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SAN ANTONIO REGION

GEOLOGIC ASSESSMENT  
FOR  
REGULATED ACTIVITIES

COUNTY ENGINEER

ON THE EDWARDS AQUIFER RECHARGE/TRANSITION ZONES  
AND RELATING TO 30 TAC §213.5(b)(3), EFFECTIVE DECEMBER 27, 1996

PROJECT NAME: Harmon Ranch, 1500 Acres, East of Highway 306,  
Comal County, Texas

TYPE OF PROJECT:  WPAP  AST  SCS  CST

PROJECT INFORMATION

Project is on the:  Recharge Zone  Transition Zone  Both

Recharge Zone Boundary:

- The Recharge Zone boundary is located on-site. This Geologic Assessment includes a description of the geologic or manmade features identified on-site.
- The Recharge Zone boundary is located within the downgradient area.
- The Recharge Zone boundary is not located within the downgradient area.

2. 100-year floodplain boundaries:

- The 100-year floodplain is located on-site. This Geologic Assessment includes a description of the geologic or manmade features identified on-site and within the 100-year floodplain downgradient of the site for a distance of one-half mile or to the Recharge Zone boundary, whichever is less.
- The 100-year floodplain is located downgradient of the site within a distance of one-half mile or the Recharge Zone boundary, whichever is less. This Geologic Assessment includes a description of the geologic or manmade features identified on-site and within the 100-year floodplain downgradient of the site for a distance of one-half mile or to the Recharge Zone boundary, whichever is less.
- No part of the area downgradient of the site is located within the 100-year floodplain. This Geologic Assessment includes a description of the geologic or manmade features identified on-site.



**STRATIGRAPHIC COLUMN**

<b><u>STRATIGRAPHIC FORMATION</u></b>	<b><u>THICKNESS</u></b>	<b><u>DESCRIPTION</u></b>
Edwards Limestone - Person Formation	160 to 214 ft	Upper unit includes a hard, dense, recrystallized limestone; mudstone; and rudistid biomicrite. Middle unit includes recrystallized leached limestone and burrowed mudstone and wackestone, highly leached in places, vuggy, with solution breccias, honeycombed. The lower unit consists of shaley to wispy, dense limestone and mudstone.
Edwards Limestone - Kainer Formation	260 to 310 ft	Upper unit includes dense, tightly cemented miliolid grainstone; with patches of mudstone to wackestone, The upper middle unit includes highly altered crystalline limestone and chalky mudstone with chert nodules and lenses; The lower middle unit includes dense crystalline limestone with occasional zones of grainstone and layers of variably burrowed mudstone; The lower unit includes a marly, nodular limestone and some miliolid grainstone.
Glen Rose Formation	900 ft.	Limestone, dolomite and marl as alternating resistant and recessive beds forming staircase topography.

## SITE GEOLOGY NARRATIVE

The following discussion is a site-specific assessment of existing geological conditions and potential recharge features within Harmon Ranch, Comal County, Texas. This project site consists of approximately 1500 acres located east of Highway 306. The Harmon Ranch is bounded by Highway 306, to the east, by barbed wire fence, to the north, south, and southwest, and by the Guadalupe River, to the northwest. The boundaries of this site, as presented on the Site Geological Map was determined by field observations and fence line markers on the topographic map provided by Pro-Tech Engineering Group.

As indicated by topographic contours provided on Plate 1, the predominant direction of surface runoff across the northern portion of the site is to the northwest along minor drainages that eventually intersect Deep Creek. Deep Creek is an ephemeral surface water body that flows to the southwest and drains into the Guadalupe River. Surface runoff for the southern portion of the site flows toward the southwest along minor drainages that eventually intersect Isaac Creek. Isaac Creek is also an ephemeral surface water body that flows to the Guadalupe River.

One hundred and eighteen potential recharge features were identified on the site. These features include closed depressions, fractured rock outcrops/zones, vuggy rock outcrops/zones, solution cavities, solution cavity zones, fault zones, man-made features, and man-made zones. The significance of potential recharge features or feature areas was assessed using definitions and guidance provided in Instruction to Geologists (TNRCC-0586). All features within site and downgradient areas that meet the criteria presented in this reference were mapped. The characteristics of all features and the assessments of these features, as defined by the TNRCC, are presented in the attached Geologic Assessment Tables (TNRCC-0629).

### Stratigraphy

As presented on the attached Stratigraphic Column, information pertaining to the lithologies of outcropping geologic units located on and downgradient of the site was taken from Hanson and Small (1994), in conjunction with field observations. As shown on the Site Geologic Map, three geologic formations were observed within site boundaries.

The Kainer Formation comprises the majority of the site and downgradient areas except for higher elevations and the northwest corner of the site in Deep Creek. The Kainer Formation is a member of the Edwards Limestone Group and consists primarily of recrystallized limestones and mudstones. The Kainer Formation is commonly divided into four members: (i) Grainstone member; (ii) Kirschberg evaporite member; (iii) Dolomitic member; and (iv) Basal nodular member. According to Hanson and Small (1994), all four members outcrop on the project site, however only the Kirschberg evaporite member was conclusively identified during field reconnaissance. This member is an extremely vuggy, crystalline limestone with common to abundant chert nodules.

The Person Formation comprises the center portion of the site. (Site Geologic Map). The Person Formation is a member of the Edwards Limestone and consists primarily of 60 to 90 ft. of recrystallized limestones, leached limestones, and mudstones. The Person Formation is

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commonly divided into three separate units: (i) Cyclic/Marine member; the upper unit consists of a hard, dense recrystallized limestone and mudstone; (ii) Leached/Collapsed member; the middle unit includes leached limestone which commonly exhibit moldic porosity, burrowed mudstone, and solution breccias; and (iii) Regional/Dense member; the lower unit consists of shaley limestones and dense mudstone. The upper or Cyclic/Marine member of the Person Formation was found to represent the Edwards Limestone exposed on the site. Based upon the work of Maclay (1995), this unit contains many open fractures and possesses low matrix permeability with total porosity on the order of 5 to 10%.

The Glen Rose formation comprises the northwest corner of the project site in Deep Creek. The Glen Rose Formation is a limestone, dolomite, marl as alternating beds of recessive and resistant layers forming a stair-step topography. The Glen Rose is considered to be the lower confining unit of the Edwards aquifer.

### Structure

These site and downgradient areas are located within the Balcones Fault Zone and as such possess a distinct structural trend. This zone consists of a northeast trending, *en echelon* normal fault system, which juxtaposes Upper Cretaceous lithologies in the southeast with Lower Cretaceous lithologies in the northwest. As a result of this larger-scale, regional faulting, minor internal fault sequences and fractures exist within this zone, which follow the same structural trend and accommodate localized displacement. The site lacked distinct structural surface expressions.

### Fault Zones

As indicated on the Site Geological Map, one normal fault zone (S-13) was identified. The location of this feature was identified from published geological references in conjunction with field observations. The strike of this fault zone is oriented along the northeast/southwest structural trend. Feature S13 is located within the Glen Rose formation. Based upon the criteria presented in TNRCC-0629, it appears that this fault zone does not represent a sensitive recharge feature because it lies stratigraphically and topographically below the Edwards Group.

### Fractured Rock Outcrops / Fractured Rock Zones

The fractured rock outcrops and fractured rock zones were identified at the site as per the qualifications presented in TNRCC-0586. All of the outcrops, which were observed to be aerially extensive and laterally discontinuous, were classified as Fractured Rock Zones. As with the fault zone, it was observed that the majority of these features follow a northeast/southwest orientation as governed by prevailing structural controls within the Balcones Fault Zone. Fractured rock outcrops/zones are located predominantly along drainages within exposures of the Kainer Formation.

### **Karstic Characteristics**

Numerous potential recharge features were identified within the site boundaries that may be

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attributed to karstification of the limestone terrain. These features, some of which may be structurally controlled, include solution cavities, solution cavity zones, vuggy rock outcrops/zones, and closed depressions. The most common location of some of these features were found along the very steep slopes (wall) of the western portion of the site.

#### Caves / Cave Zones

No caves or cave zones were identified on the project site.

#### Sinkholes

Two sinkholes were identified on the project site. Feature S-2 was located in the streambed of the westernmost branch of Deep creek. The feature is partially enclosed by alluvium though water was not observed at the time of field reconnaissance. The feature appears to have been enhanced by scour from surface runoff. This feature was ranked as sensitive, having high potential for transmitting fluids to the Edwards Aquifer.

Feature S-98 was identified in the drainage located on the northwest portion of the project site. The feature contained coarse infilling and was ranked as potentially sensitive, having high potential for recharge.

#### Solution Cavities / Solution Cavity Zones

Several solution cavities were identified within site boundaries. The majority of these features are located within vuggy rock zones or within the streambeds and the latter are believed to be associated with the dissolution of limestone within ephemeral streambeds

~~Five~~ <sup>5</sup> solution cavity zones were identified within the site area along the drainages on the north and south regions as well as within a vuggy rock zone, Features S-54A and F-54B, located on the eastern side of the site, along Isaac Creek. Zones located in the drainages contained solution cavities, which are oriented horizontally along bedding planes. Cavities ranged from 1 to 10 feet in length, 1 to 3 feet high, and 1 to 3 feet deep. Solution cavities located within the vuggy zone were oriented randomly and were generally 1 to 2 feet in diameter.

~~Three~~ solution cavity zones were identified within the downgradient area of the site along the 100-year floodplain of the Isaac Creek (Downgradient Geologic Map). Individual features within the zones were generally oriented horizontally along bedding planes. Cavities ranged from 1 to 10 feet in length, 1 to 3 feet high, and 1 to 3 feet deep. These features are ranked as sensitive, having moderate to high potential of transmitting fluids to the Edwards Aquifer.

#### Vuggy Rock Outcrops / Vuggy Rock Zones

Based upon field observations, ~~twenty-two~~ <sup>Several</sup> vuggy rock outcrops were identified at the site as per the qualifications presented in TNRCC-0586. ~~Of these, thirteen outcrops that were observed to be aerially extensive and laterally discontinuous were classified as Vuggy Rock Zones.~~ The majority of these outcrops appeared to be comprised of high to moderate density, moderate to large diameter vugs, infilled with fine-grained materials.

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Three vuggy rock zones (A-11 and A-20 through A-23) were identified within downgradient drainage area assessed during this investigation (Downgradient Geologic Map). These features are ranked as potentially, having high potential of transmitting fluids to the Edwards Aquifer.

#### Closed Depressions

Numerous man-made closed depressions associated with tree uprooting during predevelopment activities were observed on the project site. These areas are typically located on the ridges on the north end of the project site and were included in Feature S-118. The depressions ranged from 1 to 5 feet in diameter and are 0.5 to 2 feet deep. All of these features contained fine-grained infilling. These features are classified as not sensitive, having a low potential for recharge.

Numerous natural closed depressions were observed in the drainages. The features were the result of scour from surface runoff. These features are classified as not sensitive, having a low potential for recharge.

Two man-made closed depressions were identified on the project site. Both depressions are water retention structures and used as stock tanks. Both features were observed to hold water during the time of field reconnaissance and therefore, these features are classified as not sensitive, having a low potential for recharge.

As shown on the Downgradient Geologic Map, twenty closed depressions were identified within the downgradient drainage areas associated with this site. The majority of features, located within the Isaac Creek 100-year floodplain, were typically infilled with fine-grained materials. Based upon TNRCC-0586 criteria and professional judgment, all closed depressions within the 100-year flood plain were ranked as being not sensitive recharge features, having high potential of transmitting fluids to the Edwards Aquifer.

#### **Man-Made Features**

As shown on the Site Geologic Map, five man-made features were identified within site boundaries that may serve to enhance the transmission of surface runoff into the Edwards Aquifer. Features S-20, S-51, and S-52 are 1-ft diameter exploratory holes. The depth to which these features extend into the subsurface is unknown and it is unknown whether the bases of these borings are plugged with impermeable material such as concrete. Assuming these features to be unplugged, they were classified as sensitive, having high potential for transmitting fluids into the Edwards Aquifer.

Feature S-21 is an agricultural water well located on the project site. The depth and condition of this well is unknown. It is also unknown whether this well is still operational. Since this well has not been properly abandoned, it was classified as sensitive, having high potential for transmitting fluids into the Edwards Aquifer.

Feature S-118 is a man-made zone consisting of all roads and recently cleared areas. The zone contains numerous closed depressions associated with uprooting of trees. Closed

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depressions within the roads are formed by vehicle traffic. Individual features within the zone are classified as not sensitive, however due to the numerous feature types, density of the features and the large aerial extent of the zone, the feature as a whole has been classified as potentially sensitive, having moderate potential for transmitting fluids to the Edwards Aquifer.

### Additional Comments Site Location

- S-1 Discontinuous fractured vuggy rock zone. Density, aperture, and infilling varies across feature but generally zone is high density, large aperture with fine-grained infilling. Areas near cliffs lacked any infilling. Vugs generally appear to be interconnected but varied with density. The contact of this zone was estimated in some areas on the north end due to inaccessibility of the area.
- S-2 Feature is a large sinkhole that may have been enhanced by scour due to surface runoff. The feature appears to be able to hold approximately three feet of water due to a depression formed by alluvium at the mouth of the sinkhole.
- S-3 Solution cavities were present in the walls and the bottom of the stream channel and are the result of scour from surface runoff. Several solution cavities were present as stair step features in the channel due to severe scour. These features may have been collapse features but there is no evidence remaining to justify this conclusion.
- S-4 Closed depression formed due to scour from surface runoff. Water was noticed in the depression however, field reconnaissance was performed shortly after a rain event.
- S-5 Same as S-3.
- S-6 - S-7 Same as S-4.
- S-8 Same as S-3.
- S-9 - S-11 Same as S-4.
- S-13 Fault zone is mapped according to published fault in Deep Creek. (Small, 1994). Numerous closed depressions, holding water, and solution cavities were observed during field reconnaissance, however since this zone lies in the Glen Rose formation, recharge potential is low.
- S-14 Man-made closed depression formed by automobile tires.
- S-14 Man-made roads which contain numerous closed depressions due to clearing activities.
- S-15 Man-made closed depression formed by the uprooting of a tree.
- S-16 through S-19:  
Same as S-14.
- S-20 Feature is an approximately 8-in diameter exploratory borehole. This feature was observed to be partially capped with limestone cobbles. This feature may serve as a conduit for the vertical migration of fluids during precipitation / runoff events.

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**Additional Comments**  
**Site Location**  
(Features S-21 - S-40)

- S-21 Feature is approximately 1-ft diameter active water well. This feature is associated with a windmill, water tank, and pumping apparatus located immediately adjacent and is presumed to have been used historically to supply water for domestic/stock purposes. To the extent that the surface completion may have been degraded through time, this feature may potentially serve as a conduit for the vertical migration of fluids during precipitation / runoff events.
- S-25 Man-made water retention feature for livestock. Feature contained water at the time of field reconnaissance.
- S-29 Same as S-25.
- S-30 Feature is a natural closed depression. No water was observed in the depression at the time of the field reconnaissance. The cause of the depression is unknown.
- S-31 Same as S-3.
- S-33 through S-35:  
Natural closed depression formed by scour due to surface runoff. No water was observed in the depressions.
- S-38 Same as S-33.
- S-40 through S-42:  
Same as S-33
- S-44 Same as S-33
- S-48 Same as S-33
- S-49 Man-made closed depression formed by excavation of soils.
- S-50 Natural closed depression formed by the uprooting of a tree.
- S-51 Same as S-20.
- S-52 Same as S-20.

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**Additional Comments**  
**Site Location**  
(Features S-54 - S-98)

- S-54A Although vugs were the predominant feature identified, numerous solution cavities showing evidence of channelized solutioning were also observed. Vugs were observed to be interconnected in some instances. The designated zone contains numerous scattered vuggy rock outcrops on the order of 20 by 30 feet. Hence, the numerous individual features were mapped as one area.
- S-54B Although vugs were the predominant feature identified, numerous solution cavities showing evidence of channelized solutioning were also observed. Vugs were observed to be interconnected in some instances. The designated zone contains numerous scattered vuggy rock outcrops on the order of 20 by 30 feet. Hence, the numerous individual features were mapped as one area.
- S-55 Vugs appeared to be interconnected.
- S-56 Approximately nine solution cavities were observed within this zone.
- S-57 Vugs appeared to be interconnected.
- S-63 Same as Feature S-54.
- S-64 Vugs appeared to be interconnected.
- S-65 Closed depression appears to have been constructed as a water retention structure and used as a stock tank. Feature was not observed to be holding water during the time of field reconnaissance.
- S-66 Feature is a manmade excavation measuring approximately 141x21x6.5-ft and appears to have been constructed as a water retention structure.
- S-70 Fractures do not appear to be oriented along the NE/SW regional structural trend.
- S-71 Closed depressions appear to have been formed as the result of scour and differential erosion during precipitation/runoff events.
- S-72 Same as Feature S-70.
- S-74 and S-80 Vugs appeared to be interconnected.
- S-82 ~~Closed depressions appear to have been formed as the result of scour along the drainage channel.~~ *Same as feature S-54*
- S-83 Same as Feature S-54.
- S-84 Same as Feature S-71.
- S-86, S-87, S-89, and S-90 Vugs appeared to be interconnected.

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- S-98 This sinkhole is located within an ephemeral drainage and appears to have been formed as the result of dissolution and collapse. Vugs were also observed in association with this feature.

**Additional Comments**  
**Site Location**  
(Features S-99 - S-118)

- S-99 Closed depression within this zone appears to have been formed as the result of scour and differential erosion during precipitation/runoff events.
- S-100 Vugs appeared to be interconnected.
- S-117A Vuggy rock zone. Density, aperture, and infilling varied across feature but generally zone is high density, with medium apertures and fine-grained infilling. Vugs generally appear to be interconnected but varied with density and restricted to very steep slopes.
- S-117B Vuggy rock zone. Density, aperture, and infilling varied across feature but generally zone is high density, with medium apertures and fine-grained infilling. ~~Vugs generally appear to be interconnected but varied with density and restricted to very steep slopes.~~
- S-118 This area contains all man-made roads and clearing. Numerous man-made closed depressions were found in this zone. Most were formed by the uprooting of trees. None of the individual features were sensitive, however, due to the aerial extent of the zone and the quantity of features within the zone, the zone has been classified as moderately sensitive with a moderate potential for recharge.

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**Additional Comments  
Drainage A  
(Features A-1 through A-29)**

A-2 through A-6:

Closed depression due to scour.

A-8 through A-10:

Closed depression due to scour.

A-11 Vugs appear to be interconnected.

A-12 through A-14:

Closed depression due to scour.

A-15 Solution cavities occur in the side of the bluff. Cavities ranged for 1 to 5 feet in length, 1 to 3 feet in height, and 1 to 3 feet deep.

A-20 and A-21:

Same as A-15.

A-22 Vugs appear to be interconnected.

A-23 through A-28:

Closed depression due to scour.

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### References

- Barnes, V.L., 1983, Geologic Atlas of Texas San Antonio Sheet; Bureau of Economic Geology, The University of Texas at Austin, Austin, Texas.
- Maclay, R.W., 1995, Geology and hydrogeology of the Edwards aquifer in the San Antonio area, Texas: U.S. Geological Survey Water Resources Investigations Report 95-4186, 64 p.
- National Flood Insurance Program, 1986, Flood Insurance Rate Map, Comal County, Texas (Unincorporated Areas); Federal Emergency Management Agency, Maps 485463 0110C, and 485463 0105C.
- Small, T. A. and Hanson, J.A., 1994, Geologic Framework and Hydrogeologic Characteristics of the Edwards Aquifer Outcrop, Comal County, Texas: U.S. Geological Survey Water Resources Investigations Report 94-4117, p 4-7.
- Texas Water Commission (TWC), 1986, Edwards Aquifer Recharge Zone Map, Castle Hills Quadrangle; TWC, San Antonio, Texas.
- United States Geological Survey (USGS), 1992, Castle Hills Quadrangle; USGS, Denver, Colorado.

11. Geologic or manmade features.

Geologic or manmade features were discovered on the project site during the field investigation. They are shown and labeled on the SITE Geologic Map and are described in the attached Geologic Assessment Table.

Geologic or manmade features were not discovered on the project site during the field investigation.

12.  The Recharge Zone boundary and the 100-year floodplain is shown and labeled, if appropriate.

13. All known wells (oil, water, unplugged, capped and/or abandoned, test holes, etc.):

There are 4 (#) wells present on the project site and the locations are shown and labeled. (Check all of the following that apply)

The wells are not in use and have been properly abandoned.

The wells are not in use and will be properly abandoned.

The wells are in use and comply with 30 TAC §238.

There are no wells or test holes of any kind known to exist on the project site.

DOWNGRADIENT GEOLOGIC MAP

Downgradient Geologic Map Scale 1" = 400 '

Items 14 through 16 must be included on the Downgradient Geologic Map.

14.  Surface Geologic Units are shown and labeled.

15. Geologic or manmade features:

Geologic or manmade features were discovered within the downgradient area. They are shown and labeled on the Downgradient Geologic Map and described in the attached Geologic Assessment Table.

No geologic or manmade features were discovered within the downgradient area.

16. All known wells (oil, water, unplugged, capped and/or abandoned, test holes, etc.):

- \_\_\_\_\_ There are \_\_\_\_\_ (#) wells present on the project site and the locations are shown and labeled. (Check all of the following that apply)
  - \_\_\_\_\_ The wells are not in use and have been properly abandoned.
  - \_\_\_\_\_ The wells are not in use and will be properly abandoned.
  - \_\_\_\_\_ The wells are in use and comply with 30 TAC §238.
- There are no wells or test holes of any kind known to exist on the project site.

**ADMINISTRATIVE INFORMATION**

17.  One (1) original and three (3) copies of the following forms, in the order listed below, have been provided.
- \* THIS FORM
  - \* GEOLOGIC ASSESSMENT TABLE
  - \* SITE GEOLOGIC MAP
  - \* DOWNGRAIDENT GEOLOGIC MAP, if needed

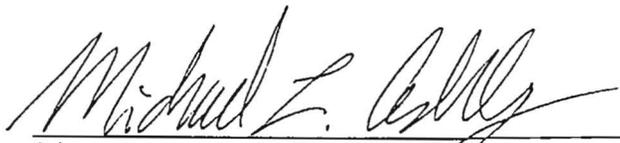
To the best of my knowledge, the responses to this form accurately reflect all information requested concerning the proposed regulated activities and methods to protect the Edwards Aquifer. This **GEOLOGIC ASSESSMENT** is hereby submitted for TNRCC review. The application was prepared by:

Date(s) Geologic Assessment was performed: July - August 1998  
Date(s)

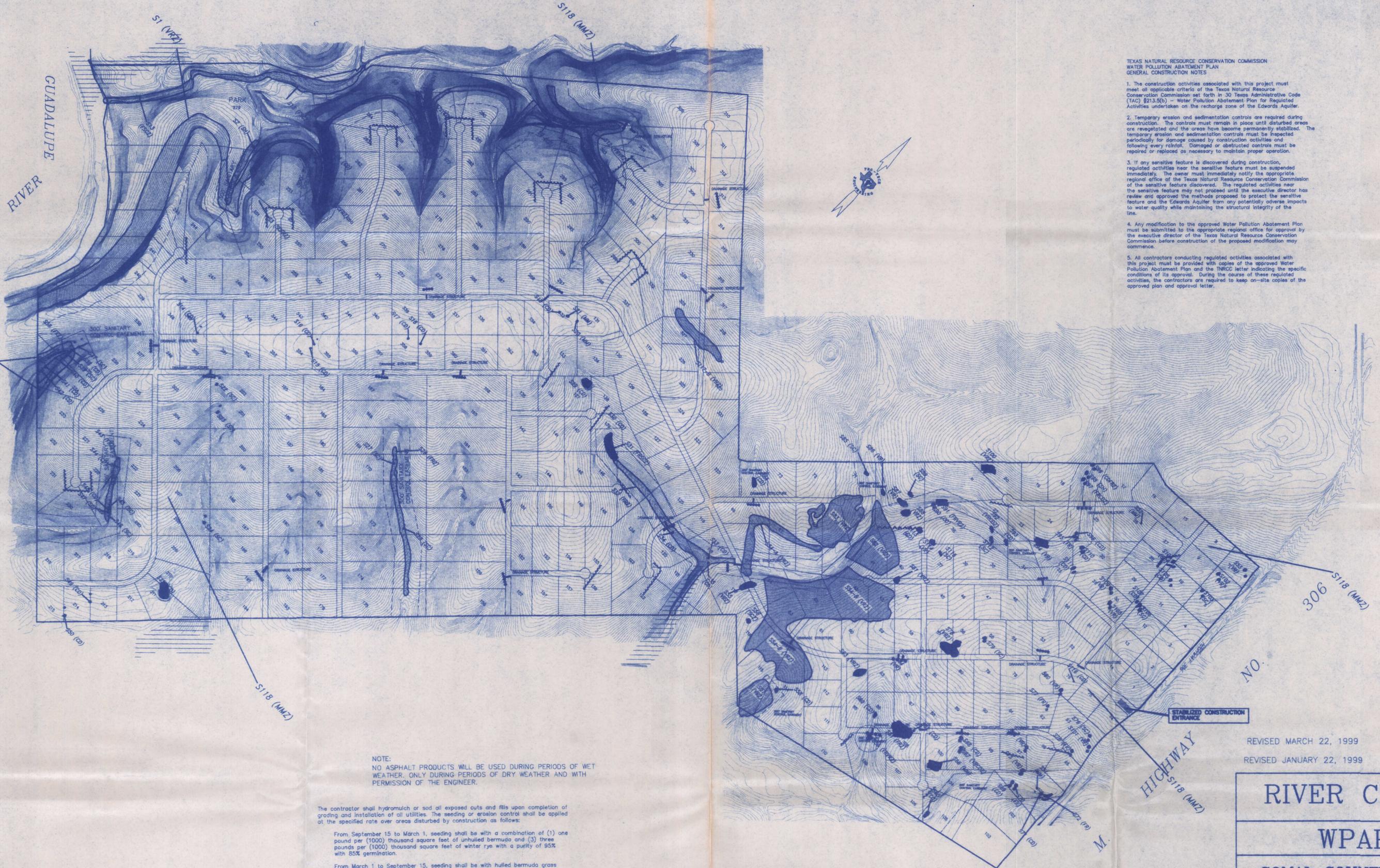
Michael L. Ashby  
Print Name of Geologist (512) 339-1745  
Telephone

(512) 339-6174  
FAX

Sept. 11, 1998  
Date

  
Signature of Geologist

Representing: Raba-Kistner-Brytest Consultants, Inc.  
(Name of Company)



- TEXAS NATURAL RESOURCE CONSERVATION COMMISSION  
 WATER POLLUTION ABATEMENT PLAN  
 GENERAL CONSTRUCTION NOTES
1. The construction activities associated with this project must meet all applicable criteria of the Texas Natural Resource Conservation Commission set forth in 30 Texas Administrative Code (TAC) §213.5(b) - Water Pollution Abatement Plan for Regulated Activities undertaken on the recharge zone of the Edwards Aquifer.
  2. Temporary erosion and sedimentation controls are required during construction. The controls must remain in place until disturbed areas are revegetated and the areas have become permanently stabilized. The temporary erosion and sedimentation controls must be inspected periodically for damage caused by construction activities and following every rainfall. Damaged or obstructed controls must be repaired or replaced as necessary to maintain proper operation.
  3. If any sensitive feature is discovered during construction, regulated activities near the sensitive feature must be suspended immediately. The owner must immediately notify the appropriate regional office of the Texas Natural Resource Conservation Commission of the sensitive feature discovered. The regulated activities near the sensitive feature may not proceed until the executive director has reviewed and approved the methods proposed to protect the sensitive feature and the Edwards Aquifer from any potentially adverse impacts to water quality while maintaining the structural integrity of the line.
  4. Any modification to the approved Water Pollution Abatement Plan must be submitted to the appropriate regional office for approval by the executive director of the Texas Natural Resource Conservation Commission before construction of the proposed modification may commence.
  5. All contractors conducting regulated activities associated with this project must be provided with copies of the approved Water Pollution Abatement Plan and the TNRC letter indicating the specific conditions of its approval. During the course of these regulated activities, the contractors are required to keep on-site copies of the approved plan and approval letter.

NOTE:  
 NO ASPHALT PRODUCTS WILL BE USED DURING PERIODS OF WET WEATHER. ONLY DURING PERIODS OF DRY WEATHER AND WITH PERMISSION OF THE ENGINEER.

The contractor shall hydromulch or sod all exposed cuts and fills upon completion of grading and installation of all utilities. The seeding or erosion control shall be applied at the specified rate over areas disturbed by construction as follows:

From September 15 to March 1, seeding shall be with a combination of (1) one pound per (1000) thousand square feet of unhulled bermuda and (3) three pounds per (1000) thousand square feet of winter rye with a purity of 95% with 85% germination.

From March 1 to September 15, seeding shall be with hulled bermuda grass (Dynoden Dactolyn) at a rate of (1) one pound per (1000) thousand square feet with a purity of 95% with 85% germination.

Fertilizer shall have an analysis of 15-10-5 and shall be applied at the rate of 800 pounds per acre. Mulch type to be Comed, applied at a rate of 2100 pounds per acre. Restoration shall be acceptable when the grass has reached a height of at least 1-1/2" (95% coverage and no bare spots larger than 16 square feet exist.

The seeded or planted area is to be irrigated or sprinkled in a manner which will not erode the topsoil but will sufficiently soak the soil to a depth of 6 inches. The irrigation shall occur at seven day intervals for the first two months. Rainfall occurrences of at least 1 inch shall postpone the watering operation for one week.

- LEGEND
- DRAINAGE STRUCTURE
  - \*\*\*\*\* ROCK BERM
  - ~~~~~ SILT FENCE

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 COUNTY ENGINEER

REVISED MARCH 22, 1999  
 REVISED JANUARY 22, 1999

**RIVER CHASE**

**WPAP**

**COMAL COUNTY, TEXAS**



**PRO-TECH**  
**ENGINEERING GROUP**  
 INCORPORATED  
 100 E. San Antonio St., Suite 100  
 San Marcos, TX 78666  
 (512) 353-3335



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E.O. 14625 SCALE: 1"=500' SHEET 1 of 2

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GEOLOGIC ASSESSMENT TABLE																	PROJECT NAME: Harmon Ranch Geological Assessment																											
FEATURE ID			FEATURE CHARACTERISTICS														PHYSICAL SETTING																											
1A	1B	1C	2	3			4			5			6		7		8			9			10		11	12		13				14				15		16		17				
LOCATION	TYPE (1)	POINTS	GEOLOGIC FORMATION	VERTICAL FEATURE (FEET)			HORIZONTAL FEATURE (FEET)			LENGTH & WIDTH (FEET)			TREND (C, CD, FR, FZ, SC, SH)		DENSITY (FR, VR)		APERTURE (FR, VR)			INFILLING (CD, FR, FZ, SC, SH, VR)			RELATIVE INFILTRATION RATE		SUB-TOTAL	SENSITIVITY		DRAINAGE AREA (ACRES)				TOPOGRAPHY (2)				SUB-TOTAL RECHARGE		COMMENTS						
				C	CD	SC	SH	C	SC	FZ	FR	VR	Z																															
				X	Y	Z	X	Y	Z																																			
S-21	MM	35	Kep																				35	70		✓	0					10		10	✓		✓							
S-22	SC	10	Kek	8	15	2								SE									5			10	25		✓	5				10		15	✓	✓						
S-23	SC	10	Kek	8	8	1								SE									5			10	25		✓	5				10		15	✓	✓						
S-24	SC	10	Kek					4	1	2													5			10	25		✓					10		20	✓	✓						
S-25	CD	10	Kek	125	125	15																	5			10	15	✓					10		20	✓	✓							
S-26	FRZ	0	Kek								1650x50				0			5					5			10	10	✓				15		20	35		✓	✓						
S-27	SC	10	Kek	2	4	2																	5			10	25		✓				10		20	✓	✓							
S-28	SC	10	Kek					4	1	1				SE												15	0		25		✓		15		20	35		✓	✓					
S-29	CD	10	Kek	50	100	15																	5			10	25		✓				10		20	✓	✓							
S-30	CD	10	Kek	4	6	0.5								SE									5			15	✓					5		10		15	✓	✓						
S-31	FRSCZ	35	Kek								250x60				0			5					5			10	60		✓				10		20	30		✓	✓					
S-32	FRZ	0	Kek								2200x60							5					5			10	10	✓					10		20	30		✓	✓					
S-33	CD	10	Kek	5	6	1																	5			15	✓						15		20	35		✓	✓					
S-34	CD	10	Kek	15	30	10																	5			10	25		✓				15		20	35		✓	✓					
S-35	CD	10	Kek	10	20	1																			10			10	30		✓			15		20	35		✓	✓				
S-36	FRZ	0	Kek								500x50				0			0					5			0	5	✓					10		20	30		✓	✓					
S-37	SC	10	Kek					2	1	1				N												15	0		25		✓		10		20	30		✓	✓					
S-38	SC	10	Kek	3	3	1																	5			0	15	✓					10		20	30		✓	✓					
S-39	SC	10	Kek	1	3	1								N												15	0		25		✓		10		20	30		✓	✓					
S-40	CD	10	Kek	4	4	2																	5			10	25		✓				10		20	30		✓	✓					

(1) C = 35, CD = 10, FR = 0, FZ = 15, MM = 35, SC = 10, SH = 20, VR = 0, ZONE = 35

(2) WALL = Vertical/near vertical wall above 100-yr floodplain  
 FLOODPLAIN = 100-yr floodplain  
 STREAM BED = Ordinary High Water Mark

I have read, understood, and followed the Texas Natural Resource Conservation Commission's Instructions to Geologists. The information presented here complies with that document and is a true representation of the conditions observed in the field.

*Michael G. Gentry*

9-11-98

Geologist signature

Date

Sheet 2 of 7













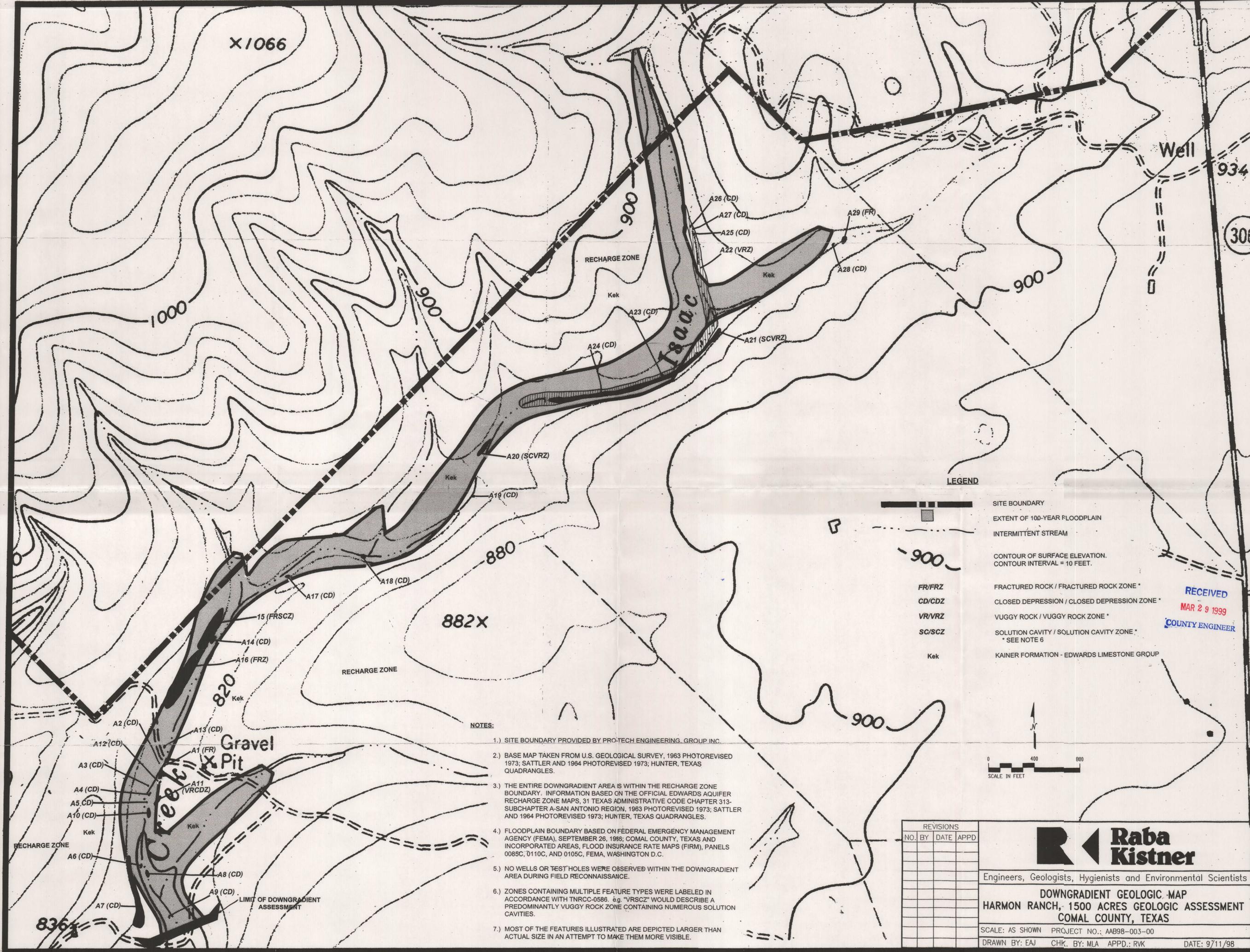
DOWNGRADIENT GEOLOGIC ASSESSMENT TABLE													PROJECT NAME: Hamon Ranch Geological Assessment																									
FEATURE ID			FEATURE CHARACTERISTICS										PHYSICAL SETTING																									
1A	1B	1C	2	3			4	5	6		7			8			9		10		11	12		13				14			15		16		17			
LOCATION	TYPE (1)	POINTS	GEOLOGIC FORMATION	VERTICAL FEATURE (FEET)			HORIZONTAL FEATURE (FEET)	LENGTH & WIDTH (FEET)	TREND (C, CD, FR, FZ, SC, SH)		DENSITY (FR, VR)			APERTURE (FR, VR)			INFILLING (CD, FR, FZ, SC)			RELATIVE INFILTRATION RATE		SUB-TOTAL	SENSITIVITY		DRAINAGE AREA (ACRES)				TOPOGRAPHY (2)			SUB-TOTAL		POTENTIAL RECHARGE		COMMENTS		
				C, CD, SC, SH			C, SC	FZ, FR, VR, Z	DIRECTION		LOW	MODERATE	HIGH	SMALL	MEDIUM	LARGE	CEMENTED	FINE	COARSE	NONE	NONE / LOW	MODERATE	HIGH	NOT POSSIBLE	SENSITIVE	<1	<10	<50	>50	WALL	HILLTOP	HILLSIDE	FLOODPLAIN	STREAMBED	NONE / LOW	MODERATE	HIGH	YES
				X	Y	Z	X	Y	Z																													
A-20	SCVRZ	35	Kek				200x10															30	65		✓			15				20	35		✓	✓		
A-21	SCVRZ	35	Kek				2000x10															30	65		✓			15				20	35		✓	✓		
A-22	VRZ	0	Kek				3500x50				10		10		5							10			✓			15				20	35		✓	✓		
A-23	CD	10	Kek	6	10	3											5			0					✓			15				20	35		✓	✓		
A-24	CD	10	Kek	10	20	2											5			0					✓			15				20	35		✓	✓		
A-25	CD	10	Kek	8	10	1											5			0					✓			15				20	35		✓	✓		
A-26	CD	10	Kek	5	20	1											5			0					✓			15				20	35		✓	✓		
A-27	CD	10	Kek	8	15	0.5											5			0					✓			15				20	35		✓	✓		
A-28	CD	10	Kek	6	30	1											5			0					✓			15				20	35		✓	✓		
A-29	FR	0	Kek				40x5	NE	10	0			5		5						10				✓			15				20	35		✓			

(1) C = 35, CD = 10, FR = 0, FZ = 15, MM = 35, SC = 10, SH = 20, VR = 0, ZONE = 35

(2) WALL = Vertical/near vertical wall above 100-yr floodplain  
 FLOODPLAIN = 100-yr floodplain  
 STREAM BED = Ordinary High Water Mark

I have read, understood, and followed the Texas Natural Resource Conservation Commission's Instructions to Geologists. The information presented here complies with that document and is a true representation of the conditions observed in the field.

*Michael Kelly* 9/14/98  
 \_\_\_\_\_  
 Geologist signature Date



**LEGEND**

- SITE BOUNDARY
- EXTENT OF 100-YEAR FLOODPLAIN
- INTERMITTENT STREAM
- CONTOUR OF SURFACE ELEVATION. CONTOUR INTERVAL = 10 FEET.
- FRACTURED ROCK / FRACTURED ROCK ZONE \*
- CLOSED DEPRESSION / CLOSED DEPRESSION ZONE \*
- VUGGY ROCK / VUGGY ROCK ZONE \*
- SOLUTION CAVITY / SOLUTION CAVITY ZONE \*
- KAINER FORMATION - EDWARDS LIMESTONE GROUP

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**NOTES:**

- 1.) SITE BOUNDARY PROVIDED BY PRO-TECH ENGINEERING, GROUP, INC.
- 2.) BASE MAP TAKEN FROM U.S. GEOLOGICAL SURVEY, 1963 PHOTOREVISED 1973; SATTLER AND 1964 PHOTOREVISED 1973; HUNTER, TEXAS QUADRANGLES.
- 3.) THE ENTIRE DOWNGRADIENT AREA IS WITHIN THE RECHARGE ZONE BOUNDARY. INFORMATION BASED ON THE OFFICIAL EDWARDS AQUIFER RECHARGE ZONE MAPS, 31 TEXAS ADMINISTRATIVE CODE CHAPTER 313-SUBCHAPTER A-SAN ANTONIO REGION, 1963 PHOTOREVISED 1973; SATTLER AND 1964 PHOTOREVISED 1973; HUNTER, TEXAS QUADRANGLES.
- 4.) FLOODPLAIN BOUNDARY BASED ON FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA), SEPTEMBER 26, 1986; COMAL COUNTY, TEXAS AND INCORPORATED AREAS, FLOOD INSURANCE RATE MAPS (FIRM), PANELS 0085C, 0110C, AND 0105C, FEMA, WASHINGTON D.C.
- 5.) NO WELLS OR TEST HOLES WERE OBSERVED WITHIN THE DOWNGRADIENT AREA DURING FIELD RECONNAISSANCE.
- 6.) ZONES CONTAINING MULTIPLE FEATURE TYPES WERE LABELED IN ACCORDANCE WITH TNRCC-0586. e.g. "VRSCZ" WOULD DESCRIBE A PREDOMINANTLY VUGGY ROCK ZONE CONTAINING NUMEROUS SOLUTION CAVITIES.
- 7.) MOST OF THE FEATURES ILLUSTRATED ARE DEPICTED LARGER THAN ACTUAL SIZE IN AN ATTEMPT TO MAKE THEM MORE VISIBLE.

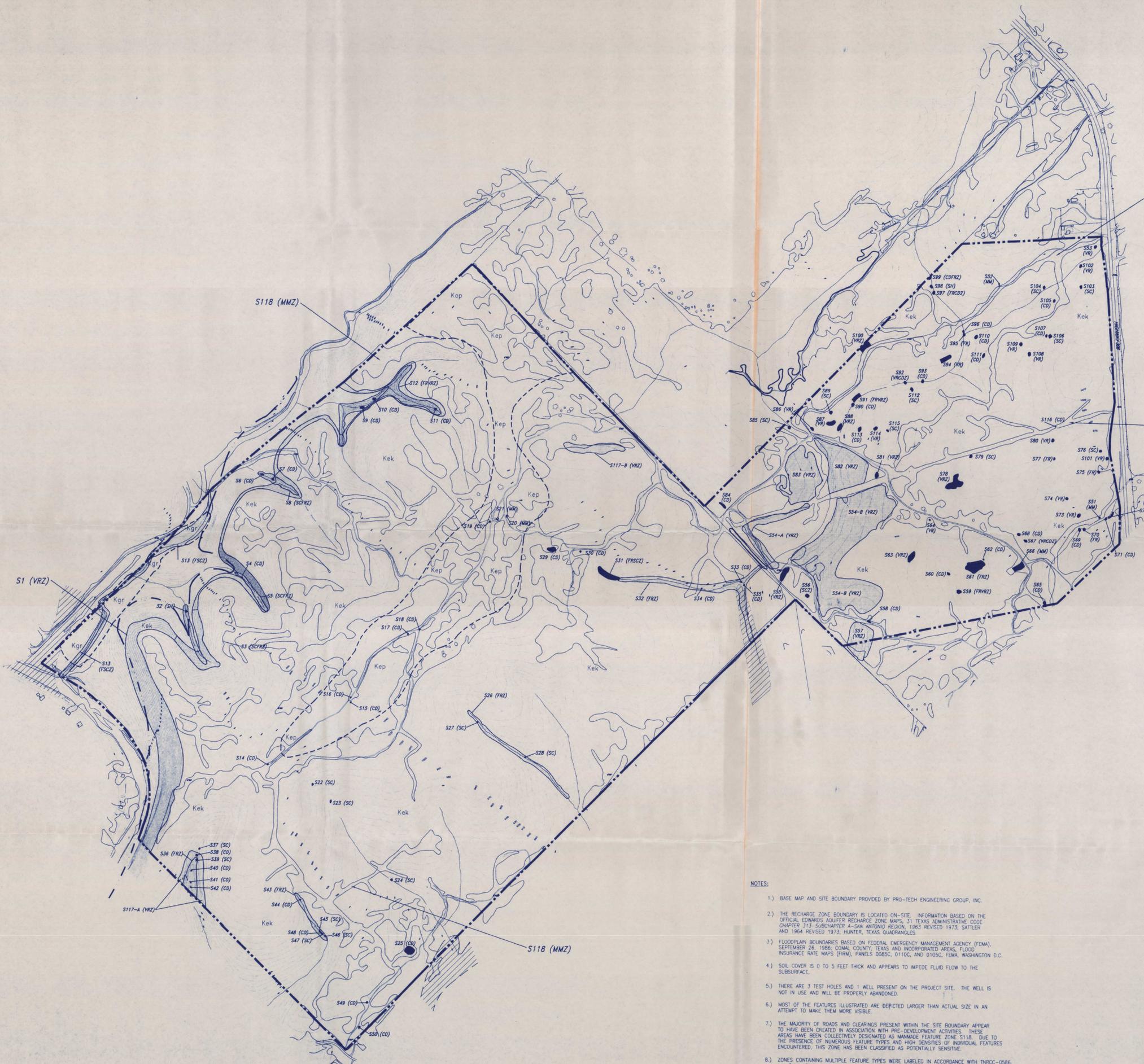
REVISIONS			
NO.	BY	DATE	APPD



Engineers, Geologists, Hygienists and Environmental Scientists

**DOWNGRADIENT GEOLOGIC MAP**  
**HARMON RANCH, 1500 ACRES GEOLOGIC ASSESSMENT**  
**COMAL COUNTY, TEXAS**

SCALE: AS SHOWN PROJECT NO.: AAB98-003-00  
 DRAWN BY: EAJ CHK. BY: MLA APPD.: RVK DATE: 9/11/98



- LEGEND**
- SITE BOUNDARY
  - CONTOUR OF SURFACE ELEVATION  
CONTOUR INTERVAL = 10 FT.
  - FENCE
  - STREAM
  - EXTENT OF 100-YEAR FLOODPLAIN
  - RECHARGE ZONE BOUNDARY
  - FR/FRZ FRACTURED ROCK/FRACTURED ROCK ZONE \*
  - SH SINKHOLE
  - F/FZ FAULT/FAULT ZONE \*
  - SC/SCZ SOLUTION CAVITY/SOLUTION CAVITY ZONE \*
  - CD/CDZ CLOSED DEPRESSION/CLOSED DEPRESSION ZONE \*
  - MM/MMZ MANMADE/MANMADE ZONE
  - VR/VRZ VUGGY ROCK/VUGGY ROCK ZONE \*
  - \* SEE NOTE 8
  - FORMATION CONTACT
  - Kgr GLEN ROSE FORMATION
  - Kep PERSON FORMATION, EDWARDS LIMESTONE GROUP
  - Kek KAINER FORMATION, EDWARDS LIMESTONE GROUP

- NOTES:**
- 1) BASE MAP AND SITE BOUNDARY PROVIDED BY PRO-TECH ENGINEERING GROUP, INC.
  - 2) THE RECHARGE ZONE BOUNDARY IS LOCATED ON-SITE. INFORMATION BASED ON THE OFFICIAL EDWARDS ACQUIFER RECHARGE ZONE MAPS, 31 TEXAS ADMINISTRATIVE CODE CHAPTER 313-SUBCHAPTER A-SAN ANTONIO REGION, 1963 REVISED 1973; SATTLER AND 1964 REVISED 1973; HUNTER, TEXAS QUADRANGLES.
  - 3) FLOODPLAIN BOUNDARIES BASED ON FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA), SEPTEMBER 26, 1986; COMAL COUNTY, TEXAS AND INCORPORATED AREAS, FLOOD INSURANCE RATE MAPS (FIRM), PANELS 0108C, 0110C, AND 0105C, FEMA, WASHINGTON D.C.
  - 4) SOIL COVER IS 0 TO 5 FEET THICK AND APPEARS TO IMPEDE FLUID FLOW TO THE SUBSURFACE.
  - 5) THERE ARE 3 TEST HOLES AND 1 WELL PRESENT ON THE PROJECT SITE. THE WELL IS NOT IN USE AND WILL BE PROPERLY ABANDONED.
  - 6) MOST OF THE FEATURES ILLUSTRATED ARE DEPICTED LARGER THAN ACTUAL SIZE IN AN ATTEMPT TO MAKE THEM MORE VISIBLE.
  - 7) THE MAJORITY OF ROADS AND CLEARINGS PRESENT WITHIN THE SITE BOUNDARY APPEAR TO HAVE BEEN CREATED IN ASSOCIATION WITH PRE-DEVELOPMENT ACTIVITIES. THESE AREAS HAVE BEEN COLLECTIVELY DESIGNATED AS MANMADE FEATURE ZONE S118. DUE TO THE PRESENCE OF NUMEROUS FEATURE TYPES AND HIGH DENSITIES OF INDIVIDUAL FEATURES ENCOUNTERED, THIS ZONE HAS BEEN CLASSIFIED AS POTENTIALLY SENSITIVE.
  - 8) ZONES CONTAINING MULTIPLE FEATURE TYPES WERE LABELED IN ACCORDANCE WITH TNRCC-0586. E.G. "FRSCZ" WOULD DESCRIBE A PREDOMINANTLY VUGGY ROCK ZONE CONTAINING NUMEROUS SOLUTION CAVITIES.

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1	RVK	2/99	GWR



Engineers, Geologists, Hygienists and Environmental Scientists

REVISED SITE GEOLOGIC MAP  
HARMON RANCH, 1500 ACRES GEOLOGIC ASSESSMENT  
COMAL COUNTY, TEXAS

SCALE: AS SHOWN PROJECT NO.: AAB98-003-00  
DRAWN BY: EAJ CHK. BY: MLA APPD.: RVK DATE: 9/11/98