APPENDIX F
COVER BORROW MATERIAL EVALUATION

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1.0 BACKGROUND

This appendix summarizes the available quantities and characteristics of materials to be used for reclamation of the tailings impoundments at Cotter Corporation's Canon City Milling Facility. Geotechnical and radiological data on tailings, interim cover, and potential cover materials were collected for Cotter in 1989 by Water, Waste & Land, Inc. (documented in WWL, 1990) and in 1999 by Shepherd Miller, Inc. (documented in Appendix A of MFG, 2005). The analyses presented in ESCI (1995) were based on the data documented in WWL (1990).

Material properties of the interim cover, the random fill, and the cover materials were previously presented by MFG (2005). Additional field exploration and testing is currently in progress to further evaluate the geotechnical and radiological properties of potential cover materials and fill soils, as well as the in-place interim cover and random fill. The updated results will be presented in a future submittal of this appendix. Characterization data on the random fill, interim cover, and potential, available cover materials from the current investigation will be summarized after laboratory testing has been completed.

2.0 BORROW INVESTIGATION AND IN-PLACE MATERIALS TESTING

In June, 2011, MWH supervised 19 soil borings to depths ranging from 10 to 40 feet below the ground surface. The purpose of the borings is to characterize and quantify the borrow materials on-site for future use in reclamation. Figures F-1 through F-3 show the proposed borrow areas and the locations of the borings.

Drilling was conducted with a truck mounted CME75 drill rig using hollow-stem augers with an outside diameter of 7.625 inches. Continuous dry core sampling was conducted at each of the borehole locations, using a sampler with an outside diameter of 4.25-inches to collect 3-inch diameter continuous core samples. Samples for natural water content tests were sealed in plastic bags in the field for transport to the laboratory.

In addition, field nuclear density testing is being conducted on the interim cover material and the random fill that had been previously placed at the site. Samples of these materials were collected for radiological and geotechnical laboratory testing. Figures F-4 and F-5 show the locations of the field density tests. Testing was conducted using a Troxler 3440 nuclear density gauge and the direct measurement method. Test depths ranged from 2 to 12 inches.

3.0 IN-PLACE INTERIM COVER AND RANDOM FILL

MWH conducted field tests on and collected samples of material covering existing tailings (described as interim cover) in the secondary impoundment and used for fill over demolition debris (random fill) in the primary impoundment. The results will be summarized in Tables F.1 and F.2 following completion of the borrow investigation.

Table F.1 Summary of In-place Interim Cover and Random Fill Properties – Laboratory

Sample ID	Depth (ft)	Impoundment[b]	Activity Concentration		Passing No. 200 Sieve (%)	Gravel (%)	Standard Proctor (pcf @ opt. w.c.)	Specific Gravity	Natural w.c.[b] (%)	Remolded Permeability[c] (cm/sec)
			Ra-226 (pCi/g)	Th-230 (pCi/g)						
		Primary – Random Fill								
		Secondary Interim Cover								

[a] Location of sample within primary or secondary tailings impoundment
[b] w.c. - water content by weight.
[c] Sample remolded to 95% of the maximum standard Proctor density.

The laboratory test result discussion below will be completed after review of test results.

Radium activity concentration. Measured radium-226 activity concentration values from interim cover samples ranged from _____ to ___ picocuries per gram, with a mean value of pCi/g. Activity concentration values for thorium-230 range from ___ to ___ pCi/g with a mean value of pCi/g.

Grain-size distribution. Grain-size distribution testing of interim cover and random fill samples is summarized in Table F.1, in terms of the percentage of particles smaller than the No. 200 sieve (0.074 mm). These values range from _____ to ___ percent passing the No. 200 sieve. The percentage of gravel (4.76 to 76.2 mm) ranged from __ to ___, by weight.

Standard Proctor. Maximum dry unit weight values from compaction tests range from approximately to pcf with corresponding optimum water contents ranging from _____ to _____. These values are shown with other moisture-density relationships in Figure F.1.

Specific gravity. The measured specific gravity of solids values of the interim cover samples in Table F.1 ranged from _____ to ___. The measured specific gravity values are consistent with values for natural soils in the area.

Water content. Interim cover sample water content values are shown in Table F.1. Values range from approximately ___ to ___ percent (by weight).

Permeability Testing. Remolded flexible wall permeability tests were performed on samples remolded to 95% of the maximum standard Proctor density. Test results ranged from ___ to ___ cm/sec for the samples tested.

Table F.2 Summary of In-place Interim Cover and Random Fill Properties – Field Test Results: Nuclear Density Gauge

Test ID	Test Depth (in)	Impoundment[a]	Total Density (pcf)	Water Content (%)	Dry Density (pcf)	% of Maximum Proctor
		Primary – Random Fill				
		Secondary Interim Cover				

[a] Location of sample within primary or secondary tailings impoundment

In-place nuclear density testing is being conducted on the interim cover soils on the secondary impoundment and the random fill that had been placed in the primary impoundment. Test results indicate the total densities of the random fill ranged from __ to ___ pcf, with water contents between ___ and __%. Dry densities ranged from _____ to ___ pcf. These results correspond to between _____ and __% of the maximum Proctor values. Test results indicate the total densities of the interim cover ranged from _____ to ___ pcf, with water contents between _____ and _____%. Dry densities ranged from _____ to ___ pcf. These results correspond to between _____ and _____% of the maximum Proctor values.

4.0 BORROW MATERIALS

The borings conducted for the borrow investigation generally encountered between 6 and 10 feet of overburden soils, consisting of sandy clays and clayey sands overlying weathered bedrock. The bedrock was predominantly weathered sandstone interlayered with weathered claystone. The borings in areas D, E, and F extended to approximately 30 feet below the ground surface. Borings E-1 and G-1 were conducted through existing embankment fills. The borings conducted on the northern end of borrow area B and in borrow area A, generally encountered auger refusal on very hard sandstone at depths of 15 feet or less.

MWH collected samples of material from potential borrow sources to be used as cover soil during reclamation. The test results will be summarized in Table F.3 and discussed following the table after completion of the borrow investigation.

Table F.3 Summary of Potential Cover Material Properties

Material description	( )	( )	( )
Fraction passing No. 200 sieve (%)			
Percentage Gravel (%)			
Natural water content			
Liquid limit (%) - Plastic limit (%) - Plasticity index (%)			
Specific gravity			
Standard Proctor test Maximum dry density (pcf) @ Optimum water content (%)			
Permeability (cm/sec)			
15-Bar water content (%)			

Grain-size distribution. Grain-size distribution testing of borrow samples is summarized in terms of values passing the No. 200 sieve (0.074 mm) and the percentage of gravel. The percent passing the no. 200 sieve for the samples tested ranged from __ to __ percent passing the No. 200 sieve. The percentage of gravel (4.76 to 76.2 mm) ranged from __ to _____ by weight.

Atterberg limits. Assessment of cover material plasticity with Atterberg limit testing is presented in Table F.3 in terms of liquid limit, plastic limit, and plasticity index. The fine-grained portion of the samples tested classify as __ to ___().

Specific gravity. The measured specific gravity of solids values ranged from ___ to ___. The measured specific gravity values are consistent with values for natural soils in the area.

Standard Proctor. Maximum dry unit weight values from compaction tests range from approximately ___ to ___ pcf with corresponding optimum water contents ranging from __ to __. These values are shown with other moisture-density relationships in Figure F.1.

Water content. Natural water contents of the samples ranged from ___ to ____ percent (by weight). Water contents representing long-term conditions measured at 15 bars of suction range from approximately __ to ___ percent (by weight). A 15-bar water content of ___ percent will be used in the radon emanation modeling in Appendix D.

Permeability Testing. Remolded flexible wall permeability tests were performed on samples remolded to 95% of the maximum standard Proctor density. Test results ranged from __ to _____ cm/sec for the samples tested.

Triaxial Shear Testing. Consolidated-undrained triaxial shear tests were conducted on Shelby tube samples collected within the primary embankment at boring G-1.

Radium activity concentration. For cover materials to be excavated from borrow area X, a radium-226 activity concentration value of _____ pCi/g was used. For cover materials to be excavated from the borrow area X, a conservative radium-226 activity concentration value of pCi/g was used.

5.0 MATERIAL QUANTITIES

Available quantities of materials to be used for reclamation will be assessed based on the findings of the borrow investigation conducted in June 2011. The quantity calculations based on the materials encountered during the borrow investigation and required volumes of materials for the proposed reclamation will be compared to show that there is sufficient material for borrow existing on the site. Borrow materials will come from both excavation for the proposed diversion channels as well as from the designated borrow areas. The riprap for the reclamation will be imported from an off-site commercial source.

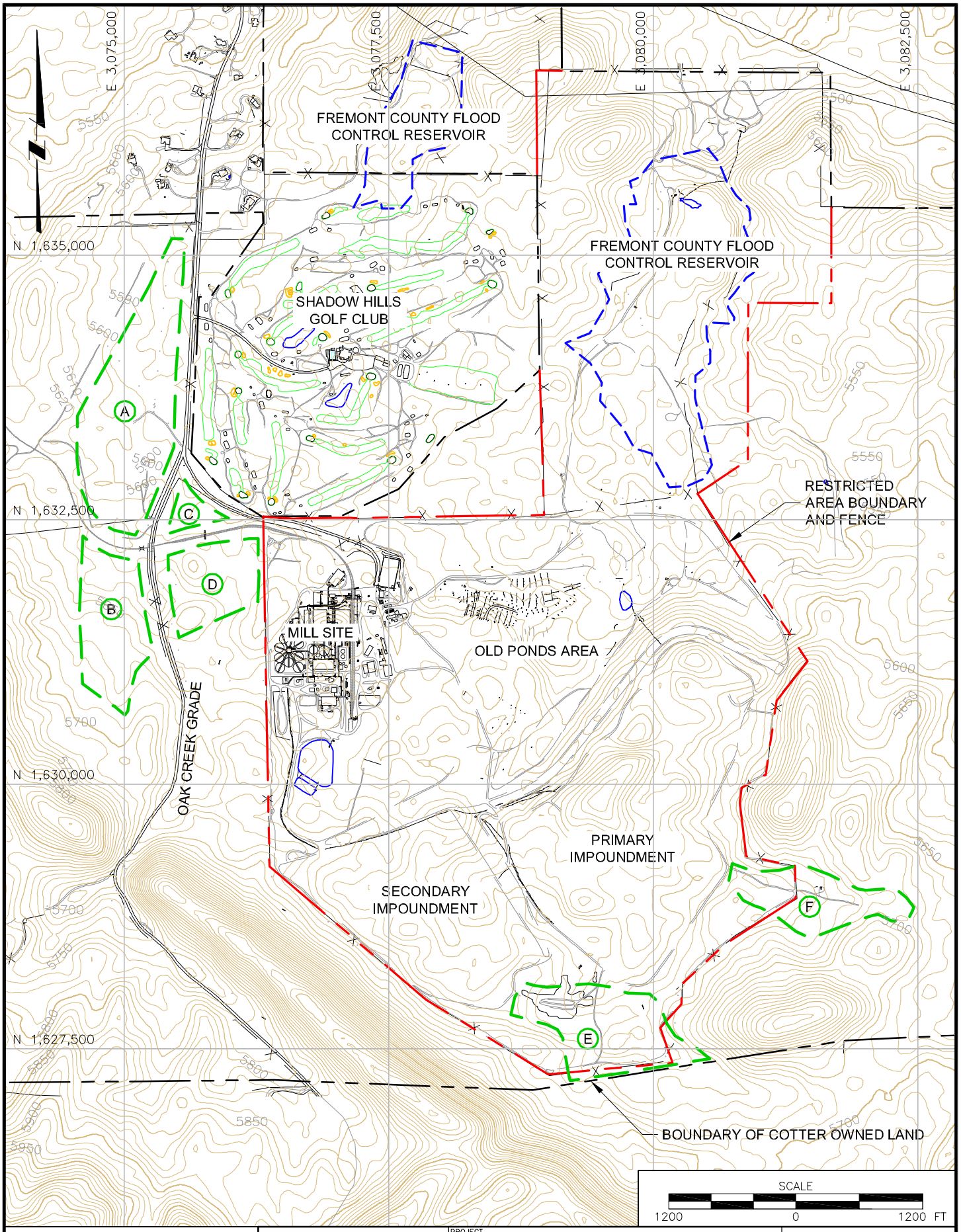
6.0 REFERENCES

Earth Science Consultants, Inc. (ESCI), 1995. "Decommissioning and Reclamation, Chapter 9," prepared for Cotter Corporation and included in the Cotter Corporation Application for Amendment to Radioactive Materials License 369-01, December.

MFG, Inc. (MFG), 2005. 2005 Update of the Mill Decommissioning and Tailings Reclamation Plan for the Cotter Corporation Canon City Milling Facility. Prepared for Cotter Corporation. August.

Rogers, V.C., K.K. Nielson, and D.R. Kalkwarf, 1984. "Radon Attenuation Handbook for Uranium Mill Tailings Cover Design," NUREG/CR-3533, prepared for U.S. Nuclear Regulatory Commission, April.

Water, Waste and Land, Inc. (WWL), 1990. "Canon City Tailings Basin Reclamation Plan," prepared for Cotter Corporation, January.



REFERENCE:
- EXISTING GROUND CONTOURS FROM USGS (SEAMLESS.USGS.GOV).
- SITE TOPOGRAPHY FROM COTTER CORPORATION (2007).

COTTER CORPORATION (N.S.L.)

PROJECT: CANON CITY MILLING FACITLITY

TITLE: POTENTIAL COVER MATERIAL BORROW AREA LOCATIONS

MWH

DATE: JUNE 2011

FIGURE F-1

FILE NAME: 1007533 BH02

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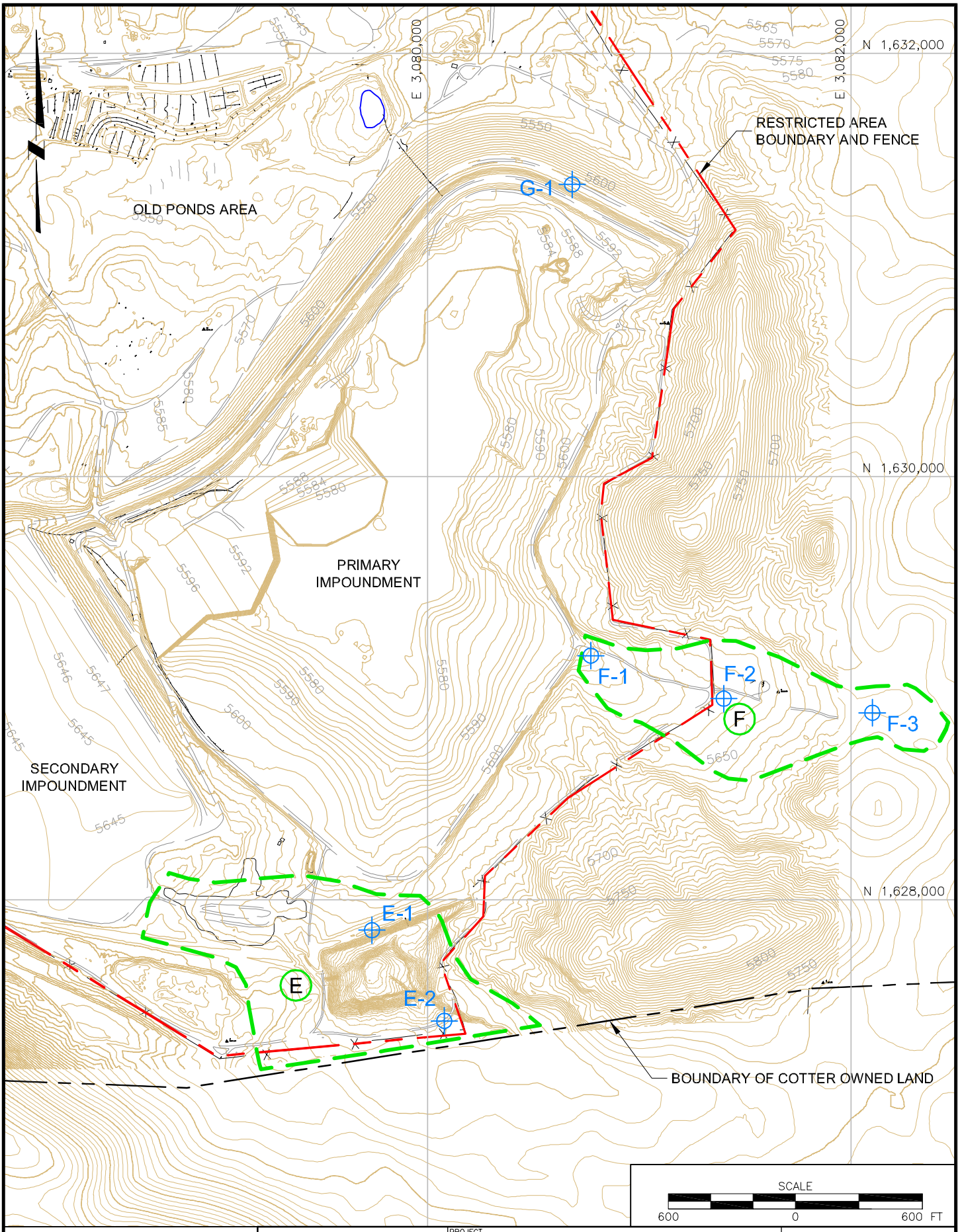

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- EXISTING GROUND CONTOURS FROM USGS (SEAMLESS.USGS.GOV).
- SITE TOPOGRAPHY FROM COTTER CORPORATION (2007).

COTTER CORPORATION (N.S.L.)

PROJECT
CANON CITY MILLING FACITLITY

TITLE
SOUTHEAST BORROW AREA WITH PROPOSED EXPLORATION HOLE LOCATIONS

MWH

DATE JUNE 2011

FIGURE F-2

FILE NAME 1007533 BH01

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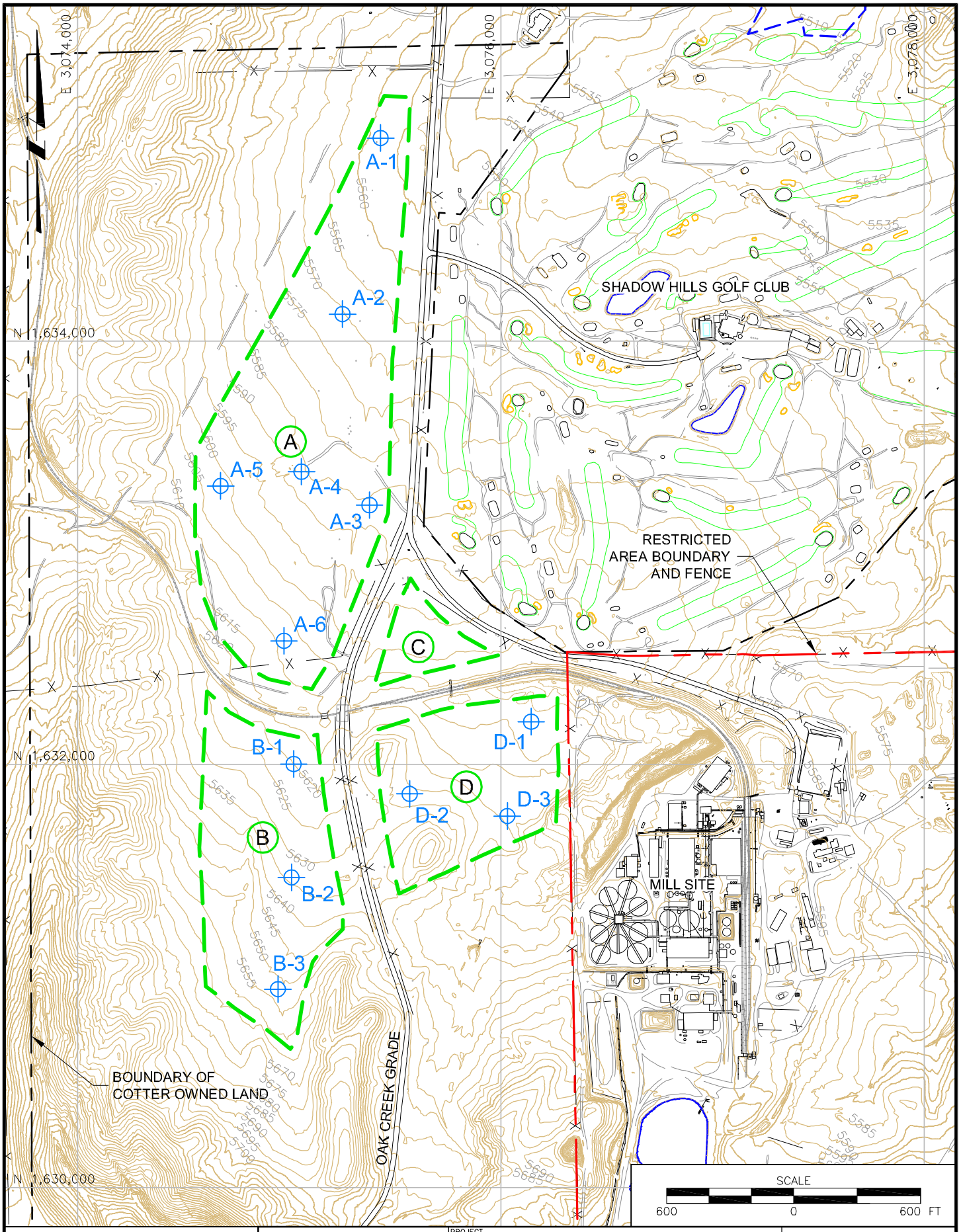

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- SITE TOPOGRAPHY FROM COTTER CORPORATION (2007).

COTTER CORPORATION (N.S.L.)

PROJECT: CANON CITY MILLING FACITLITY

TITLE: NORTHWEST BORROW AREA WITH PROPOSED EXPLORATION HOLE LOCATIONS

MWH

DATE: JUNE 2011

FIGURE F-3

FILE NAME: 1007533 BH01

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