OBJECTIVE:

Estimate the pre-development and post-development runoff generated on site during the 100-year, 24-hour storm event using the TR-55 volume estimation method, based on effective curve number (CN). The post-development volume estimation will take into account the 240 acres of zero-discharge areas within the site (see Attachment 1).

METHOD:

The U.S. Department of Agriculture Natural Resource Service (NRCS), formerly known as the Soil Conservation, has developed procedures for the estimation of basin runoff volumes (NRCS, 1986). This procedure relies on the determination of an effective curve number (CN) that represents the entire basin in addition to the basin size and the effective rainfall. Once these variables are known, the following equations can be used to estimate runoff volumes generated for a particular rainfall event.

SCS runoff equation (NRCS, 1986):

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

where

Q = runoff (inches)
P = rainfall (inches)
S = potential maximum retention after runoff begins (inches) = $\frac{1000}{CN} - 10$

ASSUMPTIONS AND DATA:

- 100-year, 24-hour rainfall depth = 3.0 inches (Kleinfelder, 2009a)
- Total site drainage area = 1,566 acres (Kleinfelder, 2009b)
- Pre-development effective site CN for the 1,566 acres = 64 (Kleinfelder, 2009b)
- Soil types present within the site (see Appendix A2), (Edge, 2009) (Kleinfelder, 2009b)
  - Ba (Barx fine sandy loam) – CN = 51
  - Be (Begay fine sandy loam) – CN = 51
  - Mi (Mikim loam) – CN = 63
  - Pa (Paradox fine sandy loam) – CN = 51
  - RO (Rock Outcrop) – CN = 80
  - Va (Vananda silty clay) – CN = 70

CALCULATIONS:

Pre-Development Runoff Volume Determination

In previous evaluations, five basins (Basins 1-5) were been delineated to define the drainage that starts upstream of the site and flows through the site (see Attachment 1, [Kleinfelder 2009b]). These five basins result in a total drainage area of 1,566 acres. Based on the available reference information, the pre-development 100-year runoff volume for the site can be determined.

$$S = \frac{1000}{64} - 10 = 5.63\ inches$$

$$Q = \frac{\left(3 - 0.2(5.625)\right)^2}{(3 + 0.8(5.625))} = 0.47\ inches$$

Generated Runoff Volume (V) in acre-ft = Q (in ft) x Area (acres)

$$V = 0.47\ in * \left(\frac{1ft}{12in}\right) * 1{,}566\ acres = 61.3\ acre - ft$$

Post-Development Runoff Volume Determination

The 240 acres of zero-discharge areas are distributed among each of the five delineated basins. Since the zero-discharge areas will not contribute to runoff after the site is developed, to determine the area contributing to post-development runoff, the acreage within each basin is reduced depending on the amount of zero-discharge area present within the basin. This area reduction will affect the effective CN for each basin as well. The effective CN for each basin is recalculated in order to determine the effective CN for the total remaining site area contributing to runoff (1,326 acres). Table 1 summarizes the reduction in area for each basin and the corresponding soil types of these areas.

Table 1: Revised Basin Characteristics due to Zero-Discharge Area Removal

Basin	Pre-Development		Post-Development		
	Drainage Area (acres)	Effective CN	Drainage Area (acres)	Summary of Removed Areas and Soil CN	Effective CN
1	808.9	67	797.9	10.1 ac Pa (CN=51) 0.9 ac Mi (CN=63)	68
2	151.7	53	54.3	59.4 ac Pa (CN=51) 24.4 ac Mi (CN=63) 13.6 ac Ba (CN=51)	52
3	85.1	51	54.3	16.6 ac Ba (CN=51) 14.2 ac Pa (CN=51)	51
4	395.9	62	295.0	66.6 ac Mi (CN=63) 9.1 ac Ba (CN = 51) 25.2 ac Pa (CN=51) 0.3 ac Be (CN=51)	65[a]
5	124.4	65	124.4	n/a	65[b]
Total	1,566	64	1,326	---	66

[a]Accounts for approximately 6.8 acres of designated impervious area (CN = 98) in basin
[b]Accounts for approximately 0.9 acres of designated impervious area (CN = 98) in basin

After accounting for the zero-discharge areas and impervious areas under post-development conditions, the revised effective CN can be used to calculate the post-development runoff volume:

$$S = \frac{1000}{66} - 10 = 5.15\ inches$$

$$Q = \frac{\left(3 - 0.2(5.15)\right)^2}{(3 + 0.8(5.15))} = 0.55\ inches$$

$$V = 0.55\ in * \left(\frac{1ft}{12in}\right) * 1{,}326\ acres = 60.8\ acre - ft$$

DISCUSSION:

Comparing the pre-development runoff volume generated by the site basins of 61.3 acre-ft with the post-development runoff volume of 60.8 acre-ft indicates a volume reduction of less than 1% even though the total basin area decreases from 1,566 acres to 1,326 acres (15%). The small magnitude of this reduction is due to two primary factors. First, the zero-discharge areas are mostly located in areas with high infiltration potential. Removal of these areas reduces the amount of the watershed that contributes to infiltration and as a result, a relative increase in generated runoff is observed. Second, the development of the site includes new impervious areas (access roads, administration building, etc.) that are not designated as zero-discharge areas. As a result, watershed areas that previously contributed to infiltration on site will be impervious and thus generate more runoff.

CONCLUSION:

Using the TR-55 method, the pre-development runoff volume generated by the site during the 100-year, 24-hour event was estimated to be 61.3 acre-ft. After accounting for the 240 acres of zero-discharge areas and approximately 8 acres of proposed impervious areas, post-development runoff generated during this event is estimated to be 60.8 acre-ft. These values indicate that less than a 1% decrease in runoff volumes will be observed between pre- and post-development conditions.

REFERENCES:

Edge Environmental, Inc. (Edge). 2009. Piñon Ridge Project Environmental Report. November 2009.

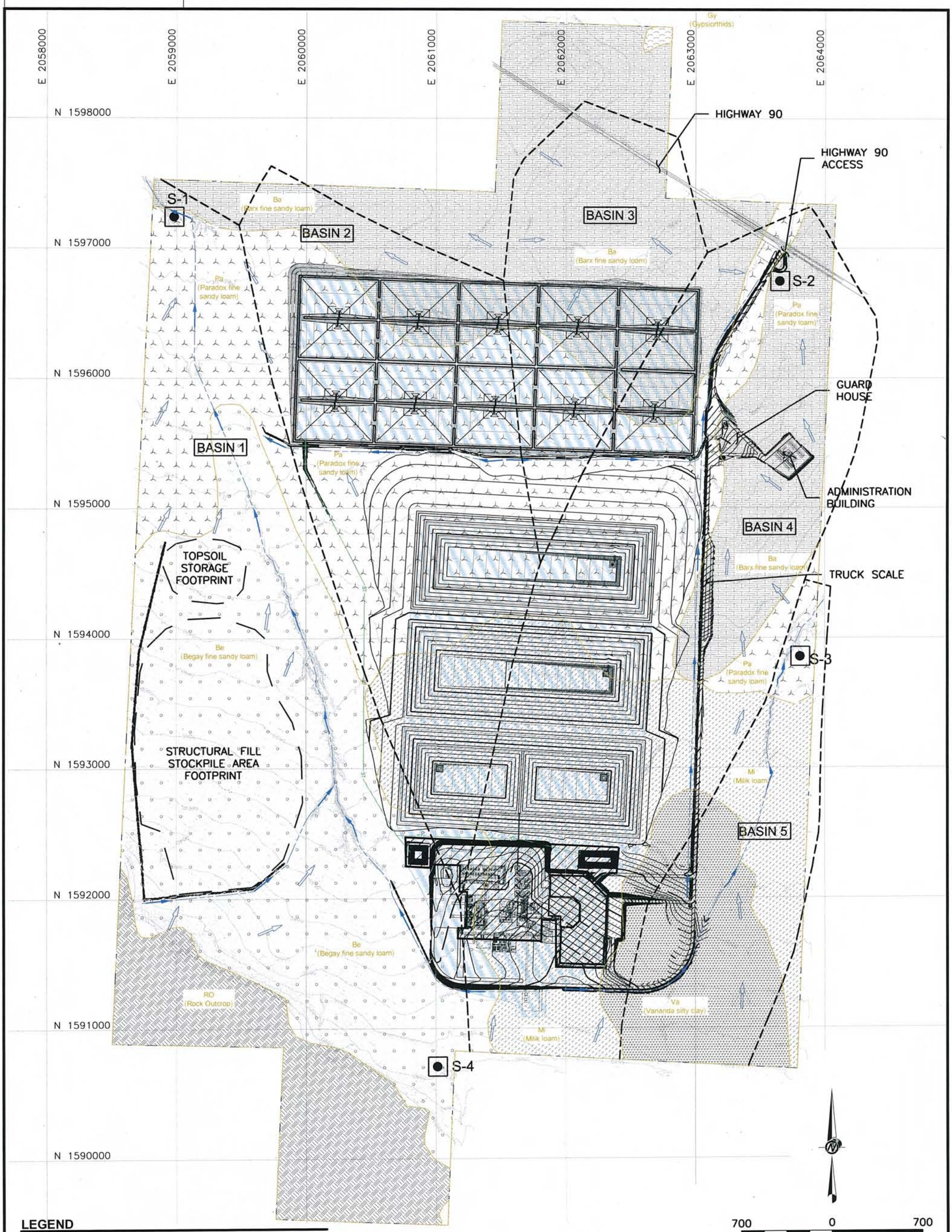
Kleinfelder (Kleinfelder). 2009a. Site Drainage Analysis and Design Report, Energy Fuels Resources Corporation, Piñon Ridge Project, Montrose County, Colorado. February 2009.

Kleinfelder (Kleinfelder). 2009b. Baseline Surface Hydrology Modeling Report in Support of the Application for a License for Source Material Milling, Piñon Ridge Uranium Mill, Montrose County, Colorado. September 2009.

United States Department of Agriculture Natural Resources Conservation Service (NRCS). 1986. Urban Hydrology for Small Watersheds, Technical Release 55 (TR-55). June 1986.

ATTACHMENT 1 TO APPENDIX A4
PIÑON RIDGE PROJECT LAYOUT AND SITE DRAINAGE BASINS

Dwg Name: N:\07\073-81694_D ... res River\07381694D001.dwg
Layout Name: Layout1 Machine: DEN1-W-CBAXTER
Last Update: Mar 10, 2010 16:57 By: CPBaxter
Last Plot: Mar 11, 2010 08:50 By: CPBaxter



LEGEND

- EXISTING GROUND TOPOGRAPHY
- PROPOSED GRADES (175, 150)
- PROJECT BOUNDARY
- STORMWATER PONDS OVERFLOW SYSTEM
- STOCKPILE AREA FOOTPRINTS
- SITE DRAINAGE
- SHEET FLOW DRAINAGE
- S-1 SURFACE WATER SAMPLER LOCATION
- ZERO DISCHARGE AREA
- BASIN 2 DRAINAGE BASIN ID
- WATERSHED BOUNDARY
- NRCS SOIL BOUNDARY
- Va (Vananda silty clay) NRCS SOIL TYPE

PRO.

ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT
MONTROSE COUNTY, COLORADO

TITLE

PROJECT LAYOUT AND SITE DRAINAGE BASINS

Golder Associates
DENVER, COLORADO

PROJECT No.	073-81694		FILE No.	07381694D001
DESIGN	SPS	10/20/09	SCALE AS SHOWN	REV. A
CADD	JR/CB	3/10/09		
CHECK	SPS	3/10/09		
REVIEW				