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Petrographic Analysis of Cores from Plant 42

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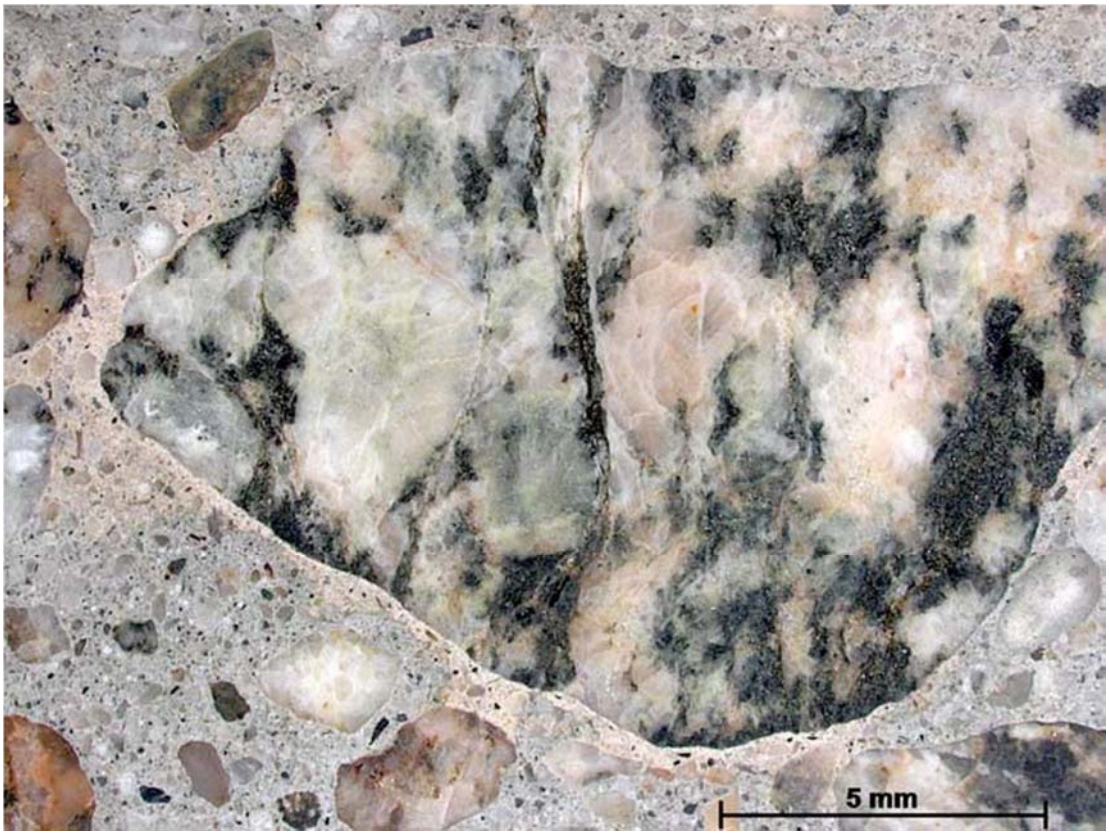

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Preface

This study was conducted in support of the US-AFCEC. The 13 cores, from Air Force Plant 42, were logged in as CMB No. 160143-1 to 160143-13, were subjected to an in-depth analysis consisting of visual and petrographic examination. The technical monitor was Dr. Robert D. Moser of the U.S. Army Engineer Research and Development (ERDC).

The work was performed by the Concrete and Materials Branch (GMC), of the Engineering Systems and Materials Division (GM), US Army Engineer Research and Development Center (ERDC), Geotechnical and Structures Laboratory (ERDC-GSL). At the time of publication, Christopher M. Moore was Chief, CEERD-GMC; Dr. Gordon W. McMahon was Chief, CEERD-GM. The Deputy Director of ERDC-GSL was Dr. William P. Grogan and the Director was Mr. Bart Durst.

COL Bryan Green was the Commander of ERDC, and Dr. Jeffery P. Holland was the Director.

1 Scope

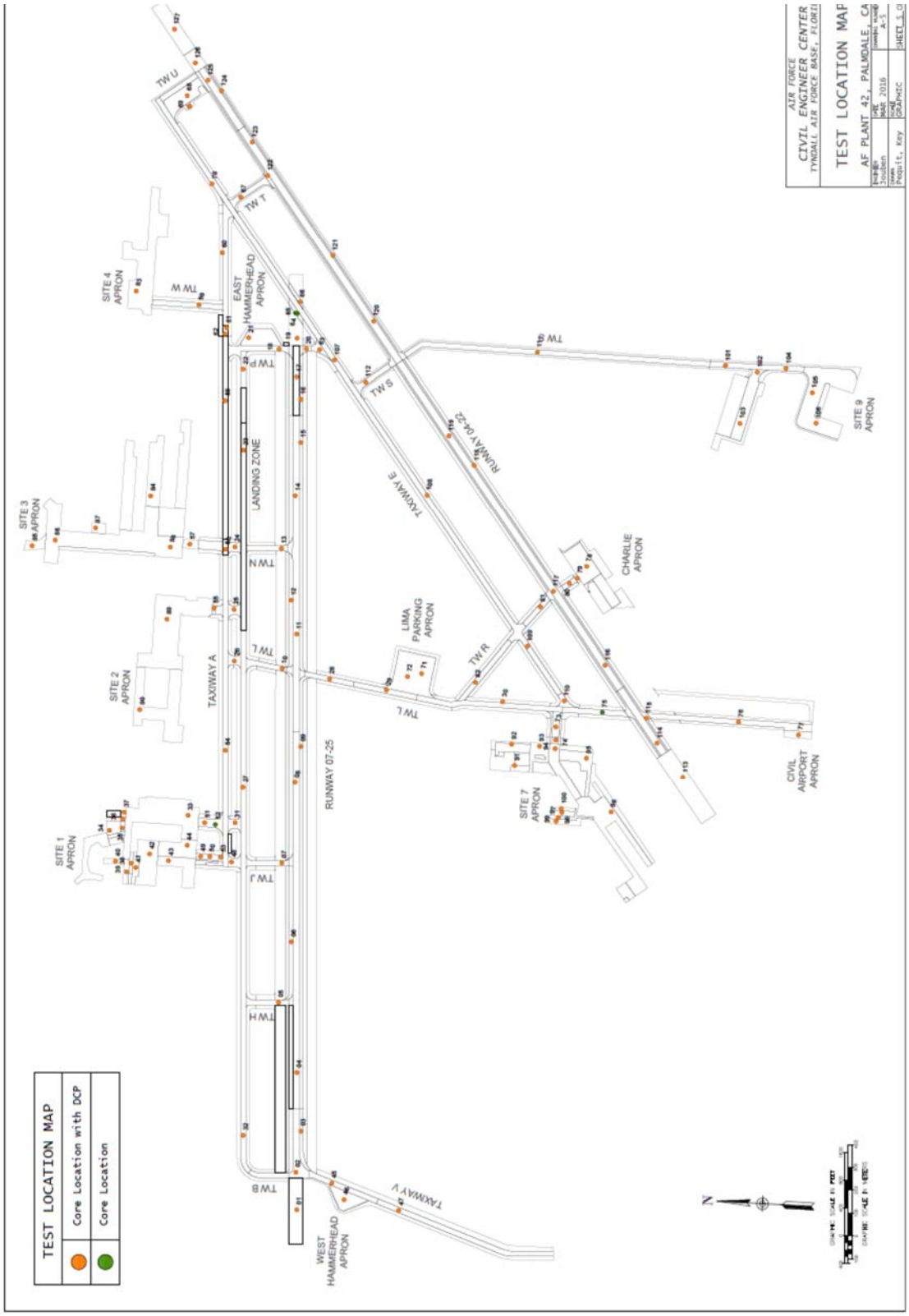
The Concrete and Materials Branch (CMB) of the Geotechnical and Structures Laboratory was requested to perform an analysis on concrete core samples extracted from Air Force Plant 42. A total of 13 cores were provided to the CMB which were checked in under CMB Serial Numbers 160143-1 to 160143-13. Table 1 lists the cores received with the CMB serial number, original sample identifier, section sample came from, and core length. Each core underwent petrographic examination according to ASTM C-856. Scanning electron microscopy (SEM) imaging, was performed on a samples to identify material in voids. The location of the extracted core locations can be seen in Figure 1.

The following sections provide a summary of the methods utilized, results obtained from each core, and a summary of observed condition of cores for the site investigated.

Table 1. Summary of cores received, corresponding CMB Serial No, core number from site, section sample came from, and core length.

CMB ID	Core #	Section	Core Length (in)
160143-1	02T	R01A	8.5
160143-2	04T	R03C	8.75
160143-3	05T	T03A	9.75
160143-4	08T	803C	9.5
160143-5	11T	R14C	6.5
160143-6	13T	T14A	6.75
160143-7	25T	T06A	7.5
160143-8	28	T33A	9.875
160143-9	54T	T07A	6.75
160143-10	56T	T35A	9.5
160143-11	78T	A13B	6.75
160143-12	120T	R13C	7.75
160143-13	123T	R13C	6.625

Figure 1. Test location map of AF Plant 42 with core number locations.



2 Methods

Testing was conducted to determine the mineralogical constituents of the concrete and any possible chemical reactions and microstructural deterioration present. The following describes the methods utilized.

2.1 Petrographic Analysis

Modes of distress such as sulfate attack, microcracking, and overall concrete quality were assessed by visual examination of the as received cores as well as a petrographic analysis performed on polished cross sections conducted according to ASTM C856 - Standard Practice for Petrographic Examination of Hardened Concrete. A 25 mm thick section of a core was cut and prepared for the petrographic analysis. The section for petrographic analysis was polished using diamond incrusted polishing pads. The polished sample was imaged using a Zeiss Stereo Discovery V20 microscope at magnifications of 5 X to 40 X. An overall image was obtained for the sample at low magnification, and at least three selected sites were also imaged at higher magnification. Specific focus was given to microcracking, air void structure, aggregate deterioration, and any other possible modes of concrete deterioration that are relevant for service life estimation.

2.2 Scanning Electron Microscopy (SEM)

A specimen was examined using scanning electron microscopy (SEM) to obtain high-resolution image to examine the deposits within an air void to determine the crystallinity of the deposit. SEM imaging was per-formed using an FEI Nova NanoSEM 630, capable of high-resolution imaging on non-conductive materials. Imaging was performed in low-vacuum mode at pressures of 0.1-0.5 mbar and accelerating voltage of 15kV.

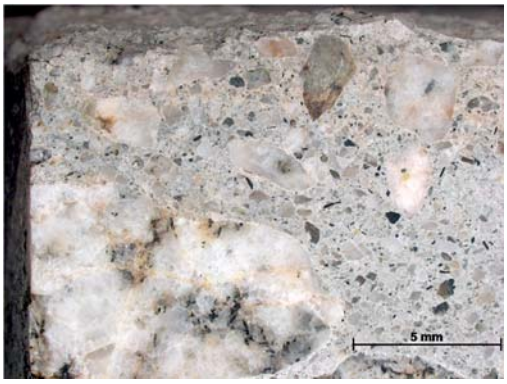
3 Results and Discussion

3.1 Core Sample 160143-1 (02T)

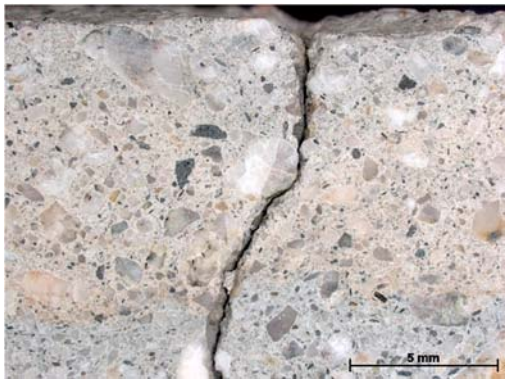
The as-received core 160143-1 (02T) is shown in Figure 2. The core was 8.5 inches long and 6 inches in diameter. There were 2 cracks greater than 0.5mm in width, one extends 3 in into core, extends through 2 coarse aggregates and terminates at a coarse aggregate. The second crack extends 3.5 in into core, extends around 1 coarse aggregate, but through 4 others. Carbonation staining is within the top inch from the surface. There was some staining along the longer crack, indicating the crack was most likely a shrinkage crack from construction. There was minor aggregate distress observed, but no severe ASR deterioration observed. See Figure 3 for low and high magnification microscopy images of 160143-1 (02T).

Figure 2. The as-received core 160143-1 (02T).

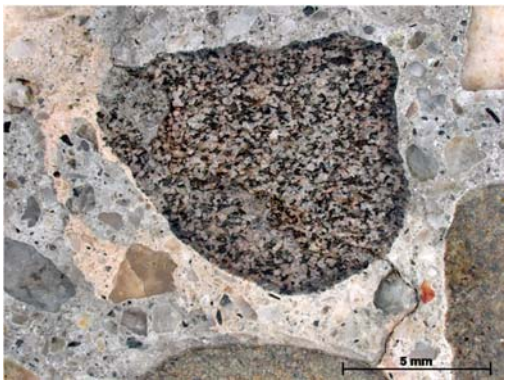
Figure 3. Low and High magnifications of 160143-1 (02T). (a) minor carbination sataining at the surface, (b) carbination stainging and crack at the surface, (c) carbination staining around cracked aggregate, (d) high magnifiction to see fine aggregate and cement, minir cracking.



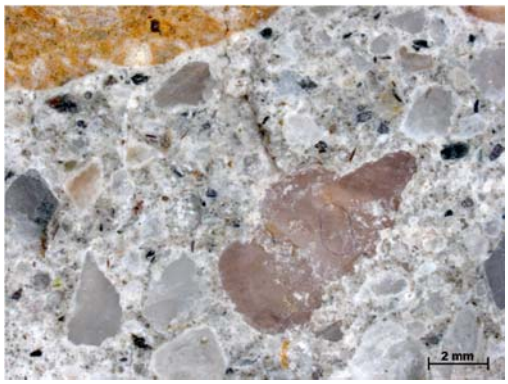
(a) Low magnification photomicrograph



(b) Low magnification photomicrograph



(c) Low magnification photomicrograph



(d) High magnification photomicrograph

3.2 Core Sample 160143-2 (04T)

The as-received core 160143-2 (04T) is shown in Figure 4. The core was 8.75 inches long and 6 inches in diameter. A crack over 2 in into concrete, greater than 0.5mm width, extends through 2 coarse aggregates and terminates at a coarse aggregate. Carbonation staining is within the top inch from the surface, mainly around aggregates. There was some staining along the longer crack, indicating the crack was most likely a shrinkage crack from construction. Air voids are infilled with precipitates (ettringite and calcium hydroxide). A void, seen in Figure 5 (b), appears to be from an aggregate that popped out earlier or from a large entrapped air void

Figure 4. The as-received core 160143-2 (04T).

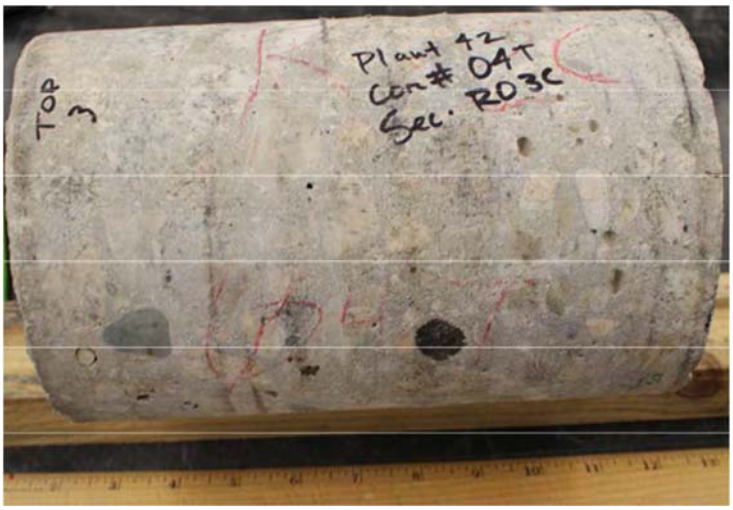
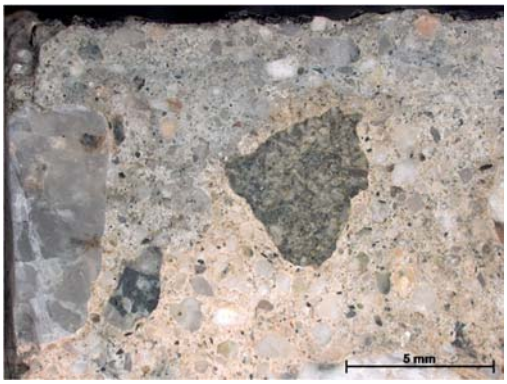
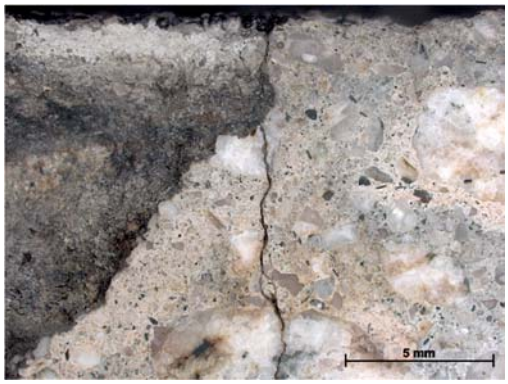


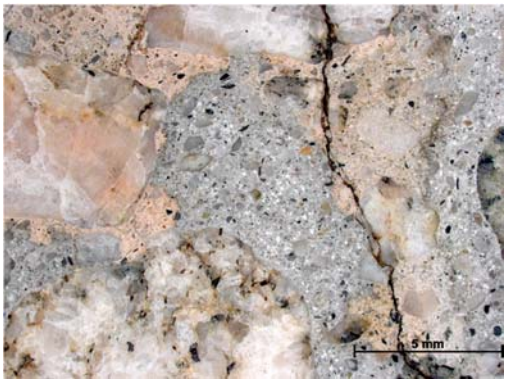
Figure 5. Low and High magnifications of 160143-2 (04T). (a) carbination sataining at the surface, (b) carbination stainging, crack at the surface, and large void most likely due to aggregate pop out, (c) carbination staining around cracked aggregate, (d) high magnifiction to see fine aggregate and cement, minir cracking.



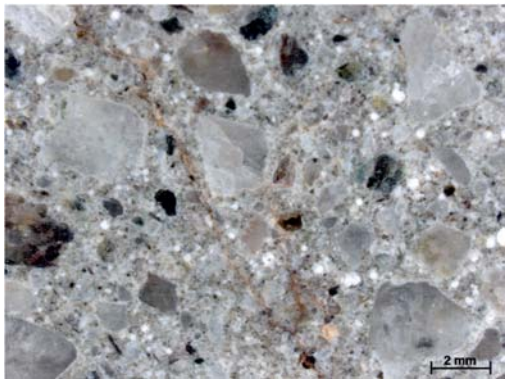
(a) Low magnification photomicrograph



(b) Low magnification photomicrograph



(c) Low magnification photomicrograph



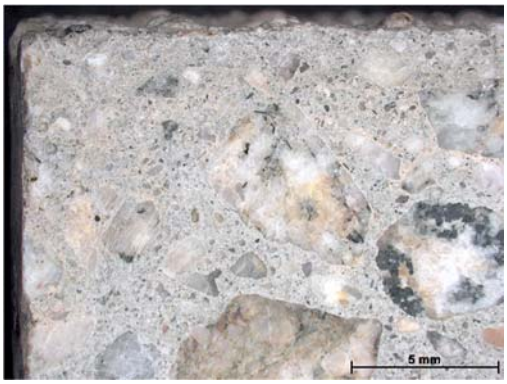
(d) High magnification photomicrograph

3.3 Core Sample 160143-3 (05T)

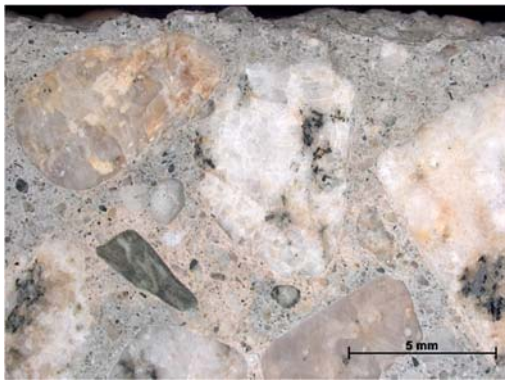
The as-received core 160143-3 (05T) is shown in Figure 6. The core was 9.75 inches long and 6 inches in diameter. There was minor carbonation staining within an inch of the surface. A crack was observed to extend 3mm, was less than 0.1 mm width and terminates at a coarse aggregate. Some crack was observed in the coarse aggregate of which followed the foliated fabric of the aggregate. Voids were partially infilled with a white deposit, most likely ettringite and calcium hydroxide. See Figure 7 for low and high magnification microscopy images of 160143-1 (02T).

Figure 6. The as-received core 160143-3 (05T).

Figure 7. Low and High magnifications of 160143-3 (05T). (a) minor carbination sataining at the surface, (b) carbination stainging at the surface, (c) carbination staining around cracked aggregate, (d) high magnifiction to see fine aggregate and cement.

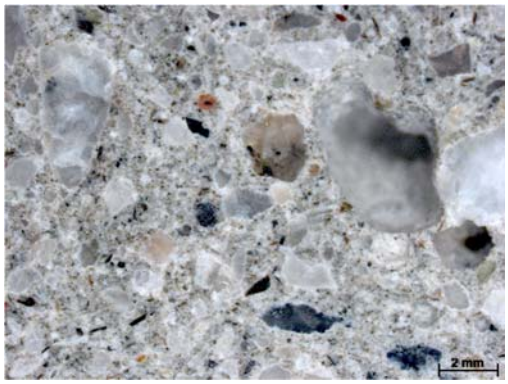


(a) Low magnification photomicrograph



(b) Low magnification photomicrograph

(c) Low magnification photomicrograph



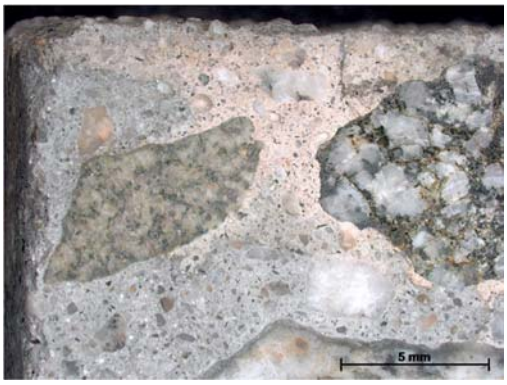
(d) High magnification photomicrograph

3.4 Core Sample 160143-4 (08T)

The as-received core 160143-4 (08T) is shown in Figure 8. The core was 9.5 inches long and 6 inches in diameter. The large vertical crack in as received core caused sample to separate upon cutting core. The crack did not appear to go through any coarse aggregates. Minor carbonation staining within an inch of the surface was observed. There was no visible signs of ASR gel or damage due to ASR gel expansion. Voids were partially infilled with a white deposit, most likely ettringite and calcium hydroxide. See Figure 9 for low and high magnification microscopy images of 160143-4 (08T).

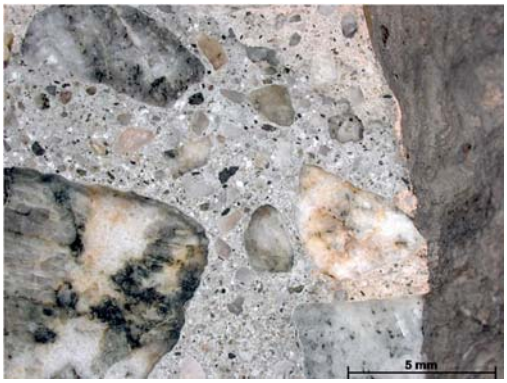
Figure 8. The as-received core 160143-4 (08T).

Figure 9. Low and High magnifications of 160143-4 (08T). (a) minor carbination sataining at the surface, (b) carbination stainging at the surface, (c) carbination staining following preexisting crack, (d) high magnifiction to see fine aggregate and cement.

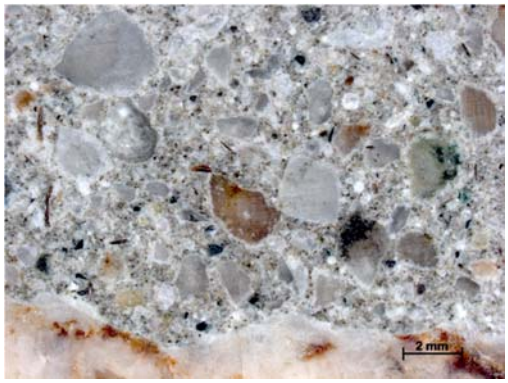


(a) Low magnification photomicrograph

(b) Low magnification photomicrograph



(c) Low magnification photomicrograph



(d) High magnification photomicrograph

3.5 Core Sample 160143-5 (11T)

The as-received core 160143-5 (11T) is shown in Figure 10. The core was 6.5 inches long and 6 inches in diameter. Very minor staining at surface is due to carbonation and deeper in sample oxidation of iron oxide inclusions in aggregates. Voids were partially infilled with a white deposit, most likely ettringite and calcium hydroxide. There were 2 vertical cracks observed, the first extended 20mm, greater than 0.2 mm wide and terminates in a coarse aggregate. The second crack extended 12mm and terminated at a coarse aggregate, and was greater than 0.1mm width. This sample contained large entrapped air voids (greatest was 3/8" x ¼"). A coarse aggregate has cracking throughout the aggregate, cracks follow the foliation of the aggregate and does not appear to extend into paste. Some of the microcracks appear to be infilled with gel, evidence of minor ASR. See Figure 11 for low and high magnification microscopy images of 160143-5 (11T).

Figure 10. The as-received core 160143-5 (11T).

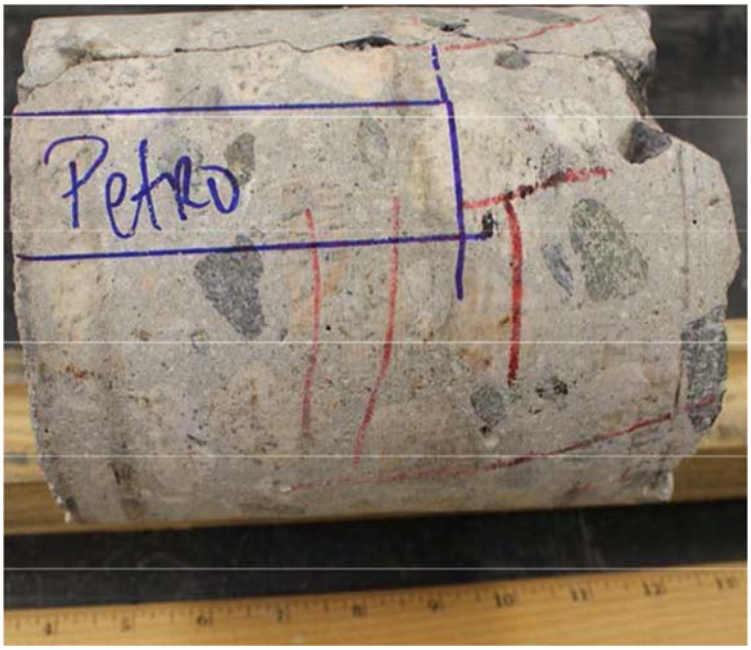
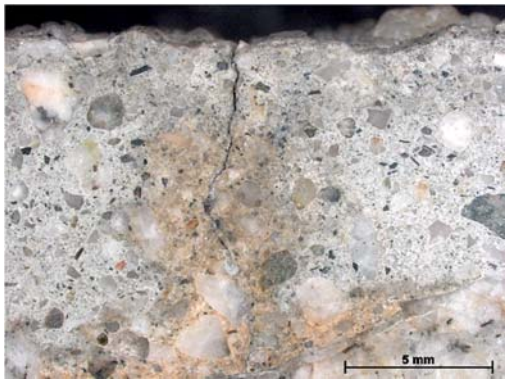
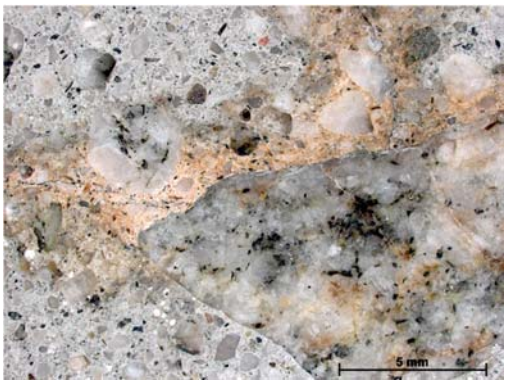


Figure 11. Low and High magnifications of 160143-5 (11T). (a) minor carbination sataining at the surface, (b) carbination stainging at the surface following older crack, (c) carbination staining around coarse aggregate, (d) high magnifiction to see fine aggregate and cement.

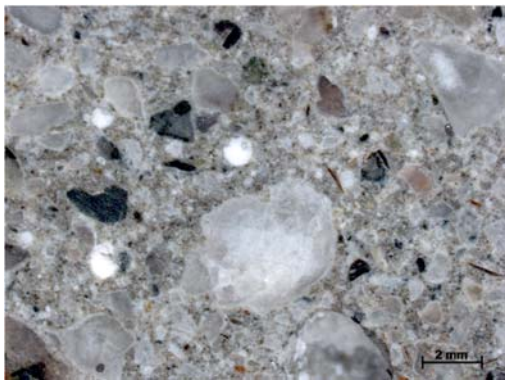
(a) Low magnification photomicrograph



(b) Low magnification photomicrograph



(c) Low magnification photomicrograph



(d) High magnification photomicrograph

3.6 Core Sample 160143-6 (13T)

The as-received core 160143-6 (13T) is shown in Figure 12. The core was 6.75 inches long and 6 inches in diameter. Minor carbonation staining within a half inch of the surface was observed. There was no visible signs of ASR gel or damage due to ASR gel expansion. Voids were partially in-filled with a white deposit, most likely ettringite and calcium hydroxide. A crack, 11mm deep and less than 0.1mm width, was observed. Carbonation staining was observed along this crack. See Figure 13 for low and high magnification microscopy images of 160143-6 (13T).

Figure 12. The as-received core 160143-6 (13T).

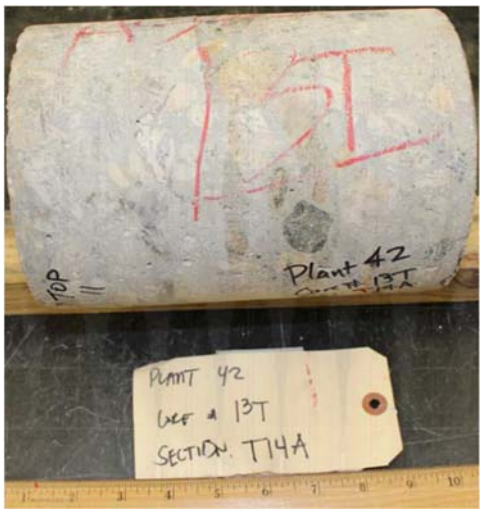
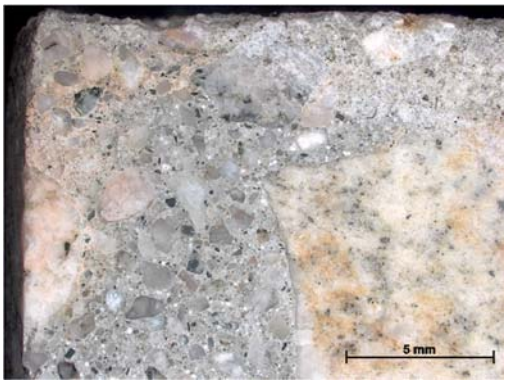
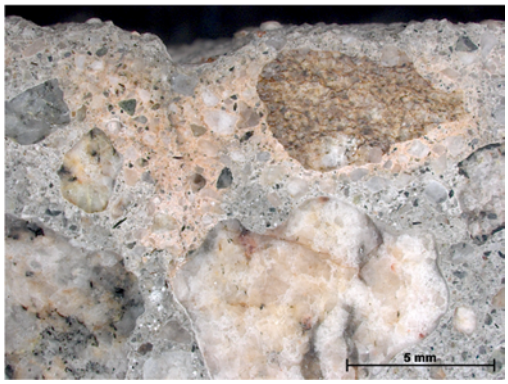


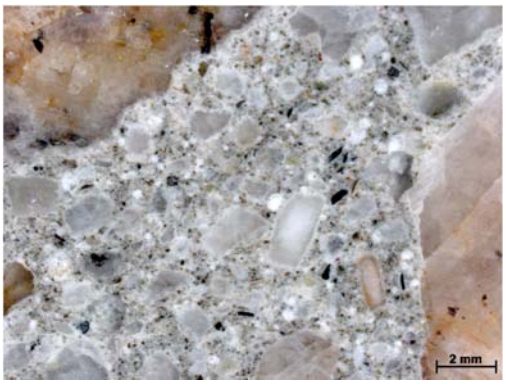
Figure 13. Low and High magnifications of 160143-6 (13T). (a) minor carbination sataining at the surface, (b) carbination stainging at the surface around coarse aggregates, (c) high magnifiction to see fine aggregate and cement.



(a) Low magnification photomicrograph



(b) Low magnification photomicrograph



(c) High magnification photomicrograph

3.7 Core Sample 160143-7 (25T)

The as-received core 160143-7 (25T) is shown in Figure 14. The core was 7.5 inches long and 6 inches in diameter. Minor carbonation staining within an inch of the surface was observed. There was no visible signs of ASR gel or damage due to ASR gel expansion. Voids were partially infilled with a white deposit, most likely ettringite and calcium hydroxide. A crack extends 45mm from the surface and was greater than 0.5mm width. The crack extended around 1 coarse aggregate, but through 2 others, likely due to mechanical stresses. See Figure 15 for low and high magnification microscopy images of 160143-7 (25T).

Figure 14. The as-received core 160143-7 (25T).

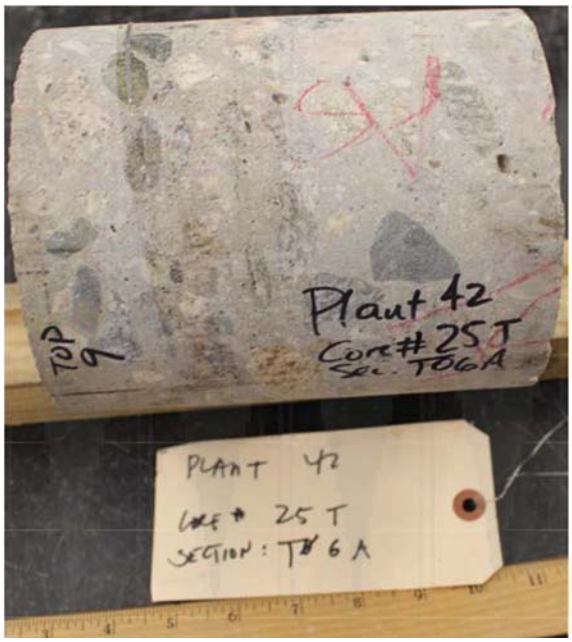
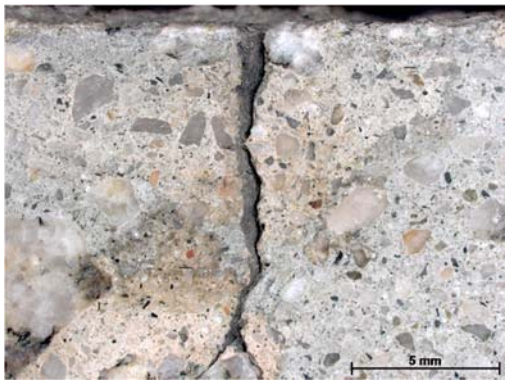
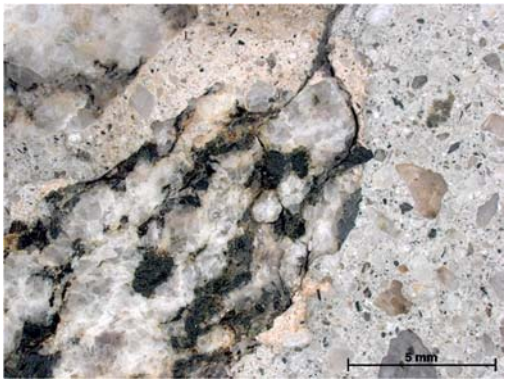


Figure 15. Low and High magnifications of 160143-7 (25T). (a) little to no carbination sataining at the surface, (b) carbination stainging at the surface following older crack, (c) carbination staining around cracked coarse aggregate, (d) high magnifiction to see fine aggregate and cement.

(a) Low magnification photomicrograph



(b) Low magnification photomicrograph



(c) Low magnification photomicrograph

(d) High magnification photomicrograph

3.8 Core Sample 160143-8 (28)

The as-received core 160143-8 (28) is shown in Figure 16. The core was 9.875 inches long and 6 inches in diameter. Minor carbonation staining within an inch of the surface was observed. There was no visible signs of ASR gel or damage due to ASR gel expansion. Voids were partially infilled with a white deposit, most likely ettringite and calcium hydroxide. A crack extended through the sample, greater than 0.5mm width, but sample remained intact. The crack did not extend through any aggregates except the edge of one at 3 in in depth. See Figure 17 for low and high magnification microscopy images of 160143-8 (28).

Figure 16. The as-received core 160143-8 (28).

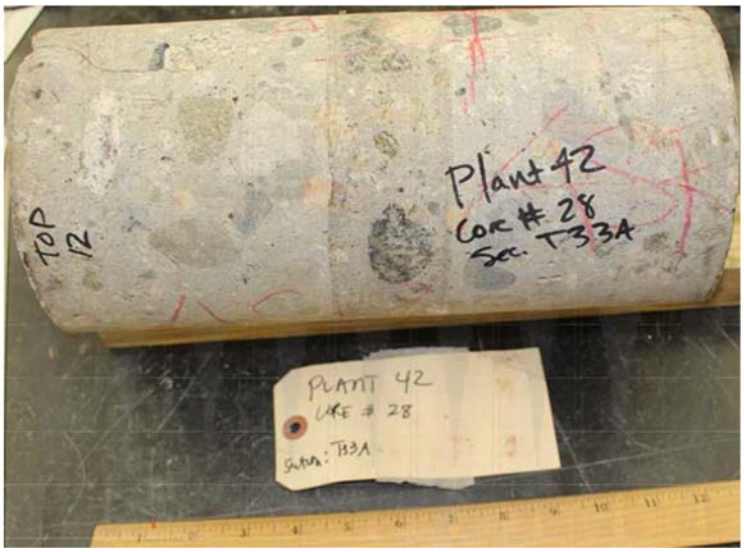
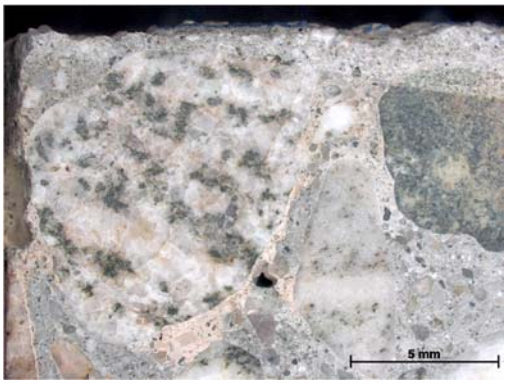
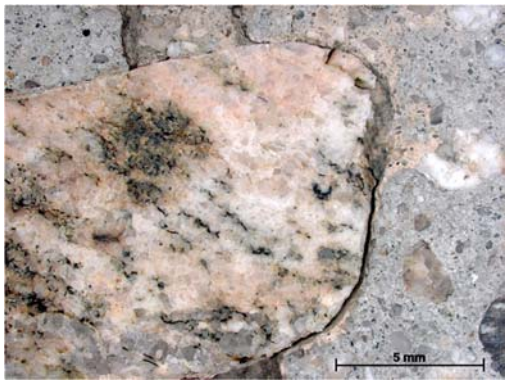


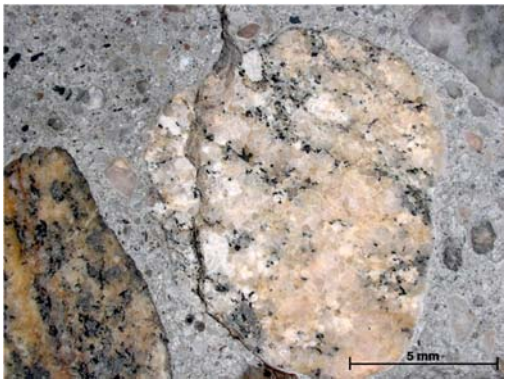
Figure 17. Low and High magnifications of 160143-8 (28). (a) minor carbination sataining at the surface, (b) carbination stainging following crack around coarse aggregate, (c) crack extending through coarse aggregate, (d) high magnifiction to see fine aggregate and cement.



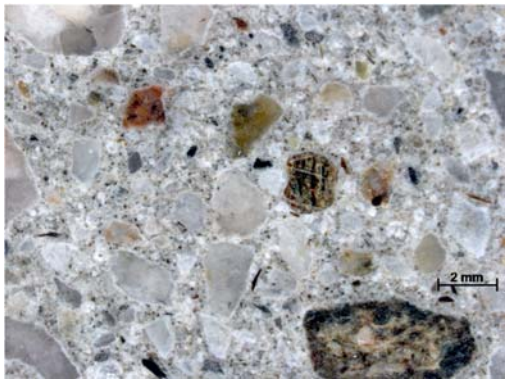
(a) Low magnification photomicrograph



(b) Low magnification photomicrograph



(c) Low magnification photomicrograph



(d) High magnification photomicrograph

3.9 Core Sample 160143-9 (54T)

The as-received core 160143-9 (54T) is shown in Figure 18. The core was 6.75 inches long and 6 inches in diameter. Minor carbonation staining within an inch of the surface was observed. There was no visible signs of ASR gel or damage due to ASR gel expansion. Voids were partially infilled with a white deposit, most likely ettringite and calcium hydroxide. A crack at surface was 7mm deep and less than 0.1 mm in width, and terminates at a coarse aggregate. Coarse aggregate near the surface show signs of chemical weathering at grain boundaries within the aggregate, most likely due to wetting at the surface. Similar aggregates look like a gneiss and show no sign of weathering of chemical alteration with depth. See Figure 19 for low and high magnification microscopy images of 160143-9 (54T).

Figure 18. The as-received core 160143-9 (54T).

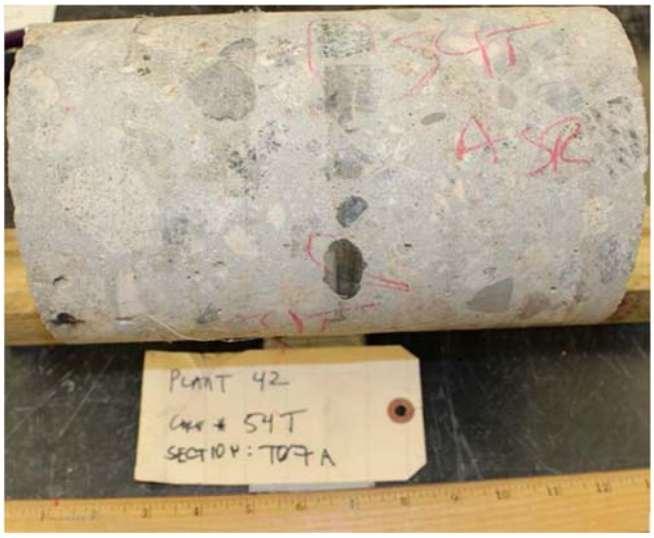
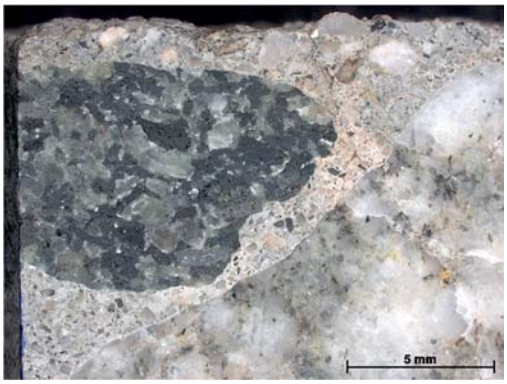
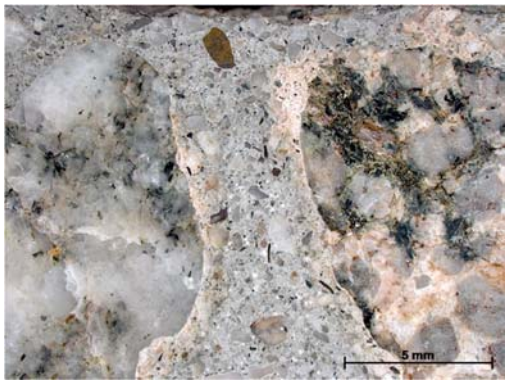


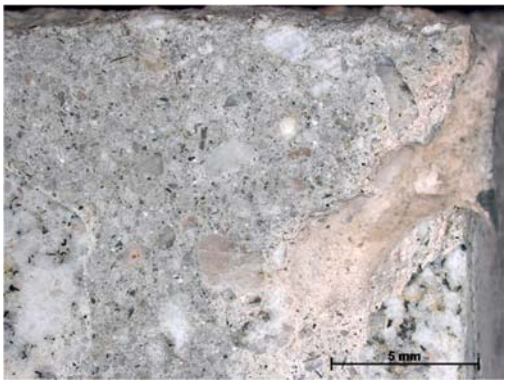
Figure 19. Low and High magnifications of 160143-9 (54T). (a) minor carbination sataining at the surface, (b) carbination stainging following coarse aggregate, (c) carbination staining in older void, (d) high magnifiction to see fine aggregate and cement.



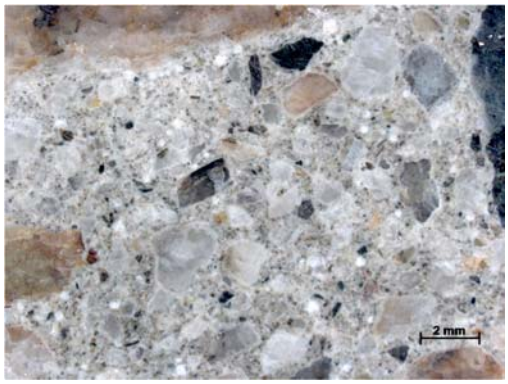
(a) Low magnification photomicrograph



(b) Low magnification photomicrograph



(c) Low magnification photomicrograph



(d) High magnification photomicrograph

3.10 Core Sample 160143-10 (56T)

The as-received core 160143-10 (56T) is shown in Figure 20. The core was 9.5 inches long and 6 inches in diameter. There was no visible signs of ASR gel or damage due to ASR gel expansion, and no visible staining due to carbonation. Voids were partially infilled with a white deposit, most likely ettringite and calcium hydroxide. Two cracks were observed, both 20mm deep and greater than 0.2mm width. See Figure 21 for low and high magnification microscopy images of 160143-10 (56T).

Figure 20. The as-received core 160143-10 (56T).

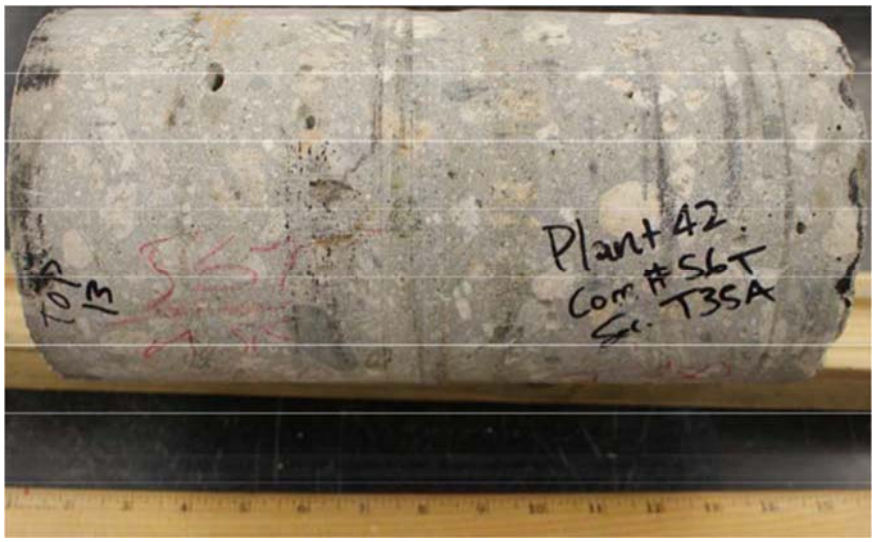
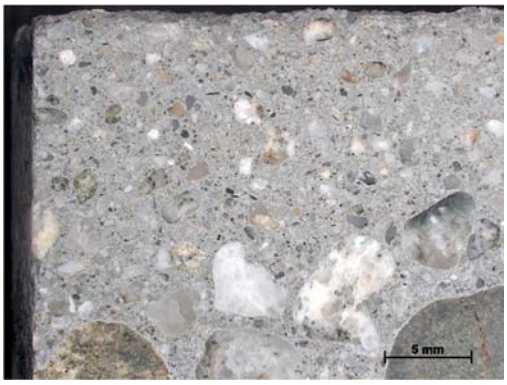


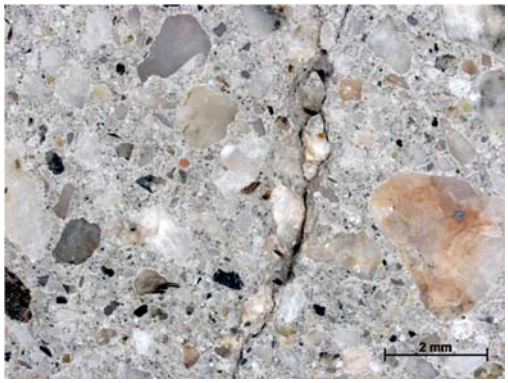
Figure 21. Low and High magnifications of 160143-10 (56T). (a) little to no carbination sataining at the surface, (b) cracks at the surface of the sample, (c) crack in coarse aggregate with iron staining, (d) high magnifiction to see fine aggregate and cement with cracking.



(a) Low magnification photomicrograph

(b) Low magnification photomicrograph

(c) Low magnification photomicrograph



(d) High magnification photomicrograph

3.11 Core Sample 160143-11 (78T)

The as-received core 160143-11 (78T) is shown in Figure 22. The core was 6.75 inches long and 6 inches in diameter. Minor carbonation staining within an inch of the surface was observed. There was no visible signs of ASR gel or damage due to ASR gel expansion. Voids were partially infilled with a white deposit, most likely ettringite and calcium hydroxide. A crack was observed that extends 15mm from the surface and was less than 0.1mm in width. See Figure 23 for low and high magnification microscopy images of 160143-11 (78T).

Figure 22. The as-received core 160143-11 (78T).

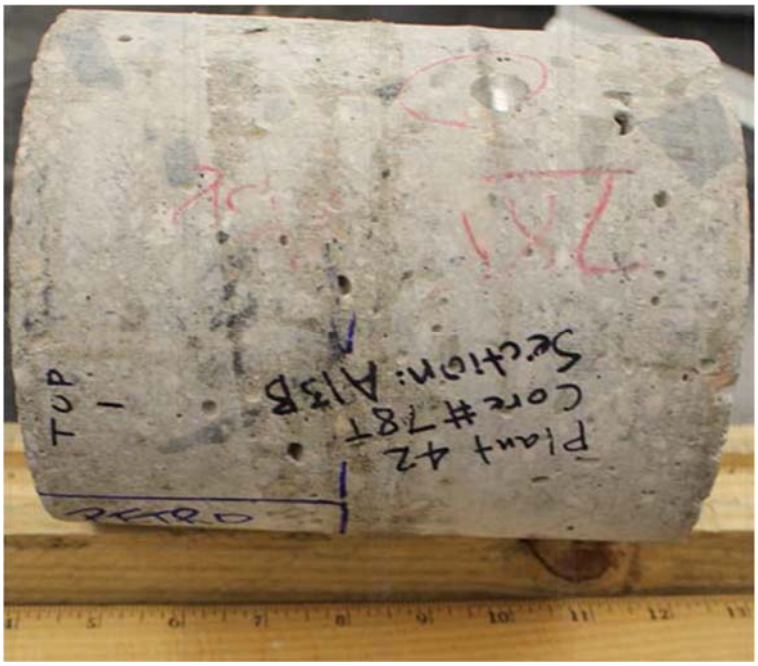
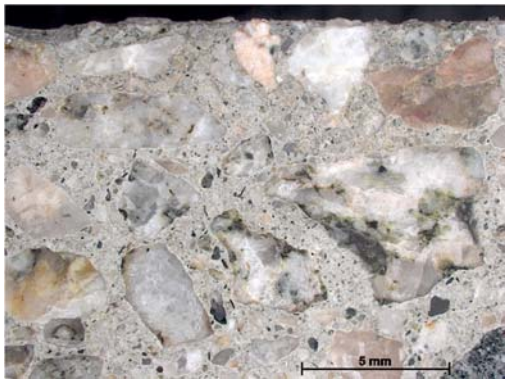
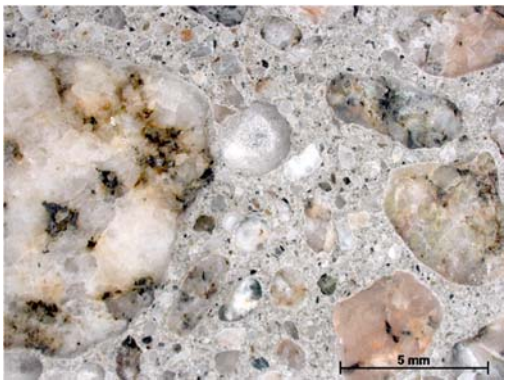


Figure 23. Low and High magnifications of 160143-10 (56T). (a) little to no carbination sataining at the surface, (b)little to no satining at the surface, (c) very little destress seen within the sample, (d) high magnifiction to see fine aggregate and cement.

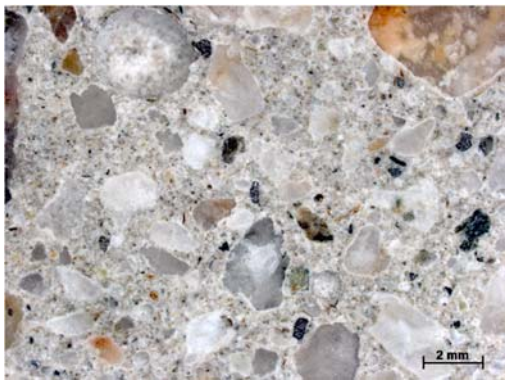
(a) Low magnification photomicrograph



(b) Low magnification photomicrograph



(c) Low magnification photomicrograph



(d) High magnification photomicrograph

3.12 Core Sample 160143-12 (120T)

The as-received core 160143-12 (120T) is shown in Figure 24. The core was 7.75 inches long and 6 inches in diameter. There was no visible carbonation staining observed. There was no visible signs of ASR gel or damage due to ASR gel expansion. Voids were partially infilled with a white deposit, most likely ettringite and calcium hydroxide. A crack was observed at the surface, extends 30mm into sample and was less than 0.1mm in width. See Figure 25 for low and high magnification microscopy images of 160143-12 (120T).

Figure 24. The as-received core 160143-12 (120T).

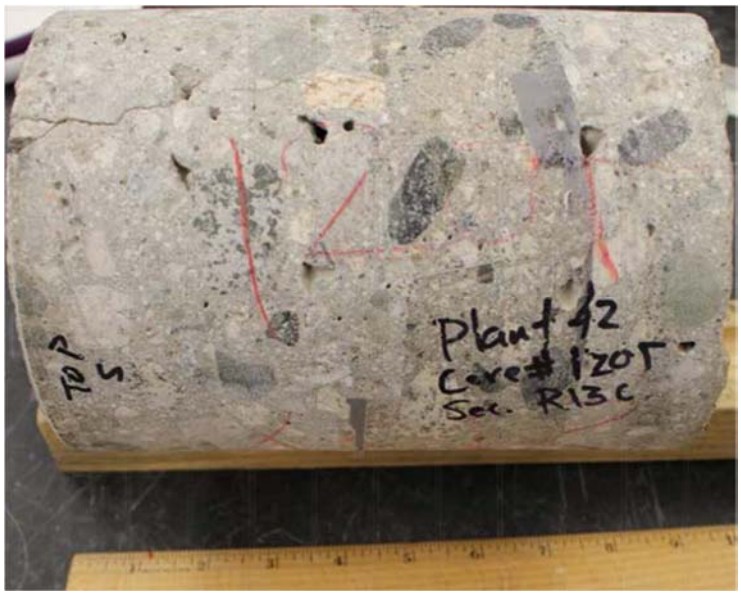
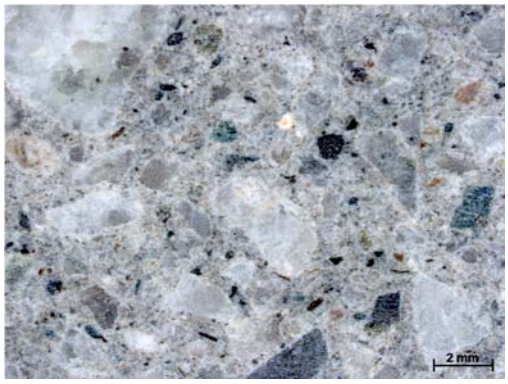


Figure 25. Low and High magnifications of 160143-12 (120T). (a) little to no carbination sataining at the surface, (b) fine crack at the surface of the sample, (c) minor staining around coarse aggregate, (d) high magnifiction to see fine aggregate and cement.

(a) Low magnification photomicrograph

(b) Low magnification photomicrograph

(c) Low magnification photomicrograph



(d) High magnification photomicrograph

3.13 Core Sample 160143-13 (123T)

The as-received core 160143-13 (123T) is shown in Figure 26. The core was 6.625 inches long and 6 inches in diameter. Carbonation staining was observed only around large entrapped air voids. Large entrained air voids have little to no deposits of ettrignite or calcium hydroxide. There was no visible signs of ASR gel or damage due to ASR gel expansion. Two cracks were observed in the core. The first; a 3 mm crack, less than 0.2mm in width extends from the surface, terminates at a large entrapped air void (1/4" x ¾"), reappears at a coarse aggregate boundary and extends into another entrained air void (1/8" x 1/4"). The second was a 15mm crack that was less than 0.1mm in width. See Figure 27 for low and high magnification microscopy images of 160143-13 (123T).

Figure 26. The as-received core 160143-13 (123T).

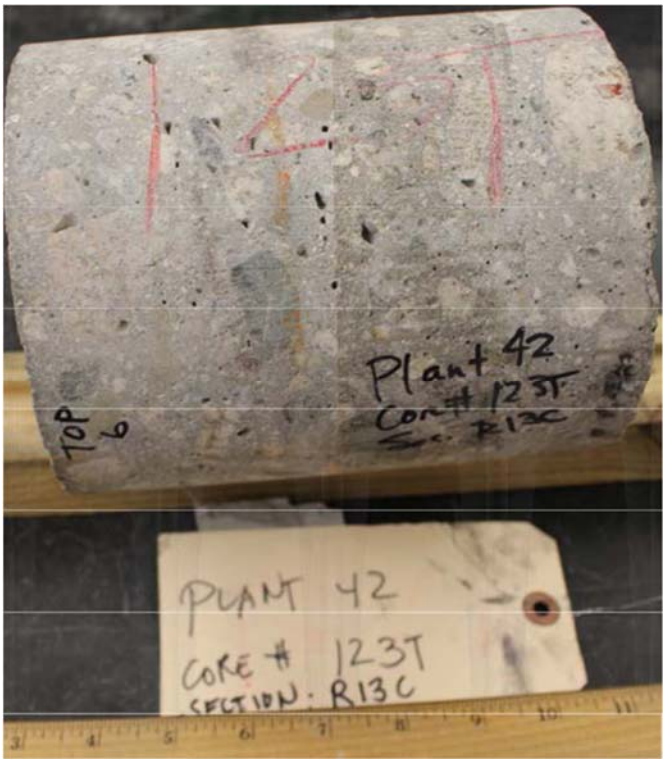
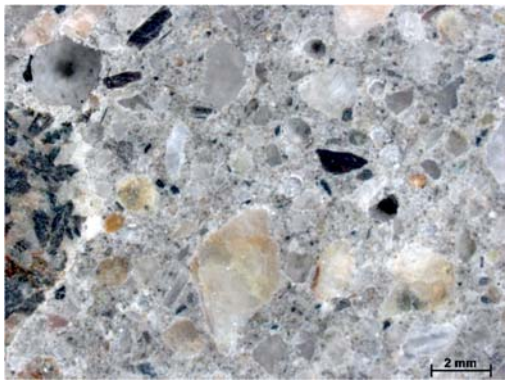


Figure 27. Low and High magnifications of 160143-13 (123T). (a) little to no carbination sataining at the surface, (b) minor staining around coarse aggregate, (c) cracking through large entrapped air void, with little to no staining, (d) high magnifiction to see fine aggregate and cement.

(a) Low magnification photomicrograph

(b) Low magnification photomicrograph

(c) Low magnification photomicrograph

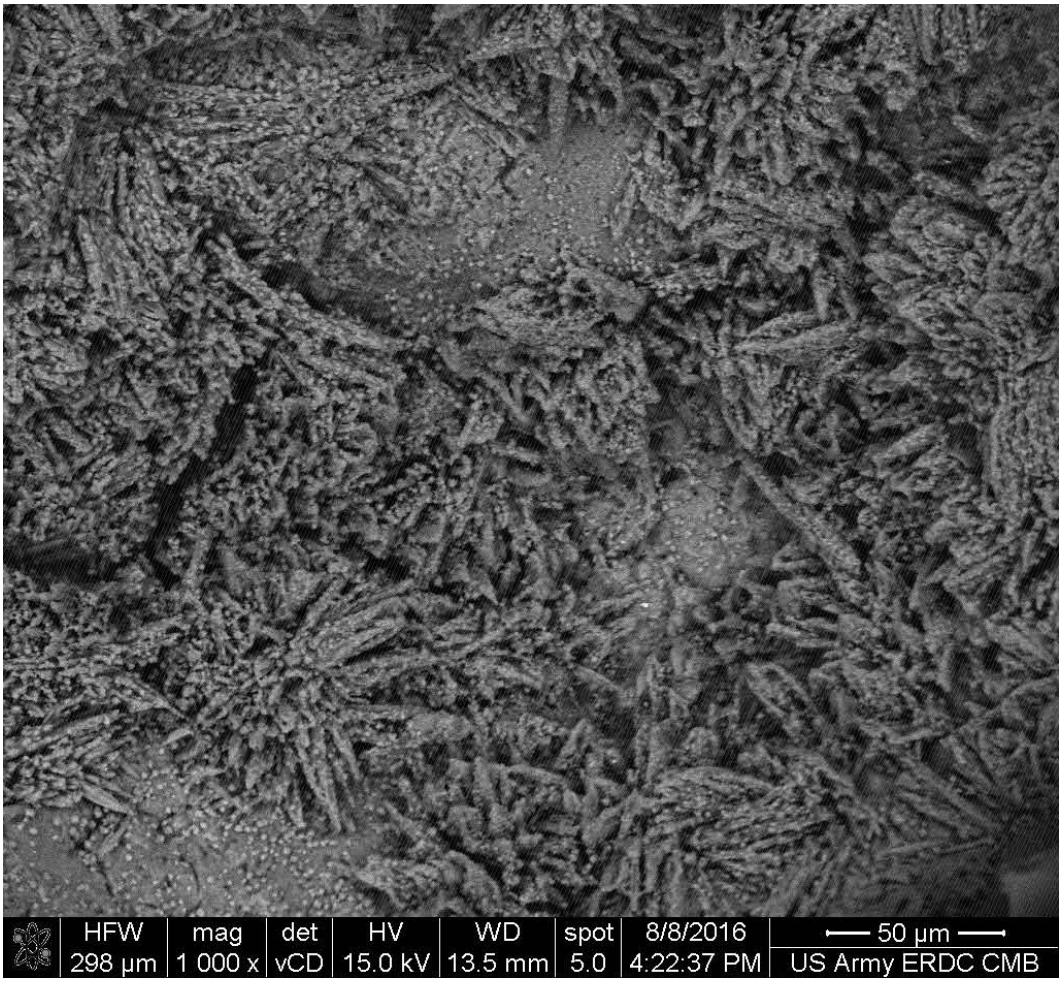


(d) High magnification photomicrograph

3.14 Scanning Electron Microscopy (SEM)

Core 160143-6 (13T) was evaluated in the SEM to determine the constituents of the white deposits that are found filling voids for most of the samples. In the image of a void, Figure 28, the radial needle-like crystals are ettrignite and the smaller particles throughout the image are calcium hydroxide. If the deposits were ASR gel, there would be no crystal form and the gel would most likely by highly cracked.

Figure 28. SEM image of a void in core 160143-6 (13T). The radial needle-like crystals are ettrignite, while the small particles are calcium hydroxide.



4 Summary and Conclusions

This study examined thirteen concrete cores provided to the ERDC by the US-AFCEC from Air Force Plant 42. The 13 cores, which were logged in as CMB No. 160143-1 to 160143-13, were subjected to an in-depth analysis consisting of visual and petrographic examination. The results of the study include were:

- Minor evidence of ASR was observed in 160143-5 (Core # 11T). Some of the microcracks appear to be infilled with gel.
- Staining was typically within an inch of the surface of each sample and due to carbonation.
- Air Void infilling is ettrignite and calcium hydroxide.
- Summary of observed cracks according to crack width
  - # 11T, # 04T, # 08T, # 25T and # 28 (≥0.5 mm)
  - # 11T, # 56T, and # 123T (≥ 0.2 mm)
  - # 05T, # 13T, # 54T, # 78T, and # 120T (≤0.1 mm)

Most of the cracks appear to have been caused by mechanical stresses and/or shrinkage. There is little evidence of ASR induced issues. The presence of cracks larger than 0.2 mm can reduce the mechanical properties and durability of the concrete.

Contact Information

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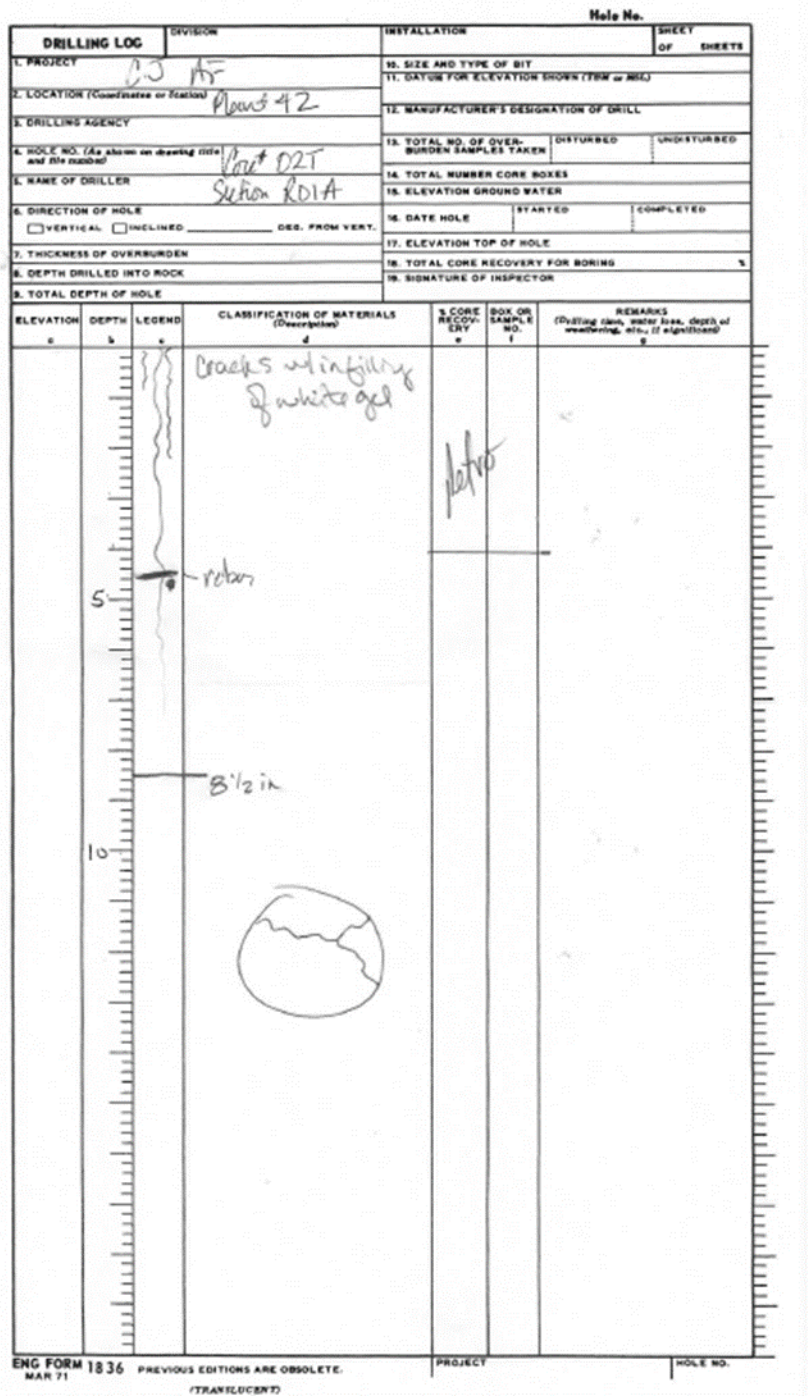
Robert.D.Moser@usace.army.mil

Appendix A



Hole No.

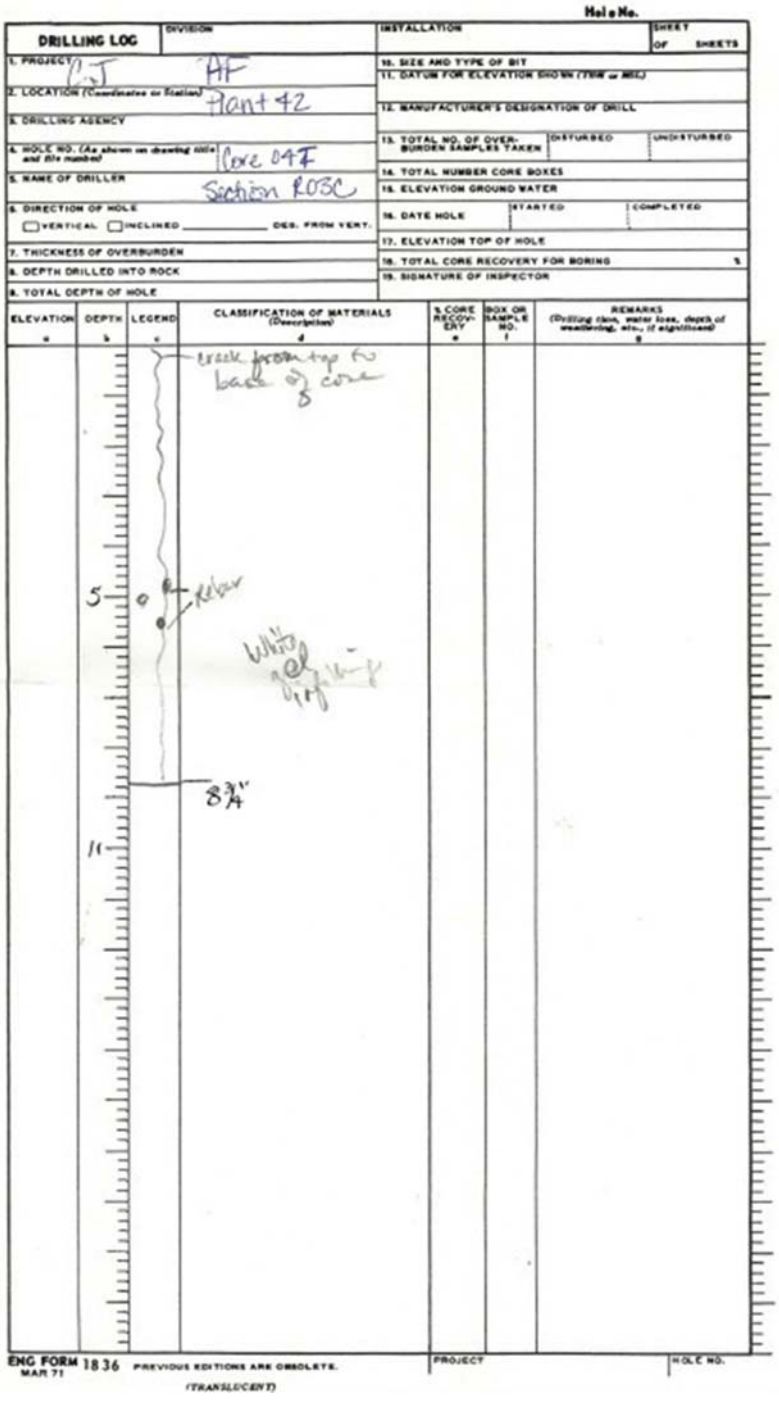
DRILLING LOG | DIVISION | INSTALLATION | SHEET OF SHEETS

1. PROJECT: DJ AF
2. LOCATION (Coordinates or Station): Plant 42
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number): Core D2T
5. NAME OF DRILLER: Sutton RDIA
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE | STARTED | COMPLETED
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Descriptions) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Cracks w/ infilling of white gel			
				petro		
	5		return			
			8 1/2 in			
	10					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT | HOLE NO.



Hole No.

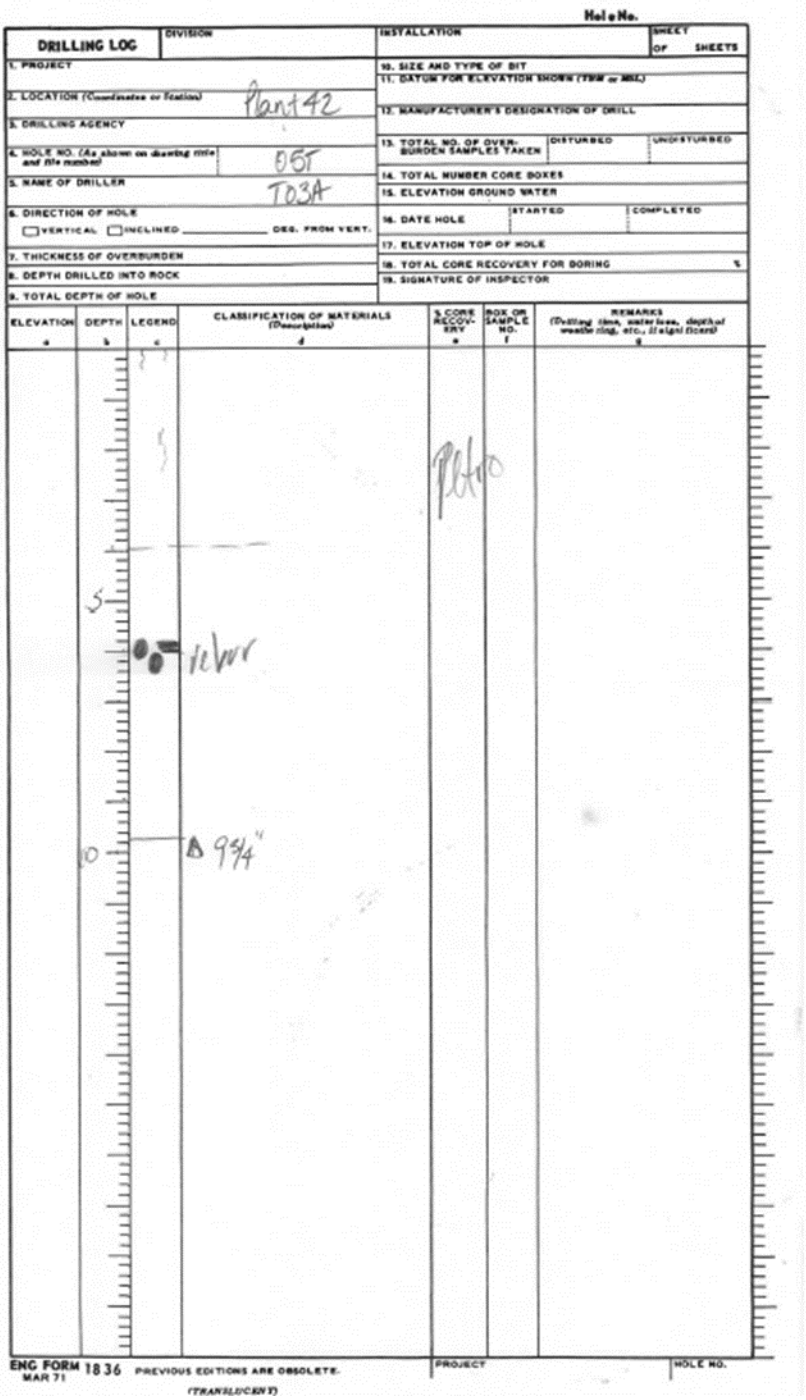
DRILLING LOG | DIVISION | INSTALLATION | SHEET OF SHEETS

1. PROJECT: [illegible] AF
2. LOCATION (Coordinates or Station): Plant 42
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number): Core 047
5. NAME OF DRILLER: Section ROSC
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED | COMPLETED
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Descriptions) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Rock from top to bottom of core			
	5		Rebar			
			White @ [illegible]			
			8 3/4"			
	10					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT | HOLE NO.



Hole No.

DRILLING LOG | DIVISION | INSTALLATION | SHEET OF SHEETS

1. PROJECT
2. LOCATION (Coordinates or Station) Plant 42
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number) 05T
5. NAME OF DRILLER T03A
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE | STARTED | COMPLETED
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
				Petro		
	5		Silver			
	10		Δ 9¾"			

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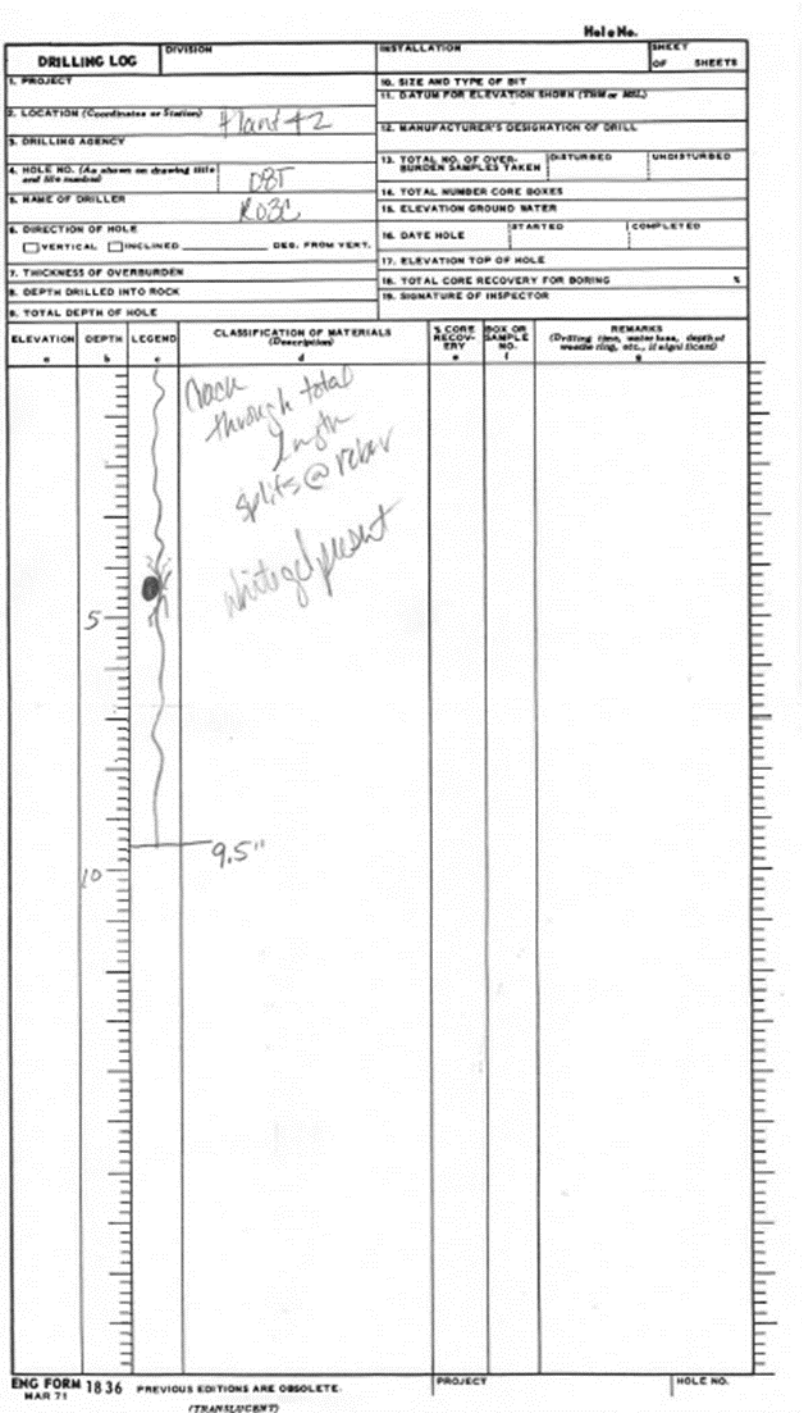
PROJECT | HOLE NO.



Hole No.

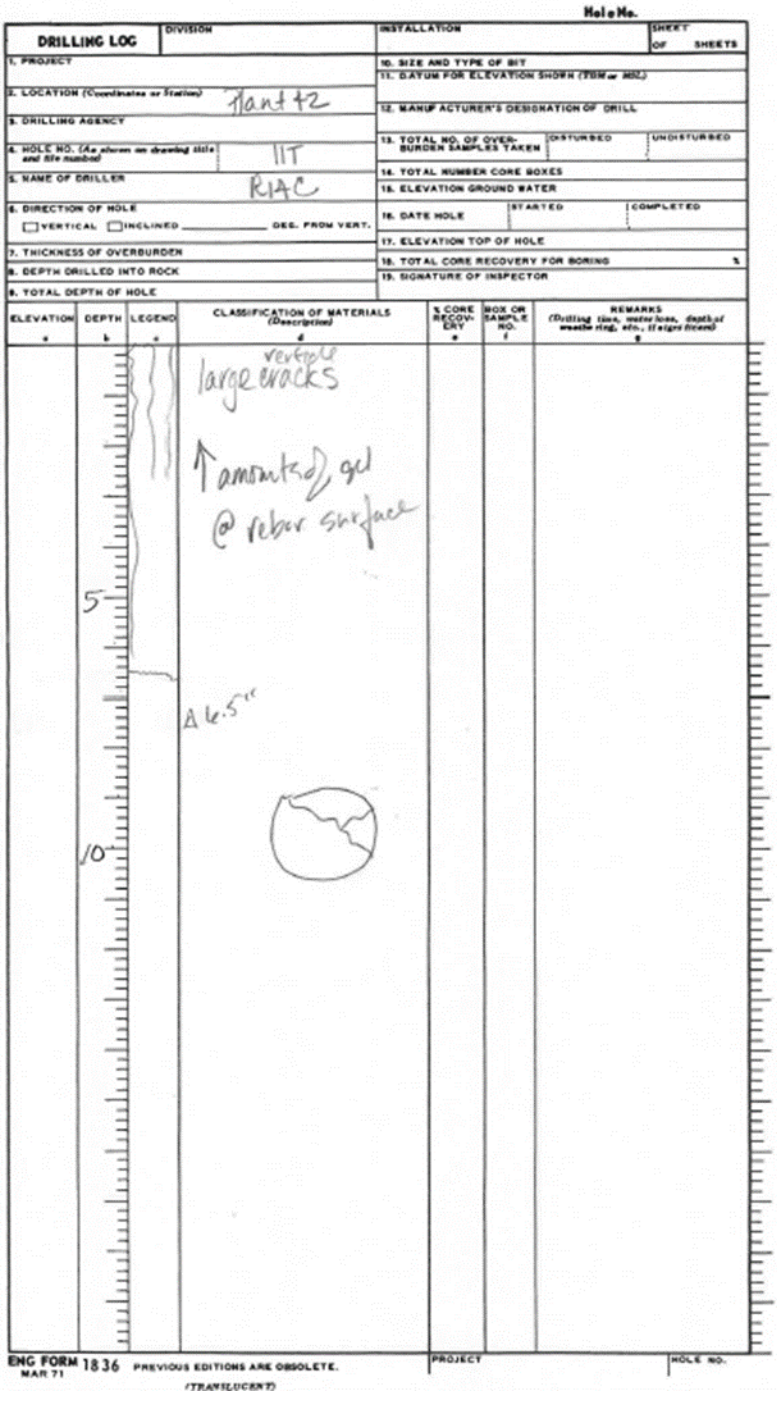
DRILLING LOG | DIVISION | INSTALLATION | SHEET OF SHEETS

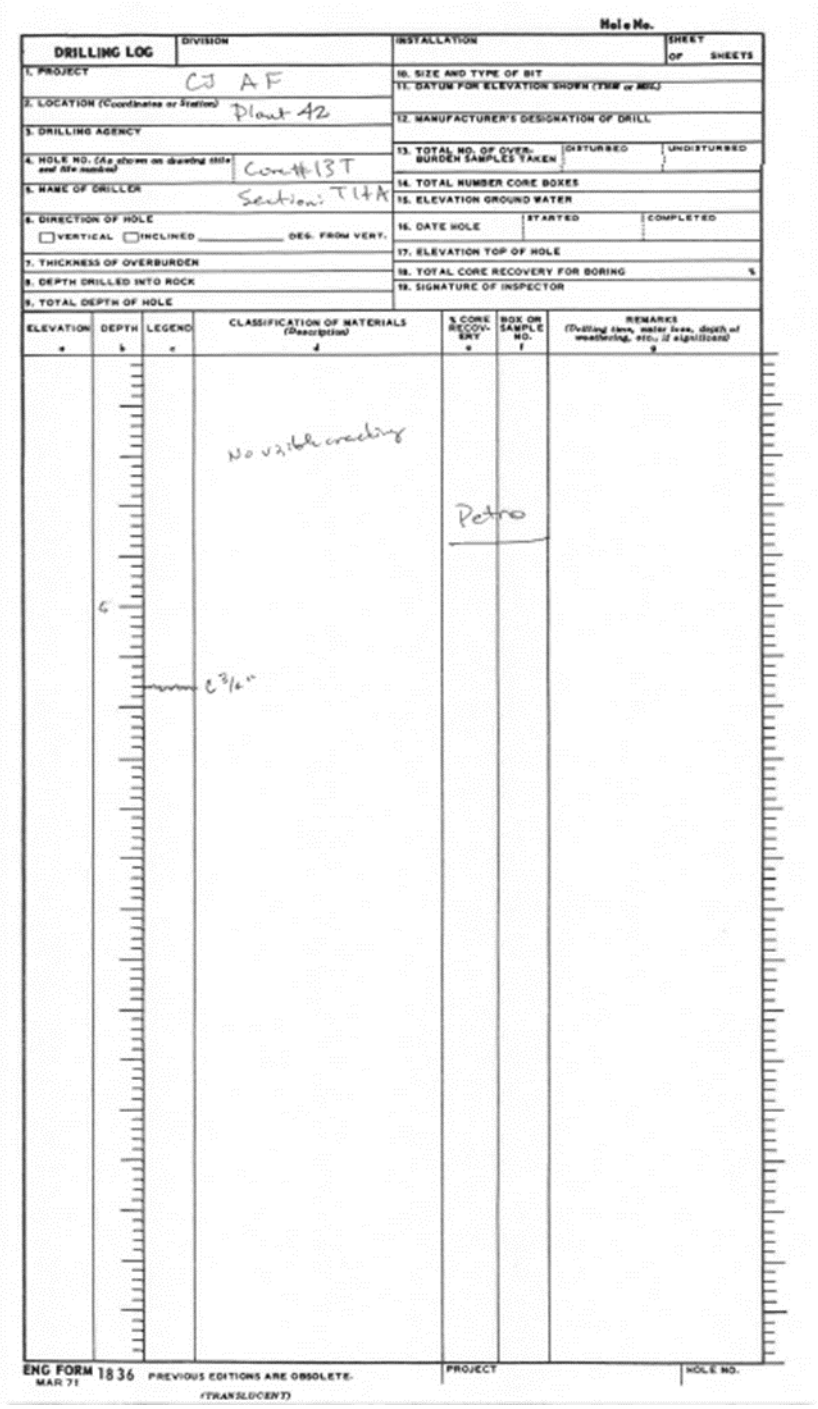
1. PROJECT
2. LOCATION (Coordinates or Station) Plant 42
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number) DBT
5. NAME OF DRILLER KO3C
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE | STARTED | COMPLETED
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Descriptions) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weather ring, etc., if significant) g
	5		Rock through total length splits @ relax white/gl/pink			
	10		9.5"			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT | HOLE NO.


Hole No.
DRILLING LOG
DIVISION
INSTALLATION
SHEET
OF SHEETS
1. PROJECT
2. LOCATION (Coordinates or Station) Plant 42
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number) 11T
5. NAME OF DRILLER RIAC
6. DIRECTION OF HOLE
VERTICAL INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN
DISTURBED
UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE
STARTED
COMPLETED
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR
ELEVATION a
DEPTH b
LEGEND c
CLASSIFICATION OF MATERIALS (Description) d
% CORE RECOV-ERY e
BOX OR SAMPLE NO. f
REMARKS (Drilling time, water loss, depth of weathering, etc., if of importance) g
vertical
large cracks
amounted gel
@ rebar surface
5
Δ 6.5"
10
ENG FORM 1836
MAR 71
PREVIOUS EDITIONS ARE OBSOLETE.
(TRANSLUCENT)
PROJECT
HOLE NO.



Hole No.

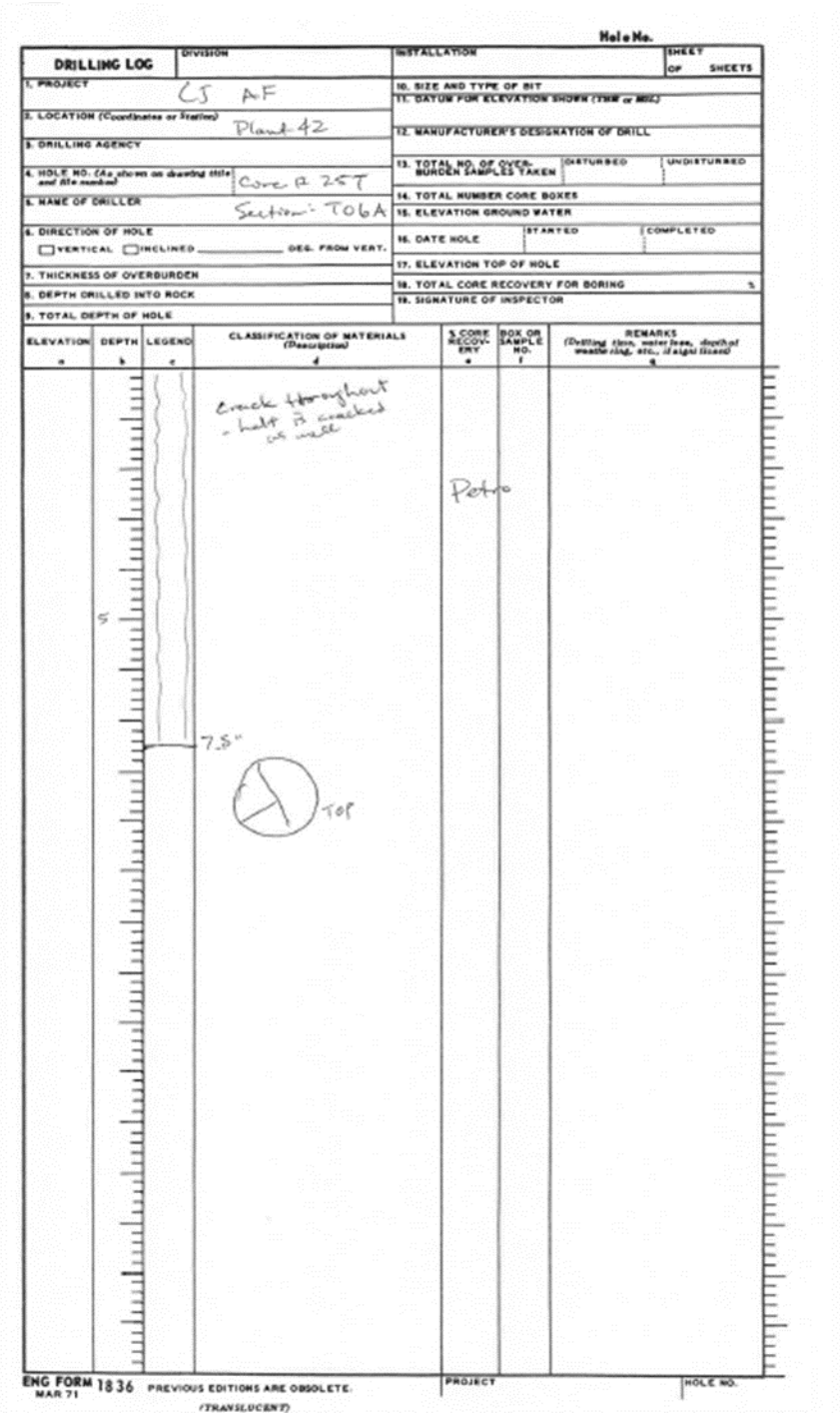
DRILLING LOG | DIVISION | INSTALLATION | SHEET OF SHEETS

1. PROJECT: CJ AF
2. LOCATION (Coordinates or Station): Plant 42
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number): Core #13T
5. NAME OF DRILLER: Section: T14A
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (USGS or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE | STARTED | COMPLETED
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc.; if significant) g
			No visible cracking	Petro		
	6					
			@ 3/4"			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT | HOLE NO.



Hole No.

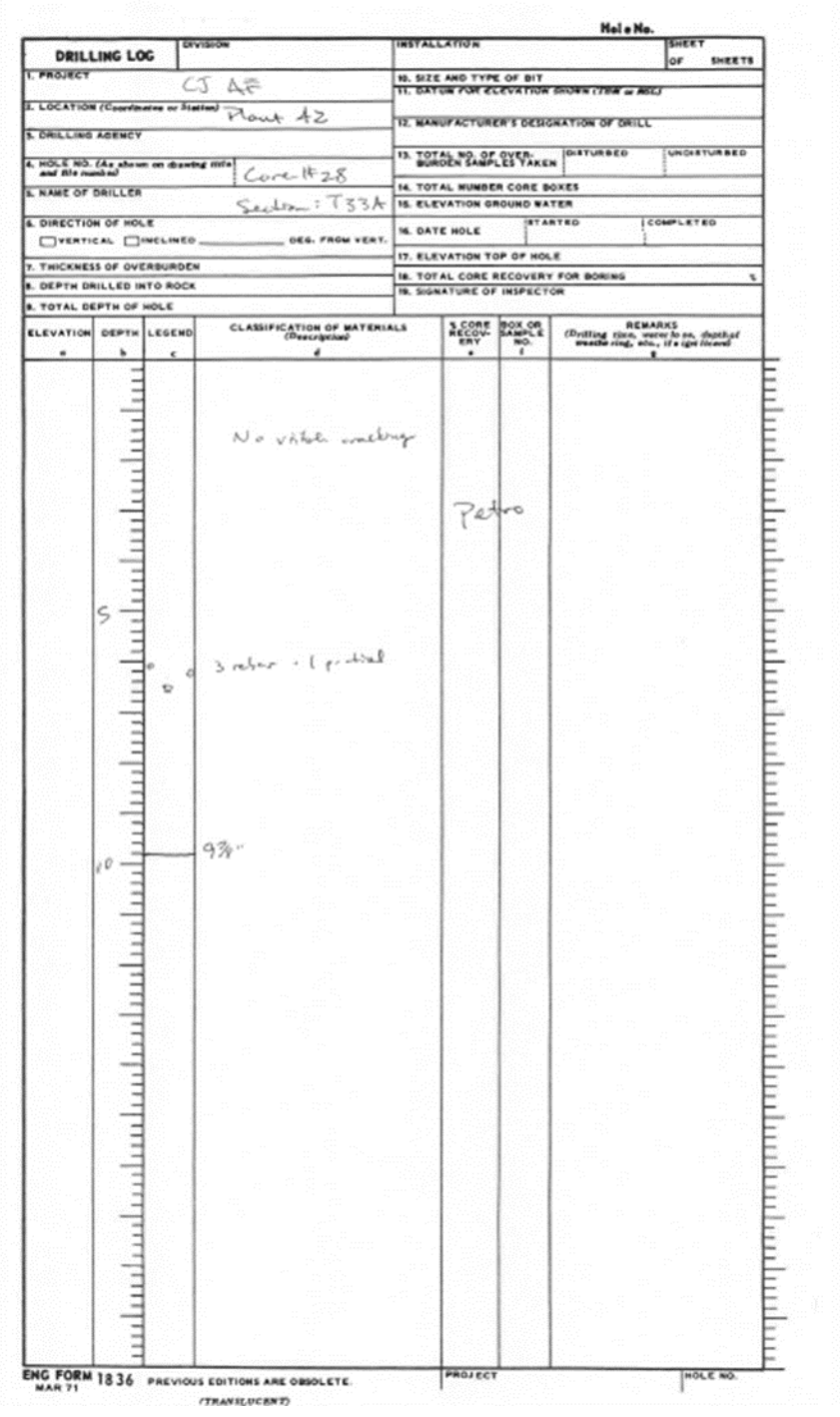
DRILLING LOG | DIVISION | INSTALLATION | SHEET OF SHEETS

1. PROJECT: CJ AF
2. LOCATION (Coordinates or Stations): Plant 42
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number): Core R 25T
5. NAME OF DRILLER: Section: T06A
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE | STARTED | COMPLETED
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Crack throughout - half is cracked on wall	Petro		
	5		7.5"			
			Top			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT | HOLE NO.



Hole No.

DRILLING LOG | DIVISION | INSTALLATION | SHEET OF SHEETS

1. PROJECT: CJ AF
2. LOCATION (Coordinates or Station): Plant 42
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number): Core #28
5. NAME OF DRILLER: Section: T33A
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE | STARTED | COMPLETED
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if a cpt. is used) g
			No visible cracking			
				Petro		
	5					
			3 rebar + 1 partial			
	10		9¾"			

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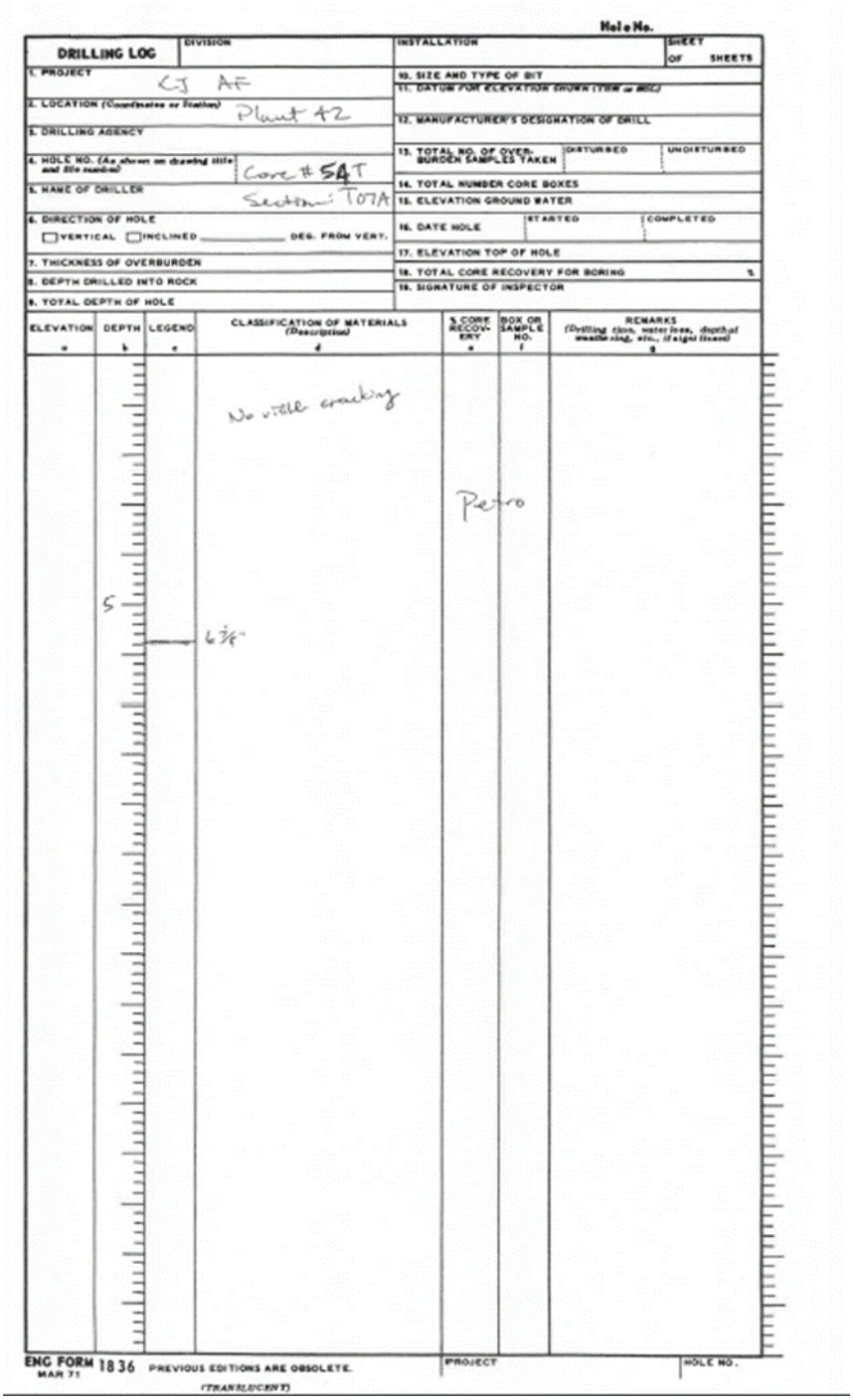
PROJECT | HOLE NO.



Hole No.

DRILLING LOG | DIVISION | INSTALLATION | SHEET OF SHEETS

1. PROJECT: CJ AF
2. LOCATION (Coordinates or Station): Plant 42
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number): Core # 54T
5. NAME OF DRILLER: Section: T07A
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE | STARTED | COMPLETED
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			No visible cracking			
				Petro		
	5					
			6 3/4"			

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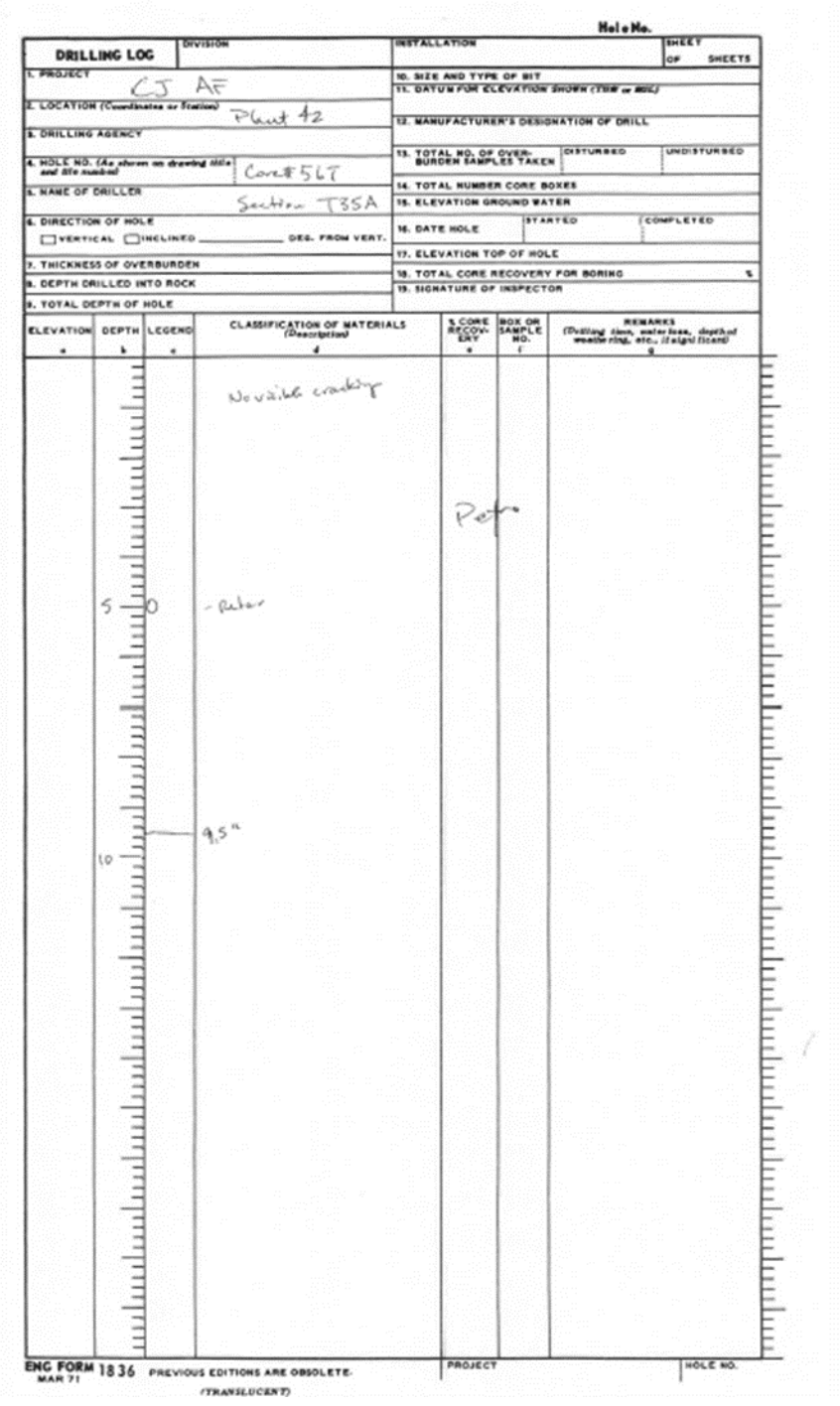
PROJECT | HOLE NO.



Hole No.

DRILLING LOG | DIVISION | INSTALLATION | SHEET | OF SHEETS

1. PROJECT: CJ AF
2. LOCATION (Coordinates or Station): Plant 42
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number): Core #5LT
5. NAME OF DRILLER: Section T35A
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE | STARTED | COMPLETED
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			No visible cracking			
				Pet.		
	5		- Water			
			9.5'			
	10					

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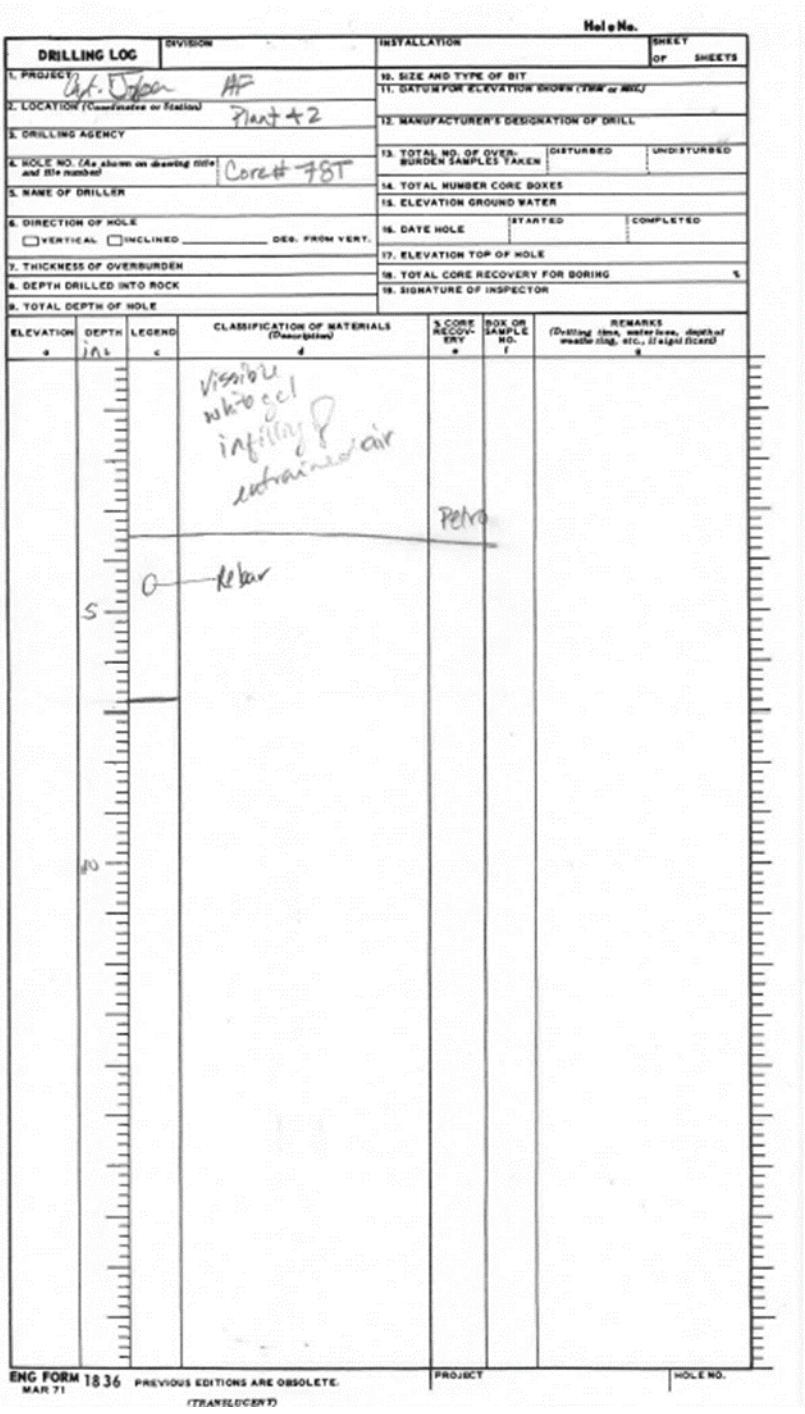
PROJECT | HOLE NO.



Hole No.

DRILLING LOG | DIVISION | INSTALLATION | SHEET OF SHEETS

1. PROJECT: Ft. Dix AF
2. LOCATION (Coordinates or Station): Plant 42
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number): Core # 7ST
5. NAME OF DRILLER
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (MSL or MLW)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED | COMPLETED
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH (Ft.)	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	5		visible whitened infilling? entrained air	Petro		
			0 Rebar			
	10					

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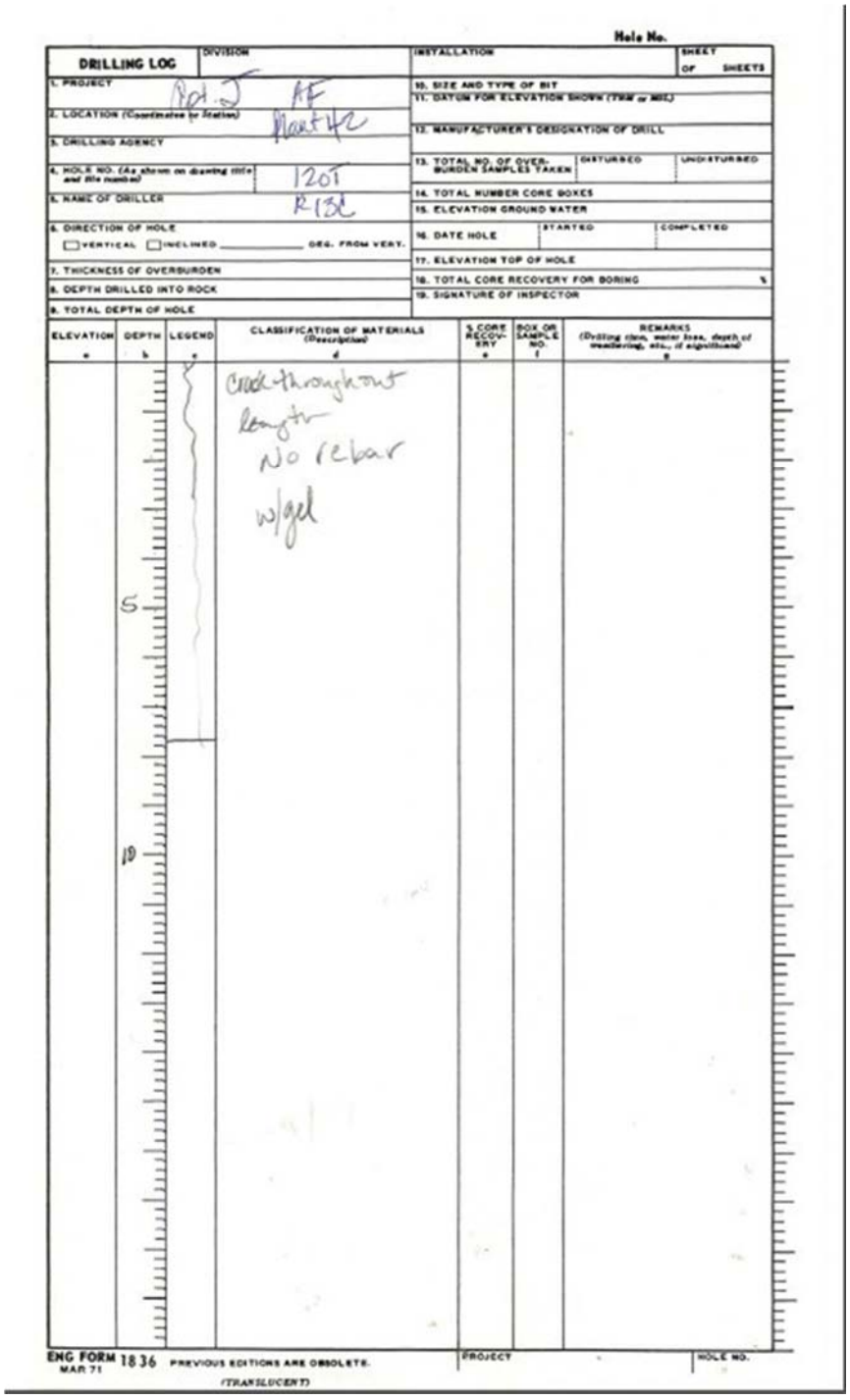
PROJECT | HOLE NO.



Hole No.

DRILLING LOG | DIVISION | INSTALLATION | SHEET OF SHEETS

1. PROJECT: Pol. 2 AF
2. LOCATION (Coordinates or Station): Mont AC
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number): 120T
5. NAME OF DRILLER: R13L
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE | STARTED | COMPLETED
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	5		Crack throughout length No rebar w/gel			
	10					

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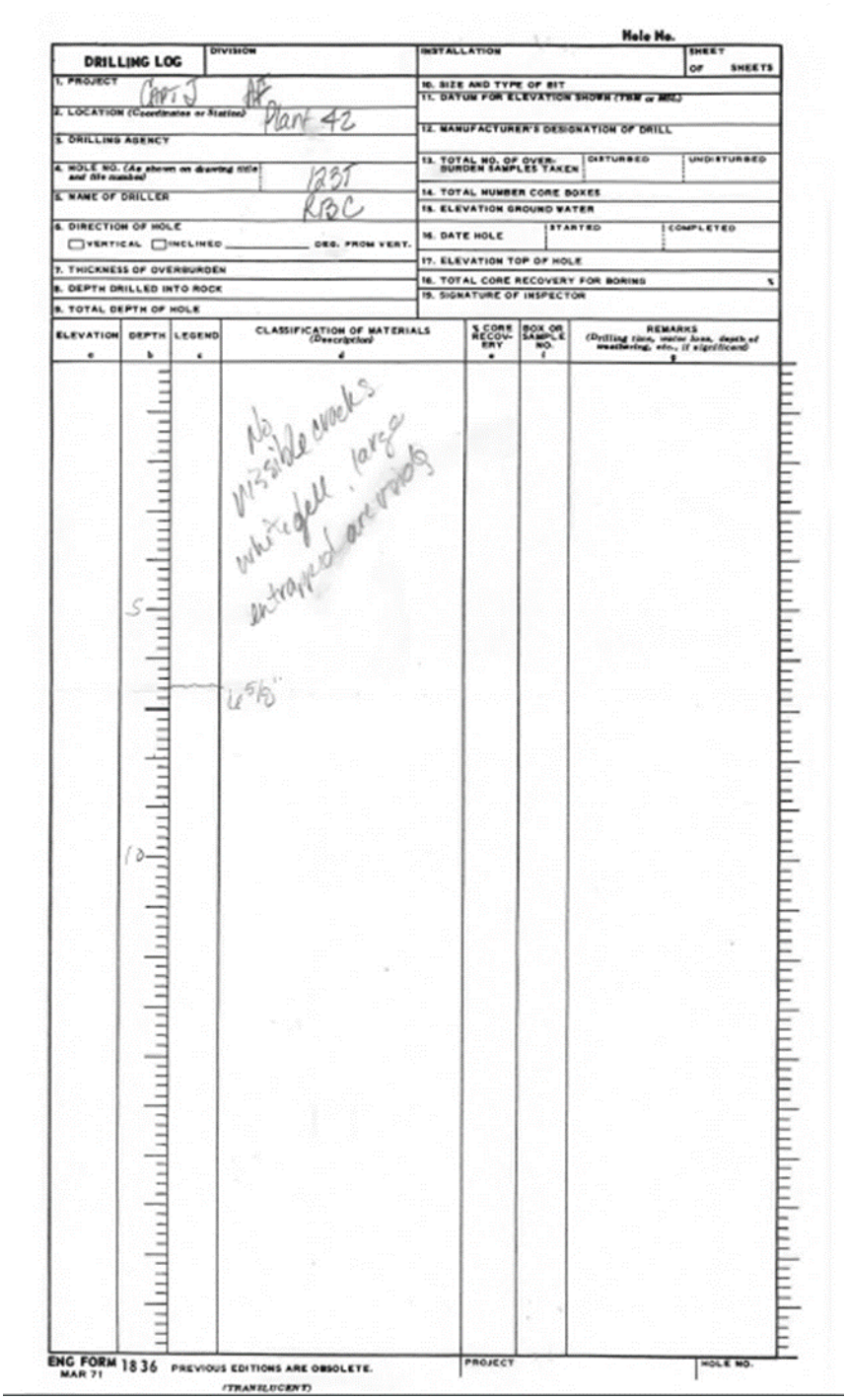
PROJECT | HOLE NO.



Hole No.

DRILLING LOG | DIVISION | INSTALLATION | SHEET OF SHEETS

1. PROJECT — Corps of AF
2. LOCATION (Coordinates or Station) — Plant 42
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number) — 123
5. NAME OF DRILLER — RBC
6. DIRECTION OF HOLE — ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (MSW or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE — STARTED — COMPLETED
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	5		No visible cracks which could large entrapped air voids			
			6'5½"			
	10					

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PROJECT | HOLE NO.