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## **Appendix M**

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### **WELL COMPLETION AND BORING LOGS**

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Pilot hole drilling and well construction were completed by Total Support Services (TSS). Drilling was completed using hollow stem augers equipped with a three-tooth tungsten-carbide bit. Augers used for drilling were five-foot standard lengths. Drill penetration times varied from 1 minute per foot to 67 minutes per foot. Lithologic sampling during drilling was completed by use of a retrievable wire line split sample barrel. The barrel has a round spring catcher at the base. Drilled formation is allowed to enter the barrel through the catcher, but cannot slip back out past the catcher. At five-foot intervals when augers were added to the drill string, the barrel was retrieved, emptied, and run on wire line back into the augers. The soil and rock cuttings generated during the drilling process were examined in the field as the monitoring well borings were advanced in order to log the borehole stratigraphy and to identify water-bearing zones. No soil samples were retained for chemical analysis during this portion of the field program.

### **Local Geology**

All boreholes were drilled through a thin to moderately thick veneer of soil. The soils were not mature and generally contained angular rock fragments from the underlying bedrock unit. The rock fragments were predominantly limestone. The soil horizon varied from 2 feet to 12 feet in thickness and was composed of dark brown to brownish gray to black, organic soil with minor amounts of quartz sand and lithic fragments. In two boreholes (MW-SC3 and MW-SBR1), a large quantity of highly rounded cobbles was penetrated with the organic soil, or inter-bedded with the soil.

As previously discussed, beneath the soil layer, the Main Street Limestone member of the Cretaceous Georgetown Formation has an average thickness of 35 feet in the study area. Monitoring wells MW-HC1, MW-HC2, MW-SBR1, MW-SBR2, MW-SBR3, and MW-SBR5 were all completed in the Main Street Limestone. Drilling was characterized by a medium- to fine-grained chalky limestone containing variable amounts of terrigenous material. Bedding was encountered on a massive 4 foot to 8-foot scale. Cuttings in the upper portion of the borehole appeared to be weathered limestone that was light gray to white in color. The limestone was inter-bedded with sandy calcareous marl. The upper portions of the boreholes were also characterized by fracturing and meteoric solution activity. Minor terrigenous and biologic accessories were encountered during drilling.

The Main Street Limestone was generally more massive lower in the boreholes. All drilling completed in the Main Street Limestone was ended after encountering a massive non-fractured medium gray limestone bed beneath the marl rich unit described above. Penetration times in the more massive unit were in excess of one hour per foot. Little to no dissolution was noticed in this unit.

Boreholes MW-SC1, MW-SC3, MW-SC5, MW-OC1, and MW-LR1 were completed in the Weno Limestone and Denton Clay (also called the Denton Marl) members of the Cretaceous Georgetown Formation. Drilling was characterized by a fine-grained chalky limestone containing moderate amounts of terrigenous material. Fine bedding was encountered and varied between marl and more sediment-rich units. Cuttings appeared to be highly weathered and the limestone and marl were light gray to yellowish gray in

color. The upper portions of the boreholes were also characterized by fracturing and meteoric solution activity, with more massive beds being found at depth.

### **Local Hydrogeology**

The upper portions of all boreholes in the study area showed visible meteoric dissolution. Most boreholes revealed solution enhanced bedding features and/or fracturing in the upper 20 to 30 feet. Wells were completed, when possible, through these features and several feet into the more massive layers below in order to take advantage of potential fluid migration pathways. All completed wells contained groundwater at the time of development with the exception of MW-HC2.

Water could be seen flowing into boreholes MW-HC1 and MW-SBR1 after the augers were removed from the borehole. It appears from the field investigation that water enters the wells from solution features and/or fractures in the limestone. These features act as conduits for local fluid transport in the study area.

### **Monitoring Well Construction**

All monitoring wells were constructed using 2-inch schedule 40 PVC well casing and 2-inch schedule 40 PVC 0.10 slot well screen. Well casing and screen was “tri-lock” threaded with O-rings. All well materials were in new condition. Each monitoring well was constructed with at least 15 feet of well screen installed across the shallow water table to accommodate seasonal water-table fluctuations. The screen in each monitoring well was placed from the bottom of the borehole (which extends at least 10 feet below where groundwater was first encountered) and the screen extended at least 5 feet above the top of the water table. Upon reaching total well depth, the well casing was run inside the augers. To ensure the stability of the borehole during well construction, the monitoring wells were installed through the drill string. After the riser casing and capped screen were positioned to the desired depth in the borehole, a sand pack consisting of clean, non-carbonate, 16/30-mesh silica sand was placed in the annulus between the screen and borehole wall. The sand was slowly poured down the annulus between the screen and the drill pipe, and allowed to settle out of the drill pipe as the drill pipe was slowly retracted from the borehole. The depth of the sandpack in the annular space was monitored continuously using a weighted probe. As the drill pipe was pulled upward and the sand settled out through the bottom of the pipe, additional sand was added so that sand always remained in the bottom end of the drill string. This prevented the borehole from collapsing around the screen before the sand pack was in place. Sand was added until it was 2 feet above the top of the screen after the drill string was removed. After the required sand pack thickness had been achieved, the sand was allowed to settle for approximately 15 minutes, after which the depth of the sand pack was verified. If additional sand was required, it was added to the borehole as described above. The sand was once again allowed to settle and the thickness of the sand pack was verified. This process continued until settlement of the sand pack was no longer observed. A two-foot thick well seal composed of bentonite hole plug was placed on top of the well gravel pack. After the bentonite seal had been adequately hydrated, the remaining annular space was grouted with neat Portland cement. No accelerator, such as calcium chloride, was added to the cement grout. The cement grout was placed to a depth that allowed for a

protective surface completion to be installed as described below. The well and borehole were then sealed by surface completion.

### Well Completion

Two types of well completions were utilized during this study. Standard well completions were accomplished by use of a 4-inch by 4-inch locking cap steel riser. Risers were delivered in standard 5-foot lengths. Risers were cemented into the ground 2-feet leaving a 3-foot stick up, enclosing the 2-inch PVC casing. Surface completions were finished by means of a 4-foot by 4-foot square raised concrete pad. The concrete pad sloped away from the steel casing toward the ground surface. The inner PVC well casing of each well was capped with a lockable, protective, expandable well cap. Well completions were protected by the installation of bollard posts outside each corner of the well pad. Well risers and bollards were painted safety yellow for increased visibility.

Flush mount completions were used at wells MW-SC3 and MW-OC1 due to their locations in high traffic areas. Flush-mount completions utilized a 6-inch bolted aluminum manhole cover set in a 4-foot by 4-foot square flush concrete pad. No bollards or visibility paint were used on flush mount completions.

Drilled depths and general well completion data are presented in **Table 1**, and well completion logs are included with this report at the end of this appendix.

**Table 1**  
**Well Completion Data**

Well Number	Drilled Depth	Screen Interval	First Water	Completion Type
MW-HC1	20-feet	6 – 19.5 feet	2.8-feet	Standard Riser
MW-HC2	35-feet	10 – 34.5 feet	NA	Standard Riser
MW-SC1	25-feet	7- 24.5 feet	17-feet	Standard Riser
MW-SC3	25-feet	7- 24.5 feet	16.5-feet	Flush Mount
MW-SC5	23.5-feet	6 – 23 feet	7.2-feet	Standard Riser
MW-OC1	30-feet	10 – 29.5 feet	21-feet	Flush Mount
MW-LR1	25-feet	5 - 24.5 feet	16.5-feet	Standard Riser
MW-SBR1	25-feet	7- 24.5 feet	12.5-feet	Standard Riser
MW-SBR2	37.5-feet	10 – 37 feet	23.5-feet	Standard Riser
MW-SBR3	25-feet	6 – 24.5 feet	15.1-feet	Standard Riser
MW-SBR5	24.5-feet	6 – 24 feet	8.6-feet	Standard Riser

*All depths are referenced from ground level.*

All drill cuttings were captured and containerized at the well head location in sealed 55-gallon drums approved by the Department of Transportation. The drums were labeled with well location information, drum contents (cuttings), and given a drum number corresponding to the number of drums at the location. All drums containing soil and drill cuttings were sampled for perchlorate, and samples were delivered to BRA for shipment to the USACE Engineer Research and Development Center Environmental Laboratory at

the Environmental Chemistry Branch in Omaha, Nebraska for analysis. A summary of the analytical results can be found below in **Table 2**.

### **Well Development**

Following well construction, the wells were developed by bailer and pump methods until discharge water from the well was free of silt and sediment. Development of the wells was completed to ensure that accurate groundwater levels were present in the completed wells, and that perching of water was not occurring due to screen plugging. The monitoring wells were developed no sooner than 24 hours after grouting and well construction was completed.

An electric water-level meter was used to measure the depth to groundwater and the total depth of the monitoring well prior to and immediately after well development. During well development, pH, specific conductivity, and temperature of the purge water were periodically monitored with a field portable meter (e.g., Hydrolab). The selected water-quality meter was calibrated daily according to the manufacturers' instructions. All calibration information and water quality measurements were recorded on a Monitoring Well Development Form. At a minimum, water quality measurements were taken at the beginning of well development and after evacuation of each borehole volume. Well development continued at each well for a maximum of 4 hours or until three consecutive water quality measurements met the following criteria:

- Specific conductivity  $\pm 10$  percent
- Temperature  $\pm 1^\circ$  C
- Turbidity  $< 20$  nephelometric turbidity units (NTUs)
- Within  $\pm 0.2$  pH units.

Wells MW-SBR2 and MW-SC1 contained only minor amounts of water at the time of development. As such, the wells were purged and allowed to fully recover numerous times over the 3 days of well development. Purge water from these wells was only clean after numerous purging events.

Well MW-HC2 was dry to its total depth when the wells were developed. No development of this well was undertaken. Subsequently water has slowly filled MW-HC2, but the water level record from this well does not resemble surface water level measurements taken in the area, or the signatures of other ground water monitoring wells constructed for this study.

All purge water was captured and containerized at the well head location in sealed 55-gallon drums. The drums were labeled with well location information and drum number corresponding to the well location. All drums containing development water were temporarily stored near the well and sampled for perchlorate, and samples were delivered to BRA for shipment to the USACE Engineer Research and Development Center Environmental Laboratory at the Environmental Chemistry Branch in Omaha, Nebraska for analysis. A summary of the analytical results can be found in **Table 2**.

**Table 2  
Analytical Results**

<b>Monitoring Well Number</b>	<b>Cuttings Result</b>	<b>Water Result</b>
MW-HC1	ND	ND
MW-HC2	ND	ND
MW-SC1	ND	ND
MW-SC3	ND	1 µg/l* (J)
MW-SC5	ND	9.1 µg/l
MW-OC1	ND	ND
MW-LR1	ND	ND
MW-SBR1	ND	1 µg/l* (J)
MW-SBR2	ND	ND
MW-SBR3	ND	2 µg/l* (J)
MW-SBR5	ND	ND

\* Results reported below the method detection limit (1 µg/l).

**Investigation Derived Waste Disposal**

Investigation derived waste (IDW) that demonstrated to contain no concentrations of perchlorate through laboratory analysis was deposited in the vicinity of the well head. Private land owners were consulted as to the most appropriate deposit areas for the drill cuttings and development water. All empty 55-gallon containers and lids from IDW containing no perchlorate were then transported to the City of Waco landfill for disposal.

IDW that was found to contain concentrations of perchlorate through laboratory analysis was held at the well head while arrangements for proper disposal were made. MWH contracted with Safety-Kleen Systems for the disposal of all IDW containing perchlorate. IDW was picked up from the well head location and transported by Caldwell Environmental Associates, Inc., to Onyx Environmental Services of Port Arthur, Texas for disposal in a Class A environmental landfill.

**Well Surveying**

MWH subcontracted with ZWA for surveys of all well locations. Reference elevations were linked to the steel well housing adjacent to the top of casing on above ground completions, and to the steel ring on flush mount completions. Surveying was accomplished by use of a GPS unit. The unit was stationed at the site, and allowed to collect and refine satellite data for an average of 3-hours. The long duration for data collection at individual sites increases the accuracy of the readings. Locations with low topographic relief were allowed to collect data for longer periods.

The data point collected from the GPS unit was then applied to the well site using standard surveying methods. In addition to the reference elevation, elevations for pad corners and ground surface at pad corners were collected. A summary of reference elevations can be found in **Table 3**.

**Table 3**  
**Monitoring Well Survey Results**

<b>Well Number</b>	<b>TOC Elevation</b>
MW-HC1	669.22'
MW-HC2	604.34'
MW-SC1	766.90'
MW-SC3	730.32'
MW-SC5	618.71'
MW-OC1	710.00'
MW-LR1	613.03'
MW-SBR1	620.50'
MW-SBR2	549.33'
MW-SBR3	507.21'
MW-SBR5	465.13'



## LOG OF MW - SC1

**Project:** Bosque and Leon River Watersheds Study  
**Location:** Station Creek at Texas A&M Property

**Started:** 11-15-02  
**Finished:** 11-15-02  
**Method:** Auger  
**Contractor:** Total Support Services  
**Observed By:** M. Randal Skinner

**Lat:** 31°22'53.95925"  
**Long:** 97°29'28.44477"  
**Elev TOC:** 766.90 feet  
**Drilled Depth:** 25 feet  
**Completed Depth:** 25 feet

DEPTH (feet)	% RECOVERY	USCS	LITHOLOGY	LITHOLOGIC DESCRIPTION	WELL COMPLETION
1	80%	CL	[Hatched pattern]	<b>0' - 5', Soil (organic)</b> Silty clay, dark brown to black, dry stream/marsh deposit	<div style="text-align: right;">           2.5-foot Riser with Locking Cover            Ground Surface            Cement Seal            Bentonite Seal            3 - feet            2-inch Sch-40 PVC, 0.010-slot screen            5 - feet            7 feet            16/30-mesh silica sand pack            First Water @ 17.0- feet            2-inch Sch-40 PVC, Casing            24.5-foot 2-inch Sch-40 PVC, well plug            25.0-foot         </div>
2					
3					
4					
5	60%	CL	[Horizontal line pattern]	<b>5' - 14.5', Sandy - Claystone</b> Gray brown, dry, friable, bedding is fine, possible organics in bedding layers. moderatley indurated	
6					
7					
8					
9					
10					
11					
12					
13					
14					
15	40%	LS	[Brick pattern]	<b>14.5 - 25', Limestone</b> Tan to gray, thickly bedded, recrystalized, slight dissolution, meteoric Clay (interbedded marl) Dark gray, slightly moist, friable, bedding is thin, moderatley indurated	
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

Represents the first observed water encountered during drilling



## LOG OF MW - SC3

**Project:** Bosque and Leon River Watersheds Study  
**Location:** Station Creek at SR 107

**Started:** 11-14-02  
**Finished:** 11-14-02  
**Method:** Auger  
**Contractor:** Total Support Services  
**Observed By:** M. Randal Skinner

**Lat:** 31°22'01.86505"  
**Long:** 97°29'46.86490"  
**Elev TOC:** 730.32 feet  
**Drilled Depth:** 25 feet  
**Completed Depth:** 25 feet

DEPTH (feet)	% RECOVERY	USCS	LITHOLOGY	LITHOLOGIC DESCRIPTION	WELL COMPLETION
1	80%	CL		<b>0' - 5', Rock &amp; Fill</b> Limestone pebbles, well sorted, moderately rounded,	Flush Mount Cover Ground Surface Cement Seal 3 - feet Bentonite Seal 2-inch Sch-40 PVC, Casing 5 - feet 7 - feet 2-inch Sch-40 PVC, 0.010-slot screen First Water @ 16.5-feet 16/30-mesh silica sand pack 24.5-feet 2-inch Sch-40 PVC, well plug 25.0-feet
2					
3					
4					
5					
6	45%	LS		<b>5 - 25', Limestone</b> Gray, thickly bedded, slightly fossiliferous recrystallized, slight dissolution, meteoric Clay (interbedded marl) Dark gray, slightly moist, friable, bedding is thin, moderately indurated	
7					
8					
9					
10					
11					
12					
13					
14					
15					
16	60%				
17					
18					
19					
20					
21					
22					
23					
24					
25					
Represents the first observed water encountered during drilling					



## LOG OF MW - OC1

**Project:** Bosque and Leon River Watersheds Study  
**Location:** Onion Creek at SR 107

**Started:** 11-15-02  
**Finished:** 11-15-02  
**Method:** Auger  
**Contractor:** Total Support Services  
**Observed By:** M. Randal Skinner

**Lat:** 31°21'08.20041"  
**Long:** 97°28'43.38948"  
**Elev TOC:** 710.00 feet  
**Drilled Depth:** 30 feet  
**Completed Depth:** 30 feet

DEPTH (feet)	% RECOVERY	USCS	LITHOLOGY	LITHOLOGIC DESCRIPTION	WELL COMPLETION
1	90%	CL		<b>0' - 5', Soil &amp; Rock</b> Limestone pebbles, well sorted, moderately rounded, Dark organic soil	<p style="text-align: right;"> <b>WELL COMPLETION</b>            Flush Mount Cover            Ground Surface            Cement Seal            3 - feet            Bentonite Seal            2-inch Sch-40 PVC, Casing            8 - feet            10 - feet            2-inch Sch-40 PVC, 0.010-slot screen            First Water @ 21-feet            16/30-mesh silica sand pack            29.5-feet 2-inch Sch-40 PVC, well plug            30.0-feet         </p>
2					
3					
4					
5					
6	60%	LS		<b>5 - 17', Limestone</b> Tan to gray, thickly bedded, recrystalized, slight dissolution, meteoric interbedded with marl, slightly moist, friable, bedding is thin, moderatley indurated	
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18	30%	LS		<b>17' - 30', Limestone</b> Very Hard	
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
▼ Represents the first observed water encountered during drilling					



## LOG OF MW - SC5

**Project:** Bosque and Leon River Watersheds Study  
**Location:** Station Creek at Oglesby Neff Park Road

**Started:** 11-13-02  
**Finished:** 11-14-02  
**Method:** Auger  
**Contractor:** Total Support Services  
**Observed By:** M. Randal Skinner

**Lat:** 31°19'24.18202"  
**Long:** 97°29'15.38574"  
**Elev TOC:** 618.71 feet  
**Drilled Depth:** 23.5 feet  
**Completed Depth:** 23.5 feet

DEPTH (feet)	% RECOVERY	USCS	LITHOLOGY	LITHOLOGIC DESCRIPTION	WELL COMPLETION
1 2 3 4 5 6 7 8 9	80%	CL		<b>0' - 10', Soil (organic)</b> Stream Deposit, dark brown to black, moist, highly organic	<p>2.5-foot Riser with Locking Cover            Ground Surface            Cement Seal            2-inch Sch-40 PVC, Casing            3 - feet            4 - feet Bentonite Seal            6 - feet            First Water @ 7.2-feet            2-inch Sch-40 PVC, 0.010-slot screen            16/30-mesh silica sand pack            23.0-feet 2-inch Sch-40 PVC, well plug            23.5-feet</p>
10 11 12 13 14	70%	CL & GR		<b>10' - 15, Soil (organic)</b> Stream Deposit, dark brown to black, moist,, highly organic <b>with</b> Limestone pebbles, well sorted,	
15	50%	GR		<b>Gravel Layer 15'-15.5'</b>	
16 17 18 19 20 21	60%	CL		<b>15.5' - 21', Sandy - Claystone</b> Tan brown, dry, friable, bedding is fine, possible organics in bedding layers. moderatley indurated	
22 23 23.5	15%	LS		<b>21' - 23.5', Limestone</b> Gray, thickly bedded, slightly fossiliferous Gray, slightly moist, friable,	
Represents the first observed water encountered during drilling					



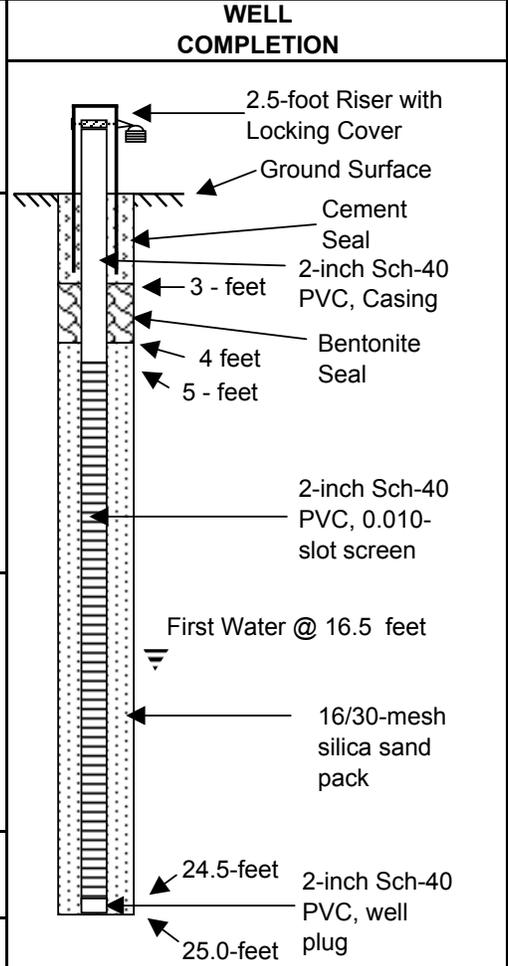
## LOG OF MW - LR1

**Project:** Bosque and Leon River Watersheds Study  
**Location:** Leon River at Hwy 236

**Started:** 11-22-02  
**Finished:** 11-22-02  
**Method:** Auger  
**Contractor:** Total Support Services  
**Observed By:** M. Randal Skinner

**Lat:** 31°18'49.91350"  
**Long:** 97°28'21.09970"  
**Elev TOC:** 613.03 feet  
**Drilled Depth:** 25 feet  
**Completed Depth:** 25 feet

DEPTH (feet)	% RECOVERY	USCS	LITHOLOGY
1	80%	CL	<b>0' - 14', Soil (organic)</b>
2			Silty clay, dark brown, dry
3			stream/marsh deposit
4			River deposit, becomes more silty
5			at base.
6			Possible bedding
7			
8			
9			
10			
11			
12			
13			
14	60%	LS	<b>14 - 22', Limestone</b>
15			Medium gray, moderately bedded,
16			recrystallized, slight dissolution, meteoric
17			Clay (interbedded marl)
18			Dark gray, slightly moist, friable,
19			bedding is thin, moderatley indurated
20			
21			
22			
23			<b>22' - 25', Limestone</b>
24			Very Hard
25			



▼ Represents the first observed water encountered during drilling



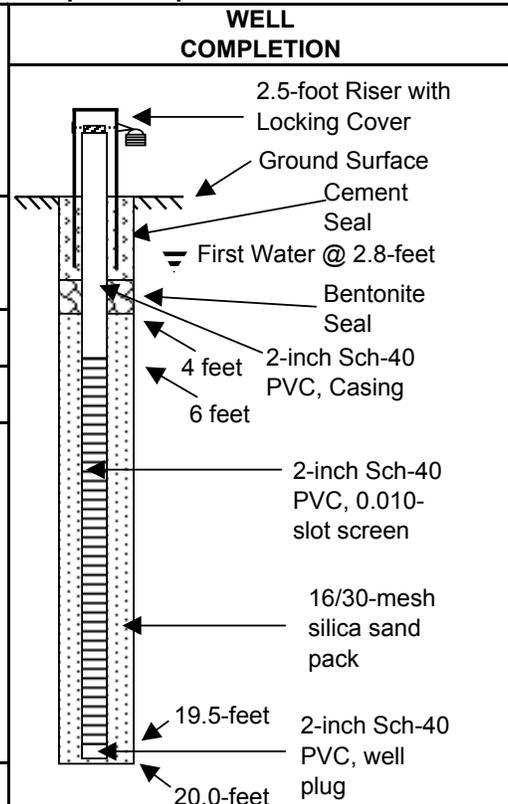
## LOG OF MW - HC1

**Project:** Bosque and Leon River Watersheds Study  
**Location:** Harris Creek at Middle Windsor Road

**Started:** 11-21-02  
**Finished:** 11-21-02  
**Method:** Auger  
**Contractor:** Total Support Services  
**Observed By:** M. Randal Skinner

**Lat:** 31°27'02.43722"  
**Long:** 97°24'12.02084"  
**Elev TOC:** 669.22 feet  
**Drilled Depth:** 20.0 feet  
**Completed Depth:** 20.0 feet

DEPTH (feet)	% RECOVERY	USCS	LITHOLOGY
1 2 3 4	90%	CL	0' - 4', Fill with Gravel
5 6	40%	CL	4' - 6' Claystone Silty clay, dark brown, partly dry to wet
7 8	40%	CL	6' - 8' Claystone (weathered LS) Silty clay, gray, partly dry to wet
9 10 11 12 13 14 15 16 17 18 19 20	60%	LS	8' - 20', Limestone Gray, thickly bedded, slightly fossiliferous recrystallized, slight dissolution, meteoric Clay (interbedded marl) Dark gray, slightly moist, friable, bedding is thin, moderately indurated



▽ Represents the first observed water encountered during drilling



# LOG OF MW - HC2

**Project:** Bosque and Leon River Watersheds Study  
**Location:** Harris Creek near Val Verde Road

**Started:** 11-11-02  
**Finished:** 11-11-02  
**Method:** Auger  
**Contractor:** Total Support Services  
**Observed By:** M. Randal Skinner

**Lat:** 31°28'52.49381"  
**Long:** 97°21'38.25835"  
**Elev TOC:** 604.34 feet  
**Drilled Depth:** 35 feet  
**Completed Depth:** 35 feet

DEPTH (feet)	% RECOVERY	USCS	LITHOLOGY	LITHOLOGIC DESCRIPTION	WELL COMPLETION	
1	90%	CL		<b>0' - 5', Soil</b> Silty clay, dark brown, dry black - organic layers throughout		2.5-foot Riser with Locking Cover
2				Ground Surface		
3				Cement Seal		
4				3 - feet Bentonite Seal		
5						
6	90%	CL		<b>5' - 10', Soil</b> Silty clay, dark brown, dry minor amount of limestone pebbles black - organic layers at top	2-inch Sch-40 PVC, Casing	
7				8 feet		
8						
9						
10						
11	90%	CL		<b>10' - 12.5', Claystone</b> Gray brown, dry, friable, bedding is fine, minor amount of limestone pebbles	10 - feet	
12						
13						
14						
15						
14	60%	LS		<b>12.5 - 31', Limestone</b> Gray, thickly bedded, slightly fossiliferous recrystalized, slight dissolution, meteoric Clay (interbedded marl) Dark gray, slightly moist, friable, bedding is thin, moderatley indurated	2-inch Sch-40 PVC, 0.010-slot screen	
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
32	10%	LS		<b>31 - 35', Limestone</b> Gray, Very Hard,	16/30-mesh silica sand pack	
33						
34						
35						
35						
Represents the first observed water encountered during drilling						
					34.5-feet	2-inch Sch-40 PVC, well plug
					35.0-feet	



## LOG OF MW - SBR3

<b>Project:</b> Bosque and Leon River Watersheds Study <b>Location:</b> South Bosque River at Church Road	<b>Started:</b> 11-13-02 <b>Finished:</b> 11-13-02 <b>Method:</b> Auger <b>Contractor:</b> Total Support Services <b>Observed By:</b> M. Randal Skinner	<b>Lat:</b> 31°27'39.34026" <b>Long:</b> 97°17'45.51484" <b>Elev TOC:</b> 507.21 feet <b>Drilled Depth:</b> 25 feet <b>Completed Depth:</b> 25 feet
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DEPTH (feet)	% RECOVERY	USCS	LITHOLOGY	LITHOLOGIC DESCRIPTION	WELL COMPLETION
1	80%	CL		<b>0' - 12', Soil (organic)</b>	<p style="font-size: small;">           2.5-foot Riser with Locking Cover            Ground Surface            Cement Seal            2-inch Sch-40 PVC, Casing            3 - feet Bentonite Seal            5 - feet            6 - feet            16/30-mesh silica sand pack            2-inch Sch-40 PVC, 0.010-slot screen            First Water @ 15.1-feet            24.5-feet 2-inch Sch-40 PVC, well plug            25.0-feet         </p>
2				Silty clay, dark brown to black, dry stream/marsh deposit	
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13	60%	LS		<b>12 - 22', Limestone</b>	<p style="font-size: small;">           24.5-feet 2-inch Sch-40 PVC, well plug            25.0-feet         </p>
14				Gray, thickly bedded, slightly fossiliferous recrystallized, slight dissolution, meteoric Clay (interbedded marl)	
15					
16					
17					
18					
19					
20					
21					
22					
23	20%	LS		<b>22' - 25', Limestone</b>	<p style="font-size: small;">           25.0-feet         </p>
24				as above, very hard	
25					
Represents the first observed water encountered during drilling					



## LOG OF MW - SBR1

**Project:** Bosque and Leon River Watersheds Study  
**Location:** South Bosque River at Indian Trail Road

**Started:** 11-13-02  
**Finished:** 11-14-02  
**Method:** Auger  
**Contractor:** Total Support Services  
**Observed By:** M. Randal Skinner

**Lat:** 31°24'29.11142"  
**Long:** 97°22'08.28999"  
**Elev TOC:** 620.50 feet  
**Drilled Depth:** 25 feet  
**Completed Depth:** 25 feet

DEPTH (feet)	% RECOVERY	USCS	LITHOLOGY	LITHOLOGIC DESCRIPTION	WELL COMPLETION
1			[Soil symbol]	<b>0' - 2', Soil (organic)</b>	<p style="text-align: right;">2.5-foot Riser with Locking Cover</p> <p style="text-align: right;">Ground Surface</p> <p style="text-align: right;">Cement Seal</p> <p style="text-align: right;">3 - feet 2-inch Sch-40 PVC, Casing</p> <p style="text-align: right;">5 - feet Bentonite Seal</p> <p style="text-align: right;">7 - feet Bentonite Seal</p> <p style="text-align: right;">First Water @ 12.5-feet</p> <p style="text-align: right;">2-inch Sch-40 PVC, 0.010-slot screen</p> <p style="text-align: right;">16/30-mesh silica sand pack</p> <p style="text-align: right;">24.5-foot 2-inch Sch-40 PVC, well plug</p> <p style="text-align: right;">25.0-foot</p>
2	80%	CL	[Silty clay symbol]	Silty clay, dark brown, dry	
3	40%	GR	[Gravel symbol]	<b>2' - 12', Gravel &amp; Dirt</b>	
4				Limestone pebbles, well sorted, moderately rounded,	
5				Dirt is Fe rich and thin	
6				Adjacent area has been quarried for gravel	
7					
8					
9					
10					
11					
12					
13	60%	LS	[Limestone symbol]	<b>12 - 25', Limestone</b>	
14				Gray, thickly bedded, slightly fossiliferous	
15				recrystallized, slight dissolution, meteoric	
16				Clay (interbedded marl)	
17				Dark gray, slightly moist, friable,	
18				bedding is thin, moderatley indurated	
19					
20					
21					
22					
23					
24					
25					

∇ Represents the first observed water encountered during drilling



## LOG OF MW - SBR2

**Project:** Bosque and Leon River Watersheds Study  
**Location:** South Bosque River near Cotton Belt Pkw

**Started:** 11-12-02  
**Finished:** 11-12-02  
**Method:** Auger  
**Contractor:** Total Support Services  
**Observed By:** M. Randal Skinner

**Lat:** 31°25'33.59777"  
**Long:** 97°18'53.11641"  
**Elev TOC:** 549.33 feet  
**Drilled Depth:** 37.5 feet  
**Completed Depth:** 37.5 feet

DEPTH (feet)	% RECOVERY	USCS	LITHOLOGY	LITHOLOGIC DESCRIPTION	WELL COMPLETION
1	90%	CL	[Soil pattern]	<b>0' - 4', Soil</b> Silty clay, dark brown, partly dry to moist, no limestone fraction, grades orange at base.	<p style="text-align: right;">2.5-foot Riser with Locking Cover</p> <p style="text-align: right;">Ground Surface</p> <p style="text-align: right;">Cement Seal</p> <p style="text-align: right;">← 3 - feet</p> <p style="text-align: right;">Bentonite Seal</p> <p style="text-align: right;">← 8.0-feet</p> <p style="text-align: right;">2-inch Sch-40 PVC, Casing</p> <p style="text-align: right;">← 10.0-feet</p> <p style="text-align: right;">← 23.5 - feet</p> <p style="text-align: right;">2-inch Sch-40 PVC, 0.010-slot screen</p> <p style="text-align: right;">First Water @ 23.5 - feet</p> <p style="text-align: right;">← 16/30-mesh silica sand pack</p> <p style="text-align: right;">← 37.0-feet</p> <p style="text-align: right;">2-inch Sch-40 PVC, well plug</p>
2					
3					
4					
5	40%	CL & LS	[Limestone pattern]	<b>4' - 11' Weathered Limestone and Soil</b> Weathered limestone, mostly as rounded to sub angular chips, grayish brown to dark orange, dry	
6					
7					
8					
9					
10					
11					
12	90%	CL	[Claystone pattern]	<b>11' - 16', Claystone</b> Gray brown, dry, friable, bedding is fine, possible organics in bedding layers. moderatley indurated	
13					
14					
15					
16					
17	90%	CL	[Claystone pattern]	<b>16' - 26', Claystone</b> Dark gray, slightly moist, friable, bedding is thin, possible organics in bedding layers, moderatley indurated	
18					
19					
20					
21					
22					
23					
24					
25					
26					
27	70%	CL & LS	[Limestone pattern]	<b>26' - 32', Limestone with Clay</b> Gray, thickly bedded, slightly fossiliferous recrystalized, slight dissolution, meteoric Clay (interbedded marl)	
28					
29					
30					
31					
32	60%	LS	[Limestone pattern]	<b>32' - 37.5', Limestone</b> Gray, thickly bedded, slightly fossiliferous recrystalized, slight dissolution, meteoric	
33					
34					
35					
36					
37					
				Represents the first observed water encountered during drilling	



## LOG OF MW - SBR5

**Project:** Bosque and Leon River Watersheds Study  
**Location:** South Bosque River at HWY 84

**Started:** 10-21-02  
**Finished:** 10-22-02  
**Method:** Auger  
**Contractor:** Total Support Services  
**Observed By:** M. Randal Skinner

**Lat:** 31°29'05.31520"  
**Long:** 97°16'17.624000"  
**Elev TOC:** 465.13 feet  
**Drilled Depth:** 24.5 feet  
**Completed Depth:** 24.5 feet

▼ Represents the first observed water encountered during drilling