosynthetics have expanded to maintain contact with the liner subgrade. The minimum separation distance between construction equipment and the geosynthetics are listed in Table 3-13.

Any geosynthetic material that in the opinion of the CQA monitor has been damaged by the soil protective cover placement must be repaired and retested in accordance with Sections 5.4.4 and 6.4.4.

7.4 TESTING AND VERIFICATION

7.4.1 Manufacturer's Testing

The granular drainage layer shall be tested at the source to assure that the granular drainage layer meets the specifications. Material property requirements are provided in Section 7.2.1. Minimum source testing requirements are provided in Table 3-14.

Table 3-14
Granular Drainage Layer Source Tests

Test	Standard	Frequency
Gradation	ASTM D 422	1 per source
Hydraulic Conductivity	ASTM D 2434	1 per source
Carbonate Content	JLT-S-105-89 or ASTM D 3042 ^a	1 per source

^aUse an HCL solution having a pH of 5 or lower.

Geocomposite property requirements are provided in Section 7.2.2. Minimum manufacturer's testing requirements are provided in Table 3-15.

Table 3-15
Geocomposite Manufacturer's Tests

Material	Test	Standard	Frequency
Geotextile	Weight	ASTM D 5261	1 per 100,000 SF
	Apparent Opening Size	ASTM D 4751	1 per 100,000 SF
	Grab Strength	ASTM D 4632	1 per 100,000 SF
HDPE Drainage Net	Specific Gravity	ASTM D 1505	1 per 100,000 SF
	Thickness	ASTM D 5199	1 per 100,000 SF
	Carbon Black	ASTM D 1603	1 per 100,000 SF
Geocomposite	Transmissivity	ASTM D 4716	1 per 100,000 SF

7.4.2 Thickness Verification

The as-built thickness for both thicknesses of protective cover or drainage layer shall be determined by standard survey methods. Prior to the placement of geosynthetics, the top of liner subgrade elevations will be determined at a minimum rate of one survey point per 5,000 square feet of lined area. After the protective cover is completed, the top of the protective cover elevations will be determined at the same locations as the top of liner subgrade elevations. The as-built vertical thickness will be the difference between the top of liner subgrade elevations and the top of protective cover elevations, reported to the nearest 0.1 foot.

8 CONSTRUCTION QUALITY ASSURANCE FOR THE LEACHATE COLLECTION SYSTEM

8.1 GENERAL

The leachate collection system consists of the leachate collection layer, collection trenches, piping, and the sumps. This section includes information regarding the leachate collection system (geotextiles, pipes, aggregates). Details of the leachate collection system design are provided in Appendix 3A. Material properties are described in Section 8.2. The CQA monitor shall provide on-site observation during leachate collection system and piping installation. The GP shall make sufficient site visits during the leachate collection system installation to document the installation in the GLER, in accordance with Section 9.

8.2 MATERIALS

8.2.1 Geotextile

The leachate aggregate that is placed in the collection trenches and sumps shall be wrapped in a geotextile filter fabric. The geotextile shall have the minimum properties listed in Table 3-16.

Table 3-16
Geotextile Properties

Test	Standard	Required Property
Material		Nonwoven polypropylene or polyester
Apparent Opening Size	ASTM D 4751	100 sieve maximum
Unit Weight	ASTM D 5261	16 oz/yd ²
Grab Strength	ASTM D 4632	300 lb

Manufacturer quality control testing procedures and frequencies for geotextile are listed in Section 8.5.1.

8.2.2 Leachate Pipe

The leachate piping includes perforated collection trench pipes and the solid sidewall riser pipes. The leachate piping shall meet the cell classification PE 345434C in accordance with ASTM D 3350. The pipe shall have the minimum SDR rating and perforation schedule shown on the plans and specifications.

8.2.3 Leachate Aggregate

Leachate aggregate will be placed in the collection trenches and in the sumps. The leachate aggregate shall consist of manufactured or natural materials having the properties listed in Table 3-17.

Table 3-17
Leachate Aggregate Properties

Test	Standard	Required Property	
		Sieve	% Passing
Gradation	ASTM D 422	1 1/2"	95 – 100
		1/2"	20 – 50
		3/8"	<15
Hydraulic Conductivity	ASTM D 2434	$\geq 1.0 \times 10^{-2}$ cm/sec	
Carbonate Content	JLT-S-105-89 or ASTM D 3042 ^a	Maximum 15% loss	

^a Use an HCL solution having a pH of 5 or lower.

Conformance testing procedures and frequencies for leachate aggregate are listed in Section 8.5.1.

8.2.4 Delivery and Storage

Geotextile shall be shipped in rolls labeled with the manufacturer's name, roll number, and lot or batch number. The CQA monitor shall inspect the rolls for shipping damage and complete a geosynthetics receipt log for all materials delivered to the site. Damaged rolls shall be rejected.

Pipe shall be shipped in bundles labeled with the manufacturer's name and cell classification number.

The geotextile and pipe shall be unloaded and handled with equipment that does not cause damage. Rolls will not be pushed, slid, or dragged to the storage location. The geotextile must not be stored on wet, soft, or rocky subgrade, but must be stored on a stable subgrade. Geotextile must not be stacked more than five rolls high to avoid crushing the roll cores. The stored geotextile and pipe must be protected from puncture, grease, dirt, excessive heat, or other damage.

8.3 PREPARATION

Prior to installation of the leachate collection system, the geomembrane shall be tested and verified in accordance with Section 6.5. The CQA monitor shall observe that the surface to receive the leachate collection system is free of debris, stones, and dirt. Also, the CQA monitor will verify that the geotextile conformance documentation has been submitted and approved, if geotextile is to be installed.

8.4 INSTALLATION/PLACEMENT

8.4.1 Geotextile

Geotextile shall be placed around the leachate aggregate in the collection trenches and the sumps in accordance with the plans. Geotextile shall be deployed by equipment that will unroll the geotextile without damaging or stretching it and deployment equipment must not damage the underlying geosynthetics. Smoking and damaging shoes shall not be permitted on the geotextile and only low-ground pressure supporting equipment shall be allowed on the geotextile. Adjacent rolls shall be overlapped and be sewn or heat bonded together.

During geotextile placement, the CQA monitor must:

- Provide full-time observation.
- Observe the condition of the geotextile and note any defects. All defects must be repaired or replaced.
- Observe that people working on the geocomposite and GM do not smoke, wear shoes that could damage the GM, or engage in activities that could damage the GM.

- Observe that the deployment method minimizes wrinkles in the GM and the geocomposite.
- Observe that the geotextile panels have been properly seamed.

Any panels that are not installed in accordance with this section shall be marked by the CQA monitor and be removed and replaced by the installer.

8.4.2 Leachate Pipe

Leachate pipe shall be placed to the lines and grades shown on the plans. The pipe shall be joined in accordance with the manufacturer's recommendations and the project specifications.

Construction equipment shall not be allowed to travel directly over the leachate pipes to prevent crushing or excessive deflection until aggregates and protective cover have been placed. Minimum equipment separation distances listed in Section 7.4.1, Table 3-13 shall be observed.

During leachate pipe placement, the CQA monitor must:

- Provide full-time observation.
- Observe the condition of the pipes and note any defects. All defective pipes must be replaced.
- Observe that people working on the geocomposite and GM do not smoke, wear shoes that could damage the GM or geocomposite, or engage in activities that could damage the GM or geocomposite.
- Observe that construction equipment does not damage pipes.
- Observe that the perforations and pipe orientation are in accordance with the plans and specifications.
- Observe that the pipes and fittings are joined in accordance with the project specifications and the manufacturer's recommendations.

Any pipes that are not installed in accordance with this section shall be marked by the CQA monitor and be repaired or be removed and replaced by the installer.

8.4.3 Leachate Aggregate

Leachate aggregate shall be placed in the collection trenches and sumps to the lines and grades shown on the plans. During leachate aggregate placement, the CQA monitor must:

- Observe that leachate aggregate is placed in accordance with the plans and specifications.

- Observe that the leachate aggregate is consistent with the conformance test samples.
- Observe that leachate aggregate placement activities do not dislodge or damage leachate pipes or underlying geosynthetics.

8.5 TESTING AND VERIFICATION

8.5.1 Manufacturer's Testing

Geotextile property requirements are provided in Section 8.2.1. Minimum manufacturer's testing requirements are provided in Table 3-19.

Table 3-19
Geotextile Manufacturer's Tests

Test	Standard	Frequency
Weight	ASTM D 5261	1 per 100,000 SF
Apparent Opening Size	ASTM D 4751	1 per 100,000 SF
Grab Strength	ASTM D 4632	1 per 100,000 SF

The leachate piping manufacturer shall provide a certification that the pipe meets the cell classification PE 345434C in accordance with ASTM D 3350, and the minimum SDR rating and perforation schedule shown on the plans and specifications.

The leachate aggregate shall be tested at the source to assure that the aggregate meets the specifications. Material property requirements are provided in Section 8.2.3. Minimum source testing requirements are provided in Table 3-20.

Table 3-20
Leachate Aggregate Source Tests

Test	Standard	Frequency
Gradation	ASTM D 422	1 per source
Hydraulic Conductivity	ASTM D 2434	1 per source
Carbonate Content	JLT-S-105-89 or ASTM D 3042 ^a	1 per source

^a Use an HCL solution having a pH of 5 or lower.

8.5.2 Construction Testing

The leachate aggregate shall be tested to assure that it meets the specifications. Material property requirements are provided in Section 8.2.3. The CQA monitor will collect the leachate aggregate for conformance testing onsite. Conformance testing requirements are provided in Table 3-21.

**Table 3-21
Leachate Aggregate Conformance Tests**

Test	Standard	Frequency
Gradation	ASTM D 422	1 per 3,000 cy
Hydraulic Conductivity	ASTM D 2434	1 per 3,000 cy
Carbonate Content	JLT-S-105-89 or ASTM D 3042 ^a	1 per 3,000 cy

^a Use an HCL solution having a pH of 5 or lower.

8.5.3 Verification

The as-built location of the leachate piping shall be determined and reported in the GLER. All aspects of the leachate collection system will be documented in the GLER as stated in Section 9.

9 DOCUMENTATION

After construction of the liner system, the GP will submit a GCLER/SLER and GLER in triplicate to the TCEQ on behalf of the owner. The GCLER/SLER and GLER may be combined into a single report. These reports will be submitted to the TCEQ prior to the disposal of solid waste over the specified constructed area. If no response, either written or verbal is provided within 14 days, the GCLER/SLER or GLER shall be considered approved and solid waste placement may proceed. Testing, evaluation, and submission of the GCLERs/SLERs and GLERs for liner system construction will be in accordance with the requirements of this SLQCP prepared for the provisions of current TCEQ rules.

At a minimum, the GCLER/SLER and GLER will contain the following:

- A summary of all construction activities in accordance with the SLQCP.
- A detailed description of the liner and leachate collection systems.
- All laboratory and field test results.
- Sampling and testing location drawings.
- A description of significant construction problems and the resolution of these problems.
- Record drawings.
- The GP will sign and seal a statement of compliance with the SLQCP and construction plans.
- The data and other information must be sufficient to support the conclusions in the reports.
- The seal and signature of the GP in accordance with the Texas Engineering Practice Act.

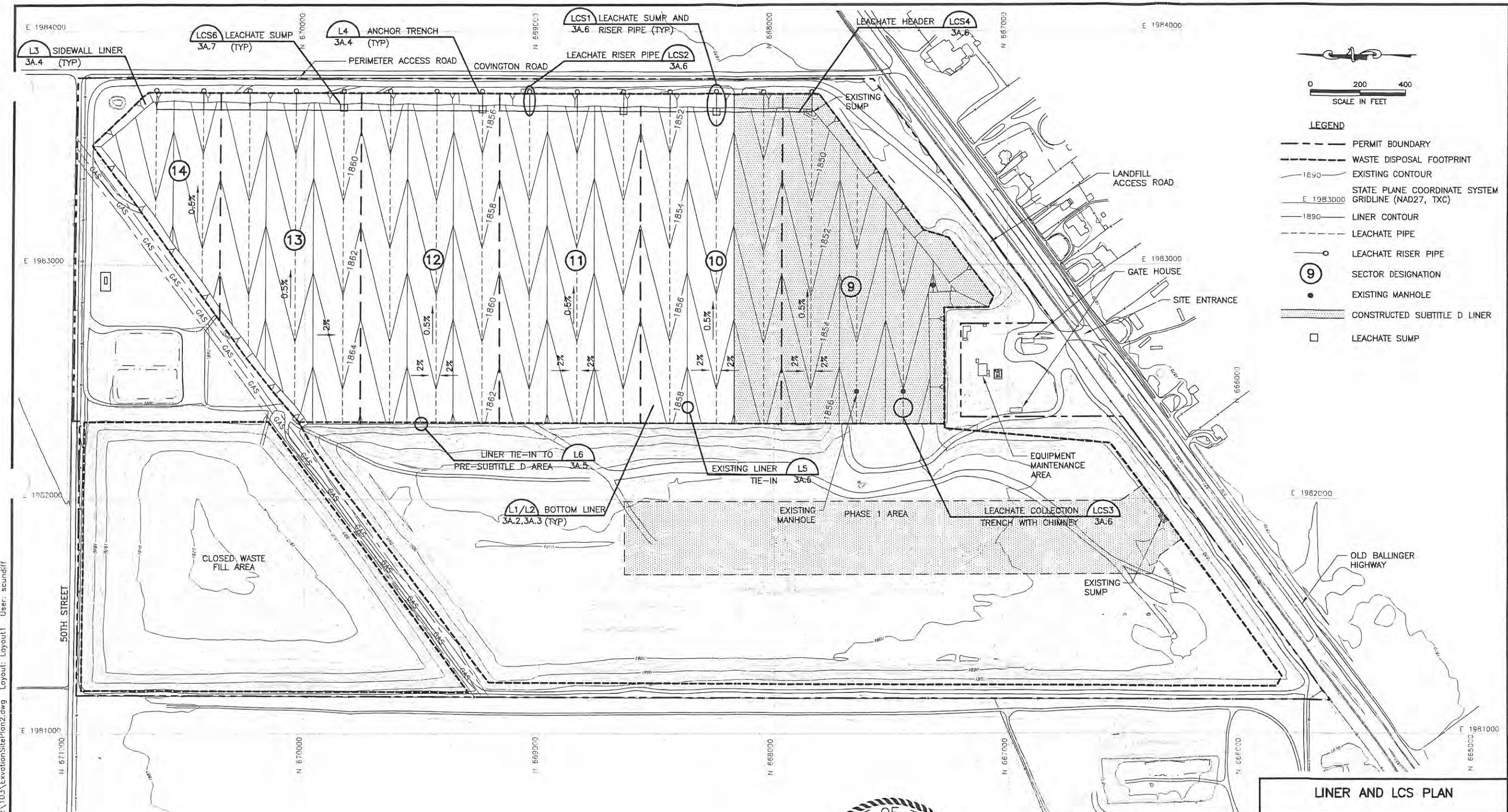
Markers shall be placed on site so that the disposal areas for which the GCLER/SLER and GLER have been submitted and approved are readily determinable. The markers are to provide site workers immediate knowledge at all times of the extent of approved disposal areas. These markers shall be located so that they are not destroyed during operations and shall be in accordance with Part IV, Section 8.7.

The surface of the liner will be covered with a layer of solid waste within a period of six months to mitigate the effects of surface erosion and rutting due to traffic. Liner surfaces not covered with waste within six months shall be checked by the GP, who

shall then submit a letter report on his findings to the TCEQ. Any required repairs shall be performed promptly. An addendum to the GLER shall be submitted on the new construction for all liners that need repair due to damage.

APPENDIX 3A
LINER AND LEACHATE COLLECTION SYSTEM DETAILS

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- NOTES:
1. EXISTING CONTOURS COMPILED FROM AERIAL SURVEY FLOWN ON MAY 11, 2006 BY METROPOLITAN AERIAL SURVEYS.
 2. EXCAVATION CONTOURS ARE COMPILED FROM THE CITY OF SAN ANGELO, 1994 PERMIT MODIFICATION.
 3. PHASE I AREA AND CELLS 9 AND 10A LINER SYSTEM ARE CONSTRUCTED.
 4. DEEPEST EXCAVATION AT BOTTOM OF LEACHATE SUMPS: 1844.19 FT-MSL.
 5. LEACHATE COLLECTION TRENCHES AT 0.5% SLOPE.



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										DWN : RMP		SCALE : GRAPHIC		3A.1		
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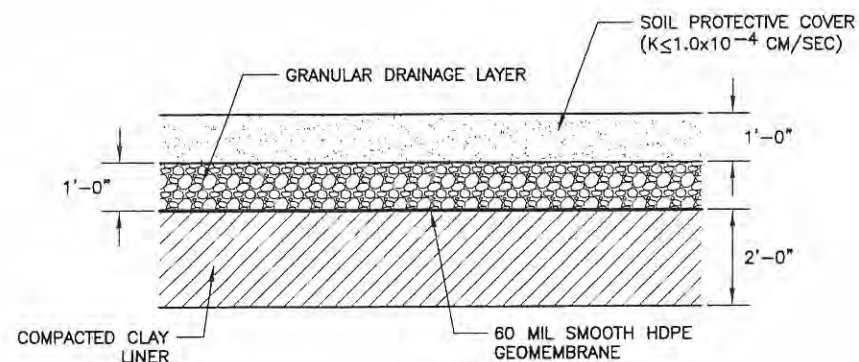
LINER AND LCS PLAN

SAN ANGELO LANDFILL

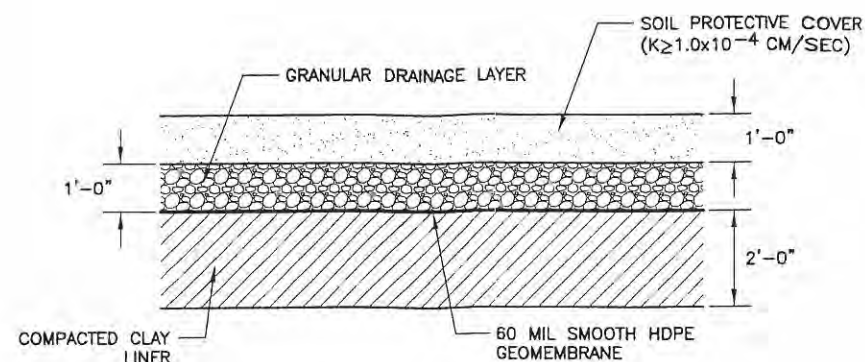
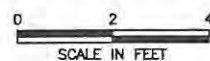
CITY OF SAN ANGELO

TCEQ PERMIT NO. MSW 79

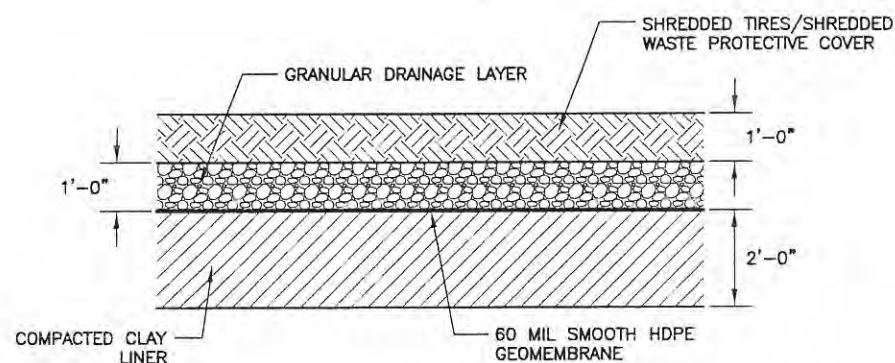
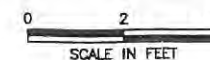
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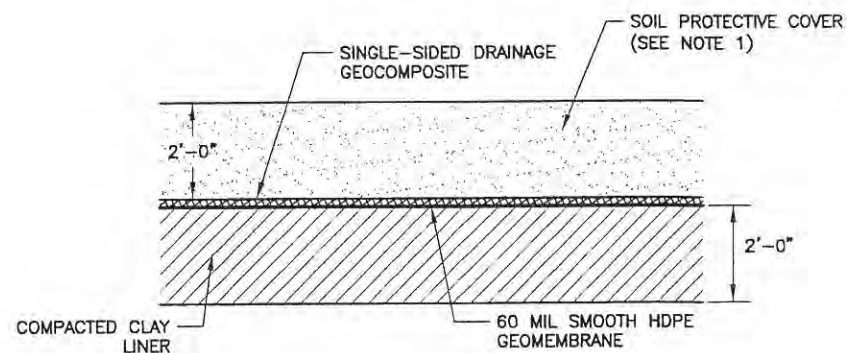
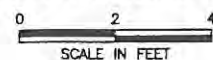
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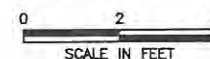
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CHIMNEYS NOT REQUIRED 3A.2



BOTTOM LINER L1C
CHIMNEYS NOT REQUIRED 3A.2



BOTTOM LINER L1D
CHIMNEY REQUIREMENTS VARY 3A.2
(SEE NOTE 1)



NOTES:

1. THE PROTECTIVE COVER HAS A COEFFICIENT OF PERMEABILITY GREATER THAN 1.0×10^{-4} CM/SEC, THEN CHIMNEYS ARE NOT REQUIRED. IF THE PROTECTIVE COVER HAS A MAXIMUM COEFFICIENT OF PERMEABILITY LESS THAN 1.0×10^{-4} CM/SEC, THEN CHIMNEYS ARE REQUIRED.

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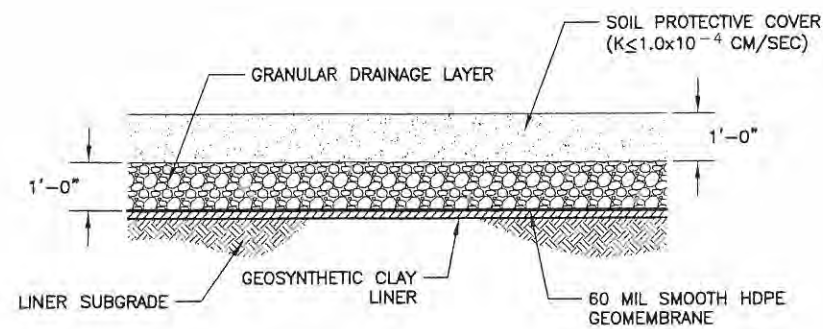
LINER DETAILS

**CITY OF SAN ANGELO
SAN ANGELO LANDFILL
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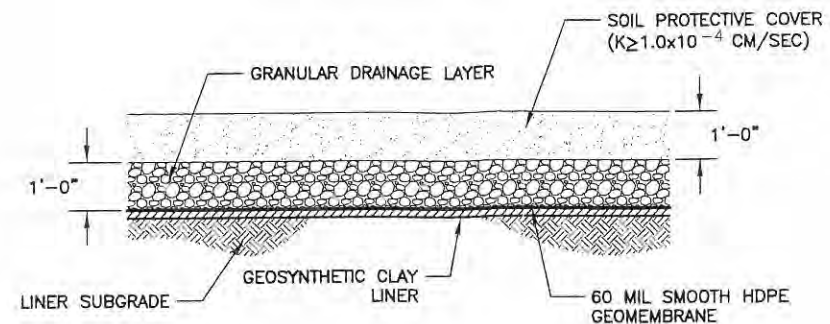


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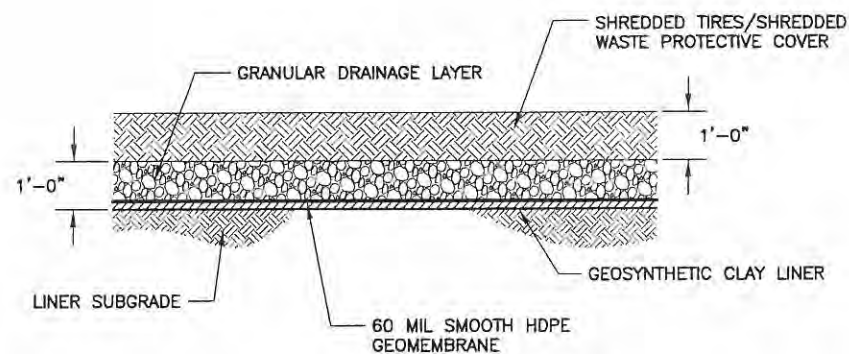
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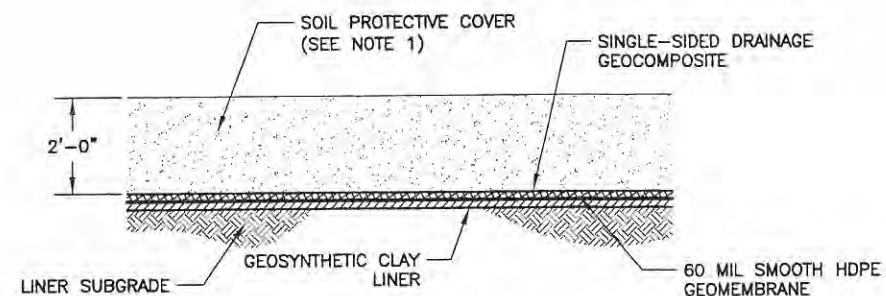
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CHIMNEYS REQUIRED 3A.3
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SCALE IN FEET



BOTTOM LINER L2B
CHIMNEYS NOT REQUIRED 3A.3
0 2 4
SCALE IN FEET



BOTTOM LINER L2C
CHIMNEYS NOT REQUIRED 3A.3
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SCALE IN FEET



BOTTOM LINER L2D
CHIMNEY REQUIREMENTS VARY 3A.3 (SEE NOTE 1)
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SCALE IN FEET



NOTES:

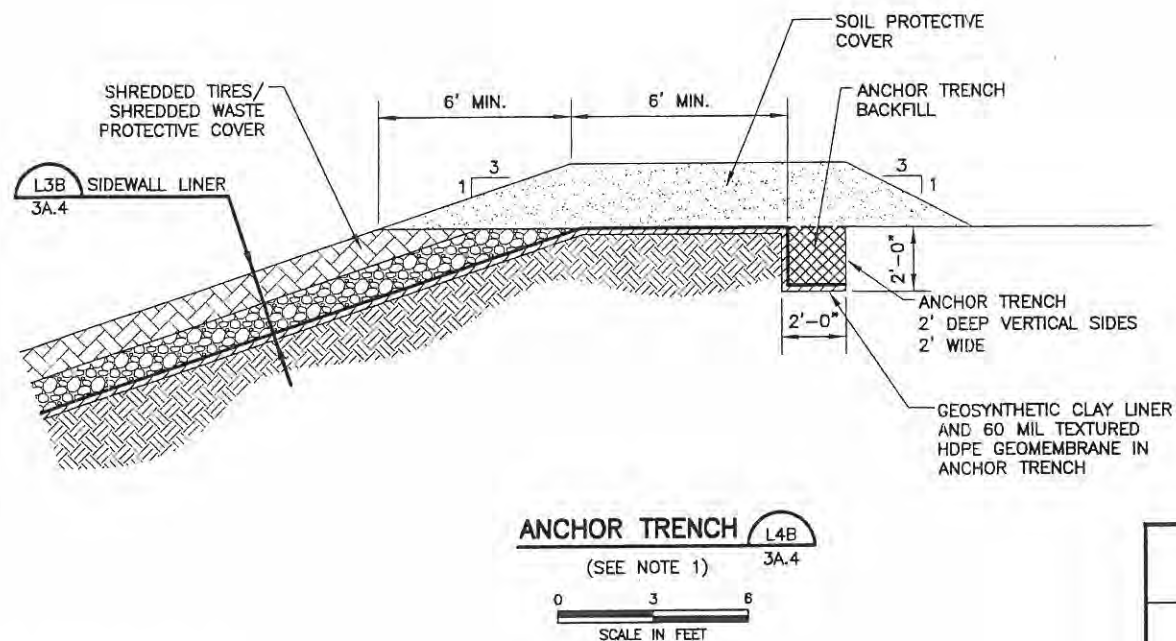
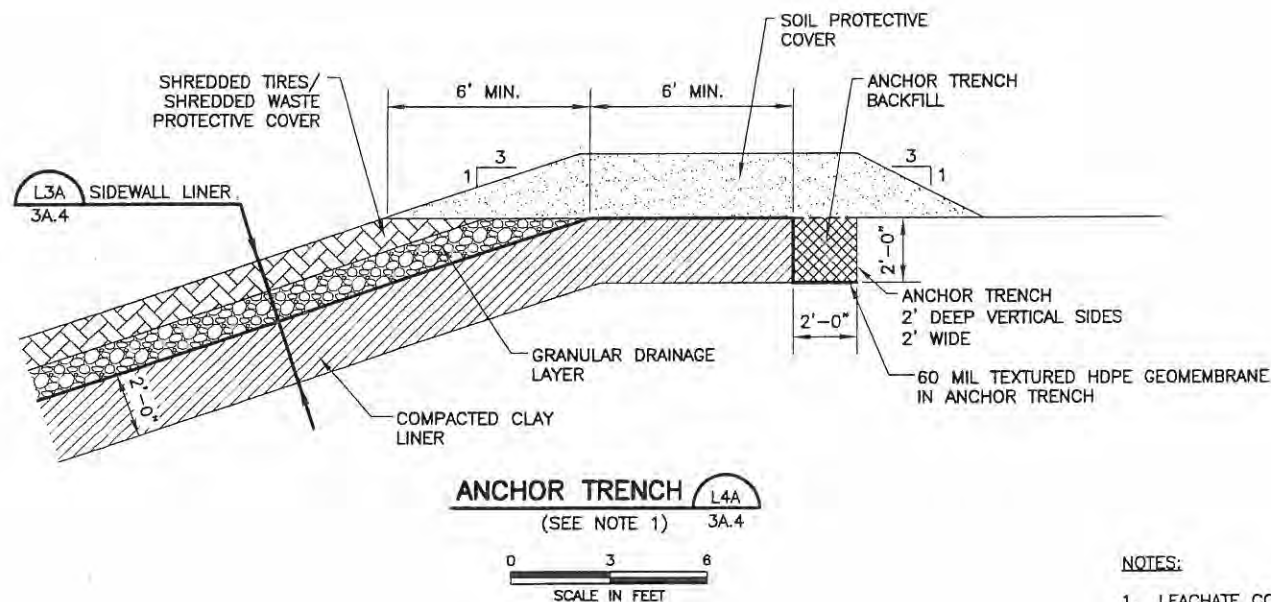
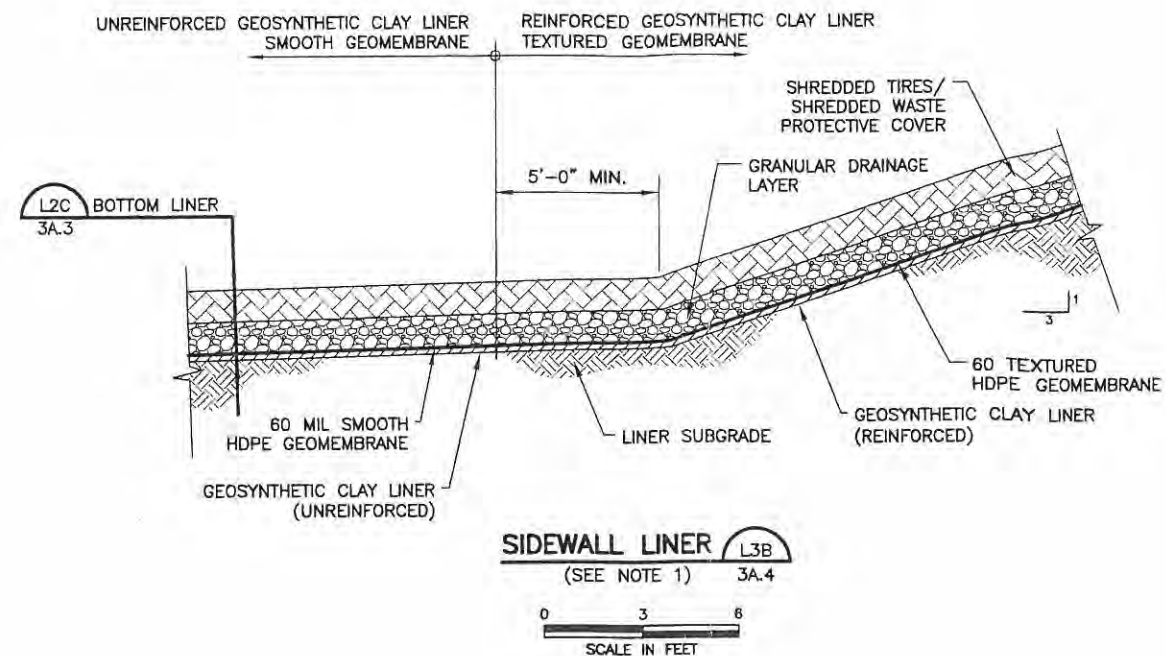
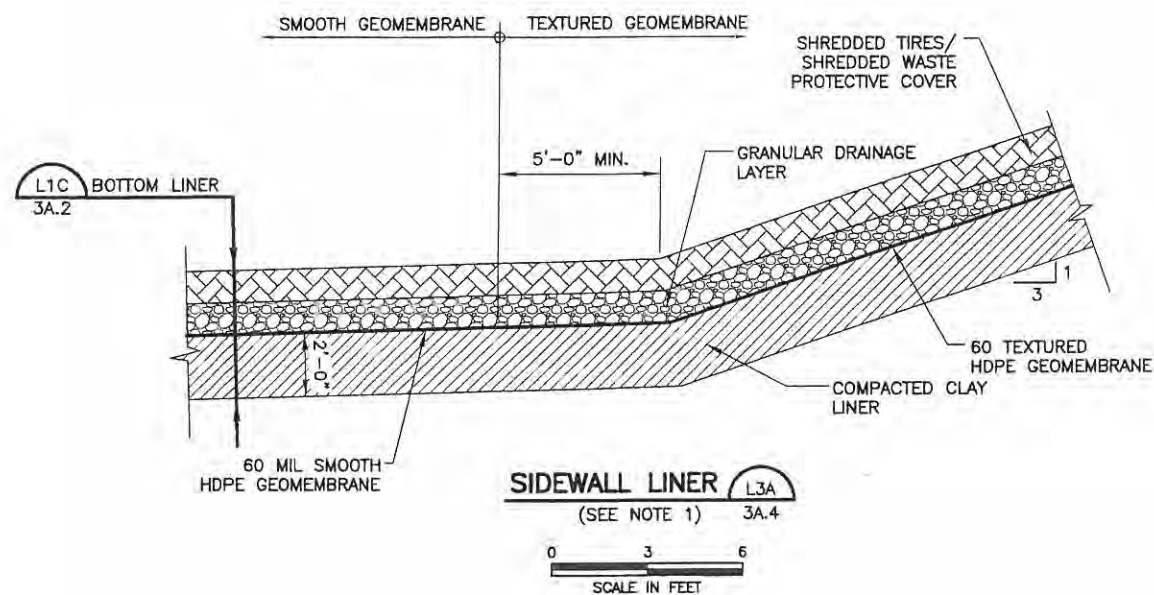
1. THE PROTECTIVE COVER HAS A COEFFICIENT OF PERMEABILITY GREATER THAN 1.0×10^{-4} CM/SEC, THEN CHIMNEYS ARE NOT REQUIRED. IF THE PROTECTIVE COVER HAS A MAXIMUM COEFFICIENT OF PERMEABILITY LESS THAN 1.0×10^{-4} CM/SEC, THEN CHIMNEYS ARE REQUIRED.

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	BIGGS & MATHEWS ENVIRONMENTAL CONSULTING ENGINEERS MANSFIELD DALLAS • WICHITA FALLS 817-563-1144		
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NOTES:

1. LEACHATE COLLECTION LAYERS L1C AND L2C ARE SHOWN. ALL LEACHATE COLLECTION LAYERS ARE INTERCHANGEABLE WITH BOTH LINER SYSTEMS.



LINER DETAILS

**CITY OF SAN ANGELO
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SLQCP PERMIT MODIFICATION**

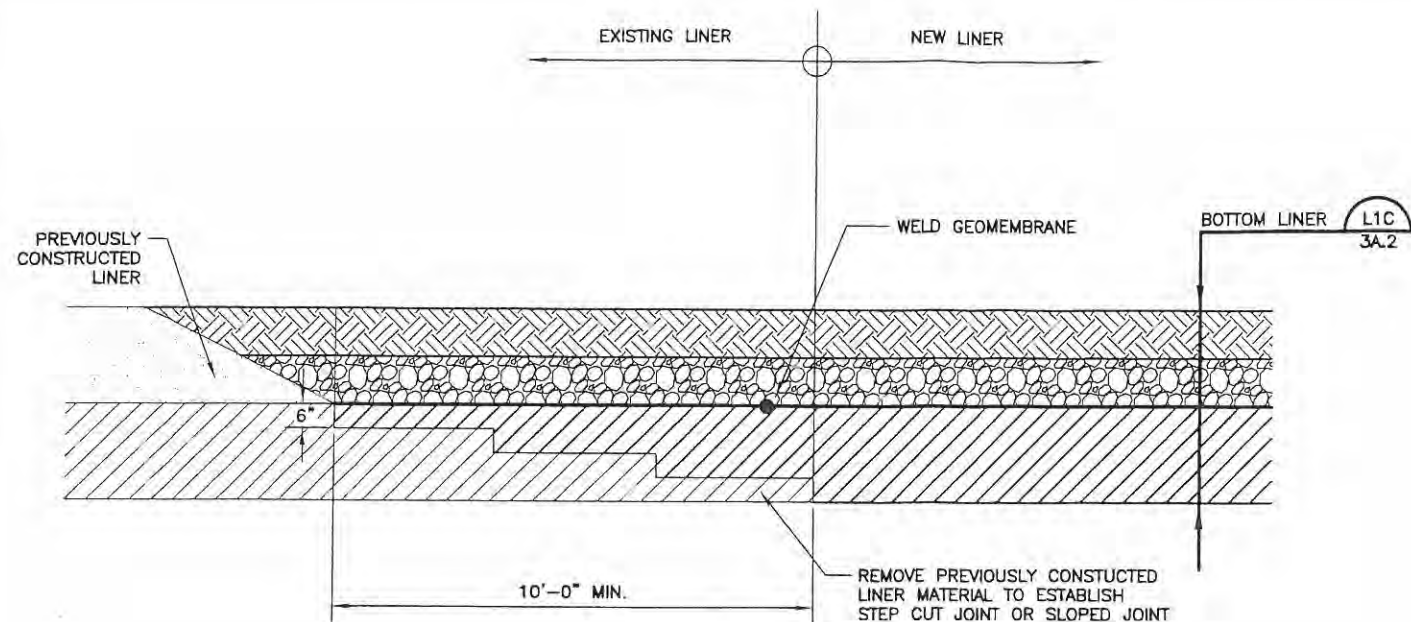


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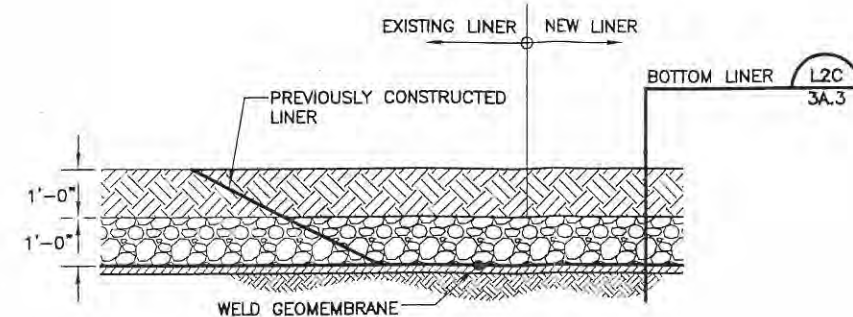
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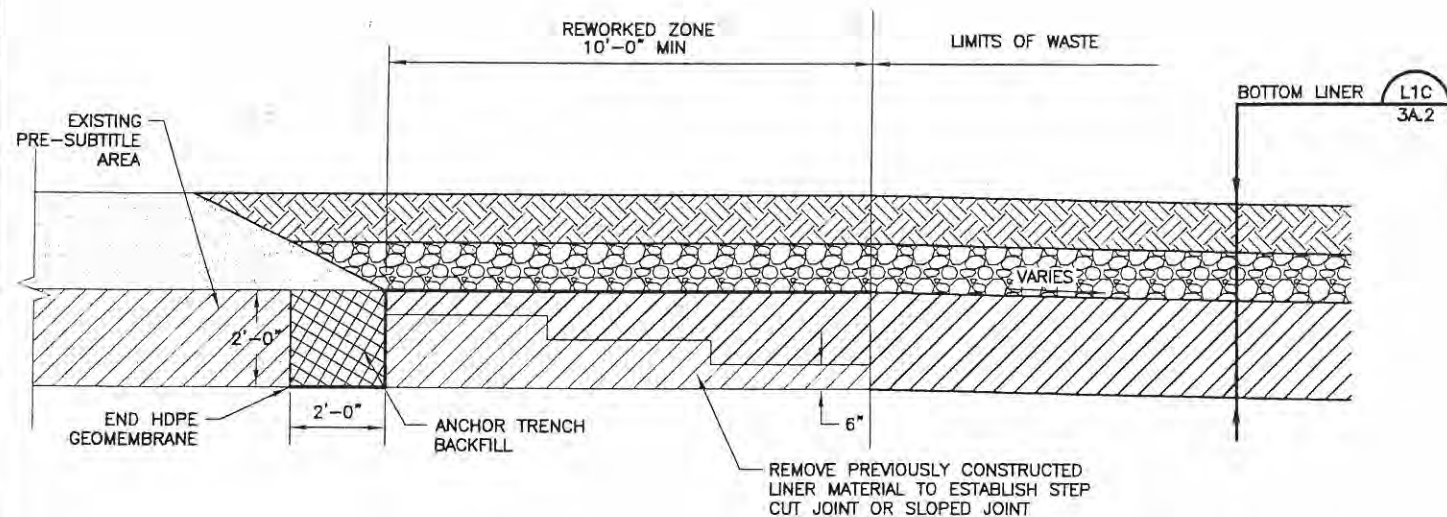
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(SEE NOTE 2)

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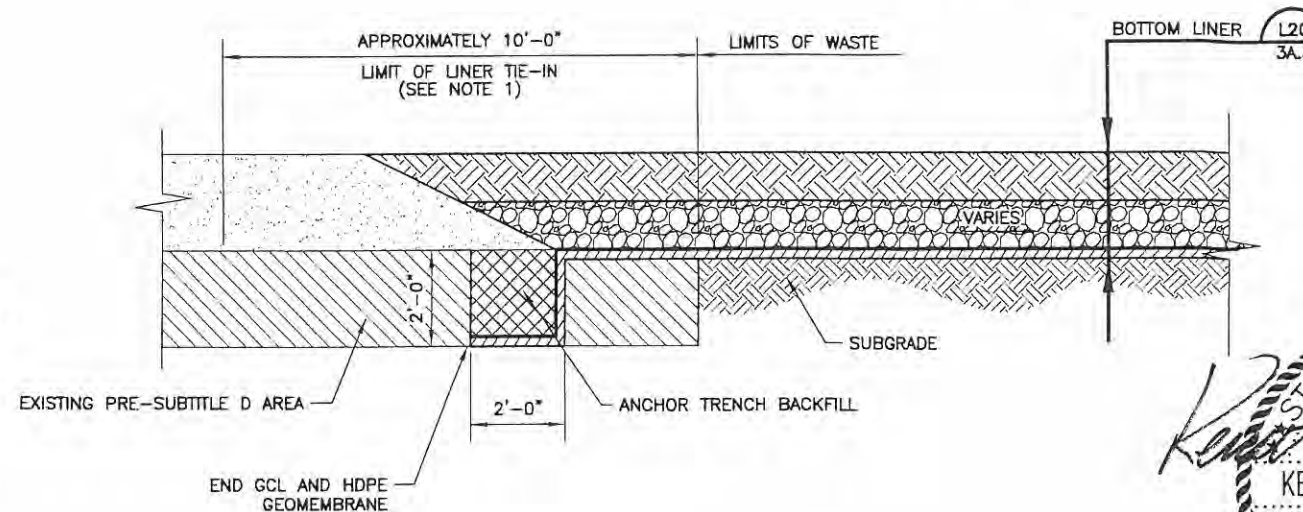
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(SEE NOTE 2)

0 2 4
SCALE IN FEET



LINER TIE-IN TO PRE-SUBTITLE D AREA L6A 3A.5
(SEE NOTE 2)

0 2 4
SCALE IN FEET



LINER TIE-IN TO PRE-SUBTITLE D AREA L6B 3A.5
(SEE NOTE 2)

0 2 4
SCALE IN FEET

NOTES:

1. THE GCL LINER WILL EXTEND INTO THE PRE-SUBTITLE D AREAS TO PROVIDE A COMPLETELY LINED CELL.
2. LEACHATE COLLECTION LAYERS L1C AND L2C ARE SHOWN. ALL LEACHATE COLLECTION LAYERS ARE INTERCHANGEABLE WITH BOTH LINER SYSTEMS.



11/19/07

LINER DETAILS

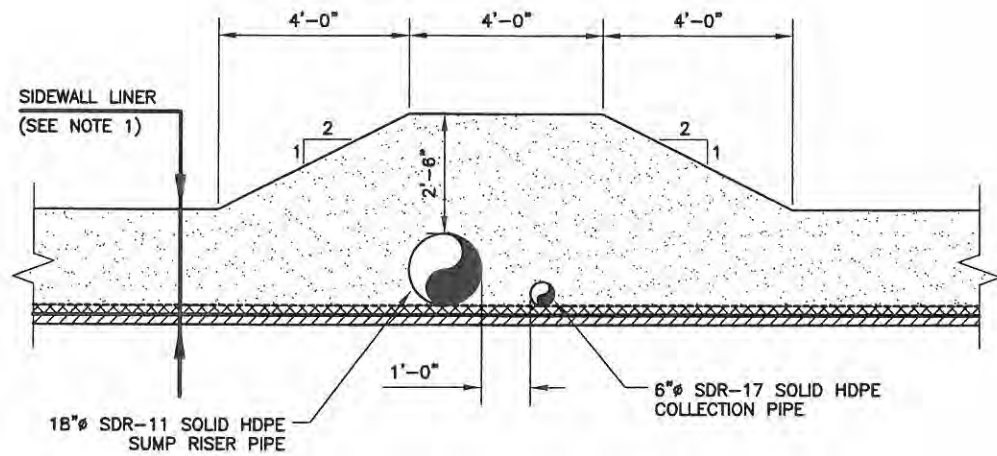
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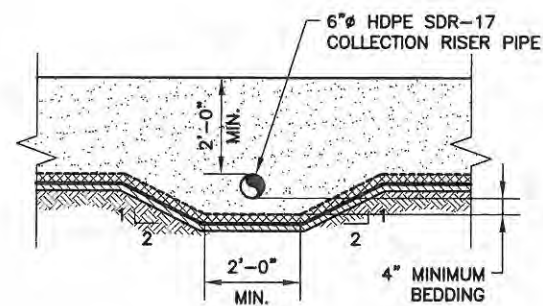
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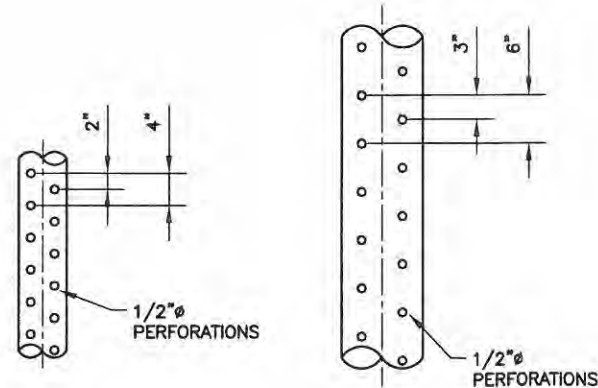
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LEACHATE SUMP AND RISER PIPE (LCS1) 3A.6
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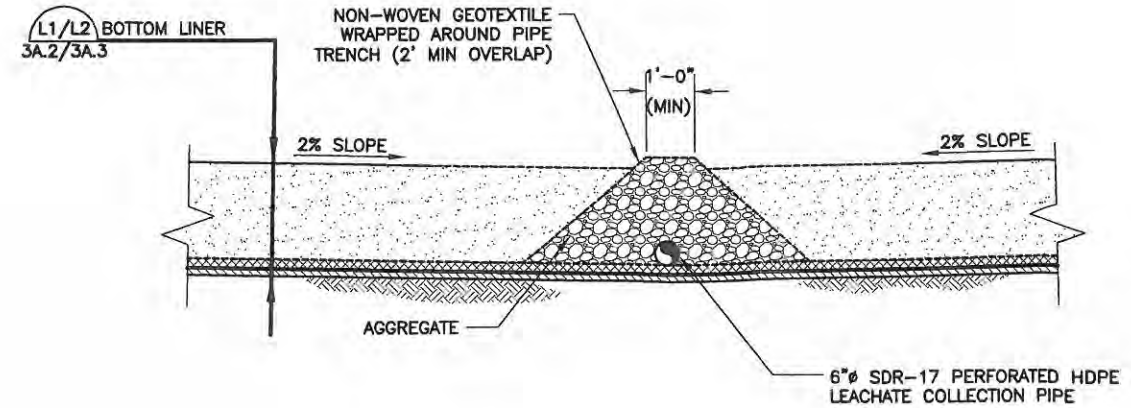
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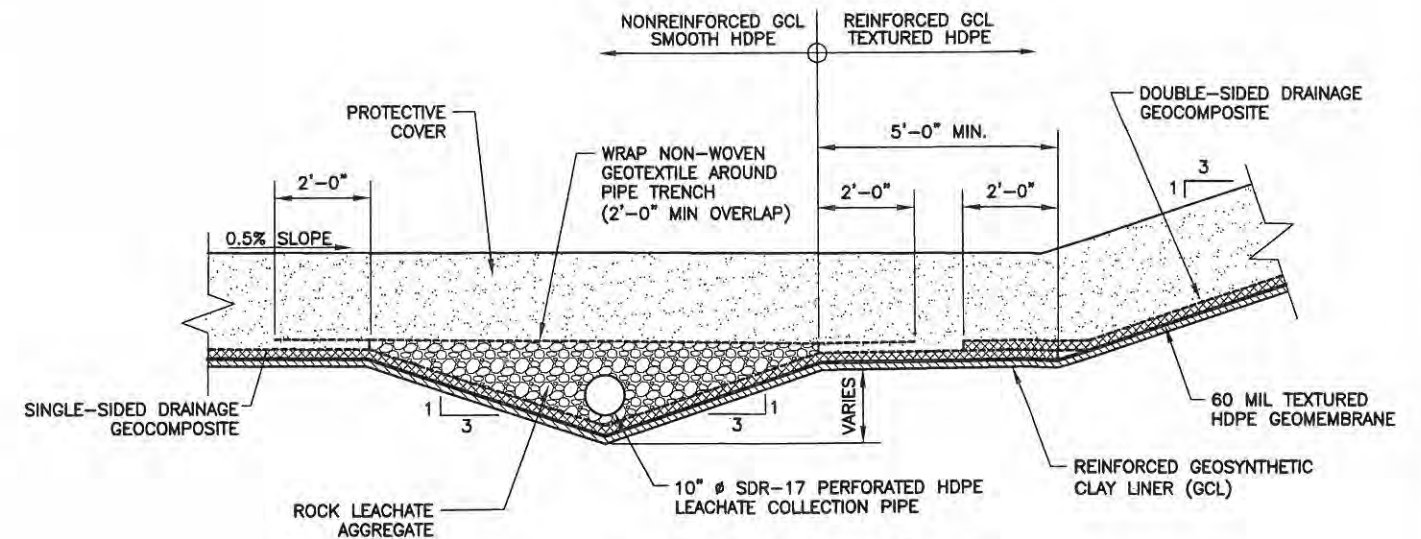
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SCALE IN FEET

NOTES:

1. LINER SYSTEM L2D SHOWN. LEACHATE COLLECTION SYSTEM CHIMNEYS ARE INTERCHANGEABLE WITH ANY LINER/PROTECTIVE COVER CONFIGURATION (WHEN REQUIRED).



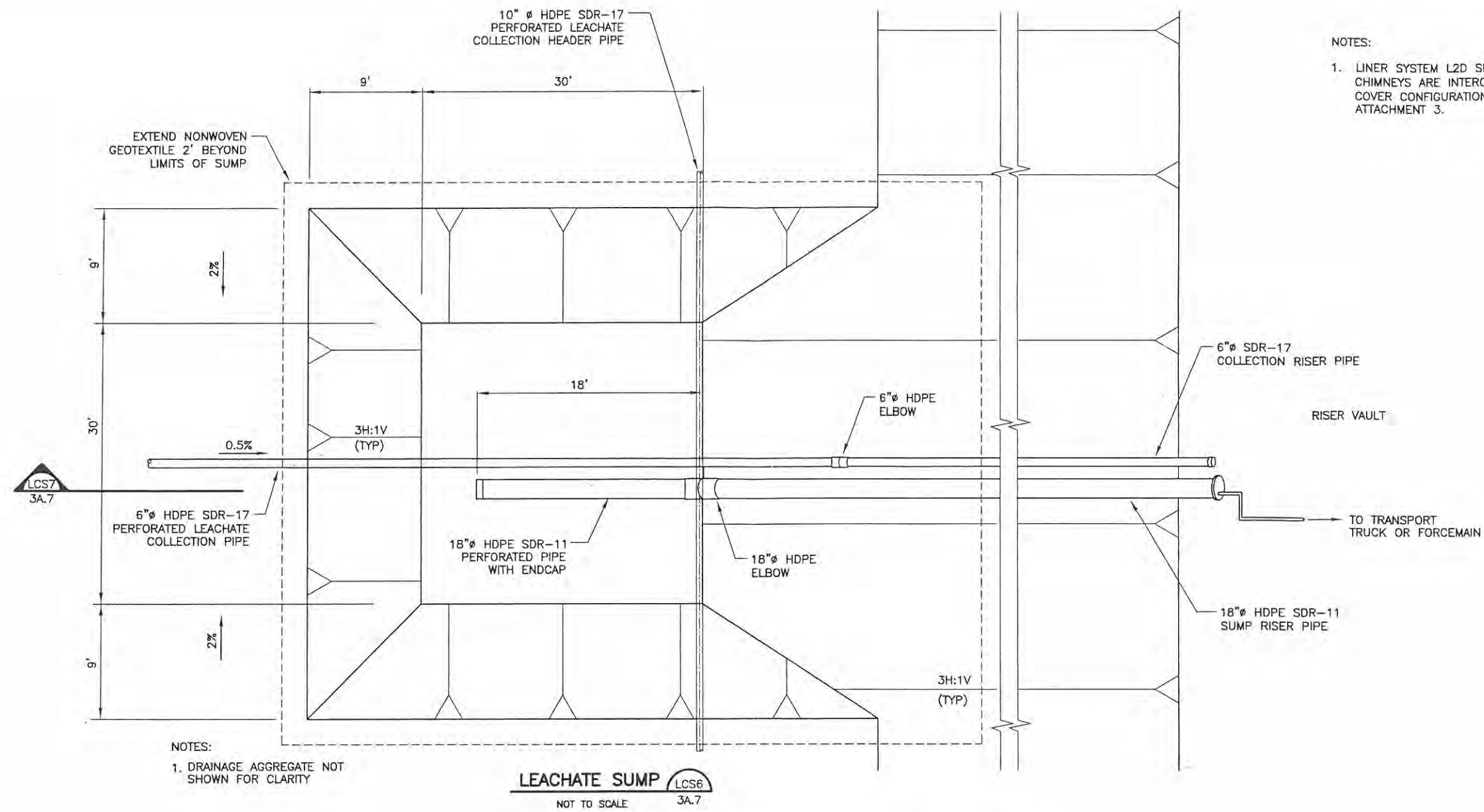
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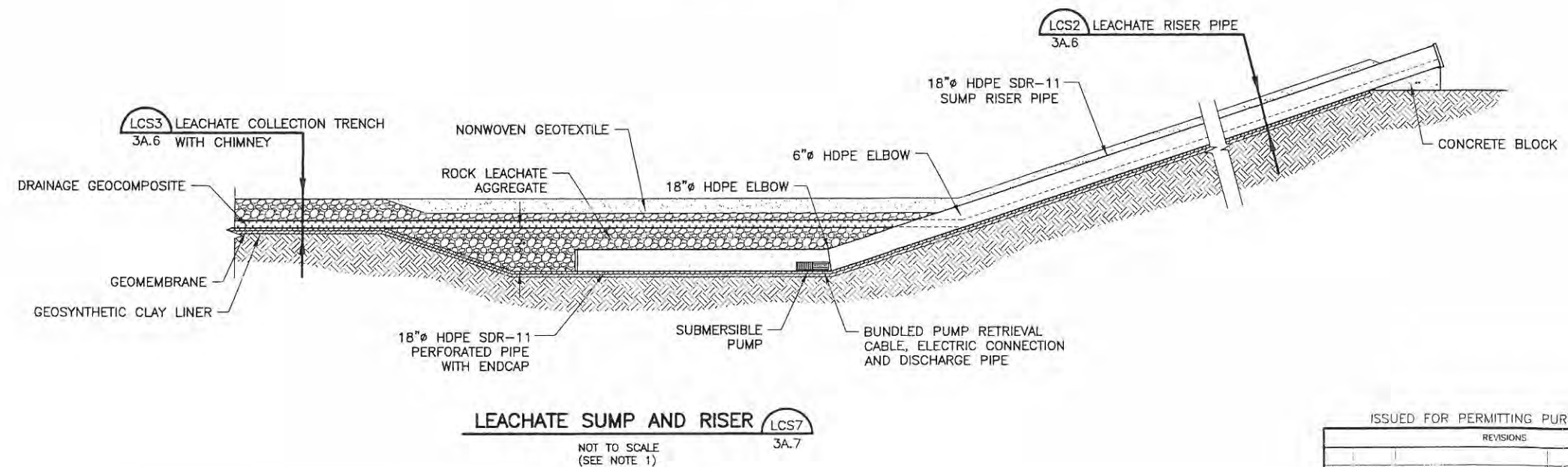
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SCALE IN FEET



LEACHATE COLLECTION SYSTEM DETAILS			
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BIGGS & MATHEWS CONSULTING ENGINEERS MANSFIELD DALLAS • WICHITA FALLS 817-563-1144		BIGGS & MATHEWS ENVIRONMENTAL CONSULTING ENGINEERS MANSFIELD DALLAS • WICHITA FALLS 817-563-1144	
ISSUED FOR PERMITTING PURPOSES ONLY		TBPE FIRM NO. F-256 TBPG FIRM NO. 50222	
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NOTES:
 1. LINER SYSTEM L2D SHOWN. LEACHATE COLLECTION SYSTEM CHIMNEYS ARE INTERCHANGEABLE WITH ANY LINER/PROTECTIVE COVER CONFIGURATION (WHEN REQUIRED), AS DISCUSSED IN ATTACHMENT 3.



LEACHATE COLLECTION SYSTEM DETAILS	
SAN ANGELO LANDFILL CITY OF SAN ANGELO TCEQ PERMIT NO. MSW 79	
	BIGGS & MATHEWS ENVIRONMENTAL CONSULTING ENGINEERS MANSFIELD DALLAS • WICHITA FALLS 817-563-1144
ISSUED FOR PERMITTING PURPOSES ONLY	
REVISIONS	
DSN: ALN	DATE: 02/08
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APPENDIX 3B
GEOSYNTHETIC RESEARCH INSTITUTE STANDARD GM13



Geosynthetic Research Institute

475 Kedron Avenue
Folsom, PA 19033-1208 USA
TEL (610) 522-8440
FAX (610) 522-8441



Revision 8: July 10, 2006
Revision schedule on pg. 11

GRI Test Method GM13*

Standard Specification for

“Test Methods, Test Properties and Testing Frequency for
High Density Polyethylene (HDPE) Smooth and Textured Geomembranes”

This specification was developed by the Geosynthetic Research Institute (GRI), with the cooperation of the member organizations for general use by the public. It is completely optional in this regard and can be superseded by other existing or new specifications on the subject matter in whole or in part. Neither GRI, the Geosynthetic Institute, nor any of its related institutes, warrant or indemnifies any materials produced according to this specification either at this time or in the future.

1. Scope

- 1.1 This specification covers high density polyethylene (HDPE) geomembranes with a formulated sheet density of 0.940 g/ml, or higher, in the thickness range of 0.75 mm (30 mils) to 3.0 mm (120 mils). Both smooth and textured geomembrane surfaces are included.
- 1.2 This specification sets forth a set of minimum, physical, mechanical and chemical properties that must be met, or exceeded by the geomembrane being manufactured. In a few cases a range is specified.
- 1.3 In the context of quality systems and management, this specification represents manufacturing quality control (MQC).

Note 1: Manufacturing quality control represents those actions taken by a manufacturer to ensure that the product represents the stated objective and properties set forth in this specification.

- 1.4 This standard specification is intended to ensure good quality and performance of HDPE geomembranes in general applications, but is possibly not adequate for the complete specification in a specific situation. Additional tests, or more restrictive

*This GRI standard is developed by the Geosynthetic Research Institute through consultation and review by the member organizations. This specification will be reviewed at least every 2-years, or on an as-required basis. In this regard it is subject to change at any time. The most recent revision date is the effective version.

values for test indicated, may be necessary under conditions of a particular application.

Note 2: For information on installation techniques, users of this standard are referred to the geosynthetics literature, which is abundant on the subject.

2. Referenced Documents

2.1 ASTM Standards

- D 792 Specific Gravity (Relative Density) and Density of Plastics by Displacement
- D 1004 Test Method for Initial Tear Resistance of Plastics Film and Sheet
- D 1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
- D 1505 Test Method for Density of Plastics by the Density-Gradient Technique
- D 1603 Test Method for Carbon Black in Olefin Plastics
- D 3895 Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis
- D 4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
- D 4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
- D 5199 Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
- D 5397 Procedure to Perform a Single Point Notched Constant Tensile Load – (SP-NCTL) Test: Appendix
- D 5596 Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
- D 5721 Practice for Air-Oven Aging of Polyolefin Geomembranes
- D 5885 Test method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry
- D 5994 Test Method for Measuring the Core Thickness of Textured Geomembranes
- D 6693 Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes

2.2 GRI Standards

- GM10 Specification for the Stress Crack Resistance of Geomembrane Sheet
- GM 11 Accelerated Weathering of Geomembranes using a Fluorescent UVA-Condensation Exposure Device
- GM 12 Measurement of the Asperity Height of Textured Geomembranes Using a Depth Gage

- 2.3 U. S. Environmental Protection Agency Technical Guidance Document "Quality Control Assurance and Quality Control for Waste Containment Facilities," EPA/600/R-93/182, September 1993, 305 pgs.

3. Definitions

Manufacturing Quality Control (MQC) - A planned system of inspections that is used to directly monitor and control the manufacture of a material which is factory originated. MQC is normally performed by the manufacturer of geosynthetic materials and is necessary to ensure minimum (or maximum) specified values in the manufactured product. MQC refers to measures taken by the manufacturer to determine compliance with the requirements for materials and workmanship as stated in certification documents and contract specifications.

ref. EPA/600/R-93/182

Manufacturing Quality Assurance (MQA) - A planned system of activities that provides assurance that the materials were constructed as specified in the certification documents and contract specifications. MQA includes manufacturing facility inspections, verifications, audits and evaluation of the raw materials (resins and additives) and geosynthetic products to assess the quality of the manufactured materials. MQA refers to measures taken by the MQA organization to determine if the manufacturer is in compliance with the product certification and contract specifications for the project.

ref. EPA/600/R-93/182

Formulation, n - The mixture of a unique combination of ingredients identified by type, properties and quantity. For HDPE polyethylene geomembranes, a formulation is defined as the exact percentages and types of resin(s), additives and carbon black.

4. Material Classification and Formulation

- 4.1 This specification covers high density polyethylene geomembranes with a formulated sheet density of 0.940 g/ml, or higher. Density can be measured by ASTM D1505 or ASTM D792. If the latter, Method B is recommended.
- 4.2 The polyethylene resin from which the geomembrane is made will generally be in the density range of 0.932 g/ml or higher, and have a melt index value per ASTM D1238 of less than 1.0 g/10 min.
- 4.3 The resin shall be virgin material with no more than 10% rework. If rework is used, it must be a similar HDPE as the parent material.
- 4.4 No post consumer resin (PCR) of any type shall be added to the formulation.

5. Physical, Mechanical and Chemical Property Requirements

- 5.1 The geomembrane shall conform to the test property requirements prescribed in Tables 1 and 2. Table 1 is for smooth HDPE geomembranes and Table 2 is for single and double sided textured HDPE geomembranes. Each of the tables are given in English and SI (metric) units. The conversion from English to SI (metric) is soft.

Note 3: The tensile strength properties in this specification were originally based on ASTM D 638 which uses a laboratory testing temperature of $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$. Since ASTM Committee D35 on Geosynthetics adopted ASTM D 6693 (in place of D 638), this GRI Specification followed accordingly. The difference is that D 6693 uses a testing temperature of $21^{\circ}\text{C} \pm 2^{\circ}\text{C}$. The numeric values of strength and elongation were not changed in this specification. If a dispute arises in this regard, the original temperature of $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$ should be utilized for testing purposes.

Note 4: There are several tests often included in other HDPE specifications which are omitted from this standard because they are outdated, irrelevant or generate information that is not necessary to evaluate on a routine MQC basis. The following tests have been purposely omitted:

- | | |
|------------------------------|--------------------------|
| • Volatile Loss | • Water Absorption |
| • Dimensional Stability | • Ozone Resistance |
| • Coeff. of Linear Expansion | • Modulus of Elasticity |
| • Resistance to Soil Burial | • Hydrostatic Resistance |
| • Low Temperature Impact | • Tensile Impact |
| • ESCR Test (D 1693) | • Field Seam Strength |
| • Wide Width Tensile | • Multi-Axial Burst |
| • Water Vapor Transmission | • Various Toxicity Tests |

Note 5: There are several tests which are included in this standard (that are not customarily required in other HDPE specifications) because they are relevant and important in the context of current manufacturing processes. The following tests have been purposely added:

- Oxidative Induction Time
- Oven Aging
- Ultraviolet Resistance
- Asperity Height of Textured Sheet (see Note 6)

Note 6: The minimum average value of asperity height does not represent an expected value of interface shear strength. Shear strength

associated with geomembranes is both site-specific and product-specific and should be determined by direct shear testing using ASTM D5321/ASTM D6243 as prescribed. This testing should be included in the particular site's CQA conformance testing protocol for the geosynthetic materials involved, or formally waived by the Design Engineer, with concurrence from the Owner prior to the deployment of the geosynthetic materials.

Note 7: There are other tests in this standard, focused on a particular property, which are updated to current standards. The following are in this category:

- Thickness of Textured Sheet
- Puncture Resistance
- Stress Crack Resistance
- Carbon Black Dispersion (In the viewing and subsequent quantitative interpretation of ASTM D 5596 only near spherical agglomerates shall be included in the assessment).

Note 8: There are several GRI tests currently included in this standard. Since these topics are not covered in ASTM standards, this is necessary. They are the following:

- UV Fluorescent Light Exposure
- Asperity Height Measurement

5.2 The values listed in the tables of this specification are to be interpreted according to the designated test method. In this respect they are neither minimum average roll values (MARV) nor maximum average roll values (MaxARV).

5.3 The properties of the HDPE geomembrane shall be tested at the minimum frequencies shown in Tables 1 and 2. If the specific manufacturer's quality control guide is more stringent and is certified accordingly, it must be followed in like manner.

Note 9: This specification is focused on manufacturing quality control (MQC). Conformance testing and manufacturing quality assurance (MQA) testing are at the discretion of the purchaser and/or quality assurance engineer, respectively.

6. Workmanship and Appearance

6.1 Smooth geomembrane shall have good appearance qualities. It shall be free from such defects that would affect the specified properties of the geomembrane.

- 6.2 Textured geomembrane shall generally have uniform texturing appearance. It shall be free from agglomerated texturing material and such defects that would affect the specified properties of the geomembrane.
- 6.3 General manufacturing procedures shall be performed in accordance with the manufacturer's internal quality control guide and/or documents.
- 7. MQC Sampling
 - 7.1 Sampling shall be in accordance with the specific test methods listed in Tables 1 and 2. If no sampling protocol is stipulated in the particular test method, then test specimens shall be taken evenly spaced across the entire roll width.
 - 7.2 The number of tests shall be in accordance with the appropriate test methods listed in Tables 1 and 2.
 - 7.3 The average of the test results should be calculated per the particular standard cited and compared to the minimum value listed in these tables, hence the values listed are the minimum average values and are designated as "min. ave."
- 8. MQC Retest and Rejection
 - 8.1 If the results of any test do not conform to the requirements of this specification, retesting to determine conformance or rejection should be done in accordance with the manufacturing protocol as set forth in the manufacturer's quality manual.
- 9. Packaging and Marketing
 - 9.1 The geomembrane shall be rolled onto a substantial core or core segments and held firm by dedicated straps/slings, or other suitable means. The rolls must be adequate for safe transportation to the point of delivery, unless otherwise specified in the contract or order.
- 10. Certification
 - 10.1 Upon request of the purchaser in the contract or order, a manufacturer's certification that the material was manufactured and tested in accordance with this specification, together with a report of the test results, shall be furnished at the time of shipment.

Table 1(a) – High Density Polyethylene (HDPE) Geomembrane -Smooth

Properties	Test Method	Test Value						Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils
Thickness (min. ave.)	D5199	nom.	Nom.	Nom.	Nom.	Nom.	Nom.	Nom.
• lowest individual of 10 values		-10%	-10%	-10%	-10%	-10%	-10%	-10%
Density mg/l (min.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc
Tensile Properties (1) (min. ave.)	D 6693	63 lb/in.	84 lb/in.	105 lb/in.	126 lb/in.	168 lb/in.	210 lb/in.	252 lb/in.
• yield strength	Type IV	114 lb/in.	152 lb/in.	190 lb/in.	228 lb/in.	304 lb/in.	380 lb/in.	456 lb/in.
• break strength		12%	12%	12%	12%	12%	12%	12%
• yield elongation		700%	700%	700%	700%	700%	700%	700%
• break elongation								
Tear Resistance (min. ave.)	D 1004	21 lb	28 lb	35 lb	42 lb	56 lb	70 lb	84 lb
Puncture Resistance (min. ave.)	D 4833	54 lb	72 lb	90 lb	108 lb	144 lb	180 lb	216 lb
Stress Crack Resistance (2)	D 5397 (App.)	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.
Carbon Black Content (range)	D 1603 (3)	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%
Carbon Black Dispersion	D 5596	note (4)	note (4)	note (4)	note (4)	note (4)	note (4)	note (4)
Oxidative Induction Time (OIT) (min. ave.) (5)								
(a) Standard OIT	D 3895	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.
— or —								
(b) High Pressure OIT	D 5885	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.
Oven Aging at 85°C (5), (6)	D 5721							
(a) Standard OIT (min. ave.) - % retained after 90 days	D 3895	55%	55%	55%	55%	55%	55%	55%
— or —								
(b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5885	80%	80%	80%	80%	80%	80%	80%
UV Resistance (7)	GM 11							
(a) Standard OIT (min. ave.)	D 3895	N.R. (8)	N.R. (8)	N.R. (8)	N.R. (8)	N.R. (8)	N.R. (8)	N.R. (8)
— or —								
(b) High Pressure OIT (min. ave.) - % retained after 1600 hrs (9)	D 5885	50%	50%	50%	50%	50%	50%	50%

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.

Yield elongation is calculated using a gage length of 1.3 inches

Break elongation is calculated using a gage length of 2.0 in.

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:

9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

Table 1(b) – High Density Polyethylene (HDPE) Geomembrane - Smooth

Properties	Test Method	Test Value							Testing Frequency (minimum) per roll
		0.75 mm nom. (mil) -10%	1.00 mm nom. (mil) -10%	1.25 mm nom. (mil) -10%	1.50 mm nom. (mil) -10%	2.00 mm nom. (mil) -10%	2.50 mm nom. (mil) -10%	3.00 mm nom. (mil) -10%	
Thickness - mils (min. ave.) • lowest individual of 10 values	D 5199	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	90,000 kg
Density (min.)	D 1505/D 792	11 kN/m 20kN/m 12% 700%	15 kN/m 27 kN/m 12% 700%	18 kN/m 33 kN/m 12% 700%	22 kN/m 40 kN/m 12% 700%	29 kN/m 53 kN/m 12% 700%	37 kN/m 67 kN/m 12% 700%	44 kN/m 80 kN/m 12% 700%	9,000 kg
Tensile Properties (1) (min. ave.) • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	93 N	125 N	156 N	187 N	249 N	311 N	374 N	20,000 kg
Tear Resistance (min. ave.)	D 1004	240 N	320 N	400 N	480 N	640 N	800 N	960 N	20,000 kg
Puncture Resistance (min. ave.)	D 4833	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	per GRI GM-10
Stress Crack Resistance (2)	D 5397 (App.)	2.0-3.0% note (4)	2.0-3.0% note (4)	2.0-3.0% note (4)	2.0-3.0% note (4)	2.0-3.0% note (4)	2.0-3.0% note (4)	2.0-3.0% note (4)	9,000 kg
Carbon Black Content - %	D 1603 (3)	2.0-3.0% note (4)	2.0-3.0% note (4)	2.0-3.0% note (4)	2.0-3.0% note (4)	2.0-3.0% note (4)	2.0-3.0% note (4)	2.0-3.0% note (4)	20,000 kg
Carbon Black Dispersion	D 5596	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	90,000 kg
Oxidative Induction Time (OIT) (min. ave.) (5) (a) Standard OIT — or — (b) High Pressure OIT	D 3895 D 5885	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	per each formulation
Oven Aging at 85°C (5), (6) (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	per each formulation
UV Resistance (7) (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs (9)	D 3895 D 5885	50% 50%	50% 50%	50% 50%	50% 50%	50% 50%	50% 50%	50% 50%	per each formulation

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction

Yield elongation is calculated using a gage length of 33 mm

Break elongation is calculated using a gage length of 50 mm

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:

9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

Table 2(a) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value						Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils
Thickness mils (min. ave.)	D 5994	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%
• lowest individual for 8 out of 10 values								
• lowest individual for any of the 10 values								
Asperity Height mils (min. ave.) (1)	GM 12	10 mil	10 mil	10 mil	10 mil	10 mil	10 mil	10 mil
Density (min. ave.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc
Tensile Properties (min. ave.) (3)	D 6693							
• yield strength	Type IV	63 lb/in.	84 lb/in.	105 lb/in.	126 lb/in.	168 lb/in.	210 lb/in.	252 lb/in.
• break strength		45 lb/in.	60 lb/in.	75 lb/in.	90 lb/in.	120 lb/in.	150 lb/in.	180 lb/in.
• yield elongation		12%	12%	12%	12%	12%	12%	12%
• break elongation		100%	100%	100%	100%	100%	100%	100%
Tear Resistance (min. ave.)	D 1004	21 lb	28 lb	35 lb	42 lb	56 lb	70 lb	84 lb
Puncture Resistance (min. ave.)	D 4833	45 lb	60 lb	75 lb	90 lb	120 lb	150 lb	180 lb
Stress Crack Resistance (4)	D 3397 (App.)	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.
Carbon Black Content (range)	D 1603 (5)	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %
Carbon Black Dispersion	D 5596	note (6)	note (6)	note (6)	note (6)	note (6)	note (6)	note (6)
Oxidative Induction Time (OIT) (min. ave.) (7)	D 3895	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.
(a) Standard OIT		400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.
— or —								
(b) High Pressure OIT	D 5885	55%	55%	55%	55%	55%	55%	55%
Oven Aging at 85°C (7), (8)	D 5721	80%	80%	80%	80%	80%	80%	80%
(a) Standard OIT (min. ave.) - % retained after 90 days	D 3895	N.R. (10)	N.R. (10)	N.R. (10)	N.R. (10)	N.R. (10)	N.R. (10)	N.R. (10)
— or —								
(b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5885	50%	50%	50%	50%	50%	50%	50%
UV Resistance (9)	GM 11							
(a) Standard OIT (min. ave.)	D 3895	N.R. (10)	N.R. (10)	N.R. (10)	N.R. (10)	N.R. (10)	N.R. (10)	N.R. (10)
— or —								
(b) High Pressure OIT (min. ave.) - % retained after 1600 hrs (11)	D 5885	50%	50%	50%	50%	50%	50%	50%

(1) Of 10 readings; 8 out of 10 must be ≥ 7 mils, and lowest individual reading must be ≥ 5 mils, also see Note 6.

(2) Alternate the measurement side for double sided textured sheet

(3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.

Yield elongation is calculated using a gage length of 1.3 inches

Break elongation is calculated using a gage length of 2.0 inches

(4) P-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.

The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(5) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.

(6) Carbon black dispersion (only near spherical agglomerates) for 10 different views:

9 in Categories 1 or 2 and 1 in Category 3

(7) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane

(8) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(9) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C

(10) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(11) UV resistance is based on percent retained value regardless of the original HP-OIT value.

Table 2(b) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		0.75 mm	1.00 mm	1.25 mm	1.50 mm	2.00 mm	2.50 mm	3.00 mm	
Thickness mils (min. ave.)	D 5994	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	per roll
• lowest individual for 8 out of 10 values									
• lowest individual for any of the 10 values									
Asperity Height mils (min. ave.) (1)	GM 12	0.25 mm	0.25 mm	0.25 mm	0.25 mm	0.25 mm	0.25 mm	0.25 mm	every 2 nd roll (2)
Density (min. ave.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	90,000 kg
Tensile Properties (min. ave.) (3)	D 6693								9,000 kg
• yield strength	Type IV	11 kN/m	15 kN/m	18 kN/m	22 kN/m	29 kN/m	37 kN/m	44 kN/m	
• break strength		8 kN/m	10 kN/m	13 kN/m	16 kN/m	21 kN/m	26 kN/m	32 kN/m	
• yield elongation		12%	12%	12%	12%	12%	12%	12%	
• break elongation		100%	100%	100%	100%	100%	100%	100%	
Tear Resistance (min. ave.)	D 1004	93 N	125 N	156 N	187 N	249 N	311 N	374 N	20,000 kg
Puncture Resistance (min. ave.)	D 4833	200N	267 N	333 N	400 N	534 N	667 N	800 N	20,000 kg
Stress Crack Resistance (4)	D 5397 (App.)	300 hr	300 hr.	300 hr.	300 hr	300 hr.	300 hr.	300 hr.	per GRI GM10
Carbon Black Content (range)	D 1603 (5)	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	9,000 kg
Carbon Black Dispersion	D 5596	note (6)	note (6)	note (6)	note (6)	note (6)	note (6)	note (6)	20,000 kg
Oxidative Induction Time (OIT) (min. ave.) (7)									90,000 kg
(a) Standard OIT	D 3895	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	
— or —									
(b) High Pressure OIT	D 3885	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	
Oven Aging at 85°C (7). (8)	D 5721								
(a) Standard OIT (min. ave.) - % retained after 90 days	D 3895	55%	55%	55%	55%	55%	55%	55%	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 90 days	D 3885	80%	80%	80%	80%	80%	80%	80%	
UV Resistance (9)	GM11								
(a) Standard OIT (min. ave.)	D 3895	N.R. (10)	N.R. (10)	N.R. (10)	N.R. (10)	N.R. (10)	N.R. (10)	N.R. (10)	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 1600 hrs (11)	D 3885	50%	50%	50%	50%	50%	50%	50%	

(1) Of 10 readings; 8 out of 10 must be ≥ 0.18 mm, and lowest individual reading must be ≥ 0.13 mm; also see Note 6.

(2) Alternate the measurement side for double sided textured sheet

(3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.

Yield elongation is calculated using a gage length of 33 mm

Break elongation is calculated using a gage length of 50 mm

The SP-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.

The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.

Carbon black dispersion (only near spherical agglomerates) for 10 different views:

9 in Categories 1 or 2 and 1 in Category 3

The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response

The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C

Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

UV resistance is based on percent retained value regardless of the original HP-OIT value.

Adoption and Revision Schedule
for
HDPE Specification per GRI-GM13

“Test Methods, Test Properties, Testing Frequency for
High Density Polyethylene (HDPE) Smooth and Textured Geomembranes”

Adopted:	June 17, 1997
Revision 1:	November 20, 1998; changed CB dispersion from allowing 2 views to be in Category 3 to requiring all 10 views to be in Category 1 or 2. Also reduced UV percent retained from 60% to 50%.
Revision 2:	April 29, 1999: added to Note 5 after the listing of Carbon Black Dispersion the following: “(In the viewing and subsequent quantitative interpretation of ASTM D5596 only near spherical agglomerates shall be included in the assessment)” and to Note (4) in the property tables.
Revision 3:	June 28, 2000: added a new Section 5.2 that the numeric table values are neither MARV or MaxARV. They are to be interpreted per the the designated test method.
Revision 4:	December 13, 2000: added one Category 3 is allowed for carbon black dispersion. Also, unified terminology to “strength” and “elongation”.
Revision 5:	May 15, 2003: Increased minimum acceptable stress crack resistance time from 200 hrs to 300 hrs.
Revision 6:	June 23, 2003: Adopted ASTM D 6693, in place of ASTM D 638, for tensile strength testing. Also, added Note 2.
Revision 7:	February 20, 2006: Added Note 6 on Asperity Height clarification with respect to shear strength.
Revision 8:	Removed recommended warranty from specification.

APPENDIX 3C
GEOSYNTHETIC RESEARCH INSTITUTE STANDARD GCL3



Geosynthetic Research Institute

475 Kedron Avenue
Folsom, PA 19033-1208 USA
TEL (610) 522-8440
FAX (610) 522-8441



Original - May 16, 2005

GRI-GCL3*

Standard Specification for

"Test Methods, Required Properties, and Testing Frequencies of Geosynthetic Clay Liners (GCLs)"

This specification was developed by the Geosynthetic Research Institute (GRI), with the cooperation of the member organizations for general use by the public. It is completely optional in this regard and can be superseded by other existing or new specifications on the subject matter in whole or in part. Neither GRI, the Geosynthetic Institute, nor any of its related institutes, warrant or indemnifies any materials produced according to this specification either at this time or in the future.

1. Scope

- 1.1 This specification covers the manufacturing quality control (MQC) of geosynthetic clay liners (GCLs), describing types of tests, the proper test methods, minimum and sometimes maximum values, and the minimum testing frequencies.

Note 1: Geosynthetic Clay Liners (GCLs) are also called Clay Geosynthetics Barriers (GBR-Cs).

- 1.2 There are two general categories of GCLs covered in this specification: reinforced and nonreinforced. Within each category there are geotextile, polymer coated geotextiles, and geomembrane/geofilm related types.
- 1.3 This specification is intended to aid manufacturers, suppliers, purchasers and users of GCLs in establishing an acceptable level of effort for manufacturing quality control.

*This GRI standard is developed by the Geosynthetic Research Institute through consultation and review by the member organizations. This specification will be reviewed at least every 2-years, or on an as-required basis. In this regard it is subject to change at any time. The most recent revision date is the effective version and is kept current on the Institute's Website <<geosynthetic-institute.org>>.

- 1.4 This specification does not address manufacturing quality assurance (MQA), product acceptance testing, or conformance testing. These are independent activities taken by organizations other than the GCL manufacturer.
- 1.5 The values stated in SI (metric) units are to be regarded as the standard. The U.S. (English) units are calculated values using a “soft” conversion accuracy.
- 1.6 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

2.1 ASTM Standards

- D 638 Test Method for Tensile Properties of Plastics
- D 792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
- D 882 Test Method for Tensile Properties of Thin Plastic Sheeting
- D 1141 Practice for Preparation of Substitute Ocean Water
- D 1505 Test Method for Density of Plastics by the Density-Gradient Method
- D 4354 Practice for Sampling of Geosynthetics for Testing
- D 4439 Terminology for Geosynthetics
- D 4632 Test Method for Grab Breaking Load and Elongation of Geotextiles
- D 4759 Practice for Determining the Specification Conformance of Geosynthetics
- D 5199 Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
- D 5261 Test Method for Measuring Mass per Unit Area of Geotextiles
- D 5721 Practice for Air-Oven Aging of Polyolefin Geomembranes
- D 5887 Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using Flexible Wall Permeameter
- D 5888 Practice for Storage and Handling of Geosynthetic Clay Liners
- D 5889 Practice for Quality Control of Geosynthetic Clay Liners
- D 5890 Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners
- D 5891 Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners
- D 5993 Test Method for Measuring the Mass Per Unit Area of Geosynthetic Clay Liners
- D 5994 Test Method for Measuring the Core Thickness of Textured Geomembrane
- D 6102 Guide for Installation of Geosynthetic Clay Liners
- D 6141 Guide for Screening the Clay Portion of a GCL for Chemical Compatibility to Liquids

- D 6243 Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method
- D 6495 Guide for Acceptance Testing Requirements for Geosynthetic Clay Liners
- D 6496 Test Method for Determining Average Bonding Peel Strength Between the Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners
- D 6693 Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
- D 6766 Test Method for Evaluation of Hydraulic Properties of Geosynthetic Clay Liners Permeated with Potentially Incompatible Liquids
- D 6768 Test Method for Tensile Strength of Geosynthetic Clay Liners

2.2 GRI Standards

- GM13 Test Properties, Testing Frequency and Recommended Warrant for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
- GM17 Test Properties, Testing Frequency and Recommended Warranty for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes
- GM18 Test Properties, Testing Frequency and Recommended Warrant for Flexible Polypropylene (fPP and fPP-R) Nonreinforced and Reinforced Geomembranes (Presently suspended as of May 3, 2004)

2.3 Government Document:

U.S. Environmental Protection Agency Technical Guidance Document "Quality Control Assurance and Quality Control for Waste Containment Facilities," EPA/600/R-93/182, September 1993, 305 pgs.

3. Terminology

3.1 Definition

3.1.1 Geosynthetic Definitions:

- 3.1.1.1 geotextile, n—a permeability geosynthetic comprised solely of textiles. (ASTM D 4439)
- 3.1.1.2 geomembrane, n—an essentially impermeable geosynthetic barrier composed of one or more synthetic sheets. (ASTM D 4439)
- 3.1.1.3 geofilm, n—a thin polymeric film which is essentially impermeable having a thickness no greater than 0.25 mm (10 mils).
- 3.1.1.4 geotextile-polymer, n—a geotextile which has been coated with, or impregnated by, a polymer such as polypropylene

- 3.1.1.5 geosynthetic clay liner, n—a manufactured hydraulic barrier consisting of clay bonded to a layer or layers of geosynthetic materials. (ASTM D 4439)

Note 1: Geotextile Related GCL is one in which two geotextiles are used respectively as cap and carrier to the bentonite. Cap and carrier designations in this standard refer to respective orientations during manufacturing. This may or may not be the as-placed orientation in the field. It can be internally reinforced by needle punching or stitching, or be nonreinforced.

Geotextile Polymer Coated GCL is one in which two geotextiles are used respectively as cap and carrier to the encased bentonite, however, one of the geotextiles has been polymer coated in a manner that the permeability and flux are decreased. Cap and carrier designations refer to the as manufactured product and not necessarily to the as-placed orientation. It can be internally reinforced by needle punching or stitching, or be nonreinforced.

Geomembrane/Geofilm Related GCL is one in which a geomembrane or geofilm is included in the cross section either above or below the cap geotextile. It can be internally reinforced needle punching or be nonreinforced. Also in the nonreinforced category is bentonite adhesively bonded to a geomembrane.

3.1.2 Material Definitions

- 3.1.2.1 bentonite—a distinct type of fine-grained clay soil typically containing not less than 80% montmorillonite clay, usually characterized by high swelling upon wetting.

- 3.1.2.2 Formulation, n - The mixture of a unique combination of ingredients identified by type, properties and quantity. For geosynthetic materials, a formulation refers to the exact percentages of resin, additives, carbon black and/or other additives. It does not necessarily refer to individual suppliers of each ingredient. The individual suppliers must meet the manufacturer's internal quality control specification.

3.1.3 Organizational Definitions:

- 3.1.3.1 installer, n—the party who installs, or facilitates installation of, any materials purchased from manufacturers or suppliers.
- 3.1.3.2 manufacturer, n—the group, corporation, partnership, or individual that manufactures a product.
- 3.1.3.3 purchaser, n—the person, company, or organization that purchases any materials or work to be performed.
- 3.1.3.4 supplier, n—the party who supplies material or services.

3.1.4 Quality Definitions:

- 3.1.4.1 Manufacturing Quality Control (MQC) - A planned system of inspections that is used to directly monitor and control the manufacture of a material which is factory originated. MQC is normally performed by the manufacturer of geosynthetic materials and is necessary to ensure minimum (or maximum) specified values in the manufactured product. MQC refers to measures taken by the manufacturer to determine compliance with the requirements for materials and workmanship as stated in certification documents and contract specifications, ref. EPA/600/R-93/182
- 3.1.4.2 Manufacturing Quality Assurance (MQA) - A planned system of activities that provides assurance that the materials were constructed as specified in the certification documents and contract specifications. MQA includes manufacturing facility inspections, verifications, audits and evaluation of the raw materials (resins and additives) and geosynthetic products to assess the quality of the manufactured materials. MQA refers to measures taken by the MQA organization to determine if the manufacturer is in compliance with the product certification and contract specifications for the project, ref. EPA/600/R-93/182
- 3.1.4.3 Construction Quality Control (CQC) - A planned system of inspections that are used to directly monitor and control the quality of a construction project. Construction quality control is normally performed by the geosynthetics manufacturer or installer, or for natural soil materials by the earthwork contractor, and is necessary to achieve quality in the constructed or installed system. Construction quality control (CQC) refers to measures taken by the installer or contractor to determine compliance with the requirements for materials and workmanship as stated in the plans and specifications for the project, ref. EPA/600/R-93/182
- 3.1.4.4 Construction Quality Assurance (CQA) - A planned system of activities that provide assurance that the facility was constructed as specified in the design. Construction quality assurance includes inspections, verification, audits, and evaluations of materials and workmanship necessary to determine and document the quality of the constructed facility. Construction quality assurance (CQA) refers to measures taken by the CQA organization to assess if the installer or contractor is in compliance with the plans and specifications for a project, ref. EPA.600/R-93/182

4. Significance and Use

- 4.1 GCLs must be properly manufactured in a manner consistent with a minimum level of quality control as determined by in-house testing of the final product. This specification presents the types of tests, standard methods of the testing, required (usually minimum) test values, and minimum testing frequencies which should be embodied in the manufacturer's quality control documents. The quoted tests, test methods and test values in Table 1 must appear in the MQC plan and the MQC report.
- 4.2 It should be clearly recognized that manufacturers may perform additional tests or at greater frequency than required in this specification, or both. In this case, the manufacturer's quality control plan will then take precedence over this specification.
- 4.3 It should also be recognized that purchasers and installers of GCLs may require additional tests or at a great frequency than called for in this specification, or both. The organization(s) producing such project specific specification or quality assurance plan should recognize that such requirements are beyond the current state-of-the-practice. If such a request is made by purchasers or installers, they should clearly communicate the requirements to the manufacturer or supplier during the contract decisions in order that disputes do not arise at a subsequent time.

5. Procedure

- 5.1 The procedures embodied in this specification are contained in the respective test methods given in Table 1.
 - 5.1.1 The minimum recommended quality control tests for the manufacture of GCLs are given in Table 1. Specific tests are performed on the bentonite, the geosynthetic component materials, and the finished GCL. Table 1(a) is in S.I. (Metric) units and Table 1(b) is in U.S. (English) units.

Note 2: The conversion from S.I. units into U.S. units is soft.
 - 5.1.2 The individual properties in Table 1 are minimum values; except fluid loss, moisture content, and permeability (or flux). They are maximum values. The manner of taking specimens is described in the appropriate test method. When an average value is indicated, it is listed in the table as "min. ave.", or "max. ave."
- 5.2 Bentonite (as received)
Two tests are required; swell index and fluid loss. The latter is a maximum value. These tests should be performed on the bentonite prior to fabrication into a GCL

or on bentonite taken from the manufactured product if the bentonite is modified in any way during manufacturing, e.g., if an adhesive is added.

5.3 Geotextile (as received)

Mass per unit area is required on the as-manufactured cap and carrier fabrics, with different values depending on the fabric being nonwoven or woven.

Note 3: These tests are to be performed on the geotextiles before manufacturing into the final GCL. Removal of the geotextiles from the manufactured product and subsequent testing will give erroneous values and is not an acceptable practice. The exception is polymer coated GCLs where the geotextile must be removed to determine its mass per unit area.

5.4 Geomembrane/Geofilm (as received)

The following tests are required; thickness, density, and tensile strength at break. All are minimum required values. Tensile strength at break is the lowest of machine direction and cross machine direction.

Note 4: These tests are to be performed on the geomembrane or geofilm before manufacturing into the final GCL. Removal of the geomembrane or geofilm from the manufactured product and subsequent testing will give erroneous values and is not an accepted practice.

5.5 GCL (as manufactured)

Six tests are required on the as-manufactured GCL with one having an alternative, i.e., hydraulic conductivity or flux. All are minimum values, with the exception of moisture content and hydraulic conductivity or flux.

5.6 GCL (long-term)

The purpose of these long-term or endurance tests is to provide confidence in the continuing acceptable performance of the bentonite and geosynthetic components of the installed GCL.

5.6.1 The durability of the bentonite is evaluated using a permeant consisting of 0.1 M calcium chloride solution. See ASTM D 6141 which is a guide for this particular aspect of the specification. The GCL is to be hydrated with distilled deionized water prior to conducting the tests with the calcium chloride solution. In this regard, ASTM D6766 Scenario 1 and Method C is the procedure to be used. Furthermore, this test is conducted twice at two different normal pressures, i.e., 35 and 500 kPa. The maximum allowable values are listed in Table 1.

5.6.2 The geotextiles in their as-received condition are evaluated by incubation in a forced air oven per ASTM D5721 set at 60°C for 50 days. The

minimum percent in tensile strength retained at break, as measured by ASTM D6768, is 65%. If individual yarns are used in reinforcing GCLs, they must also meet this same endurance criterion.

5.6.3 The geomembrane in its as-received condition is evaluated for durability via the appropriate GRI Specification. For high density polyethylene (HDPE), the specification is GRI GM13. For linear low density polyethylene (LLDPE), the specification is GRI GM17. For flexible polypropylene (fPP), the specification is GRI GM18.

5.6.4 The geofilm in its as-received condition is evaluated by incubation in a forced air oven per ASTM D5721 set at 60°C for 50 days. The minimum percent tensile strength retained at break for either MD or XMD, as measured by ASTM D882, is reported accordingly and must meet or exceed the specification value.

Note 5: It should be recognized that the above durability criterion for geofilms is not as stringent as the criteria for geomembranes stated in Section 5.6.3.

6. Workmanship and Appearance

6.1 Waterproof ink overlap lines should be printed on both edges of one of the surfaces (geotextile or geomembrane) of the manufactured GCL.

Note 6: The overlap lines are minimally 150 mm (6.0 in.) from the edges of the GCL. Other design-related situations may require greater overlap distances to be printed on the GCLs, e.g., when not backfilled in a timely manner.

6.2 Needle punched and stitch bonded GCLs shall be essentially free of broken needles and fragments of needles that would negatively effect the performance of the final product. There must be continuous needle detection and removal devices, e.g., metal detectors and magnets, used during manufacture of GCL products.

6.3 The manufactured GCL shall have good appearance qualities. It shall be free from such defects that would affect the specified properties and integrity of the product.

6.4 General manufacturing procedures shall be performed in accordance with the manufacturer's internal quality control guide and/or documents. ASTM D5888 and D5889 should be followed in this regard.

7. MQC Sampling

- 7.1 Sampling shall be in accordance with the specific test methods listed in Table 1. If no sampling protocol is stipulated in the particular test method, then test specimens shall be taken evenly spaced across the entire roll width, see ASTM D 4354.
- 7.2 The number of tests shall be in accordance with the appropriate test methods listed in Table 1.
- 7.3 The average of the test results should be calculated per the particular standard cited and compared to the minimum value listed in these tables, hence the values listed are the minimum average values and are designated as "min. ave.". When the property is a maximum value, the designation is "max. ave.".

8. MQC Retest and Rejection

- 8.1 If the results of any test do not conform to the requirements of this specification, retesting to determine conformance or rejection should be done in accordance with the manufacturing protocol as set forth in the manufacturer's quality manual.

9. Packaging and Marking

- 9.1 The GCL shall be rolled, clearly labeled, and onto a substantial core, encased in a waterproof wrapper. Packaging must be adequate for safe transportation to the point of delivery.
- 9.2 The label should include manufacturer, style, lot and/or roll number, weight, length and width.

10. Conformance and Certification

- 10.1 Conformance of the manufactured GCL to this specification, or agreed-upon variation thereof, shall be performed by the MQA organization or designated by the purchaser/owner. ASTM D 4759 can be used as a general guide, but individual test methods must be clearly stipulated and communicated to the parties involved.
- 10.2 Upon request of the purchaser in the contract or order, a manufacturer's certification that the material was manufactured and tested in accordance with this specification, together with a report of the test results, shall be furnished at the time of shipment.

Table 1(a) – Specification for Geosynthetic Clay Liners (GCLs)

Property	ASTM Test Method	Reinforced GCL			Non-Reinforced GCL			Testing Frequency
		GT-Related	GT Polymer Coated	GM-GF Related	GT-Related	GT Polymer Coated	GM-GF Related	
Clay (as received)								
swell index (ml/2g)	D5890	24	24	24	24	24	24	50 tonnes
fluid loss (ml) ⁽¹⁾	D5891	18	18	18	18	18	18	50 tonnes
Geotextiles (as received)								
cap fabric (nonwoven) - mass/unit area (g/m ²) ⁽²⁾	D5261	200	200	200	70	100	n/a/70	20,000 m ²
cap fabric - (woven) - mass/unit area (g/m ²)	D5261	100	100	100	-	-	-	20,000 m ²
carrier fabric (nonwoven composite) - mass/(g/m ²) ⁽²⁾	D5261	240	240	240	90	100	n/a/90	20,000 m ²
carrier fabric (woven) - mass/unit area (g/m ²)	D5261	100	100	100	-	-	-	20,000 m ²
coating - mass/unit area (g/m ²) ⁽³⁾	D5261	n/a	100	n/a	n/a	100	n/a	4,000 m ²
Geomembrane/Geofilm (as received)								
thickness ⁽⁵⁾ (mm)	D5199/D5994	n/a	n/a	0.40/0.50/0.10	n/a	n/a	0.40/0.75/0.10	20,000 m ²
density (g/cc)	D1505/D792	n/a	n/a	0.92	n/a	n/a	0.92	20,000 m ²
break tensile strength, MD&XMD (kN/m)	D6693	n/a	n/a	2.5	n/a	n/a	6.0	20,000 m ²
break tensile strength, MD (kN/m)	D882	n/a	n/a	2.5	n/a	n/a	2.5	20,000 m ²
GCL (as manufactured)								
mass of GCL (g/m ²) ⁽⁶⁾	D5993	4000	4050	4100	4000	4050	4100	4,000 m ²
mass of bentonite (g/m ²) ⁽⁶⁾	D5993	3700	3700	3700	3700	3700	3700	4,000 m ²
moisture content ⁽¹⁾ (%)	D5993	(4)	(4)	(4)	(4)	(4)	(4)	4,000 m ²
tensile str., MD (kN/m)	D6768	4.0	4.0	4.0	4.0	4.0	4.0	20,000 m ²
peel strength (N/m)	D6496	360	360	360	n/a	n/a	n/a	4,000 m ²
permeability ⁽¹⁾ (m/sec), "or"	D5887	5 × 10 ⁻¹¹	5 × 10 ⁻¹²	5 × 10 ⁻¹²	5 × 10 ⁻¹¹	5 × 10 ⁻¹²	5 × 10 ⁻¹²	25,000 m ²
flux ⁽¹⁾ (m ³ /sec-m ²),	D5887	1 × 10 ⁻⁸	1 × 10 ⁻⁹	1 × 10 ⁻⁹	1 × 10 ⁻⁸	1 × 10 ⁻⁹	1 × 10 ⁻⁹	25,000 m ²
GCL permeability ^{(1),(7)} (m/sec) (max. at 35 kPa)	D6766	1 × 10 ⁻⁸	1 × 10 ⁻⁹	1 × 10 ⁻⁹	1 × 10 ⁻⁸	1 × 10 ⁻⁹	1 × 10 ⁻⁹	yearly
GCL permeability ^{(1),(7)} (m/sec) (max. at 500 kPa)	D6766 mod.	5 × 10 ⁻¹⁰	5 × 10 ⁻¹¹	5 × 10 ⁻¹¹	5 × 10 ⁻¹⁰	5 × 10 ⁻¹¹	5 × 10 ⁻¹¹	yearly
Component Durability								
geotextile and reinforcing yarns ⁽⁸⁾ (% strength retained)	See § 5.6.2	65	65	n/a	65	65	n/a	yearly
geomembrane	See § 5.6.3	n/a	n/a	GM Spec ⁽⁹⁾	n/a	n/a	GM Spec ⁽⁹⁾	yearly
geofilm/polymer treated ⁽⁸⁾ (% strength retained)	See § 5.6.4	n/a	85	80	n/a	85	80	yearly

n/a = not applicable with respect to this property

(1) These values are maximum (all others are minimum)

(2) For both cap and carrier fabrics for nonwoven reinforced GCLs; one, or the other, must contain a scrim component of mass ≥ 100 g/m² for dimensional stability

(3) Calculated value obtained from difference of coated fabric to as-received fabric

(4) Value is both site-specific and product-specific and is currently being evaluated

(5) First value is for smooth geomembrane; second for textured geomembrane; third for geofilm

(6) Mass of the GCL and bentonite is measured after oven drying per the stated test method

(7) Value represents GCL permeability after permeation with a 0.1 M calcium chloride solution (11.1 g CaCl₂ in 1-liter water)

(8) Value represents the minimum percent strength retained from the as-manufactured value after oven aging at 60°C for 50 days

(9) Durability criteria should follow the appropriate specification for the geomembrane type used; i.e., GRI GM-13 for HDPE, GRI GM-17 for LLDPE or GRI GM-18 for FPP

Table 1(b) – Specification for Geosynthetic Clay Liners (GCLs)

Property	ASTM Test Method	Reinforced GCL			Non-Reinforced GCL			Testing Frequency
		GT-Related	GT Polymer Coated	GM-GF Related	GT-Related	GT Polymer Coated	GM-GF Related	
Clay (as received)								
swell index (ml/2g)	D5890	24	24	24	24	24	24	50 tonnes
fluid loss (ml) ⁽¹⁾	D5891	18	18	18	18	18	18	50 tonnes
Geotextiles (as received)								
cap fabric (nonwoven) - mass/unit area (oz/yd ²) ⁽²⁾	D5261	5.8	5.8	5.8	2.1	2.9	n/a/2.1	25,000 yd ²
cap fabric (woven) - mass/unit area (oz/yd ²)	D5261	3.0	3.0	3.0	-	-	-	25,000 yd ²
carrier fabric (nonwoven composite) - mass/(oz/yd ²) ⁽²⁾	D5261	5.9	5.9	5.9	2.7	2.9	n/a/2.7	25,000 yd ²
carrier fabric (woven) - mass/unit area (oz/yd ²)	D5261	3.0	3.0	3.0	-	-	-	25,000 yd ²
coating - mass/unit area (oz/yd ²) ⁽³⁾	D5261	n/a	2.9	n/a	n/a	2.9	n/a	5,000 yd ²
Geomembrane/Geofilm (as received)								
thickness ⁽⁵⁾ (mils)	D5199/D5994							
density (g/cc)	D1505/D792	n/a	n/a	15/20/4	n/a	n/a	15/30/4	25,000 yd ²
break tensile strength, MD&XMD (lb/in.)	D6693	n/a	n/a	0.92	n/a	n/a	0.92	25,000 yd ²
break tensile strength, MD & XMD (lb/in.)	D882	n/a	n/a	14	n/a	n/a	34	25,000 yd ²
GCL (as manufactured)								
mass of GCL (lb/ft ²) ⁽⁶⁾	D5993	0.82	0.83	0.84	0.82	0.83	0.84	5,000 yd ²
mass of bentonite (lb/ft ²) ⁽⁶⁾	D5993	0.75	0.75	0.75	0.75	0.75	0.75	5,000 yd ²
moisture content ⁽¹⁾ (%)	D5993	(4)	(4)	(4)	(4)	(4)	(4)	5,000 yd ²
tensile str., MD (lb/in.)	D6768	23	23	23	23	23	23	25,000 yd ²
peel strength (lb/in.)	D6496	2.1	2.1	2.1	n/a	n/a	n/a	5,000 yd ²
permeability ⁽¹⁾ (cm/sec), "or"	D5887	5 × 10 ⁻⁹	5 × 10 ⁻¹⁰	n/a	5 × 10 ⁻⁹	5 × 10 ⁻¹⁰	n/a	5,000 yd ²
flux ⁽¹⁾ (cm ³ /sec-cm ²),	D5887	1 × 10 ⁻⁶	1 × 10 ⁻⁷	n/a	1 × 10 ⁻⁶	1 × 10 ⁻⁷	n/a	30,000 yd ²
GCL permeability ^{(1),(7)} (cm/sec) (max. at 5 lb/in. ²)	D6766	1 × 10 ⁻⁶	1 × 10 ⁻⁷	1 × 10 ⁻⁷	1 × 10 ⁻⁶	1 × 10 ⁻⁷	1 × 10 ⁻⁷	yearly
GCL permeability ^{(1),(7)} (cm/sec) (max. at 70 lb/in. ²)	D6766 mod.	5 × 10 ⁻⁸	5 × 10 ⁻⁹	5 × 10 ⁻⁹	5 × 10 ⁻⁸	5 × 10 ⁻⁹	5 × 10 ⁻⁹	yearly
Component Durability								
geotextile and reinforcing yarns ⁽⁸⁾ (% strength retained)	See § 5.6.2	65	65	n/a	65	65	n/a	yearly
geomembrane	See § 5.6.3	n/a	n/a	GM Spec ⁽⁹⁾	n/a	n/a	GM Spec ⁽⁹⁾	yearly
geofilm/polymer treated ⁽⁸⁾ (% strength retained)	See § 5.6.4	n/a	85	80	n/a	85	80	yearly

n/a = not applicable with respect to this property :

(1) These values are maximum (all others are minimum)

(2) For both cap and carrier fabrics for nonwoven reinforced GCLs; one, or the other, must contain a scrim component of mass > 2.9 oz/yd² for dimensional stability

(3) Calculated value obtained from difference of coated fabric to as-received fabric

(4) Value is both site-specific and product-specific and is currently being evaluated

(5) First value is for smooth geomembrane; second for textured geomembrane; third for geofilm

(6) Mass of the GCL and bentonite is measured after oven drying per the stated test method

(7) Value represents GCL permeability after permeation with a 0.1 M calcium chloride solution (11.1 g CaCl₂ in 1-liter water)

(8) Value represents the minimum percent strength retained from the as-manufactured value after oven aging at 60°C for 50 days

(9) Durability criteria should follow the appropriate specification for the geomembrane used; i.e., GRI GM-13 for HDPE, GRI GM-17 for LLDPE or GRI GM-18 for rPP

APPENDIX 3D

ALTERNATE LINER DESIGN PERMIT MODIFICATION

(APPROVED BY TCEQ AS PERMIT MODIFICATION JANUARY 1999)

Barry R. McBee, *Chairman*
R. B. "Ralph" Marquez, *Commissioner*
John M. Baker, *Commissioner*
Jeffrey A. Saitas, *Executive Director*



TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

Protecting Texas by Reducing and Preventing Pollution

January 22, 1999

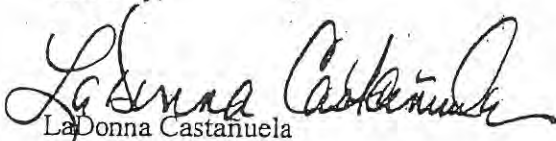
Will H. Wilde, P.E.
Director of Public Works
City of San Angelo
P.O. Box 1751
San Angelo, Texas 76902-1751

RE: CITY OF SAN ANGELO LANDFILL
Amendment to Permit No. MSW-79

Enclosed is a copy of the referenced permit for a municipal solid waste facility issued pursuant to Chapter 361, Texas Health and Safety Code. The Site Development Plan, the Site Operating Plan, and all other documents and plans prepared and submitted to support the permit application shall be considered as a part of this permit and shall be considered as operational requirements of this permit.

Should you have any questions, please contact Jessica Leyendecker of the Texas Natural Resource Conservation Commission's Office of the Chief Clerk (MC 105) at (512) 239-4517.

Sincerely,


La Donna Castanuela
Chief Clerk

LC/jl

cc: TNRCC Region 8
Nevzat Turan, P.E., TNRCC Municipal Solid Waste Division, Permit Section
(MC 124)

Barry R. McBee, *Chairman*
R. B. "Ralph" Marquez, *Commissioner*
John M. Baker, *Commissioner*
Jeffrey A. Saitas, *Executive Director*



TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

Protecting Texas by Reducing and Preventing Pollution

MINOR AMENDMENT TO MUNICIPAL SOLID WASTE PERMIT NO. MSW 79

City of San Angelo Landfill
Tom Green County

In accordance with 30 Texas Administrative Code (TAC) Section 305.62, the Site Development Plan for Municipal Solid Waste Permit No. 79 is hereby amended as follows:

Change the City of San Angelo Landfill's bottom liner system from a 2 feet thick clay and 0.06 inches thick geomembrane composite liner to a 0.25 inches thick geosynthetic lay liner and 0.06 inches thick geomembrane composite liner.

The exact details of this request are explained in the letters from Mr. Kyle B. Combest, Consultant, dated October 15, 1998 and November 16, 1998.

The Type I municipal solid waste facility is located on the northeast side of the City of San Angelo, Texas, on Old Ballinger Highway, San Angelo Texas, Tom Green County.

This minor amendment is part of Permit No. MSW 79 and should be attached thereto.

Issued Date: JAN 15 1999

ATTEST:

A handwritten signature in cursive script, appearing to read "L. Anna C. [illegible]".

A handwritten signature in cursive script, appearing to read "Jeffrey A. Saitas".

For the Commission

Barry H. McBee, Chairman
 R. B. "Ralph" Marquez, Commissioner
 John M. Baker, Commissioner
 Jeffrey A. Saitas, Executive Director



WILL
 WILDE

TEXAS NATURAL RESOURCE CONSERVATION

November 12, 1998

Protecting Texas by Reducing and Preventing

Kyle B. Combest, Environmental Geologist
 Combest Geoscience
 706 Austin
 San Angelo, Texas 76903

Subject: Minor Permit Amendment: City of San Angelo MSW Landfill
 City of San Angelo
 Municipal Solid Waste-Tom Green County: Permit App. No. MSW 79

The TNRCC Municipal Solid Waste Division received a minor permit amendment application for the landfill completion plan on October 19, 1998 for the subject municipal solid waste facility. I have completed the review of the permit amendment application for the performance based liner design. The following are review comments and the technical issues that are needed to be addressed before the application is considered technically complete.

1. Correct the typographic error in Table 1.0.1 for proposed "scenario 5: Notes" as "chimneys not required."
2. Please sign and seal the cover page(s) of the section(s) of the document.
3. (§ 305.69)
Please demonstrate the equivalency of the proposed liner system to the existing liner system.
4. Please provide information about the distance between the groundwater and the deepest elevation of the proposed excavation(s).

If you have any questions regarding this letter, please contact Mr. Nevzat Turan, P.E. of Permits Division at MC-124, P.O. Box 13087, Austin, Texas 78711-3087, or (512)239-6681.

Sincerely,

Susan H. Janek
 Susan H. Janek, P.E. Section Manager
 Municipal Solid Waste Permits Section
 Permits Division

SHJ/NT:nt

cc: Permit Application File MSW-79
 TNRCC Region 8, San Angelo

Fax Transmittal Memo

To: Kyle Combest		From: Nevzat Turan	
Co.: Combest Geoscience		Co.: TNRCC/PERMITS	
Dept.:		Phone # (512) 239-6681	
Fax # (915) 655-4304		Fax # (512) 239-6600	

DMF14

Barry R. McBee, *Chairman*
R. B. "Ralph" Marquez, *Commissioner*
John M. Baker, *Commissioner*
Jeffrey A. Saitas, *Executive Director*



TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

Protecting Texas by Reducing and Preventing Pollution

December 1, 1998

Mr. Will H. Wilde, Director
Public Works Department
City of San Angelo
P.O. Box 1751
San Angelo, Texas 76902-1751

Re: Municipal Solid Waste, Tom Green County
City of San Angelo Type I Municipal Solid Waste Disposal Facility, MSW Permit No. 79
Change in Landfill Bottom Liner Design

Dear Mr. Wilde:

We have received a letter dated October 26, 1998, from Mr. Kyle Combest, regarding the above-referenced facility. Mr. Combest requests a change in the City of San Angelo Landfill's bottom liner system from a 2 feet thick clay and 0.06 inches thick geomembrane composite liner to a 0.25 inches thick geosynthetic lay liner and 0.06 inches thick geomembrane composite liner. The staff of the Municipal Solid Waste Permits Section have determined that the request requires a minor permit amendment, and you furnished us with an adjacent landowners list on November 15, 1998. Upon review, it has been determined that the requirements of our regulations have been met; therefore, we are forwarding your request to the TNRCC Office of the Chief Clerk for processing as a minor permit amendment. The Chief Clerk will be contacting you regarding final action on this matter.

If you have any questions regarding this matter, you may contact Mr. Nevzat Turan, P.E. of my staff at 512-239-6681. The Chief Clerk, LaDonna Castañuela, may be contacted at (512) 239-3300.

Sincerely,

A handwritten signature in black ink, appearing to read "Susan H. Janek".

Susan H. Janek, P.E., Manager
Municipal Solid Waste Permits Section
Permits Division

SHJ/NT:nt

Waste Program, TNRCC Region 8
Jean Doyle, MSW



3 S. Washington Street • San Angelo, Texas 76901

16 November 1998

TNRCC Municipal Solid Waste Division - Permits
P.O. Box 13087
Austin, Texas 78711-3087
Attn: Mr. Nezvat Turan MC-124

Subject: Subject: City of San Angelo MSWLF (Permit #79)
Tom Green County, Texas
Alternate liner request

Dear Mr. Turan:

As requested in the 12 November 1998 TNRCC letter, revisions have been made to the 15 October 1998 alternate liner demonstration for The City of San Angelo. The revisions can be summarized as follows:

- As shown in Table 1.0.1 for Scenario 5, "chimneys required" has been changed to "chimneys not required";
- Appropriate pages have been signed and sealed by a Registered Professional Engineer;
- Additional information demonstrating equivalency of the proposed liner system to the existing liner system has been added to Section 4.0 of the report;
- Information regarding the distance between the ground water and the deepest excavation has been added to Section 2.4.

Please replace pages in the original document (dated 15 October 1998) with the revised pages which are attached to this letter.

If you need additional information for reviewing this request, please let us know as soon as possible and we will promptly forward the information to you. Thank you.

Sincerely,

Kyle B. Combest
Geologist/Project Manager

attachments

xc: Will Wilde, P.E., City of San Angelo Public Works Director
Adam Hernandez, TNRCC Region 8
Lawrence Kennedy, Sr., Trashaway Service, Inc.
Ed Rhodes, Charter Waste



123 S. Washington Street • San Angelo, Texas 76901

October 15, 1998

TNRCC Municipal Solid Waste Division - Permits
P.O. Box 13087
Austin, Texas 78711-3087
Attn: Ms. Susan Janek MC-124

Subject: Subject: City of San Angelo MSWLF (Permit #79)
Tom Green County, Texas
Alternate liner request

Dear Ms. Janek:

The City of San Angelo is requesting approval for an alternate liner design at the MSWLF. Attached documents describe the proposed design and demonstrate that the design meets requirements in 30 TAC 330.202.

Attached documents include the following:

- An alternate liner demonstration which includes: (1) revised engineering drawings, (2) HELP model data and results, and (3) Multimed model data and results; and
- QA/QC requirements for the installation of geosynthetic clay liners (GCLs). After the QA/QC document is approved, it will become Attachment C to the SLQCP. The SLQCP can be found in Section 3 of the permit.

Plans are being made for construction of the next cell. If you need additional information for reviewing this request, please let us know as soon as possible and we will promptly forward the information to you. Thank you.

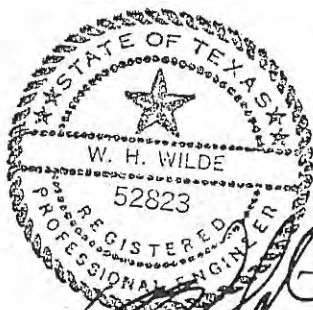
Sincerely,

Kyle B. Combest
Geologist/Project Manager

attachments

xc: Will Wilde, P.E., City of San Angelo Public Works Director
Adam Hernandez, TNRCC Region 8
Lawrence Kennedy, Sr., Trashaway Service, Inc.
Ed Rhodes, Charter Waste

ALTERNATE LINER DESIGN FOR THE
CITY OF SAN ANGELO MSWLF (Permit 79)
TOM GREEN COUNTY, TEXAS



November 18, 1998

**ALTERNATE LINER DESIGN DEMONSTRATION FOR
CITY OF SAN ANGELO MSWLF (Permit 79)
TOM GREEN COUNTY, TEXAS**

1.0 INTRODUCTION

The City of San Angelo is requesting approval for an alternate liner design at the MSWLF. The difference between the alternate design and the currently approved design is the use of a geosynthetic clay liner (gcl) rather than 2-ft of compacted clay. Both of these require the use of a flexible membrane to complete the liner. The overlying leachate collection system has various optional components, thus requiring the evaluation of 5 different scenarios (Table 1.0.1; Appendix A).

Table 1.0.1 Various design scenarios and components for liner and LCS.

Status	Scenario	Components	Notes
Approved	NA	1-ft protective cover ($k < 1.0E-04$ cm/sec) 1-ft granular drainage layer 2-ft compacted clay / fml	chimneys required clay: $k < 1.0E-07$ cm/sec
Approved	NA	1-ft protective cover ($k > 1.0E-04$ cm/sec) 1-ft granular drainage layer 2-ft compacted clay / fml	chimneys not required clay: $k < 1.0E-07$ cm/sec
Approved	NA	1-ft protective cover (shred, tires or shred. waste) 1-ft granular drainage layer 2-ft compacted clay / fml	chimneys not required clay: $k < 1.0E-07$ cm/sec
Proposed	1	2-ft protective cover ($k > 1.0E-04$ cm/sec) drainage net gcl/fml	chimneys not required $k < 5.0E-09$ cm/sec
Proposed	2	2-ft protective cover ($k < 1.0E-04$ cm/sec) drainage net gcl/fml	chimneys required $k < 5.0E-09$ cm/sec
Proposed	3	1-ft protective cover (shred, tires or shred. waste) 1-ft granular drainage layer gcl/fml	chimneys not required $k < 5.0E-09$ cm/sec
Proposed	4	2-ft protective cover ($k < 1.0E-04$ cm/sec) granular drainage gcl/fml	chimneys required $k < 5.0E-09$ cm/sec
Proposed	5	2-ft protective cover ($k > 1.0E-04$ cm/sec) granular drainage gcl/fml	chimneys not required $k < 5.0E-09$ cm/sec

The purpose of this document is to demonstrate that, by the use of these various designs, the concentrations listed in Table 1 of 30 TAC 330.200 will not be exceeded in the uppermost aquifer at the relevant point of compliance (POC). The POC is Monitoring Well 6R (Figure 1). To make these demonstrations, the following computer models were used: (1) the Hydrologic Evaluation of Landfill Performance model, and (2) the Multimedia Exposure Assessment model.

2.0 SITE DESCRIPTION

2.1 Location

The MSWLF is located near the northeastern edge of the City of San Angelo along Old Ballinger Highway. San Angelo is in the central part of Tom Green County in west-central Texas.

2.2 Physiography

The City of San Angelo is within the Concho River Valley which is bounded to the north, south, and west by the erosional edge of the Edwards Plateau. Three major streams have created the valley. These are the North Concho, Middle Concho, and South Concho. The three streams merge at San Angelo to form the Concho River.

The natural surface at the landfill slopes from the northwest to southeast at a very gradual dip of 10-ft to 12-ft per mile. Surface elevations range between 1870-ft and 1880-ft MSL in comparison to surface elevations throughout Tom Green County which range from 2,550-ft (SW corner of Tom Green County) to 1,650-ft (bed of Concho River at Tom Green-Concho County line).

2.3 Climate

The climate at San Angelo is classified as semi-arid even though the area does have some humid temperate characteristics (NFIC, 1987). Warm, dry weather predominates but rapid changes can occur with the passage of cold fronts. The summer is characterized by high temperatures, fair skies, south to southwest winds, and dry air (Table 2.3.1). Much of the rainfall occurs during thunderstorms with the heaviest rainfalls during April, May, June, September, and October. During the late summer months, particularly heavy precipitation may occur when tropical disturbances move inland from the Gulf of Mexico. The prevailing wind direction is from the south and winds can be persistent for several days. March and April are the windiest months.

Table 2.3.1. Summary of Climatic data.

MONTH	MEAN PRECIP. (in)	PEAK PRECIP. (in)	MEAN TEMP (deg F)	MAX TEMP (deg F)	MIN TEMP (deg F)	%HUMIDITY (hour 12)
January	0.87	3.85	45.40	58.50	32.20	53.00
February	0.88	2.86	49.50	63.20	35.80	49.00
March	0.92	5.00	57.10	71.60	42.60	44.00
April	1.88	5.10	65.80	79.90	51.80	43.00
May	2.92	7.10	73.30	86.40	60.30	48.00
June	2.01	5.82	80.80	93.20	68.40	49.00
July	1.88	7.21	83.60	96.10	71.00	43.00
August	1.99	8.13	83.10	95.70	70.50	45.00
September	2.88	11.00	76.10	88.30	63.90	54.00
October	2.28	6.59	66.30	79.10	53.40	53.00
November	1.14	3.55	54.30	67.40	41.20	52.00
December	1.01	2.70	47.40	60.40	34.30	51.00
Annual	20.45	NA	65.20	78.30	52.10	49.00

Notes: Precipitation records began in 1867. Monthly Precipitation peak between 1952-80. Temperature records began in 1907. Humidity records began in 1960.

2.4 Hydrogeology

The surface is formed on Quaternary-aged alluvium referred to as the Leona Formation. Commonly occurring at the base of the Leona is a gravel and clay zone that can yield ground water if a sufficient amount of gravel is present. This is the shallowest potential ground-water zone and is roughly 45-ft deep at the landfill. The Leona yields ground water in monitoring wells MW2, MW4, MW5, MW8, MW9, MW10, and MW11 (Figure 1). At MW6R and MW7R, the basal Leona does not yield ground water because the section is predominantly clay with only minor amounts of gravel (Figure 1).

Finally, underlying the Leona, is the Permian-aged Choza Formation. Fractured dolomite zones in the Choza can produce limited amounts of ground water as found in monitoring wells MW6R, MW7R, and in some of the local wells south of the landfill.

Ground-water levels typically range from 37-ft to 67-ft below natural grade. The landfill permit allows for disposal to 20-ft below natural grade, therefore any liner will be separated from the shallowest ground-water by 17-ft. Monitoring well MW2 is the most up-gradient well and is located at the northeast corner of the permitted area (Figure 1). Beginning at MW2 in the northeast corner, ground-water elevations indicate that the gradient is in a south-southwesterly direction (Figure 1). The gradient appears to flatten across the center of the site, then becomes more south-southeasterly.

To estimate hydraulic conductivity, slug tests were conducted at MW5 and MW6R on 05 December 1995. These wells were selected because they are the slowest recharging wells located along the southern border of the landfill. Water levels were measured at 1 minute intervals for a period of 30 minutes. Hydraulic conductivities were then calculated by using the Bouwer and Rice method (Bouwer and Rice, 1976). Hydraulic conductivity for MW5 was estimated at 0.48 ft/day with a transmissivity of 2.4 ft²/day. MW6R was 0.40 ft/day with a transmissivity of 2.8 ft²/day.

For additional information, the following documents further describe the landfill's soil, hydrogeologic, and hydraulic conditions: Combest (1991), Combest (1992), Combest (1995), and Combest (1996).

3.0 COMPUTER MODELS

The HELP model, developed by the US Army Corps of Engineers Waterways Experiment Station, was used to predict the amount of leachate that would be generated under various design scenarios (Table 1.0.1). The various scenarios included an active landfill with 10-ft of waste, and, a closed landfill with 40-ft of waste.

The MULTIMED model, developed by the EPA Athens Research Laboratory, was used to predict contaminant concentrations at the point of compliance. The point of compliance is MW6R (Figure 1). Important to the MULTIMED model are effects of attenuation and dilution along with fate and transport characteristics for each chemical. The critical factor that is calculated by the MULTIMED model is the dilution attenuation factor (DAF). According to the TNRCC alternate liner handbook, the DAF must be 260 or greater to ensure that constituent concentrations at the POC will not exceed the concentrations listed in Table 1 of 30 TAC 330.200.

Predictions from both models were obtained by using conservative input data. Please refer to Appendix B for input data descriptions for the HELP model and Appendix C for the MULTIMED model.

4.0 RESULTS

The DAF calculated for scenarios 3-5 was 1053 (Table 4.0.1; Appendix C). Calculations were not needed for scenarios 1 and 2 because the annual percolation was less for these scenarios than for scenarios 3-5 (Table 4.0.1). It should be mentioned again that conservative values were used for input data. As indicated by the HELP and MULTIMED models, the proposed scenarios will provide a sufficient barrier to leachate migration.

Table 4.0.1: Various design scenarios and model results.

Scenario	Description	Notes	Avg. Ann. Percolation	Max Head In & (cm)	Calc. DAF ¹	Critical DAF	Pass (Y/N)
1 (10ft waste) active	10-ft waste - Uncovered 2-ft protective cover ($k > 1.0E-04$ cm/sec) drainage net gcl/fml	chimneys not required $k < 1.0E-08$ cm/sec ²	0.0001 in	0.1 (0.254)	>1053	260	Y
1 (40ft waste) closed	fair grass and 6-in erosion layer fml and 18-in compacted clay 40-ft waste 2-ft protective cover ($k > 1.0E-04$ cm/sec) drainage net gcl/fml	chimneys not required $k < 1.0E-08$ cm/sec	0.0001 in	0	>1053	260	Y
2 (10ft waste) active	10-ft waste - Uncovered 2-ft protective cover ($k < 1.0E-04$ cm/sec) drainage net gcl/fml	chimneys required $k < 1.0E-08$ cm/sec	0.0001 in	0.1 (0.254)	>1053	260	Y
2 (40ft waste) closed	fair grass and 6-in erosion layer fml and 18-in compacted clay 40-ft waste 2-ft protective cover ($k < 1.0E-04$ cm/sec) drainage net gcl/fml	chimneys required $k < 1.0E-08$ cm/sec	0.0001 in	0	>1053	260	Y
3 (10ft waste) active	10-ft waste - Uncovered 1-ft protective cover (shred, tires or shred waste) 1-ft granular drainage layer gcl/fml	chimneys not required $k > 1.0E-02$ cm/sec $k < 1.0E-08$ cm/sec	0.0002 in	4.1 (10.4)	1053	260	Y
3 (40ft waste) closed	fair grass and 6-in erosion layer fml and 18-in compacted clay 40-ft waste 1-ft protective cover (shred, tires or shred waste) 1-ft granular drainage layer gcl/fml	chimneys not required $k > 1.0E-02$ cm/sec $k < 1.0E-08$ cm/sec	0	0	>1053	260	Y
4 (10ft waste) active	10-ft waste - Uncovered 1-ft protective cover ($k < 1.0E-04$ cm/sec) 1-ft granular drainage gcl/fml	chimneys required $k > 1.0E-02$ cm/sec $k < 1.0E-08$ cm/sec	0.0002 in	4.1 (10.4)	1053	260	Y
4 (40ft waste) closed	fair grass and 6-in erosion layer fml and 18-in compacted clay 40-ft waste 1-ft protective cover ($k < 1.0E-04$ cm/sec) 1-ft granular drainage layer gcl/fml	chimneys required $k > 1.0E-02$ cm/sec $k < 1.0E-08$ cm/sec	0	0	>1053	260	Y
5 (10ft waste) active	10-ft waste - Uncovered 1-ft protective cover ($k > 1.0E-04$ cm/sec) 1-ft granular drainage gcl/fml	chimneys not required $k > 1.0E-02$ cm/sec $k < 1.0E-08$ cm/sec	0.0002 in	4.1 (10.4)	1053	260	Y
5 (40ft waste) closed	fair grass and 6-in erosion layer fml and 18-in compacted clay 40-ft waste 1-ft protective cover ($k > 1.0E-04$ cm/sec) 1-ft granular drainage layer gcl/fml	chimneys not required $k > 1.0E-02$ cm/sec $k < 1.0E-08$ cm/sec	0	0	>1053	260	Y

¹ Critical DAF from Table 2 in TRCCC Alternate Design Handbook

² Used $1.0E-08$ for HELP Model even though the GCL is tested at $5.0E-09$. This is a more conservative assumption for the model.

To further demonstrate the adequacy of the proposed liner, the Darcy formula was used to calculate flow through time for the existing liner compared to the proposed liner. The FML was not included in this comparison because the FML is identical for both the existing liner and the proposed liner. Therefore, only the 0.25-in GCL and 24-in compacted clay were compared as shown below. The Darcy formula is:

$$Q = K \cdot A \cdot dh/dl$$

where:

Q is quantity of water per unit of time;

K is the hydraulic conductivity;

A is the cross-sectional area at a right angle to the flow direction; and

dh/dl is the hydraulic gradient

Assumptions were as follows:

24-in Clay liner

$$K = 1E-07 \text{ cm/sec}$$

$$A = 1\text{-cm}^2$$

$$dh = 10\text{-cm}$$

$$dl = 60.96\text{-cm (or 24-in)}$$

0.25-in GCL

$$K = 1E-09 \text{ cm/sec}$$

$$A = 1\text{-cm}^2$$

$$dh = 10\text{-cm}$$

$$dl = 0.635\text{-cm (or 0.25-in)}$$

Therefore:

$$Q = 1E-07\text{cm/sec} \cdot 1\text{cm}^2 \cdot 10\text{cm}/60.96\text{cm}$$

$$Q = 1.6404 \text{ E-08 cm}^3/\text{sec}$$

Therefore:

$$Q = 1E-09\text{cm/sec} \cdot 1\text{cm}^2 \cdot 10\text{cm}/60.96\text{cm}$$

$$Q = 1.5748 \text{ E-08 cm}^3/\text{sec}$$

A comparison of the flow rates (Q) shows that flow through the GCL is less than the compacted clay.

5.0 REFERENCES

Bouwer, H. and R.C. Rice, 1976, A slug test for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells. *Water Resources Research*, v. 12, no. 3, pp 423-428.

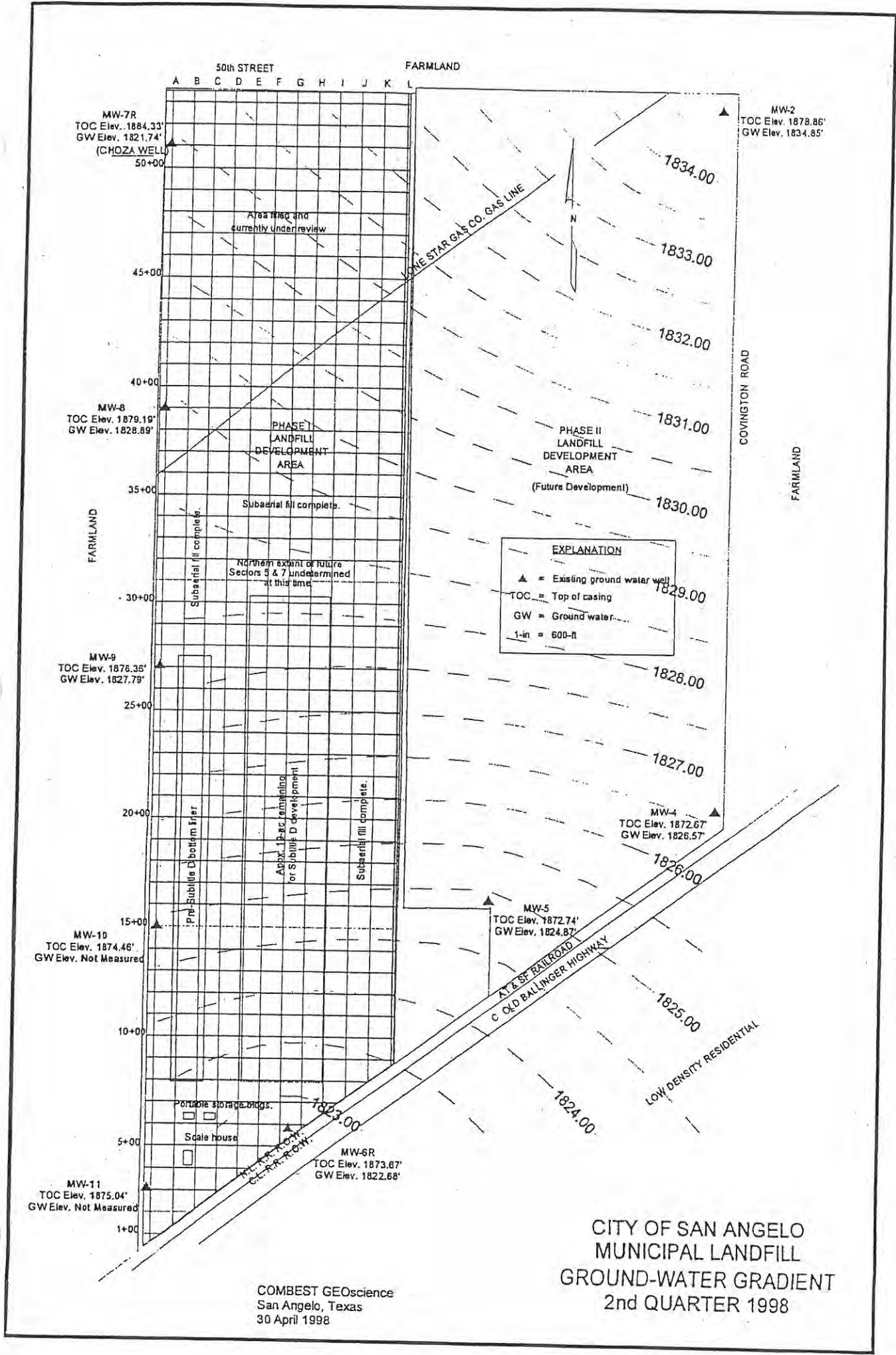
Combest, K.B., 1991, Review of hydrogeologic conditions and previous geotechnical activities at the San Angelo Municipal Landfill: Combest Geoscience, Austin, Texas, 15 pp, maps.

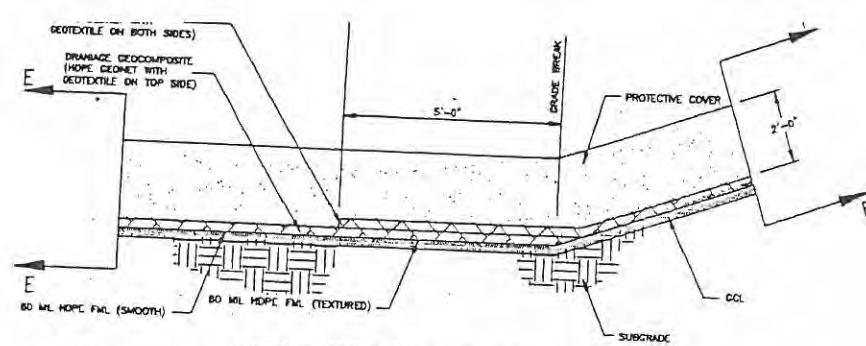
Combest, K.B., 1992, Improvement of the ground-water monitoring system and further review of hydrogeology at the San Angelo Municipal Landfill (Permit 79-A): Combest Geoscience, Austin, Texas, 41 pp., maps.

Combest, K.B., 1995, Phase I of ground-water remedial investigation and 1st quarter 1995 sampling results at the San Angelo MSWLF in Tom Green County (#79). Combest Geoscience, San Angelo, Texas.

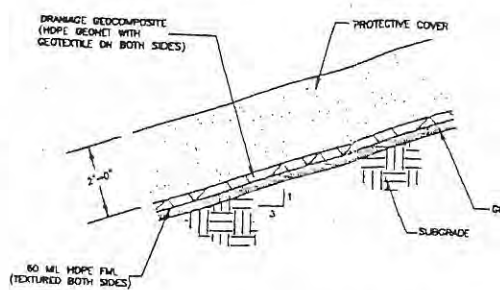
Natural Fibers Information Center (NFIC), 1987, The Climates of Texas Counties. University of Texas, Bureau of Business Research, Austin, Texas.

FIGURES

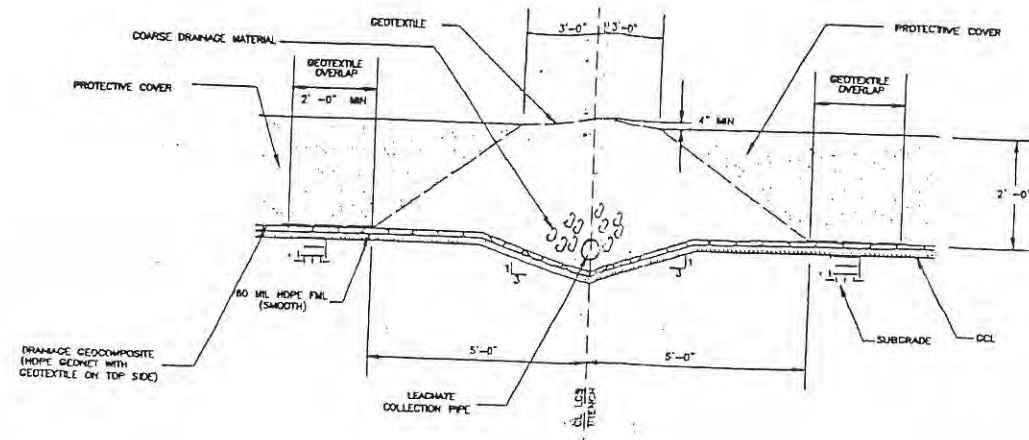




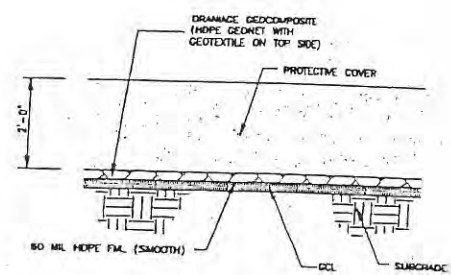
LINER TRANSITION AT SLOPE



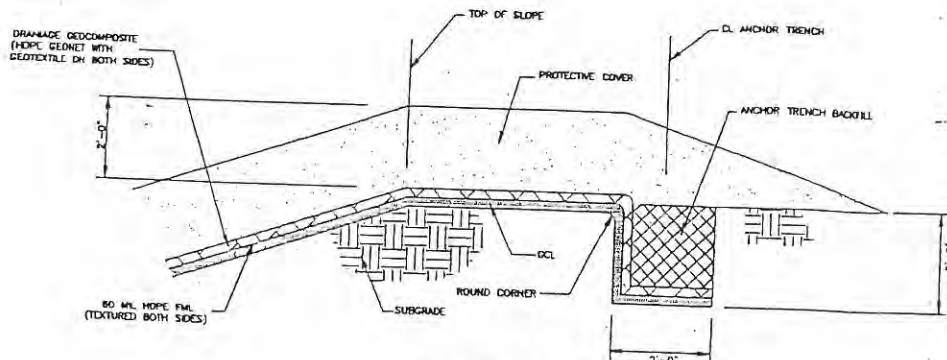
SECTION F-F
SIDEWALL LINER



LEACHATE TRENCH AND CHIMNEY



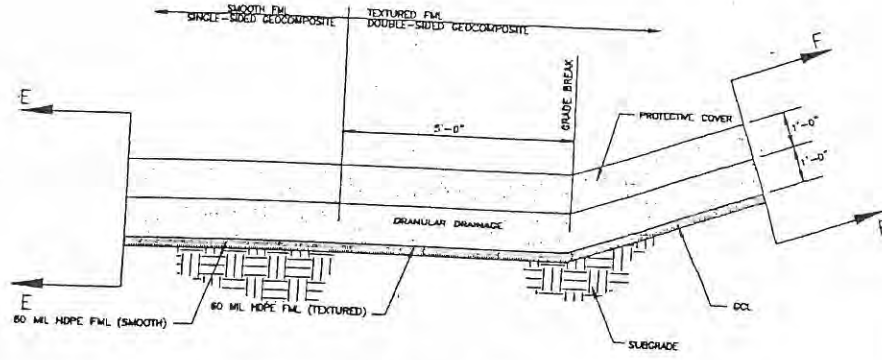
SECTION E-E
BOTTOM LINER



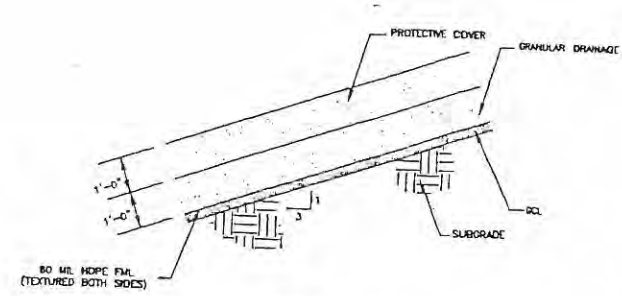
ANCHOR TRENCH

ALTERNATE DESIGN SCENARIO 2
2-ft cover soil ($k < 1.0E-04$)
drainage net
GCL/FML

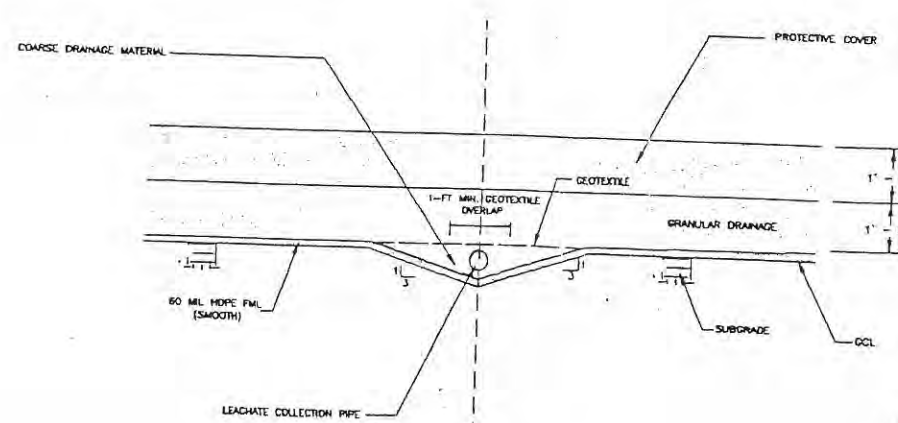
Note: chimneys required



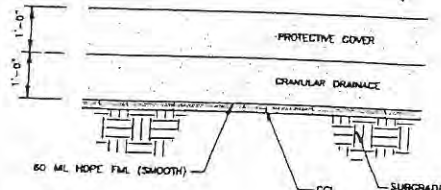
LINER TRANSITION AT SLOPE



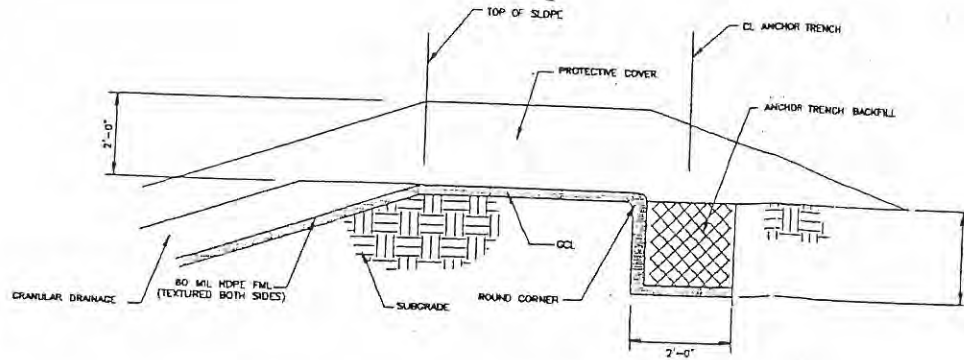
SECTION F-F
SIDEWALL LINER



LEACHATE COLLECTION TRENCH



SECTION E-E
BOTTOM LINER



ANCHOR TRENCH

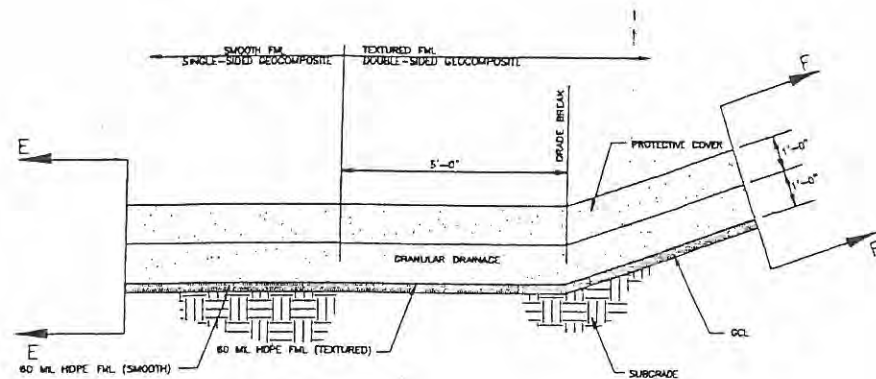
ALTERNATE DESIGN SCENARIO 3
1-ft protective cover (shred, tires or shred waste)
1-ft granular drainage ($k > 1.0E-02$ cm/sec)
GCL/FML

Note: chimneys not required

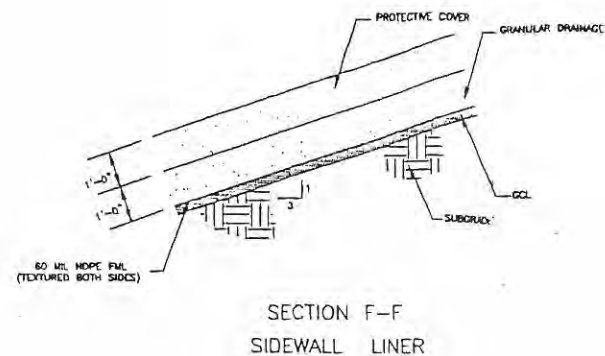


REVISION TABLE			
ITEM	DATE REVISED	DESCRIPTION	BY
1	10/12/98	Added alternate design	W.H.
2			
3			

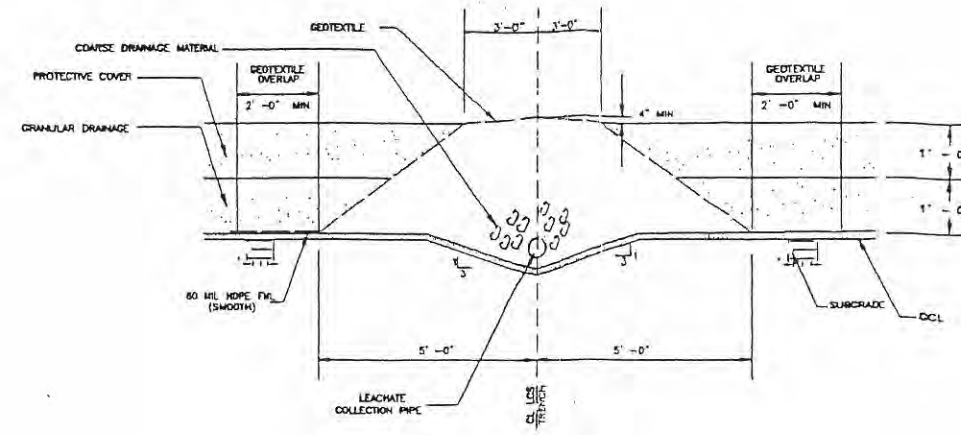
CITY OF SAN ANGELO
DEPARTMENT OF PUBLIC WORKS
1994 LANDFILL PERMIT MODIFICATION
LEACHATE COLLECTION PLAN



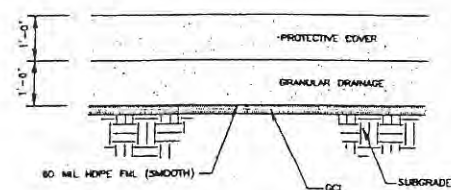
LINER TRANSITION AT SLOPE



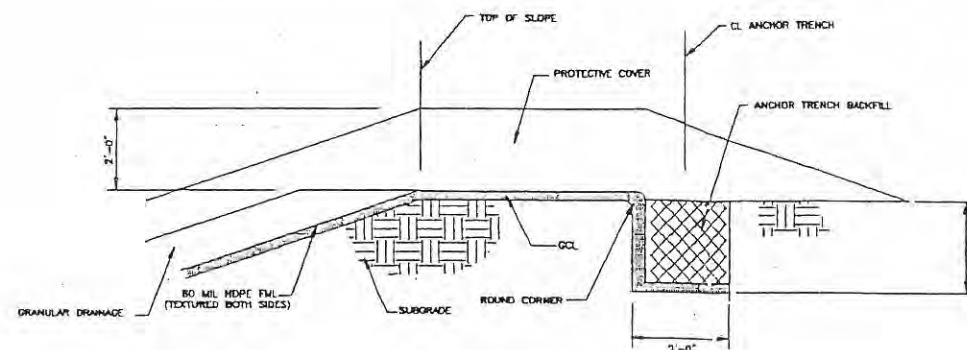
SECTION F-F
SIDEWALL LINER



LEACHATE TRENCH AND CHIMNEY



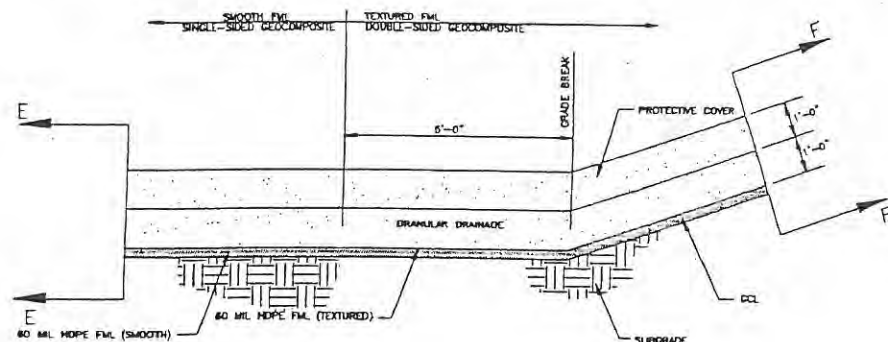
SECTION E-E
BOTTOM LINER



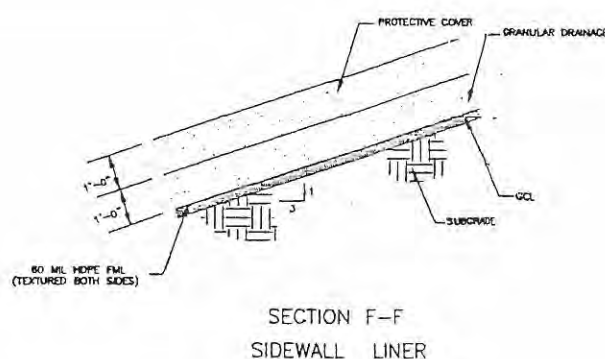
ANCHOR TRENCH

△
ALTERNATE DESIGN SCENARIO 4
1-ft protective cover ($k < 1.0E-04$ cm/sec)
1-ft granular drainage ($k > 1.0E-02$ cm/sec)
GCL/FML

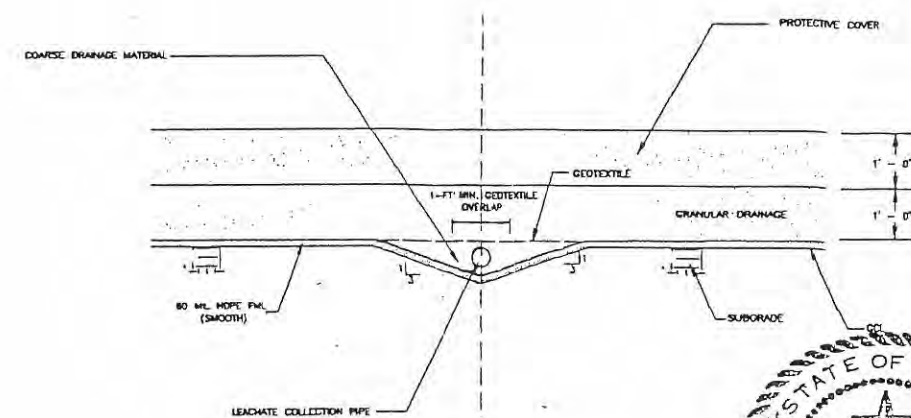
Note: chimneys required



LINER TRANSITION AT SLOPE



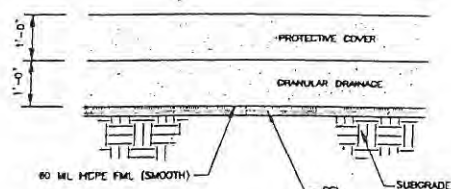
SECTION F-F
SIDEWALL LINER



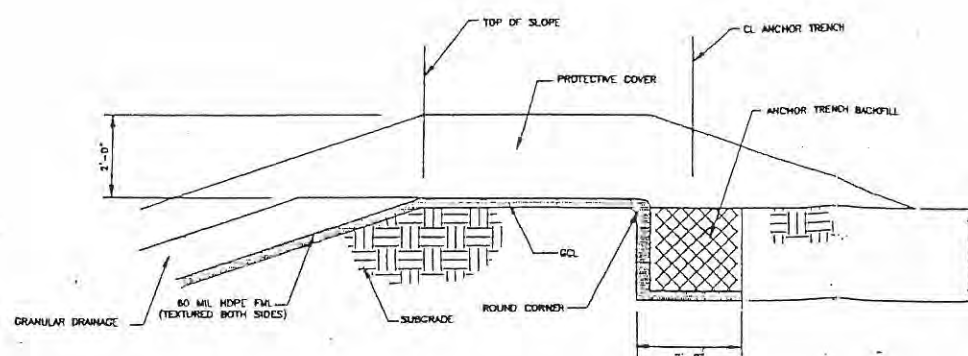
LEACHATE COLLECTION TRENCH

△
ALTERNATE DESIGN SCENARIO 5
1-ft protective cover ($k > 1.0E-04$ cm/sec)
1-ft granular drainage ($k > 1.0E-02$ cm/sec)
GCL/FML

Note: chimneys not required



SECTION E-E
BOTTOM LINER

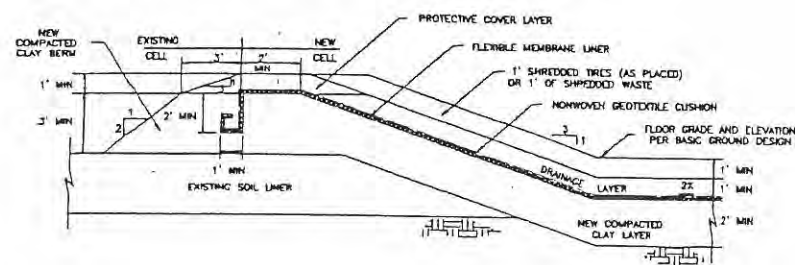


ANCHOR TRENCH

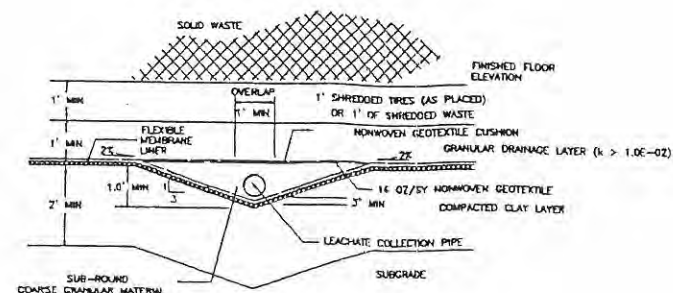


October 15, 1998

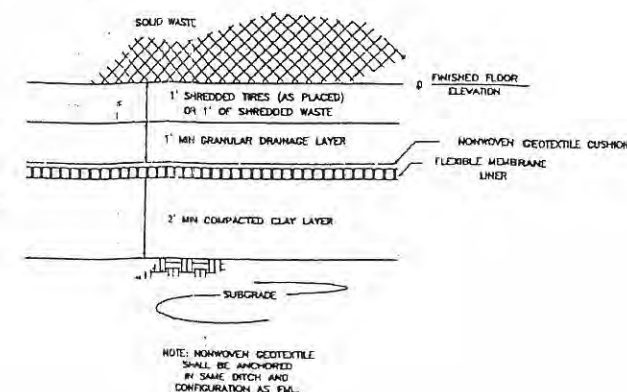
REVISION TABLE				CITY OF SAN ANGELO DEPARTMENT OF PUBLIC WORKS	
ITEM	DATE REVISED	DESCRIPTION	BY:	1994 LANDFILL PERMIT MODIFICATION	
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△					
△					



SECTION A-A
TYPICAL TIE-IN BERM

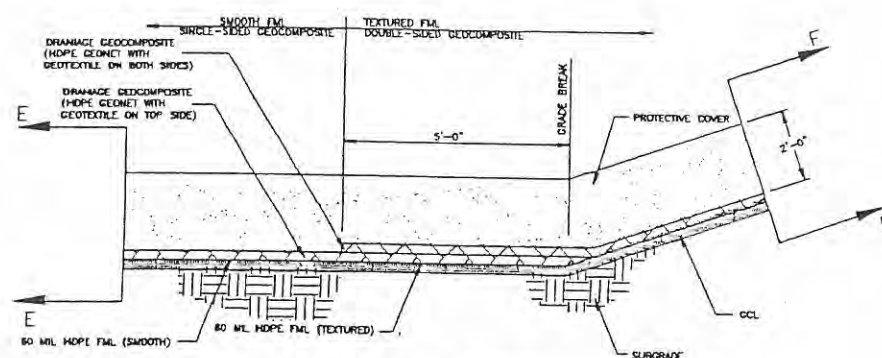


SECTION B-B
LEACHATE COLLECTION TRENCH

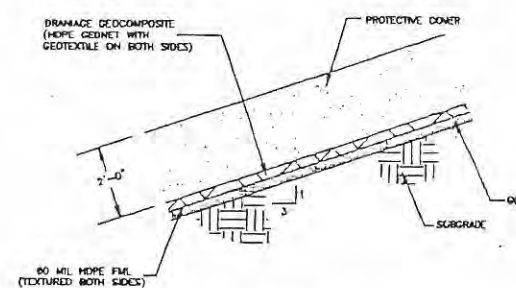


SECTION C-C
COMPOSITE LINER DETAIL

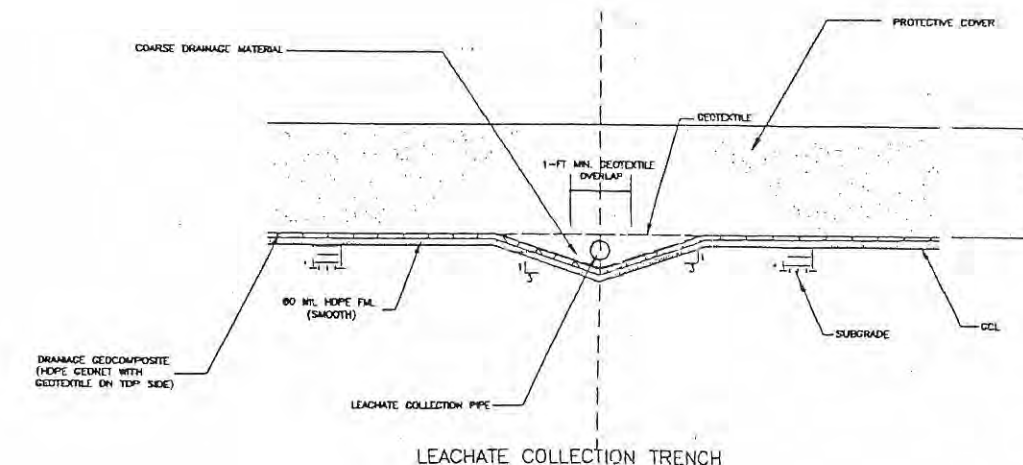
ALTERNATE DESIGN - APPROVED
1-ft shredded tires or shredded waste
1-ft granular drainage layer
FML
2-ft cloy ($k < 1.0e-07$ cm/sec)



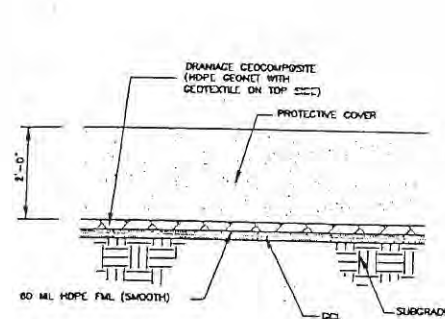
LINER TRANSITION AT SLOPE



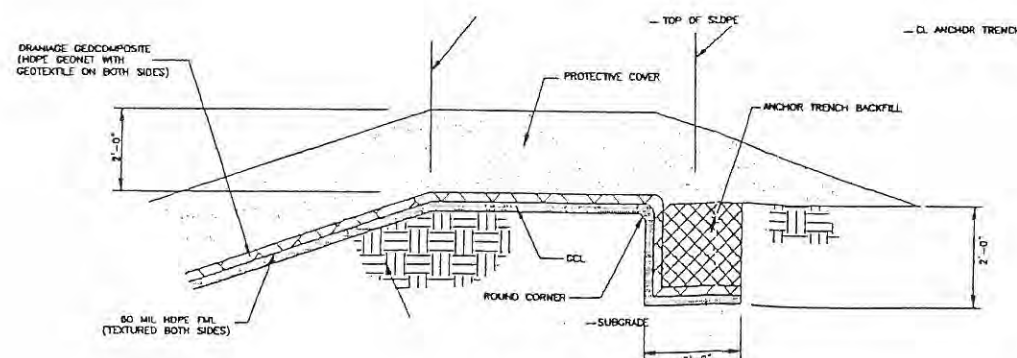
SECTION F-F
SIDEWALL LINER



LEACHATE COLLECTION TRENCH



SECTION E-E
BOTTOM LINER



ANCHOR TRENCH

ALTERNATE DESIGN SCENARIO 1
2-ft protective cover ($k > 1.0E-04$)
drainage net
GCL/FML

Note: chimneys not required



REVISION TABLE				CITY OF SAN ANGELO DEPARTMENT OF PUBLIC WORKS	
ITEM	DATE REVISED	DESCRIPTION	BY:	1994 LANDFILL PERMIT MODIFICATION	
1	4/11/98	Added alternate design	PAV	LEACHATE COLLECTION PLAN	
2	10/12/98	Deleted leachate collection trench with chimney detail	PAV	DWG. NO. 94-09 M-500	
3	10/12/98	Added alternate design	PAV		

Buddy Garcia, *Chairman*
Larry R. Soward, *Commissioner*
Bryan W. Shaw, Ph.D., *Commissioner*
Mark R. Vickery, P.G., *Executive Director*



TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

May 11, 2009

The Honorable J. W. Lown
Mayor of San Angelo
City of San Angelo
P. O. Box 1751
San Angelo, Texas 76902-1751

Re: City of San Angelo Landfill - Tom Green County
Municipal Solid Waste (MSW) – Permit No. 79
Permit Modification – 10-foot Height Increase
Tracking No. 12592510; RN102289576 / CN600251615

Dear Mayor Lown:

We have reviewed your application for a municipal solid waste permit modification dated February 20, 2008, and the revisions dated May 21, August 15, October 3, November 25, 2008, and January 27, 2009 regarding the above referenced MSW facility requesting a one-time ten-foot height increase and reduction in the limits of waste area north of the gas pipeline from 41.5 acres to 31.9 acres, creating a total waste disposal footprint of 225.2 acres. A Technically Complete package was received on February 16, 2009. The information presented is technically sufficient for a municipal solid waste permit modification.

Enclosed is a copy of the above referenced modification which is now part of your permit and should be attached thereto. The documentation prepared and submitted to support the modification request shall be considered as requirements of the permit.

If you have questions concerning this matter, please contact Ms. Gulay Aki at (512) 239-2340. When addressing written correspondence, please use Mail Code 124 (MC 124).

This action is taken under authority delegated by the Executive Director of the Texas Commission on Environmental Quality.

Sincerely,

A handwritten signature in dark ink, appearing to read "Richard C. Carmichael", is written over a faint, larger signature.

Richard C. Carmichael, Ph.D., P.E.
Manager, Municipal Solid Waste Permits Section
Waste Permits Division

RCC/GA/fp

cc: Mr. Kenneth J. Welch, P.E., Biggs & Mathews Environmental, Mansfield

Enclosure

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY



MODIFICATION TO MUNICIPAL SOLID WASTE PERMIT NO. 79 CITY OF SAN ANGELO LANDFILL

Municipal Solid Waste Permit No. 79 is hereby modified as follows:

Description of Change:

Modification of the Site Development Plan to revise the final contours and increase the maximum height of the landfill by 10 feet, from 1920 feet above mean sea level (ft-msl) to 1930 ft-msl, to improve surface water drainage and to reduce the limits of waste area north of the gas pipeline from 41.5 acres to 31.9 acres, creating a reduced total waste disposal footprint of 225.2 acres.

The details of this permit modification are contained in the application dated February 20, 2008, and the revisions dated May 21, August 15, October 3, November 25, 2008 and January 27, 2009. A Technically Complete package was received on February 16, 2009.

Part of Permit Modified:

Site Development Plan:

Attachment 2, Drawings 94-02, 94-03, 94-03A, 94-08, are revised.

Attachment 2, Drawings 94-03B, 94-03C, 94-03-D, 94-08A are added new.

Attachment 4, Run-on/Run-off Control Plan, Page 4-ii is revised.

Appendix 4A, Drainage Design Report is completely replaced. It contains the following:

Appendix 4A-A Drainage System Plans and Details

Appendix 4A-B Drainage Maps

Appendix 4A-C 10-foot Height Increase Hydrologic Calculations

Appendix 4A-D Final Cover Erosion Control Structure Design

Appendix 4A-E Perimeter Drainage Design

Attachment 5, Section 3.2.2, Estimate of Maximum Inventory Waste Ever on Site is revised.

Attachment 5.1, Landfill Completion Plan, Appendix 5D, Slope Stability Analysis is added new.

This modification is a part of Permit No. 79 and should be attached thereto.

APPROVED, ISSUED, AND EFFECTIVE in accordance with Title 30 Texas Administrative Code Chapter 305, Section (§)305.70(k)(2), §305.70(j)(13) and Chapter 330, §330.63(c), and §330.305 as effective prior to May 29, 2008.

ISSUED DATE:

MAY 04 2009

Mark V. Vike
For the Commission

Kathleen Hartnett White, *Chairman*
Larry R. Soward, *Commissioner*
H. S. Buddy Garcia, *Commissioner*
Glenn Shankle, *Executive Director*



TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

September 28, 2007

Mr. Ron Lewis
Public Works Director
City of San Angelo
P. O. Box 1751
San Angelo, TX 76902

Re: Municipal Solid Waste (MSW) – Tom Green County
City of San Angelo Landfill -- MSW Permit No. 79
Permit Modification – Subchapter G: Surface Water Drainage
WWC Numbers 11671218, 11801940, 11889924
RN102289576 / CN600251615

Dear Mr. Lewis:

We have received your application for a municipal solid waste permit modification dated March 22, 2007, and revisions dated July 9, 2007, and September 5, 2007 requesting to update the surface water drainage plans to address the requirements of Title 30 Texas Administrative Code (30 TAC) Chapter 330 Subchapter G for erosion and sedimentation controls. The information presented is technically sufficient for a municipal solid waste permit modification, and is approved with changes in accordance with 30 TAC Section (§)305.70(g)(1)(A).

Enclosed is a copy of the above referenced modification which is now part of your permit and should be attached thereto. The documentation prepared and submitted to support the modification request shall be considered as requirements of the permit.

If you have questions concerning this matter, please contact Mr. Harold Pearson, P.E. at (512) 239-4465. When addressing written correspondence, please use Mail Code 124 (MC 124).

This action is taken under authority delegated by the Executive Director of the Texas Commission on Environmental Quality.

Sincerely,

A handwritten signature in cursive script, reading "Richard C. Carmichael".

Richard C. Carmichael, Ph.D., P.E.
Manager, Municipal Solid Waste Permits Section
Waste Permits Division

RCC\HP\ft

cc: ✓ Mr. Kenneth J. Welch, P.E., Senior Engineer, Biggs & Mathews Environmental, Mansfield

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY



MODIFICATION TO MUNICIPAL SOLID WASTE PERMIT NO. 79 CITY OF SAN ANGELO LANDFILL

Municipal Solid Waste Permit No. 79 is hereby modified as follows:

Description of Change:

The permit application is revised to comply with Title 30 Texas Administrative Code (30 TAC) Chapter 330 Subchapter G regarding erosion and sedimentation controls.

The details of this permit modification are contained in the application submittals dated March 22, 2007 and the revisions dated July 9, 2007, and September 5, 2007.

Part of Permit Modified:

- Part III Site Development Plan Attachment 4 (Run-On/Run-Off Control Plan) - Cover Sheet and page ii
- Add Appendix 4B to Attachment 4 (Erosion and Sediment Control Plan)

The permit modification includes the following conditions:

- On Page ii in Attachment 4 the following paragraph is added under the heading Attachment 4B – Erosion and Sedimentation Control Plan:

"The selection of stormwater management control structures will be a continual evolution during operation and closure of the landfill. Changes to the stormwater management controls as described or depicted in the approved application materials may require a permit modification or amendment in accordance with 30 TAC Chapter 305."

• At the bottom of page 4B-1 in Appendix 4B, Attachment 4, the following text is deleted,

"Therefore, temporary erosion control structures may need to be installed on existing intermediate cover areas to control erosion and minimize soil loss if these existing intermediate cover areas have less than 60% vegetative coverage. However, existing intermediate cover areas that have existing well established vegetation (at least 60% coverage) will not be disturbed to construct temporary erosion control features."

and is replaced by the following text,

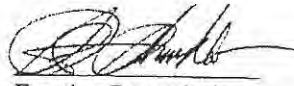
"At least 60% vegetative coverage must be established on existing intermediate cover areas. Temporary erosion control structures as depicted in Attachment 4, Appendix 4B must be constructed and installed on existing intermediate cover areas to control erosion and minimize soil loss.

This modification is a part of Permit No. 79 and should be attached thereto.

APPROVED, ISSUED, AND EFFECTIVE in accordance with 30 TAC Section (§)305.70(l), §305.70(g)(1)(A), and Chapter 330 Subchapter G.

ISSUED DATE:

SEP 28 2007


For the Commission

Robert J. Huston, *Chairman*
R. B. "Ralph" Marquez, *Commissioner*
Kathleen Hartnett White, *Commissioner*
Jeffrey A. Saitas, *Executive Director*



TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

Protecting Texas by Reducing and Preventing Pollution

December 10, 2001

Mr. W. H. Wilde
San Angelo Director of Public Works
P.O. Box 1751
San Angelo, Texas 76092

Re: Municipal Solid Waste - Tom Green
City of San Angelo Landfill - Permit No. MSW 79
Class I Modification - Revise Final Grading Plan for Drainage Improvements
Mail Log No. 02-483

Dear Mr. Wilde:

Enclosed is a copy of the above-referenced permit modification for a municipal solid waste facility issued pursuant to Chapter 361, Texas Health and Safety Code. The documentation, including the application, prepared and submitted to support the modification request shall be considered a part of this permit and shall be considered as operational requirements of this permit.

If you have any questions concerning this letter or if we may be of any assistance to you regarding municipal solid waste, you may contact Mr. Pladej "Hunt" Prompuntagorn, at MC-124, P.O. Box 13087, Austin, Texas 78711; telephone number (512) 239-1191.

Sincerely,

A handwritten signature in black ink, appearing to read "Jerry Alfred".

Jerry Alfred, Manager
MSW Permits Section
Waste Permits Division

JDA/php

Enclosure

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION



MODIFICATION TO
MUNICIPAL SOLID WASTE PERMIT N° MSW-79

City of San Angelo Landfill

Municipal Solid Waste Permit No. MSW-79 is hereby modified as follows:

Description of Changes: The City of San Angelo Landfill is approved for the proposed changes to the Final Grading Plan for drainage improvements. The proposed changes are delineated in a revised version of the request, dated November 8, 2001, prepared by Mr. W. H. Wilde, the City of San Angelo's Public Works Director.

Permit Sections Revised: Site Development Plan - Final Grading Plan

This modification is a part of Permit No. MSW-79 and should be attached thereto.

APPROVED, ISSUED, AND EFFECTIVE in accordance with 30 Texas Administrative Code Sections 305.70(g)(20).

ISSUED DATE: DEC 10 2001

A handwritten signature in black ink, appearing to read "Jeffrey A. Smith".

For the Commission

**SAN ANGELO LANDFILL
TOM GREEN COUNTY, TEXAS
TCEQ PERMIT NO. MSW 79**

PART III

**SITE DEVELOPMENT PLAN
ATTACHMENT 4
RUN-ON/RUN-OFF CONTROL PLAN**

Prepared for

CITY OF SAN ANGELO

Technically Complete February 2009



Prepared by

BIGGS & MATHEWS ENVIRONMENTAL

1700 Robert Road, Suite 100 ♦ Mansfield, Texas 76063 ♦ 817-563-1144

TEXAS BOARD OF PROFESSIONAL ENGINEERS
FIRM REGISTRATION NO. F-256

TEXAS BOARD OF PROFESSIONAL GEOSCIENTISTS
FIRM REGISTRATION NO. 50222

CONTENTS

Attachment 4 – Run-On/Run-Off Control Plan

The Attachment 4 – Run-On/Run-Off Control Plan was prepared by the City of San Angelo, dated March 31, 1994. A permit modification was prepared by the City of San Angelo which revised the Final Grading Plan on November 8, 2001. This permit modification was approved on December 10, 2001.

Appendix 4A – Drainage Design Report

Appendix 4A – Drainage Design Report was originally prepared by the City of San Angelo dated November 8, 2001. This permit modification was approved in accordance with 30 TAC §305.70(g)(20), dated December 10, 2001. This appendix has been replaced with an entirely new appendix which evaluates the drainage design of the 10-foot height increase landfill configuration consistent with the requirements of 30 TAC Chapter 330 Subchapter G. Appendices 4A-A through 4A-E have been prepared by Biggs and Mathews Environmental, Inc., dated February 2008, revised May 2008, revised August 2008, revised October 2008, and revised January 2009.

Appendix 4B – Erosion and Sedimentation Control Plan

Appendix 4B – Erosion and Sedimentation Control Plan is a new appendix that addresses the requirements of Subchapter G: Surface Water Drainage as related to the provisions for erosion and sediment controls during all phases of landfill development per §330.305(d) and §330.305(e)(2). Appendix 4B – Erosion and Sediment Control Plan has been prepared by Biggs and Mathews Environmental, Inc., dated September 2007. This appendix was approved as a permit modification by TCEQ on September 28, 2007.



The City Of

San Angelo, Texas

P. O. Box 1751 - Zip 76902



March 31, 1994

Ms. Susan Janek
Texas Natural Resource Conservation Commission
Municipal Solid Waste Division
P.O. Box 13087, Capitol Station
Austin, TX 78711-3087

RE: City of San Angelo, Permit #79
Runon/Runoff Control Plan
Leachate & Contaminated Water Plan
Soil & Liner Quality Control Plan

Dear Ms. Janek:

The City of San Angelo hereby submits for your review the enclosed Runon/Runoff Control Plan, the Leachate & Contaminated Water Plan, and the Soil & Liner Quality Control Plan for the above referenced facility. These plans are being submitted as required to modify the permit for the Subtitle "D" requirement.

Please contact me at 915 657-4206 if you have any questions.

Sincerely,

W. H. Wilde
Public Works Director

xc: Kyle Combest, Combest GeoScience
Trashaway, Inc.
Adam Hernandez, TNRCC Region 8

RUNON / RUNOFF CONTROL PLAN
FOR THE SAN ANGELO MUNICIPAL
SOLID WASTE LANDFILL (PERMIT #79)



March 31, 1994

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