APPENDIX H – RCRA CANYON OUTCROP ASSESSMENT

FINAL REMEDIAL INVESTIGATION REPORT
CASMALIA RESOURCES SUPERFUND SITE
CASMALIA, CALIFORNIA

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LIST OF ACRONYMS

CSC	Casmalia Steering Committee
DQO	data quality objective
GPS	global positioning system
GSCA	Geologic Siting Criteria Assessment
HAR	Hydrogeologic Assessment Report
HSCER	Hydrogeologic Site Characterization and Evaluation Report
HSIR	Hydrogeologic Site Investigation Report
HSR	Hydrogeologic Summary Report
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
SWAT	Solid Waste Assessment Test
WCC	Woodward-Clyde Consultants

1.0 INTRODUCTION

The Casmalia Steering Committee (CSC) completed the RCRA Canyon Outcrop Assessment during September 2004 in accordance with the scope and methods outlined in the *Casmalia Site Remediation RI/FS Work Plan*, dated June 2004. The following sections describe the nature and findings of the work completed as part of this investigation.

1.1 Purpose of the Investigation

In accordance with the scope of work described in Section 5.1.7 of the RI/FS Work Plan, entitled *Assess Geologic Mapping in RCRA Canyon*, URS geologists conducted a literature review followed by geologic field reconnaissance, field data acquisition, and data analysis activities. As stated in the RI/FS Work Plan, this investigation was conducted in order to confirm and field verify previous data pertaining to the geologic conditions on site.

1.2 Scope of the Investigation

The investigation was initiated with the compilation and review of readily available reports and documents relating to the geologic conditions at the Casmalia Resources Superfund Site (Site). Previous data used for this exercise are largely contained within the *Hydrogeologic Site Characterization and Evaluation Report* (HSCER) and the *Hydrogeologic Site Investigation Report* (HSIR), which were completed in 1988 and 1989, respectively, by Woodward-Clyde Consultants. These documents included the most recent detailed geologic studies completed at the Site, and incorporated and built upon the findings of earlier geologic investigations completed at the Site. As such, the HSCER and HSIR are the most current and comprehensive compilation of Site geologic information, and are considered to be the principal geologic references for the Site. The HSCER and/or HSIR incorporated information from the following Site characterization reports:

- Interim Work Products, Second Element of the Hydrogeologic Characterization – Woodward-Clyde Consultants, December 8, 1986;
- Calderon Legislation Water Solid Waste Assessment Test Report – Woodward-Clyde Consultants, July 1, 1987;
- Hydrogeologic Assessment Report – Canonie Environmental, September 11, 1987;
- Geologic Siting Criteria Assessment Report – Woodward-Clyde Consultants, May 11, 1988;
- Hydrogeologic Summary Report: Additional Site Characterization Work for CAO No. 88-145 – Woodward-Clyde Consultants, November 14, 1988; and
- Addendum Geologic Siting Criteria Assessment – Woodward-Clyde Consultants, November 18, 1988.

The 1989 HSIR is individually cited in Section 5.1.7 of the RI/FS Work Plan as the report from which prior data and conclusions should be examined for the purposes of this task, and while the investigation reviewed the previous studies completed at the Site (listed in the Attachment H-1), we primarily used the compiled data from the HSIR document as our primary historical data source. The nature of information presented in the principal geologic assessment reports reviewed for this effort are summarized in Table H-1.

Following the review of available literature, a field reconnaissance exercise was conducted in the RCRA Canyon area to gather pertinent geologic data for comparison with similar data collected at the Site as part of these earlier studies. This Appendix summarizes the work performed during the 2004 field reconnaissance study, describes the geologic conditions observed and recorded in the RCRA Canyon area, and presents a comparison of these recent data with respect to earlier findings originally presented in the literature reviewed.

2.0 METHODOLOGY

A literature review and field reconnaissance study were performed by URS geologists in an effort to confirm and verify previous data pertaining to the geologic conditions in the RCRA Canyon area of the Site. The first action taken was to compile all readily available reports and documents pertaining to regional and on-site geologic conditions. Following the review of available literature, geologic reconnaissance and field data acquisition were conducted in the RCRA Canyon area. A more detailed description of the methods used to complete this investigation is presented below.

2.1 Detailed Approach

2.1.1 Contractors and Subcontractors

The CSC contracted URS Corporation (URS) to complete the work. All aspects of the work were completed by URS geologists working under the direct supervision of a URS California Registered Geologist. No subcontractors were used in completing the work.

2.1.2 Equipment and Tools

The methodology used in the literature review is described below, and required the use of no special equipment or tools. The geologic reconnaissance and confirmation however required both basic and technical tools. In the field, features were located using a hand-held Garmin® global positioning system (GPS) unit, a topographic map, and a compass. Fracture plane, joint, and bedding attitudes were measured using a Brunton® compass, and rock hammers were used to clear outcrops and collect samples for examination and description. Also, geologic features noted at each of the outcroppings (bedding, fractures, joints, etc.) and representative data collection activities were photo-documented using a digital camera. After all data were collected, GEOrient®, a structural data analysis program, was used to produce the plots used for comparison with the previously published data.

2.1.3 Literature Review

Previously published reports and documents were collected from the Site library, the Santa Maria public library, the URS-Santa Barbara office library, and the Central Coast California Regional Water Quality Control Board library in San Luis Obispo, CA. The principal geologic reference documents used in this exercise are listed in Attachment H-1 to this Appendix, and summarized in Table H-1. The literature collected was then reviewed and the data extracted and compiled in an effort to summarize the previous findings. The main body of information was taken from the HSIR, completed by Woodward-Clyde Consultants in 1989. The 1989 HSIR is individually cited in Section 5.1.7 of the RI/FS Work Plan as the report from which prior data and conclusions should be examined for purposes of this task.

2.1.4 Geologic Reconnaissance

As part of the field work conducted during this investigation, each of the exposed outcroppings of the Todos Santos Member of the Sisquoc Formation in RCRA Canyon were closely examined for lithologic character, bedding orientations, presence and orientation of fractures

and joints, and other pertinent structural features, such as faults and shear zones. Locations where descriptions were made and data collected were given a distinct location ID, recorded using a GPS unit, marked with pink marking flags, and placed on a topographic base map. The URS geologist recorded all pertinent observations and measurements in a field notebook.

2.1.5 Data Reduction and Analysis

After geologic measurements were gathered in the field and compiled into an electronic spreadsheet, the data were reduced and evaluated using a structural data analysis program (GEOrient®). This program was used to generate various plots and diagrams of the geologic data collected. In particular, lower hemisphere projections and rose diagrams were found to be useful in interpreting fracture plane and joint data. These plots and diagrams were then compared with equivalent plots and diagrams produced during the previous Site investigations. Comparison of the plots produced using recent and prior data allow for conclusions to be made regarding the accuracy and representativeness of historical geologic data collected at the site. Section 3.0 summarizes the findings of the geologic reconnaissance conducted in the RCRA Canyon area.

2.2 Deviations from the RI/FS Work Plan

There were no deviations from the RI/FS Work Plan during this assessment.

3.0 INVESTIGATION RESULTS

The following sections describe the data gathered during the course of this investigation, as well as conclusions that can be drawn from these data regarding its consistency with findings from prior Site investigations. Supplementary information that supports the findings and conclusions of this investigation are presented in a series of Figures and Attachments to this Appendix.

3.1 Geologic Setting

As described in previous literature, the Site in underlain by the Todos Santos Member of the Sisquoc Formation, a Miocene-Pliocene age marine sedimentary unit which conformably overlies the Monterey Formation throughout much of the central coast of California (HSIR, 1989). The Todos Santos Member is roughly 900-1,200 feet thick in the site vicinity and has been divided into an upper, weathered claystone unit and a lower, unweathered claystone unit (HSIR, 1989). In the Casmalia Hills area, the Todos Santos Member has been uplifted and deformed into a series of broad, west-northwest trending folds. These features are related to the compression (shortening) and rotation of the Casmalia Hills between the Coast Ranges and the Transverse Ranges (HSR, 1988). Geologic conditions at the Site and within the surrounding vicinity are illustrated in Figure H-1.

3.2 RCRA Canyon Exposures

While previous investigations documented the local presence of the unweathered claystone unit in the RCRA Canyon area, the lower, unweathered claystone unit was not observed during the 2004 reconnaissance effort. The weathered/unweathered claystone contact may likely exist in the reconnaissance area; however, decades of weathering that have occurred since the original mapping was completed in the 1980s has apparently obscured the contact between these two units in the outcrop area examined.

The upper, weathered claystone, however, was identified at numerous outcroppings in RCRA Canyon, and from those exposures a significant amount of data were collected. The upper, weathered claystone unit of the Todos Santos Member crops out in discontinuous locations throughout the western portion of the Site, principally within the middle to lower reaches of the RCRA Canyon area. The largest continuous exposure of the upper, weathered claystone unit is located along the eastern wall of RCRA Canyon, extending from approximately 575 feet to 1,135 feet north of Pond A-5 (Figure H-2). A sketch map of the geologic features observed in this area is presented in Figure H-3. The location of the exposure area examined during this exercise generally corresponds with the area between stations 1+00 and 6+50 in the prior West Canyon Excavation No. 1 (as illustrated in Figure 4-2 of Geologic Siting Criteria Assessment – Attachment H-4). All of the descriptions and data collected during this investigation were taken from locations along this stretch of outcrop that were most accessible and well exposed. These locations are designated as C-02 through C-07 in Figures H-2 and H-3. Scattered outcroppings of the weathered claystone unit are also present in the upper parts of RCRA Canyon just below the perimeter road surrounding the canyon; however, these exposures were not closely investigated due to their comparatively poor quality and lack of readily distinguishable features.

As discussed above, the unweathered claystone unit of the Todos Santos Member was not observed in any of the surface exposures examined in the field. Previous studies describe the

presence of the weathered/unweathered contact in surface exposures as “limited”, and data from the unweathered unit was largely collected from excavations/trenches and core holes completed during prior Site investigations. In an attempt to locate surface exposure of the unweathered unit, the contour map of the top of the unweathered claystone unit (Figure 5.2-3 from HSCER, 1988) was compared with the site geologic map (Figure 5.1-1 from HSCER, 1988) to determine where the unweathered unit may crop out. For most of the areas in and around RCRA Canyon, the top of the unweathered unit is estimated to be approximately 30 to 40 feet below the existing ground surface, and thus would not be expected to crop out anywhere in that area. This depth to contact is consistent with borings completed during the previous studies, in which unweathered claystone was generally encountered at depths of greater than 23 feet. While the weatered/unweathered claystone contact may likely exist in the RCRA Canyon area, comparison of current Site topography in the examined outcrop area (Figures H-2 and H-3) with elevations and geologic features depicted in the Schematic Log of West Canyon Excavations 1 and 2 (Geologic Siting Criteria Assessment, Figure 4-11 – Attachment H-4), indicates that the unweathered claystone lies at an elevation *below* the current ground surface, and has apparently been obscured by decades of weathering that has occurred since the original mapping was completed in the 1980s.

3.3 Lithologic Character of RCRA Canyon Outcrops

Field notes describing the lithologic character of geologic materials exposed in the RCRA Canyon area are presented in Attachment H-3.

3.3.1 Lithology

Lithologically, the weathered claystone unit is massive to thinly bedded, light gray to light grayish brown to yellowish brown claystone to siltstone (shale). Most of the unit is a light brownish gray to light bluish gray massive claystone with finely laminated and thinly bedded sections increasing near the base of the exposure. Thin sedimentary bedding, laminae and claystone-siltstone interfaces indicate that the overall orientation of the unit is horizontal to very shallowly dipping. Attempts were made at numerous locations to measure the exact orientation of these surfaces; however, the highly weathered and fractured state of these surfaces along with their low angle precludes accurate measurement of these features, thus no bedding orientation data were collected. Previously completed detailed geologic studies of the Site also indicate that primary stratigraphic features are not usually visible in either the unweathered or weathered claystone units, and that where discernable, are typically defined by only subtle variations in grain size and sorting. Consistent with current findings, where discernable in earlier studies, bedding was described as gently dipping to horizontal throughout the Site area.

A distinct, discontinuous band and a thin marker bed were noted near the top of the most well exposed outcrop, which is located along the eastern wall of lower RCRA Canyon (Location C-02 in Figure H-3). The band has a brownish yellow to yellow color, strong internal laminae, and numerous lenticular thickenings at irregularly spaced intervals along strike. These localized thickenings appear to be related to sedimentary loading (load structures), convolution, or concretion. This feature is similar in nature to an “orange concretionary bed” recorded in this location during earlier trench investigations (Geologic Siting Criteria Assessment, Figure 4-11 – Attachment H-4).

3.3.2 Secondary Mineralization

Rock samples collected from three locations within the weathered claystone were examined using a 14X hand lens for comparison with descriptions presented in earlier reports. Fresh faces are light gray to light yellowish brown to light olive brown, and are very fine grained with fine laminae present in some samples. These observations are consistent with descriptions of the weathered claystone unit provided in the earlier reports. Additionally, samples containing secondary minerals within fracture planes were collected to determine the nature of the mineralization. Two main types of minerals were found along fractures; a brownish-yellow to reddish brown, thinly formed residue and a white to colorless, vitreous, crystalline precipitate, which tends to have a more voluminous crystal form in larger aperture fractures. Drops of hydrochloric acid were placed on fresh faces of the white, crystalline mineral with no observable reaction, and thus it was concluded not to be a calcium-carbonate rich mineral (i.e., not calcite). After comparison with previous studies (in which X-ray diffraction studies were conducted), the reddish brown mineral is likely to be hematite, while the white crystalline material is most likely a form of gypsum. Discoloration, secondary mineralization, and fracture filling materials are similar in character to those recorded on detailed trench logs from earlier Site investigations (e.g., Geologic Siting Criteria Assessment, Figures 4-3, 4-4, and D-4.2 – Attachment H-4).

3.4 Structural Features

3.4.1 Fractures and Joints

The exposures of weathered claystone along the eastern wall of RCRA Canyon were examined for structural features pertinent to the overall geologic characterization of the Site. As stated in previous reports, fracturing and jointing is pervasive throughout the weathered claystone unit, with sub-horizontal joints (low-angle, roughly bedding parallel) and sub-vertical fractures (high-angle) being most common. The horizontal joints are generally very closely spaced (1-5 cm) and are restricted to the massively bedded light gray claystone sections. These joints most likely developed as the unit was unloaded by progressive uplift and erosion. The high angle fractures commonly cut through all types of lithology within the unit, and have two common orientations. One set of fractures ranges from N28E to N82E and dips 69° to 88°SE, while the other set ranges from N32W to N81W and dips 72° to 89°NE. Northeast trending, steeply southeast dipping fracture orientations recently measured at Location C-05 are largely consistent with the findings of earlier trench investigations at this location (Geologic Siting Criteria Assessment, Feature F-28 in Figures 4-3 and D-4.2 – Attachment H-4), and illustrated on the Site Geologic Map (HSCER, Figure 5.1-1). Consistent with findings from prior Site geologic studies, fracture planes have apertures from 0mm to 15mm, which in places are filled with reddish-brown residue (hematite) or vitreous white crystalline material (gypsum), and possibly other types of secondary mineralization. It is common for a large number of fractures with similar orientations to be located within a very small area (high fracture density), while adjacent areas can have a relatively low fracture density over some distance. It is not uncommon for fractures of different orientations to cross-cut each other forming conjugate fracture sets. Measurements of the structural features are tabulated in Attachment H-2 and recorded in copies of the field notes presented in Attachment H-3.

Data collected from fracture plane and joint measurements in the weathered claystone unit as part of the recent field reconnaissance (36 in all) were plotted on lower hemisphere stereographic projections and 180° rose diagrams using GEOrient©, a structural data analysis program. The plots of these recent measurements were compared with similar plots presented

in the 1988 HSCER and 1989 HSIR, produced from data collected during prior Site hydrogeologic investigations conducted between 1985 and 1988. An inventory of pole plots for bedding, joint, and fracture measurements recorded during prior Site investigations is presented as *Exhibit 1* of EPA's March 6, 2006 comment letter to the CSC, and included herein as Attachment H-5. This inventory appears to be comprehensive and complete.

Historical structural geologic data were collected by geologists from Woodward-Clyde Consultants in accordance the methods and procedures outlined in the Standard Operating Procedure for Geologic Field Mapping (contained in Appendix A of HSCER), and reported in the HSCER and HSIR. These earlier structural measurements were collected primarily from trench excavations completed along the northern, eastern, and western facility boundaries, as well as from natural exposures, cut slopes, and trench excavations along the eastern slopes and canyon bottom of the RCRA Canyon area. At each mappable exposure, systematic evaluations of claystone discontinuities (including joints, fractures, faults and bedding) were made at stations spaced approximately 100 feet apart. These data were then compiled in an electronic database that allowed Site-wide fracture orientations to be evaluated using a data contouring program based on Schmidt equal-area stereographic projections (HSCER, Figure 5.3-1).

Historical fracture data for 288 fracture measurements recorded in the unweathered claystone during these prior geologic investigations are compared to those gathered as part of the RCRA Canyon geologic reconnaissance, as illustrated in Figures H-4 and H-4. As documented in these figures, the results from the 2004 investigation are comparable with those produced in the 1988 investigation, and confirm the validity of the data collected for the weathered claystone unit at that time. An additional comparison between the fracture and joint measurements collected from the lowermost portions of the RCRA Canyon outcrop exposure evaluated during 2004 (Stations C-03 and C-04 in Figure H-3) and those collected during earlier Site investigations for the unweathered claystone is presented in Figures H-6 and H-7. Comparison of these measurements indicate that fracture and joint orientations measured in the RCRA Canyon area during 2004 correspond much more closely with those previously collected from the weathered claystone unit rather than from the unweathered claystone unit, in that the 2004 measurements are predominated by steeply dipping northeasterly trends, and do not reflect the more wide variability in orientations characteristic of the unweathered claystone.

3.4.2 Faults

One fault with significant, apparent vertical offset (1-3 feet) was identified in the field within the weathered claystone unit exposed at Location C-02 (Figure H-3). The high angle fault strikes roughly N75W and dips about 65° to the north, offsetting the distinctive band and marker bed. The offset bedding and drag effects visible across the inferred fault plane suggest reverse sense of displacement along the fault. Reverse displacement along a fault striking N75W is consistent with the direction of regional shortening in the Casmalia Hills, as evidenced by the northwest trending folds present in the site vicinity. The fault observed at Location C-02 may relate to faults previously recorded in this general location during earlier detailed geologic studies (e.g., Geologic Siting Criteria Assessment, Figure 4-11, features F-117 and F-27 – Attachment H-5).

3.5 Conclusions Regarding Consistency with Prior Data

Overall, the data collected in the field from surface exposures of the weathered claystone unit are consistent with the data presented in earlier reports. Fracture plane and joint orientations

generally fall within the same range as those presented in earlier reports, as do the descriptions of the lithology. While the unweathered claystone unit was earlier observed in excavations completed in the RCRA Canyon area during prior Site investigations, it has since apparently been obscured by erosion during the ensuing years, and is no longer exposed at the surface in the areas evaluated. The current lack of exposure of the lower, unweathered claystoneprecludes any data collection from that unit, and thus, any direct comparison with findings for this unit from earlier reports.

In an effort to independently verify the consistency of findings from the recent RCRA Canyon Outcrop Assessment effort with those from earlier detailed Site geologic studies, URS contacted Mr. John Thackston, the former hydrogeology task leader from Woodward-Clyde Consultants who was involved in conducting prior geologic studies at the Site. He is currently a Senior Hydrogeologist with URS Corporation in Denver, Colorado.

In preparing for this independent assessment, Mr. Thackston first reviewed the work scope for this task, as presented in the RI/FS Work Plan, and reviewed EPA's September 26, 2005 comments on this Appendix (including original Attachments H-1 through H-6). He then completed a thorough review of URS' February 10, 2005 Appendix H document, including all text, tables, figures and attachments, and discussed the methods and findings of URS' recent geologic reconnaissance with the supervising URS geologist.

Based upon this independent review, Mr. Thackston concluded the recent geologic data *"…to be consistent with my understanding of the Site geology and the data presented in earlier reports for this Site prepared during 1987-1990 by Woodward-Clyde Consultants."*

4.0 EVALUATION OF ADDITIONAL DATA NEEDS

While data quality objectives (DQOs) have been established for many elements of the RI, no DQOs exist for this specific activity. Because the objectives for this task as stated in the RI/FS Work Plan have been met, and the findings of this assessment are consistent with those from previously completed geologic studies, no additional work is necessary.