WSRC-RP-2000-00391
Rev. 1

Site Selection for Surplus Plutonium Disposition Facilities At the Savannah River Site

L. D. Wike, Compiler

November 2000

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Mr. Charles E. Anderson, Director
Nuclear Material Disposition Division
United States Department of Energy
Savannah River Operations Office
P.O. Box A
Aiken, SC 29802

Dear Mr. Anderson:

FINAL REPORT – SITE SELECTION FOR SURPLUS PLUTONIUM DISPOSITION FACILITIES

Ref: Letter UG-00-124, titled *Site Confirmation for Plutonium Disposition Facilities*, from C. E. Anderson to J.G. Angelos, dated April 6, 2000

In response to your request of April 6, 2000, attached is the final report WSRC-RP-2000-00391, titled *Site Selection for Surplus Plutonium Disposition Facilities at the Savannah River Site.* The site evaluation team evaluated a total of nine sites in and around F Area. WSRC recommends placement of MOX on site 2, PDCF on site X and PIP on site 5.

The process evaluated sites 2 and X for their suitability to the Mixed Oxide Fuel Fabrication Facility (MOX) and Pit Disassembly and Conversion Facility (PDCF) missions, respectively. The remaining seven sites were evaluated for their suitability to the plutonium disposition mission. Though some sites were evaluated as more conducive than others to the construction and operation of the plutonium disposition facilities, none were found to be unacceptable.

Based on prior DOE decisions to use site X for PDCF and site 2 for MOX, the team did not consider whether those decisions represent the optimum arrangement of these facilities among the three sites and did not attempt to evaluate or optimize the placement of individual structures within the assigned plots. The team determined that sites 2 and X are suitable for the siting of new facilities, and therefore confirmed as acceptable DOE's previous decision to use site X for PDCF and site 2 for MOX.

Site 1 was found to include a hazardous waste unit and a grouted section of process sewer line the soil around which may not be disturbed for a distance of 20 feet on either side. These findings led the team to conclude that site 1 should be moved westward approximately 200 yards resolving the sewer line obstacle but further distancing site 1 from PDCF. Site 1 then scored highest overall in the evaluation process, however its distance from PDCF increased.

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Site 5 (including the area immediately to the west of it) was judged by the site evaluation team to be acceptable and has the advantage of being adjacent to the proposed PDCF site, X. Placing PDCF and PIP on adjacent sites significantly increases the flexibility of design of common features and services including the PIDAS configuration options, distribution of utilities, support facilities, etc. Therefore, the WSRC Plutonium Disposition Program recommends that site 5 be selected as the preferred site for the PIP facility. It is further recommended that the site 1 serve as an alternate site should a recommended site prove to be unacceptable.

Sincerely,

FOR

James G. Angelos, Program Manager
Plutonium Disposition Program

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SITE SELECTION FOR
SURPLUS PLUTONIUM DISPOSITION FACILITIES
AT THE SAVANNAH RIVER SITE

WSRC-RP-2000-00391
Rev. 1

November 2, 2000

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EXECUTIVE SUMMARY

A site selection study was conducted to evaluate locations for the proposed Surplus Plutonium Disposition Facilities. Facilities to be located include the Mixed Oxide (MOX) Fuel Fabrication Facility, the Pit Disassembly and Conversion Facility (PDCF), and the Plutonium Immobilization Project (PIP) facility. Objectives of the study include:

- Confirm that the Department of Energy (DOE) selected locations for the MOX and PDCF were suitable based on selected siting criteria,
- Recommend a site in the vicinity of F Area that is suitable for the PIP,
- Identify alternative suitable sites for one or more of these facilities in the event that further geotechnical characterization or other considerations result in disqualification of a currently proposed site.

The site selection process considers facility-specific requirements, sensitive environmental resources and regulatory requirements. The primary objectives of the process are cost minimization, environmental protection, and regulatory compliance.

Nine locations (i.e., Sites 1, 2, 3, 4, 5, 6, 7, X, and the Actinide Packaging and Storage Facility {APSF} Site) in the vicinity of F Area were considered for the proposed facilities. Exclusion criteria were applied to assure that all sites were minimally acceptable and suitable for the proposed facilities. Ranking criteria based upon ecological, human health, geoscience, and engineering factors were then applied to all sites. A comparative analysis indicated that four of the sites had similar high scores and two other sites had comparable low scores. The remaining three sites had intermediate scores.

It is concluded that Sites 1, X, and 2 are the best suited for the proposed missions based on their total scores. Sites 3 and 4 are the least favorably disposed for the missions. Sites 5, 6, and 7 possessed intermediate scores and would be suitable for the proposed facilities. Irrespective of its small area, the APSF site scored well and could be considered for additional space for Sites 2 and X. Although Site 5 is acceptable for use in these projects, current uses and environmental issues could result in adverse cost or schedule impacts that must be considered in any final siting decisions. Additionally, the presence of the Old F-Area seepage basin and process sewer line necessitates that Site 1 be considered for use by a facility that does not require underground connections to other facilities in the complex.

Significant opportunities exist for optimization in the placement of individual facilities as the requirements for those facilities are better defined. Such optimization could include examining subsets of currently defined sites or expansion of certain sites to create parcels more amenable to facility operations. The areas including, and adjacent to Site 5 warrant consideration in this regard, but will require further evaluation.

1.0 INTRODUCTION

The purpose of this study is to identify, assess and rank potential sites for the proposed Surplus Plutonium Disposition Facilities (PuDF) complex at the Savannah River Site (SRS). Three individual facilities are associated with the PuDF complex: Mixed Oxide Fuel Fabrication Facility (MOX); Pit Disassembly and Conversion Facility (PDCF); and the Plutonium Immobilization Project (PIP) facility. The study effort documented in this report was limited by analyses presented in the Surplus Plutonium Disposition Final Environmental Impact Statement (DOE, 1999), which restricted these facilities to locations in the vicinity of the F-Area processing facility at the Savannah River Site (SRS). Additionally, prior to initiation of this study, preferred sites had been identified by the Department of Energy (DOE) for construction and operation of both the MOX and PDCF.

The objectives for this facility siting study were to:

- Confirm that the DOE selected locations for the MOX and PDCF were suitable based upon selected environmental and engineering criteria,
- Recommend a site in the vicinity of F Area that is suitable for the PIP,
- Identify alternative suitable sites for one or more of these facilities should further geotechnical characterization or other considerations result in disqualification of a currently proposed site.

This study does not consider the impact on siting alternatives of ongoing studies concerning the possibility of supplying certain support services from consolidated facilities (e.g., inert gas storage, backup power, cooling water/chilled water, etc.) or the potential for future studies to identify advantages of combining major facility functions (e.g., shipping/receiving, waste handling, analytical labs, etc) into a common unit.

1.1 Synopsis of Site Selection Process

The site selection method utilized a simple decision-making process based on Nominal Group, Delphi and Decision Analysis techniques (Howard and Matheson, 1968; Wike, 1995). A panel of subject matter experts knowledgeable in the areas of facility engineering, regulatory compliance (e.g., National Environmental Policy Act or NEPA) and environmental sciences implemented this process.

A listing of panel members and their organizational affiliations is as follows:

J. B. Gladden (chair)	SRTC/ESTD
R. L. Geddes	SI&PD/PU&APT
M. R. Lewis	PE&CD/SGS
M. E. Maryak	PE&CD/SGS
P. H. Porter, Jr.	PE&CD/Construction
C. B. Shedrow	ESH&QA/EPD
R. R. Tansky	TSD
L. D. Wike	SRTC/ESTD
D. E. Wyatt	PE&CD/SGS

Following the identification of potential PuDF locations within the vicinity of F Area, the panel determined the most suitable locations for project implementation. These locations were

numerically ranked using a system of mutually agreed upon scoring categories that were weighted according to their relative importance. The siting evaluation reported in this document is based on information available at the time of the study. Of particular note is the variability in abundance and quality of geotechnical data available to support the assessment. Consequently, the sites identified as most suitable will undergo an in-depth geotechnical examination to confirm their acceptability for construction and operation of the individual PuDF.

2.0 FACILITY DESCRIPTIONS

The three facilities proposed for surplus plutonium disposition involve processes related to pit conversion, plutonium immobilization, and mixed oxide fuel fabrication. Each process would be carried out within its own specific facility. Pit conversion would be done in the PDCF, immobilization would be conducted in the PIP facility, and mixed oxide fuel assemblies for domestic commercial power reactors would be produced in the MOX Facility. The site selection was completed based on early design concepts. Detailed design data for the proposed facilities were not available.

PDCF would be housed in a two-story building roughly 250,000 square feet. The building would be constructed of hardened concrete walls designed and built to withstand natural phenomena hazards as well as potential facility accidents. Ancillary buildings for support activities and parking lots would also be part of the complex. A generalized description of the pit disassembly and conversion process can be found in DOE, 1999.

Immobilization of plutonium not used for mixed oxide fuel would be conducted in the PIP facility. This operation would convert various forms of plutonium into plutonium dioxide, which would then be converted into a glass or ceramic form. This form would be sealed in cans and placed in canisters at the Defense Waste Processing Facility (DWPF) for final immobilization. The PIP process building is a safety class, hardened concrete structure with a total footprint of 130,000 square feet. Process operations are located on the first floor (67,000 square feet) and the support utility equipment is located on the 2nd floor (63,000 square feet). A two-story administration building (16,000 square feet) and entry control facility (11,600 square feet) are connected to the main process building.

The MOX consists of the mixed oxide fuel Fabrication Building and a variety of support structures. The mixed oxide fuel Fabrication Building is over 370,000 square feet and consists of the mixed oxide fuel Processing Area, Aqueous Polishing Area, and the Shipping and Receiving Area. Ancillary buildings include a diesel generator building, material receipt area, a secured warehouse, an administration building, access control, and a technical support building. The MOX complex is a multi-story structure built to meet all requirements for handling special nuclear material. The three-component building would be constructed of hardened concrete designed and built to withstand natural phenomena hazards as well as potential facility accidents (DCS&W, 2000).

3.0 SITE SELECTION FOR SURPLUS PLUTONIUM DISPOSITION FACILITIES

3.1 Determination of Exclusion Criteria

The first step in the site selection process was the selection of exclusion criteria to serve as an initial screen for identifying potential development locations. The use of exclusion criteria ensures that the PuDF will not be located in areas where they could (a) adversely impact critical SRS environmental resources, (b) present a threat to human health (both on- and offsite populations) or (c) be exposed to known physical hazards and/or regulatory risks. The use of exclusion criteria minimizes the potential for project-related environmental impacts, thereby diminishing the need for significant post-Record of Decision (ROD) mitigation measures. Following is a list of exclusion criteria utilized for the PuDF siting process.

The various components of the PuDF will not be located:

- where they would encroach upon or adversely impact wetlands, high quality surface streams, waterbodies or other high value ecological resources (e.g., National Environmental Research Park Sites, pristine habitats);
- where they would adversely impact any known or proposed threatened or endangered species or their critical habitat;
- within a 100-year floodplain;
- on 'high risk' waste sites;
- in areas of known geologic risks;
- in areas of known significant groundwater contamination within the construction envelope, assumed to be 35 feet below grade based on preliminary engineering for the MOX;
- within one mile from the SRS boundary, and
- so as to contravene relevant NEPA documentation.

3.2 Candidate Site Locations

All candidate sites are located within the vicinity of F-Area (Figure 1) as described in DOE (1999). General descriptions of the candidate sites follow:

Site 1	Site 1 is located along the northwest boundary of F Area. Historically, the site was used as a parking and laydown area for F-Area construction-related activities. The initial location of this site contains a portion of the Old F-Area Seepage Basin waste unit, and associated contaminant plume. This waste unit is in the final stages of Resource Conservation and Recovery Act (RCRA) closure. Late in the site selection process it was discovered that Site 1 was bisected by the abandoned-in-place process sewer line to the Old F-Area Seepage Basin. Site 1 was subsequently relocated to the Southwest (Figure 1b). Topographically, this site is relatively flat. Drainage from the site is to the north-northeast toward tributaries of Upper Three Runs. Site 1 encompasses an area of approximately 25 acres.

Site 2	Site 2 is located due north and adjacent to the F-Area boundary. Sites 1 and X are located to the southwest and southeast of Site 2, respectively. Historically, the site has been used as a spoils pile disposition area for F-Area construction-related activities, most recently for the APSF excavation project. Topographically, Site 2 slopes to the northeast and drains toward a tributary of Upper Three Runs. Site 2 encompasses an area of approximately 32 acres.
APSF Site	The APSF Site is located within the F-Area complex, near the northeast boundary corner. Historically, this site has been used as a laydown area for F-Area construction-related activities. This site is relatively flat, but presently contains a large engineered excavation approximately 35 feet below existing grade. For purposes of the site evaluation process, it was assumed that this excavation would be backfilled to existing level grade. Drainage on the site is to the northeast through Site 2 to a tributary of Upper Three Runs. The APSF Site encompasses an area of approximately 4 acres.
Site X	Site X is located on the northeast boundary of F Area, immediately adjacent to Sites 2, 4, and 5, respectively. Historically, this site was used as a laydown area for F-Area construction-related activities. Topographically, the site slopes to the north/northeast and drains to a tributary of Upper Three Runs, which courses through Site 4. Site X encompasses an area of approximately 26 acres.
Site 3	Site 3 is located approximately 1500 feet northeast of the F-Area boundary, adjacent to the Burial Ground Expansion Area. This site is physically separated from the F-Area complex by a draw that contains a tributary to Upper Three Runs and also in part by land areas associated with Sites 4 and X. Historically, the site has been used as a source of borrow material. Topographically, this site is relatively flat, with drainage to the northeast and southwest to tributaries of Upper Three Runs. Site 3 encompasses an area of approximately 25 acres.
Site 4	Site 4 is located approximately 900 feet northeast of the F-Area boundary and approximately 300 feet northwest of the Mixed Waste Management Facility. This site is physically separated from the F-Area complex by the land areas associated with Sites X and 5, respectively. Historically, this site has never been used or developed. Site 4 is topographically low and possesses significant slope due to the presence of a tributary to Upper Three Runs. Site 4 encompasses an area of approximately 46 acres.
Site 5	Site 5 is located northeast of the F-Area boundary, immediately adjacent to Sites X and 4, respectively. Historically, this site has been used as a debris or spoils pile disposition area and the site presently contains an active ash disposal basin. Topographically, the site drains to the north through the Upper Three Runs tributary, which courses through Site 4. Site 5 encompasses an area of approximately 26 acres. Site 5 was not excluded from consideration because the ash basin is not considered a “high risk” waste site and the underlying contaminated groundwater plume lies well below the construction envelope of the proposed facilities.
Site 6	Site 6 is located along the southwestern boundary of F Area and is bounded on its

	southern margin by SRS Road C. Historically, this site has served as a forest buffer between the F-Area complex and heavily traveled SRS Road C. Topographically, Site 6 is relatively flat and possesses a slight slope to the south-southeast. Drainage from the area is towards Fourmile Branch. Site 6 encompasses an area of approximately 34 acres.
Site 7	Site 7 is located approximately 2500 feet south-southwest of F Area, immediately south of SRS Road C across from Site 6. Historically, the site has been used as a borrow pit and presently hosts the Burma Road Rubble Pile Waste Unit. This site is located on a topographic high, with drainage southward toward Fourmile Branch. Site 7 encompasses an area of approximately 61 acres.

3.3 Ranking of Candidate Sites

All sites considered for evaluation are generally acceptable for use by the facilities being sited because of the initial application of screening or exclusion criteria. The process of ranking sites serves to optimize the placement of facilities by further minimizing potential environmental impacts and reducing difficulties that might arise during construction or operation of facilities. As previously noted, the scoring and ranking presented in this document is based on available data and additional confirmatory geotechnical characterization of the most favorable sites will be required prior to project construction.

3.4 Sensitivity Analysis

Sensitivity analysis has demonstrated that Sites 1, 2, APSF and X are best suited over widely varying error ranges in primary weights. The primary weights representing the relative importance of ecology, human health, geoscience, and engineering present the greatest potential for variability. Secondary weights representing the criteria within the categories were considered to be of lesser variability since category experts determined them. They were not varied. The primary weights were simultaneously varied from 10% to 40% using the method of extreme vertices. Statistical analysis of the resulting weighted scores confirmed the robustness of the site selection (Harris, 2000: Appendix B).

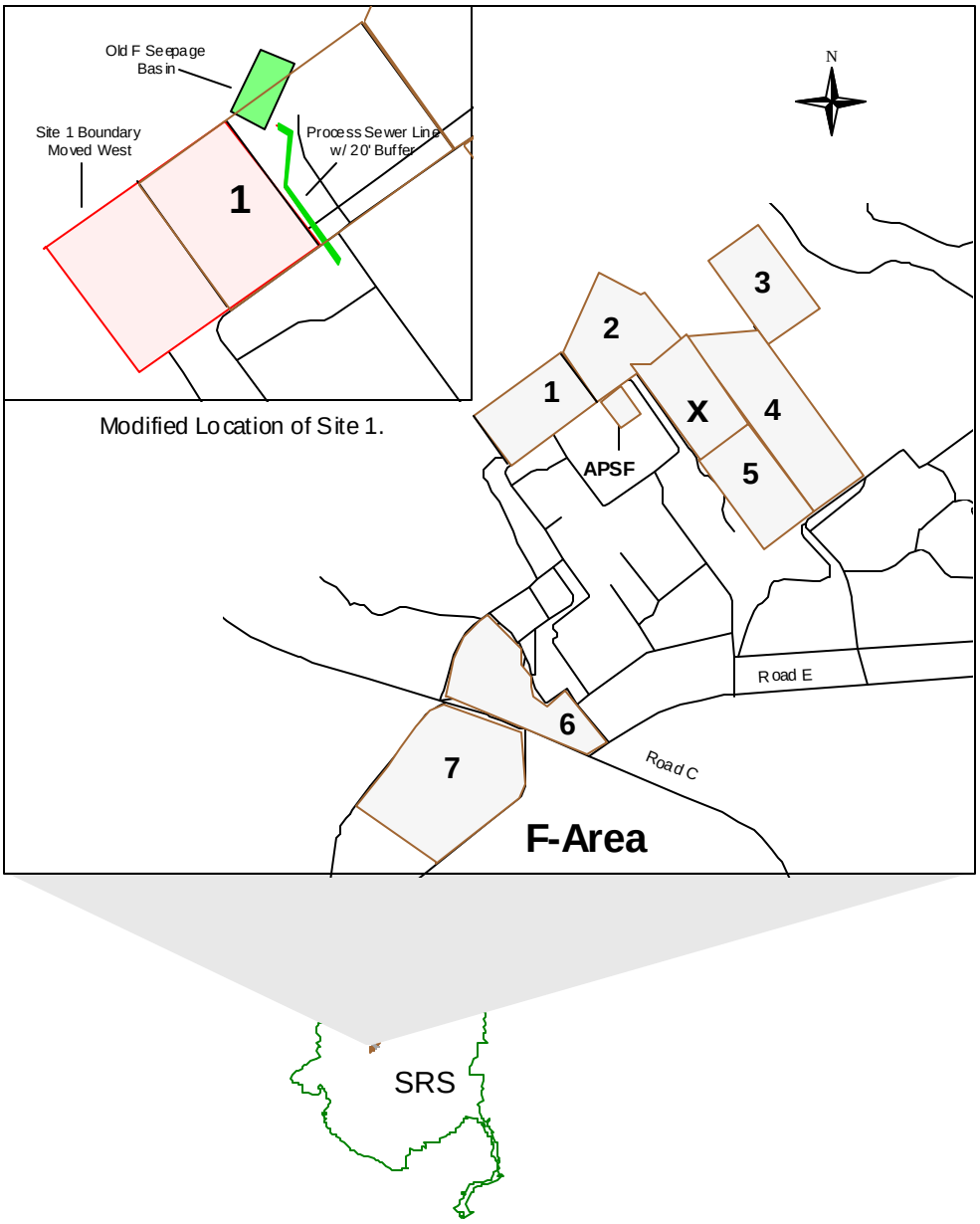

Figure 1. Location of F-Area Within Savannah River Site.

4.0 COMPARATIVE EVALUATION OF CANDIDATE SITES

4.1 Rationale for Scoring Categories and Subcategories

4.1.1 Ecology

The SRS has many sensitive ecological features including areas where plants and animals of concern are found, endangered species and their management areas, pristine headwater streams and wetlands (Figure 2), and ecological research set-aside areas. All of these attributes of the ecological resources must be considered in siting a project because they can be expensive or impossible to remediate if not properly considered and can cause cost and scheduling difficulties.

- **Terrestrial Ecology:** Location and operation of the facility should minimize impacts to plant and animal species located near the project and not degrade existing conditions. Site location should avoid areas containing high-value, limited-availability resources and ecological communities. A site in a developed area, recent clear-cut area, or area containing early growth pine plantation would have minimal terrestrial resource impact and would score highly for this category.
- **Wetlands Ecology:** The SRS has a policy of no net loss of wetlands. Therefore, the project should be located to avoid any loss of wetlands. Sites are favored that minimize potential impacts to this habitat type. Sites nearer to low quality wetlands (e.g., those associated with degraded streams) and those with no potential wetland impacts will score higher than sites near high quality wetlands.
- **Aquatic Ecology:** The proposed project should be sited to minimize impacts to aquatic resources during construction and operation of the facility. Erosion control and storm water runoff are important considerations. Sites near high quality streams would score lower than those situated near degraded or previously impacted streams.

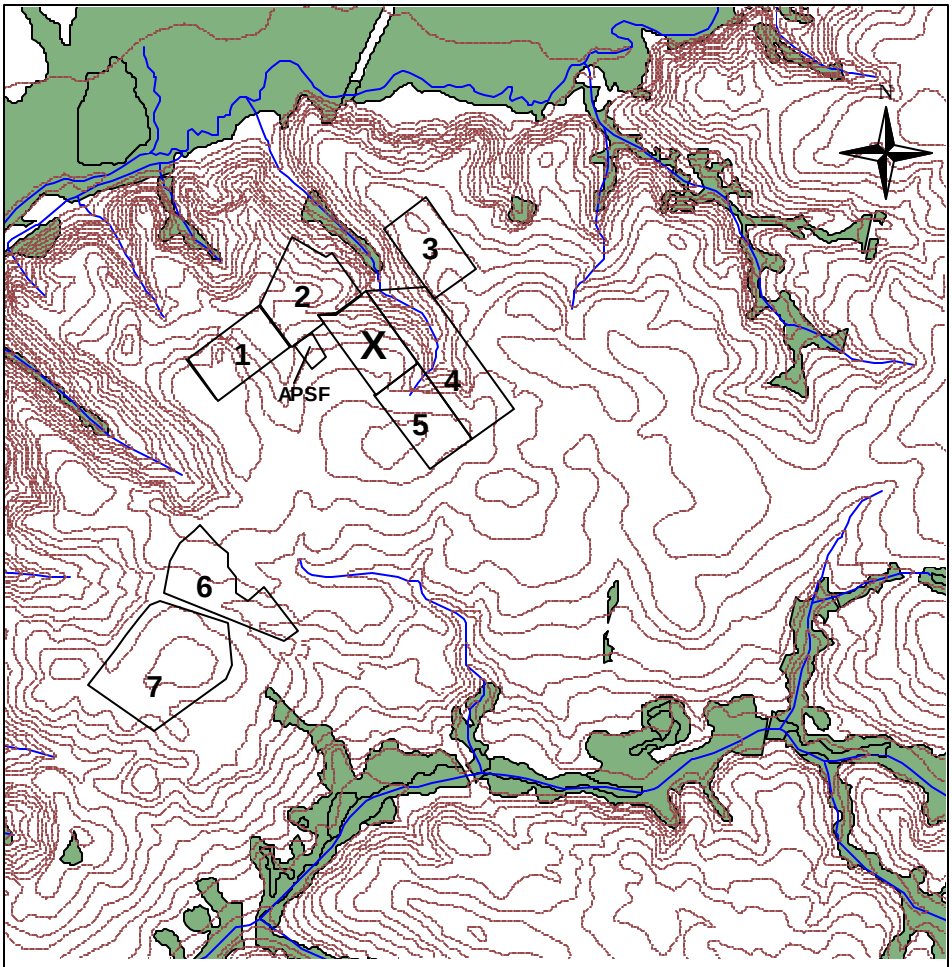

Figure 2. Potential PuDF Sites in Relation to Area Streams and Wetlands.

4.1.2 Human Health

Human health considerations include radiological effects and emergency preparedness. Radiological considerations for releases include offsite risk, potential effects on SRS workers from the proposed facility, and effect from existing facilities on workers at the proposed facility. (Figure 3)

- **Risk to Offsite Population:** As part of the site selection, doses to the offsite maximally exposed individual (MEI) have been determined for each location. Sites presenting lower risks to offsite populations score highest.
- **Effect on PuDF Workers from Nearby Facilities:** Doses were determined for a PuDF worker assuming a release from a nearby onsite radiological facility.
- **Effect of PuDF on Workers in Nearby Facilities:** The effects of releases from PuDF on workers in existing nearby facilities was assessed by evaluating proposed locations with respect to locations of workers in existing onsite facilities and prevailing wind directions for SRS.
- **Emergency Response/Preparedness:** Emergency preparedness considers protective actions, fire and emergency medical response which is measured in time for response from the nearest stations, and proximity to additional onsite hazards. Protective action considers availability of shelter and the number, direction, and congestion of evacuation routes. It was assumed for the purpose of analysis that each candidate location would have stand-alone employee notification and fire suppression systems in place (Matthews, 2000).

4.1.3 Geoscience

Five geoscience categories were evaluated including: topography, surface hydrology, subsurface hydrology, geology, and seismology Each of these categories was further subdivided into specific survey criteria. The importance of each category was weighted against the other categories. Consideration was given to the overall geographical location as well as geoscience experience in the vicinity. Each of the categories is described in Table 1 with relative percentage weights and scores per subdivision.

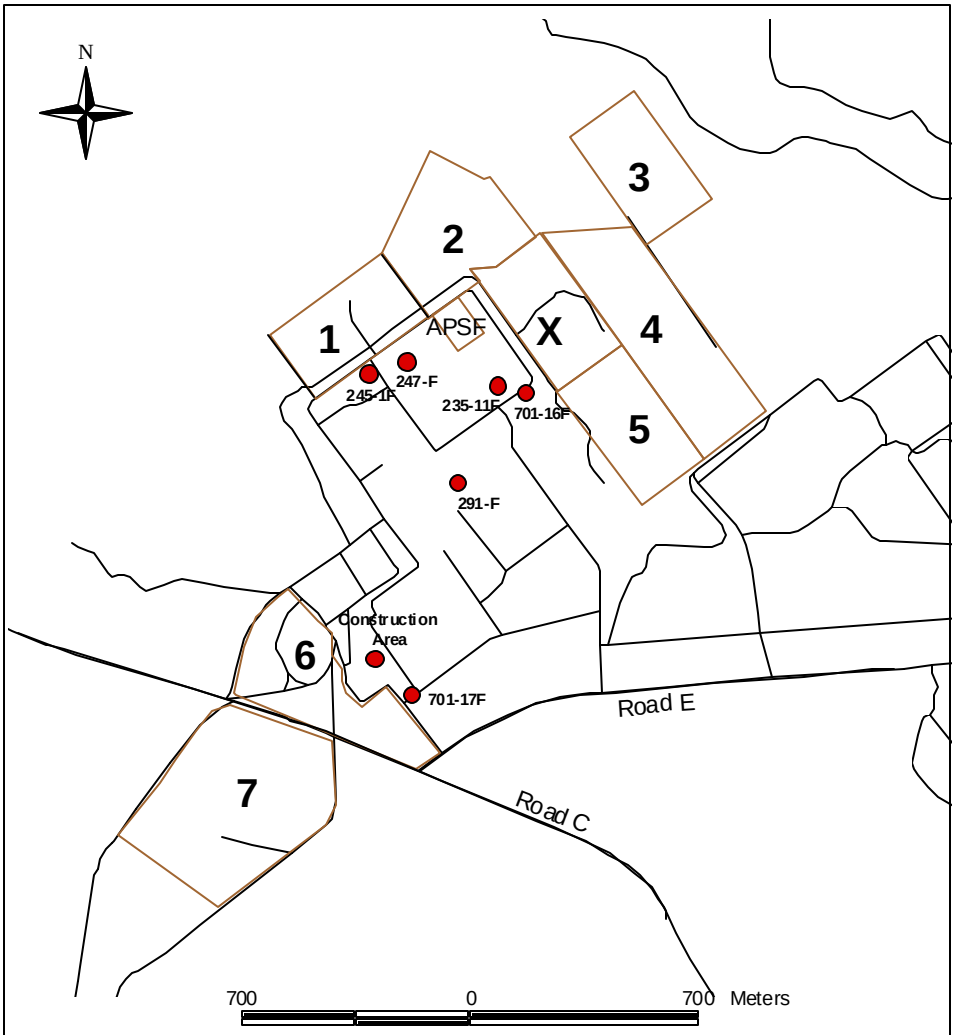

Figure 3. Potential PuDF Sites in Relation to F-Area MEI* Locations.
* = Maximually Exposed Individual

Table 1. Geoscience Categories and Specific Scoring Criteria

Specific Criterion	Description	Criteria	Scoring Values	Max Score
Topography				15
Site topography Figure 4	Topography within the possible project boundaries including the existence of hills, depressions, and slopes were evaluated. Site development on a flat site would cost less compared to a hilly site. Furthermore, steep slopes present potential adverse affects on slope stability.	Hilly, moderate, flat	0, 1, 2, 3	3
Natural drainage	Drainage improvement would cost less for a well-drained site compared to a poorly drained site.	Poor, good, acceptable	0, 1, 2, 3	3
At facility footprint	Construction of the main facility on even surfaces requires less cut and fill. Placement of structural fill under heavy structures requires additional attention to avoid excessive settlement.	Hilly, moderate, flat	0, 1, 2, 3	3
Balanced cut & fill at foundation footprint	If a balanced cut and fill is unachievable, a borrow pit or stockpile needs to be located. The cost for transporting the material is dependent on the amount of material and the distance of transportation.	Haul distance greater than 2 miles, haul distance 0 to 2 miles, balanced cut and fill	0, 1, 2, 3	3
Road and rail profiles	Access roads and rail spurs will be constructed connecting the facility to the existing road or rail. Slopes as well as amount of cuts and fills for constructing the transportation routes are evaluated.	Large slopes, cuts and fills; moderate slopes, cuts and fill; nominal slopes cut and fill	0, 1, 2, 3	3
Surface Hydrology				15
Proximity to floodplain	Distance above 100 year floodplain	Near 100 year flood plain, 10 - 50 ft above 100 yr. flood plain, greater than 50 ft above	0, 1-7, 8-10	10
Local flooding	Response to rainfall	Significant local ponding, moderate local ponding, nominal local ponding	0, 1-4, 5	5

Specific Criterion	Description	Criteria	Scoring Values	Max Score
Subsurface Hydrogeology				30
Ground water depth (Figure 5)	Average groundwater depth and seasonal fluctuations are considered. The groundwater variation could affect the allowable bearing capacity, liquefaction potential, and the future potential for groundwater contamination. Potential flow directions are also considered. High hazard facilities (PC-3 and higher) require seismic design analysis for liquefaction and deep subsidence both depending on ground-water table depths. Construction may require deep excavations and dewatering	Less than 20 feet, 20-40 feet, greater than 40 feet	0-5, 6-10, 11-15	15
Ground water contamination	The primary consideration of the subsurface hydrology is the existence of known groundwater contaminant plumes and the direction of movement in regard to the evaluation area.	Near a RCRA/ CERCLA waste site or a potential contamination flow path of a known plume	10-15, 4-9, 0-3	15
Geology				30
Known soft zones and carbonates	The presence of soft soils (or carbonate formations) is known to exist at the SRS. Ground improvement may significantly increase the construction cost.	Known zones, possible zones, no known zones	0-5, 6-15, 16-20	20
Data confidence and availability	The number and quality of borings, wells, CPT's, geophysical data, geographical data is sufficient to evaluate the subsurface	No subsurface data, minor subsurface data, more subsurface data	0, 1-5, 6-10	10
Seismology				10
Proximity to known fault	The proximity to known faulting affects both the seismic design criteria and the potential groundwater effects of the facility. The expression of faulting as defined from seismic and well log data is generally noted from the geophysical signatures of the regional aquitards. The shallowest defined regional aquitard is the Gordon Confining Unit, approximately 44 to 47 MYBP.	No fault, fault within 1/2 mile does not impact Gordon Aquitard, fault within 1/2 mile impacts Gordon Aquitard	10, 9-5, 4-0	10

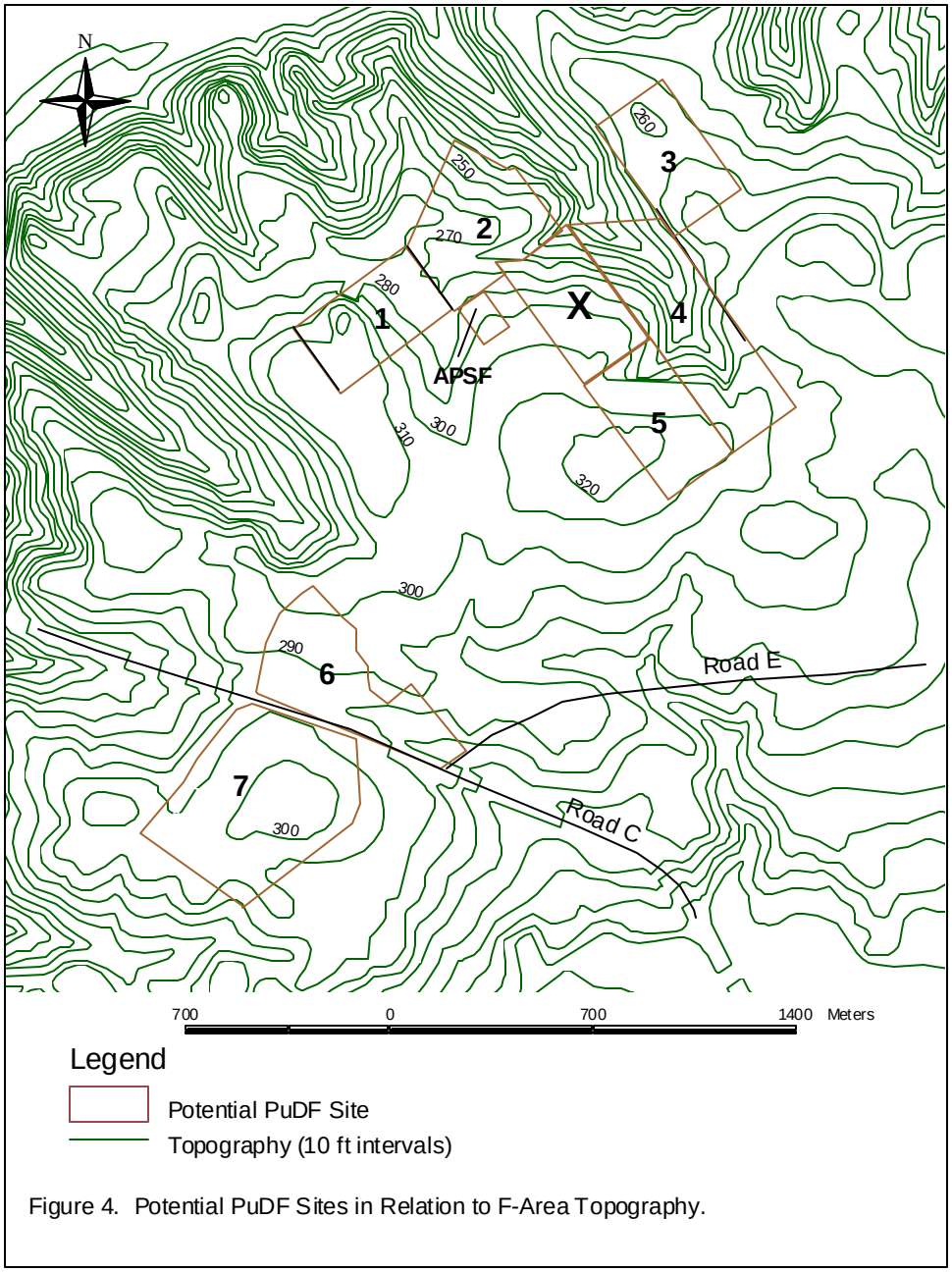

Figure 4. Potential PuDF Sites in Relation to F-Area Topography.

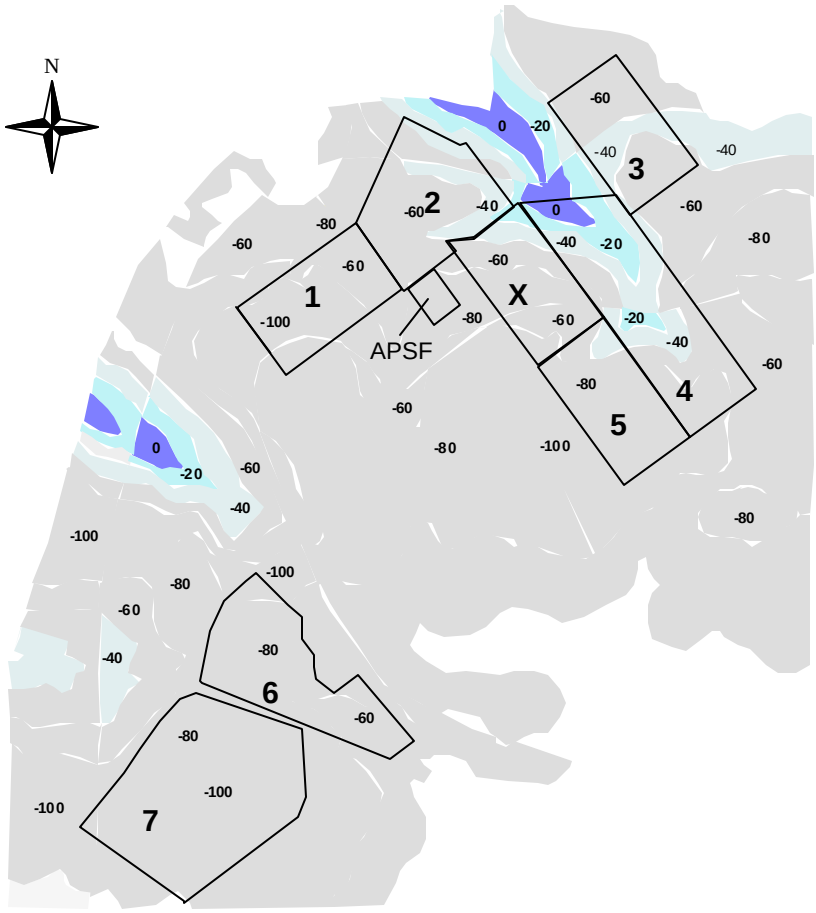

Figure 5. Potential PuDF Sites Relative to Depth to Water Table.

4.1.4 Engineering

Distance to F-Canyon tie-in: The candidate sites were evaluated for the distance (based on likely routing) to the closest point to the high level liquid waste tie-in to the east of F Canyon. The facilities were ranked 1-9 with 1 being most distant and 9 being closest to the tie-in point.

Distance to F/H ETF tie-in: The candidate sites were evaluated for the distance (based on likely routing) to the closest point on the Effluent Treatment Facility (ETF) system line to the center of the candidate site. The facilities were ranked 1-9 with 1 being most distant from the ETF system line and 9 being closest.

Disruption to existing infrastructure utilities: "Disruption" considered the need to relocate electric transmission lines, ground water monitoring wells, and other interference to construction of the new facilities caused by the meteorological tower, storm water drainage, the existing ash basin, and impact of construction traffic on existing site traffic patterns. Sites resulting in the least disruption were given the maximum scores with intermediate scores based on the extent of disruption. The cost of relocation of infrastructure and utilities was the major driver for this rating.

Well relocation – each site's score is equal to the number of monitoring wells likely to require relocation from that site.

Electric transmission line relocation – a score of 1 was awarded for an impact and a score of 6 was awarded to sites with no impact.

Other – each site was evaluated for interferences and the sites were ranked in order of the number of interferences and assigned a score on that basis.

Overall score – each site was given a composite score equal to the sum of the interference component scores. The sites were ranked on the basis of those scores and then assigned an overall score for "Disruption of Existing Utilities" from 1 to 9.

Access to utilities: Each of the candidate sites was assessed for its location relative to most existing utilities and ranked in order of increasing ease of access and given a score of from 1-9 with 1 being most difficult to connect and 9 being easiest to connect to existing utilities. The cost of these new services is directly proportional to the distance to an available tie-in point in an existing line.

Linkage to other new Pu facilities: The scoring for this criterion assumed that MOX and PDCF would remain in their present proposed locations in Sites 2 and X, respectively. The candidate sites were ranked from least centrally located to most centrally located relative to Sites 2 and X. Each site was assigned a score from 1 (most remote) to 9 (closest).

Sanitary plant tie-in: Each candidate site was ranked in two areas: distance to existing sanitary sewer line and elevation. The assumption was that a lower elevation increases the likelihood that a lift station will be needed. Scores were assigned from 1-9 for distance with 1 being farthest and 9 being closest to the existing sewer line. Scores from 1-9 were then assigned to each site for elevation with 1 being the lowest

and 9 the highest elevation. The two scores were summed for each site and the sites ranked by their composite score. The sites were assigned an overall score from 1-9 with 1 being the lowest composite score and 9 the highest.

The scoring for this subcategory is the cost of sanitary tie-in line, which is directly proportional to the distance to existing treatment facility lines.

Proximity to NPDES outfall: The candidate sites were evaluated for their distance (based on likely routing) to the closest National Pollutant Discharge Elimination System (NPDES) outfall. The assumption being that the closer a site is to an existing outfall, the less expensive the tie-in. The facilities were ranked 1-9 with 1 being most distant and 9 being closest to an existing outfall.

Construction equipment access: Each candidate site was evaluated on the degree of difficulty anticipated in bringing large-scale construction equipment from an existing site primary road. The sites were ranked in order of decreasing difficulty of site access by construction equipment and assigned scores with 1 being most difficult to access and 9 possessing the easiest access.

Suitability of construction site: Each candidate site was evaluated on the basis of cost effectiveness attributes including: separation of the construction site from existing operating facilities; the availability of approximately 20 acres of laydown area adjacent to or in close proximity to the construction site for material storage, equipment access, and excess soil disposal from excavations. The sites were ranked on the basis of these attributes and a score of 9 was assigned to the site with the best suitability to use as a construction site and 1 to the site found least suitable.

Proximity to primary road and rail: This subcategory considers proximity to existing SRS road and rail infrastructure to provide personnel access and material deliveries, during both construction and long-term facility operation. The cost of providing this infrastructure is directly proportional to the distance to existing roads and rail (Figure 6).

Each candidate site was evaluated separately for its proximity to an existing site primary road and rail line or spur. The sites were ranked two times in order of increasing distance to each and a score assigned to each site with 1 being most distant and 9 being closest. The two scores were added and the sites ranked highest to lowest based on the composite scores. The site's rank was based on the composite with a score of 9 for the site with the best access to both a primary road and rail line and 1 for the worst access.

Archeology: Evaluations of each site were made by members of Savannah River Archaeological Research Program based on best professional judgment as supported by information in King and Stephenson (2000).

Safeguards and security: Scoring of the nine candidate sites was done on the basis of the time that it would take WSI responders to arrive at the facilities from their normal posts and engage an adversary attempting to enter the facility. The highest ranking was given to sites that could be reached by the largest number of WSI responders in the least amount of time. Candidate sites that would take the longest

time to reach were ranked lowest. The sites were assigned scores on the basis of their ranking with a score of 9 for the shortest response time and 1 for the longest.

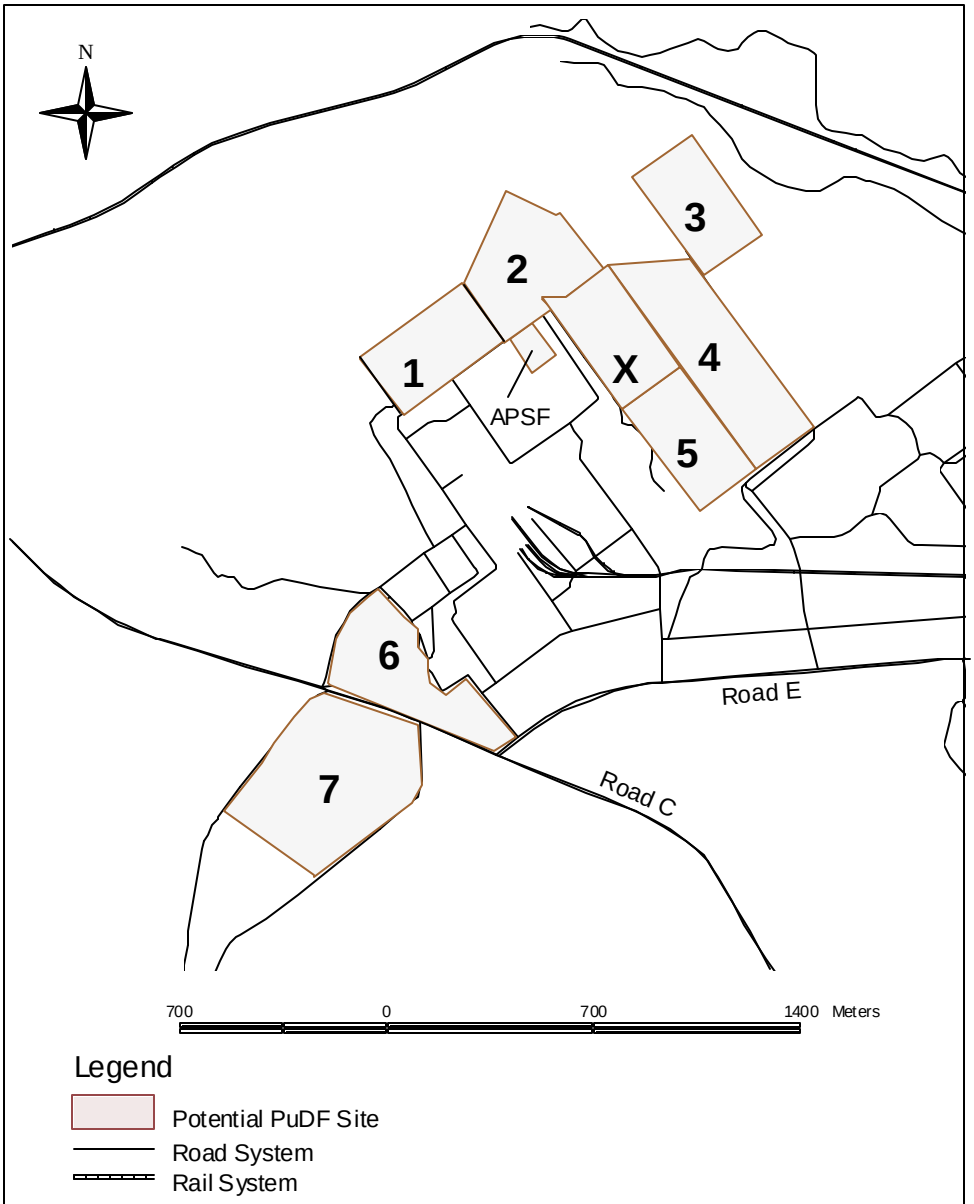

Figure 6. Potential PuDF Sites in Relation to F-Area Road and Rail Systems.

4.2 Scoring of Candidate Sites

Scoring of candidate sites was conducted based on the site lay-outs presented in Figure 1 and subsequent figures, with the exception of Site 1. The presence of the process sewer line through the original proposed location for Site 1 necessitated a minor relocation of that site to the west, as shown by the inset in Figure 1. Scoring of Site 1 is based on the placement depicted in the Figure 1 inset.

4.2.1 Ecology

Terrestrial Ecology: All candidate sites except Sites 3 and 4 scored the maximum of 20 points for terrestrial ecology (Table 2). Sites 3 and 4 are partially vegetated with mature hardwoods, which are a higher value resource than the pine plantation and disturbed areas of the other sites.

Wetlands: Sites 3 and 4 received less than maximum points because they are closer to the nearest delineated wetlands than the other sites and therefore have greater potential for impact upon these areas. All other sites received maximum scores.

Aquatic Ecology: Except for Sites 6 and 7, all other sites are within the Upper Three Runs drainage. Upper Three Runs is an important ecological resource at SRS and is a contributor to regional biodiversity. Sites 3 and 4 have the greatest potential to negatively impact Upper Three Runs and are therefore ranked the lowest. Site 2, because of its location, is slightly less likely to cause impact within the drainage and, as such, scores somewhat higher. Sites 1, 5, X, and APSF are all far enough upland from stream tributaries that their potential impacts are the least of all sites. Sites 6 and 7 are within the Fourmile Branch drainage. Site 6 is sufficiently upland that it has little potential for impact upon the Fourmile drainage. Site 7 is much closer to Fourmile Branch and as such scores slightly lower than Site 6.

4.2.2 Human Health

The evaluation of factors potentially affecting human health was based on the consequences of a radiological release from the PuDF at the proposed location to either offsite populations or workers at the nearest onsite facility, or the consequences of a release from a nearby facility on workers at the PuDF (Lee, 2000: Appendix A). These analyses were based on calculations of the relative doses associated with the events, which is a function of the proximity of other facilities, the potential releases associated with those facilities, and prevailing wind directions at the SRS. Of the suitability of the nine sites with respect to emergency preparedness considerations, evaluations were based on evaluation of aerial photography and ground-level analyses of the relative ease of access to, and egress from, the PuDF during emergency conditions. The locations of the PuDF sites and onsite worker populations and potential release sources are shown in Figure 3.

Site 1
The proposed PuDF Site 1 was given the maximum score of 20 for risk to offsite populations because it is centrally located with respect to the site boundary. Site 1 scored 17 of a possible 20 points for risk to the non-PuDF worker. Its proximity to Building 717-14F yielded a higher dose to the onsite worker relative to doses received by the nearest workers from the other proposed sites. Site 1 received the maximum

Table 2. Summary of Scoring for PuDF Candidate Sites

Category	Weight	Criteria	Weight	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site X	APS F
Ecology	10											
		Terrestrial	20	20	20	15	15	20	20	20	20	20
		Wetlands	30	30	30	20	20	30	30	30	30	30
		Aquatic	50	50	30	25	25	50	50	30	50	50
		Total		100	80	60	60	100	100	80	100	100
		Weighted Total		10	8	6	6	10	10	8	10	10
Human Health	25											
		Risk to Offsite Population	20	20	20	20	20	20	20	20	20	20
		Effect on PuDF Workers from Nearby Facilities	20	20	20	20	20	20	20	20	20	20
		Effect on Workers in Nearby Facilities	20	17	20	20	20	20	16	20	19	15
		Emergency Response/Preparedness	40	35	35	30	35	35	25	25	35	35
		Total		92	95	90	95	95	81	85	94	90
		Weighted Total		23.0	23.8	22.5	23.8	23.8	20.3	21.3	23.5	22.5
Geoscience	30											
		Topography	15	10	9	11	6	7	11	9	10	13
		Surface Hydrology	15	14	13	14	13	13	15	13	14	15
		Subsurface Hydrology	30	18	25	20	5	15	15	23	23	21
		Geology	30	8	10	11	8	10	13	13	12	15
		Seismology	10	6	6	6	6	6	6	6	6	6
		Total		56	63	62	38	51	60	64	65	70
		Weighted Total		16.8	18.9	18.6	11.4	15.3	18.0	19.2	19.5	21.0
Engineering	35											
		Distance to F/H Canyon tie-in	12	10.8	8.4	3.6	4.8	6.6	2.4	1.2	6.6	9.6
		Distance to ETF tie-in	8	7.2	5.6	0.8	1.6	2.4	6.4	4.8	3.2	4
		Disruption to existing infrastructure/utilities	7	2.5	4.2	4.9	1.4	5.6	2.1	4.2	2.8	6.3
		Access to utilities (operations and construction)	12	10.8	7.8	1.2	4.8	6	3.6	1.2	7.8	9.6
		Linkage to other new Pu facilities	6	2	4.2	1.8	3.6	2.4	1.2	1.2	5.4	4.8
		Sanitary plant tie-In	8	7.2	1.6	3.2	0.8	5.6	6.4	4	4.8	2.4
		Proximity to NPDES outfall	5	3	4.5	0.5	3	2.5	1.5	2.5	3.5	4
		Construction equipment access	5	3.5	3	0.5	1	2.25	4	3.5	2.25	1.5
		Suitability of construction site	12	6.6	8.4	3.6	6.6	4.8	10.8	10.8	9.6	1.2
		Proximity to primary road and rail	8	4	2.8	0.8	4.8	5.6	6.8	1.6	2.8	2.8
		Archaeology	2	2	0	0	2	2	1	1	0	2
		Safeguards and security	15	10.5	9	3.75	6	7.5	3.75	3	10.5	10.5
		Total		70.1	59.5	24.7	40.4	53.3	50.0	39.0	59.3	58.7
		Weighted Total		24.5	20.8	8.6	14.1	18.6	17.5	13.7	20.7	20.5
Total				74.3	71.5	55.7	55.3	66.8	65.7	62.1	73.7	74.0
Rank				1	4	8	9	5	6	7	3	2

score of 20 points for risk to potential PuDF workers from exposure to releases from a nearby facility (i.e., 291-F Canyon Stack). Its proximity to the 291-F Canyon Stack and the prevailing winds yielded a dose similar to that of other eight sites evaluated. Site 1 received 35 out of the maximum score (40) for emergency response. It was downgraded in scoring because of the lack of a major access road. leading to the site. The total raw score awarded for the Human Health category for Site 1 was 92.

Site 2
Like Site 1, the proposed PuDF Site 2 was given the maximum score of 20 for risk to offsite populations because it is centrally located with respect to the site boundary. Site 2 scored the maximum 20 points for risk to the non-PuDF worker. Its proximity to Building 247-F yielded an onsite worker dose similar to that of other eight sites evaluated. Similarly, Site 2 received the maximum score of 20 points for risk to potential workers at that site from exposure to releases from the 291-F Canyon Stack. Its proximity to that facility and the prevailing winds yielded a dose similar to that of the other eight sites evaluated. Like Site 1, Site 2 received 35 out of the maximum score (40) for emergency response. It was also downgraded in scoring because of the lack of a major access road leading to the site. The total raw score of 95 for Site 2 was amongst the highest scores awarded for the Human Health category of the nine sites evaluated.

Site 3
Like Sites 1 and 2, the proposed PuDF Site 3 was given the maximum score of 20 for risk to offsite populations because it is centrally located with respect to the site boundary. Like Site 2, Site 3 scored the maximum 20 points for risk to the non-PuDF worker due to its proximity to Building 247-F. Like Sites 1 and 2, Site 3 received the maximum score of 20 points for risk to the potential PuDF worker at that site from exposure to releases from the 291-F Canyon Stack due to its proximity to that facility and the prevailing winds. Site 3 graded out as 30 out of a possible 40 points based on the lack of a major access road and the increased distance (compared to the other proposed sites) for emergency response (Mathews, 2000). The total raw score awarded for Human Health for Site 3 was the 90.

Site 4
Like Sites 1, 2, and 3, the proposed PuDF Site 4 was given the maximum score of 20 for risk to offsite populations because it is centrally located with respect to the site boundary. Site 4 scored the maximum 20 points for risk to the non-PuDF worker due to its proximity to Building 701-16F. Like Sites 1, 2, and 3, Site 4 received the maximum score of 20 points for risk to the potential PuDF worker from exposure to releases from the 291-F Canyon Stack due to its proximity to that facility and the prevailing winds. Like Sites 1 and 2, Site 4 received 35 out of the maximum score (40) for emergency response. It was also downgraded in scoring because of the lack of a major access road leading to the site. The total raw score for Site 4 was 95 and equaled the score for Site 2. The total raw score of 95 for Site 4 was among the highest score awarded for the Human Health category of the nine sites evaluated.

Site 5
The proposed PuDF Site 5, like the others, was given the maximum score of 20 for risk to offsite populations because it is centrally located with respect to the site boundary. Site 5, like Site 4 scored the maximum 20 points for risk to the non-PuDF worker due to its proximity to Building 701-16F. Similarly, Site 5 received the maximum score of 20 points for risk to the potential PuDF worker at that site from exposure to releases from the 291-F Canyon Stack due to its proximity to that facility and the prevailing winds. Like Sites 1, 2, and 4, Site 5 received 35 out of the maximum score (40) for emergency response. It was also downgraded in scoring because of the lack of a major access road leading to the site. The total raw score of 95 for Site 5 was amongst the highest score awarded for the Human Health category of the nine sites evaluated.

Site 6
Like the other sites, the proposed PuDF Site 6 was given the maximum score of 20 for risk to offsite populations because it is centrally located with respect to the site boundary. Site 6 scored 16 of a possible 20 points for risk to the non-PuDF worker. Its proximity to the construction area yielded a higher dose to the onsite worker relative to doses received by the nearest workers to many of the other proposed sites. Like Sites 1, 2, 3, 4 and 5, Site 6 received the maximum score of 20 points for risk to the potential PuDF worker from exposure to releases from the 291-F Canyon Stack due to its proximity to that facility and the prevailing winds. Site 6 received 25 out of the maximum score (40) for emergency preparedness because of its proximity to the water treatment plant. Because the water treatment plant is considered to be a critical service that could not be staffed and operated in the event of an emergency occurrence, its proximity must be taken into account. Its predominantly upwind direction from F Area increases the potential to impact not only F Area but also the only existing major road in and out of the area if an event should occur. The advantage of a nearby major access road (SRS Road C) is a liability for this site because SRS Road C is the only existing major road in the area and impacts to that route during an event could have extensive negative impacts on other site operations. The total raw score for Site 6 was 81, the lowest score awarded for the Human Health category among the nine sites evaluated.

Site 7
Like the other sites, the proposed PuDF Site 7 was given the maximum score of 20 for risk to offsite populations because it is centrally located with respect to the site boundary. Site 7 scored the maximum 20 points for risk to the non-PuDF worker due to its proximity to Building 701-17F. Like the other proposed sites, Site 7 received the maximum score of 20 points for risk to the potential PuDF worker from exposure to releases from the 291-F Canyon Stack due to its proximity to that facility and the prevailing winds. Site 7 received 25 out of the maximum score (40) for emergency preparedness because of its proximity to the water treatment plant. Because the water treatment plant is considered to be a critical service that could not be staffed and operated in the event of an emergency occurrence, its proximity must be taken into account. Its predominantly upwind direction from F-Area increases the potential to impact not only F-Area but also the only existing major road in and out of the area if an event should occur. The advantage of a nearby major access road (SRS Road C) is a liability for this site because SRS Road C is the only existing major road in the area and impacts to that route during an event could have extensive negative impacts on

other site operations. The total raw score of 85 for Site 7 was the second lowest score awarded for the Human Health category among the nine sites evaluated.

Site X
The proposed PuDF Site X was given the maximum score of 20 for risk to offsite populations because it is centrally located with respect to the site boundary. Site X scored 19 of a possible 20 points for risk to the non-PuDF worker. Its proximity to the Building 247-F yielded a somewhat higher dose to the onsite worker relative to doses received by the nearest workers to many of the other proposed sites. Like the others, Site X was given the maximum score of 20 points for risk to the potential PuDF worker from exposure to releases from the 291-F Canyon Stack due to its proximity to that facility and the prevailing winds. Like Sites 1, 2, 4 and 5, Site X received 35 out of the maximum score (40) for emergency response. It was also downgraded in scoring because of the lack of a major access road leading to the site. The total raw score of 94 for Site X was the second highest score awarded for the Human Health category among the nine sites evaluated.

APSF Site
Like the other sites, the proposed PuDF APSF Site was given the maximum score of 20 for risk to offsite populations because it is centrally located with respect to the site boundary. The APSF Site scored 15 of 20 possible points for risk to the non-PuDF worker. Its close proximity to the Building 235-11F yielded a higher dose to the onsite worker relative to doses received by the nearest workers to many of the other proposed sites. The APSF Site received the maximum of 20 points for risk to potential PuDF workers from exposure to releases from the 291-F Canyon Stack. Its proximity to the 291-F Canyon Stack and the prevailing winds yielded a dose similar to that of other eight sites evaluated. Like Sites 1, 2, 4, 5, and X, the APSF Site received 35 out of the maximum score (40) for emergency response. It was also downgraded in scoring because of the lack of a major access road leading to the site. The total raw score awarded for the Human Health for the APSF Site was 90.

4.2.3 Geoscience

Proposed PuDF Sites 1, 2, 3, 4, 5, 6, 7, X and the APSF site were reviewed using the geoscience criteria defined below. The geoscience criteria were evaluated utilizing data from regional monitoring wells, historical geotechnical and geological borings, historical cone penetrometer test soundings and regional geological and geophysical knowledge. Table 3 provides a summary of scores by site and specific criterion. The following text presents narrative summaries of geotechnical evaluations of each of the nine sites.

Site 1
Site 1 is located along the northwest boundary of F Area. The overall orientation of the site trends southwest to northeast, approximately aligned with SRS east-west. Historically, the site was used as a parking and laydown area for F-Area construction activities. Prior to SRS, the area was in agricultural use. The northern portion of the site contains the Old F-Area Seepage Basin waste unit, process sewer line, and associated contaminant plume which is in the final stages of a RCRA closure. The site is situated along a topographic high, which is underlain by sediments of the Upland Unit. Surficial soils are generally Udorthents (disturbed soils) or Blanton Sands (BaB).

The overall topography for Site 1 has been graded relatively flat along the southern half of the site due to historical construction in the area. The northern or northwestern portion and eastern portion of the site descends topographically towards tributaries of Upper Three Runs. There is a small topographic high located in the center of the site. Locally, there are small areas that drain less quickly than other areas but the natural drainage at the facility footprint is good. The area may need to be graded flat because of the topographical change across the site. Minor road or rail profiles may need to be constructed because of the topographical relief across the site. Site 1 does not lie within the 100-year floodplain nor has there been localized flooding. The groundwater depth at Site 1 is greater than 60 feet deep. The Site 1 footprint is hydrogeologically downgradient from potential plumes emanating from the F-Canyon area. There are possible soft zones and carbonates underlying the site based on nearby data. There are no known faults within one-half mile of the footprint that disrupt the Gordon Aquitard although deeper faulting is suspected. There is only one boring or monitoring well point within the Site 1 footprint although there are a few surrounding subsurface data points.

Table 3. Geoscience criteria scoring summary.

	Maximum	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site X**	**APSF[a]**
Topography	**15**	**10**	**9**	**11**	**6**	**7**	**11**	**9**	**10**	**13**
Site topography	3	2	1	2	0	1	3	2	2	3
Natural drainage, site	3	3	3	3	3	2	1	1	2	3
Natural drainage, facility footprint	3	2	2	2	2	2	2	2	2	2
Balanced cut and fill	3	1	1	2	0	0	3	2	2	3
Road and rail profiles	3	2	2	2	1	2	2	2	2	2
Surface Hydrology	**15**	**14**	**13**	**14**	**13**	**13**	**15**	**13**	**14**	**15**
Proximity to floodplain	10	10	10	10	8	10	10	10	10	10
Local flooding	5	4	3	4	5	3	5	3	4	5
Subsurface Hydrology	**30**	**18**	**25**	**20**	**5**	**15**	**15**	**23**	**23**	**21**
Ground water depth	15	15	12	12	2	15	15	14	11	10
Ground water contamination	15	3	13	8	3	0	0	9	12	11
Geology	**30**	**8**	**10**	**11**	**8**	**10**	**13**	**13**	**12**	**15**
Soft Zones and Carbonates	20	6	5	7	6	6	9	9	5	5
Data Confidence/Availability	10	2	5	4	2	4	4	4	7	10
Seismology	**10**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**
Geoscience raw score	**100**	**56**	**63**	**62**	**38**	**51**	**60**	**64**	**65**	**70**

[a]It is assumed that the APSF excavation will be backfilled for its score to be comparable to the other sites.

Site 2
Site 2 is located due north of F Area and adjacent to the F-Area facilities. The overall orientation of the site trends west-southwest although the site is irregular in boundary. Historically, the site was used as a spoils pile area for F-Area construction activities, most recently the APSF excavation. Prior to SRS, the area was in agricultural use, sloping into northwestward into wooded lowlands. The site is underlain by sediments of the Upland Unit. Surficial soils are generally Blanton sands (BaB) or soils of the Vaucluse-Ailey association (VeD).

Site 2 is sloped to the northwest and to the south defining a topographic "nose". Locally, there are small areas that drain less quickly than other areas but the natural drainage at the facility footprint is generally good, however, preferred drainage paths have been noted. Because of the slope, cut and fill requirements are nominal. There are considerations for road or rail profiles because of the topography. Site 2 does not lie within the 100-year floodplain nor has there been localized flooding. The groundwater depth at Site 2 varies between 40 and 60 feet. The site is hydro-geologically downgradient from potential contaminants emanating from the F Canyon areas. There are possible soft zones and carbonates underlying the site based on nearby data. There are no known faults within one-half mile of the footprint that disrupt the Gordon Aquitard although deeper faulting is suspected. There are many existing boring data points in the western portion of the site and several CPT data points located in the southern and eastern portion of the site.

Site 3
Site 3 is located approximately 1500 feet northeast of F Area and adjacent to the Burial Ground Expansion Area. The overall orientation of the site trends northwest, approximately aligned with SRS north. Historically, the site was used as a borrow pit. Prior to SRS, the area was in agricultural or woodland use, grading westward into wetland and woodland. The site is situated along the central to western flank of a topographic high, which is underlain by sediments of the Upland Unit. Surficial soils are generally Lakeland sands (LaB) or Ailey sands (AeD).

The overall topography for Site 3 has been modified due to historical borrow construction in the area. Locally, there are small areas that drain less quickly than other areas but the natural drainage at the facility footprint is good. There are fill requirements for the borrow area. Because of the topographical variation across the site, there are road or rail profile considerations. Site 3 does not lie within the 100-year floodplain nor has there been localized flooding. The groundwater depth at Site 3 varies between 20 and 40 feet. The Site 3 footprint is hydrogeologically downgradient from potential plumes emanating from the Mixed Waste Management Facility. There are possible soft zones and carbonates underlying the site based on nearby data. There are no known faults within one-half mile of the footprint that disrupt the Gordon Aquitard although deeper faulting is suspected. There are several borings data points located across Site 3 interspersed with a few CPT data points.

Site 4
Site 4 is located approximately 900 feet east of the F-Area boundary and approximately 300 feet northwest of the Mixed Waste Management Facility. The overall orientation of the site trends northwest, approximately aligned with SRS north. Historically, the site has been a wetland and woodland. Currently, the site is a wetland

drainage and woodland and is the principal drainage tributary along the eastern side of F Area. The site is a topographic low and drainage underlain by sediments of the Upland Unit and Tobacco Road Formation. Surficial soils are mostly of Vaucluse-Ailey (VeD) composition.

Site 4 is a topographical low that is a tributary draining northwards toward Upper Three Runs. Locally, there are small areas that drain less quickly than other areas but the natural drainage at the facility footprint is generally good. However, after heavy rains localized ponding, seepage and increased stream flow has been noted. Because of the change in slope, the cut and fill requirements are great. There are road or rail construction considerations. Site 4 does not lie within the 100-year floodplain nor has there been localized flooding. The groundwater depth at Site 4 is less than 20 feet. The site is hydrogeologically downgradient from potential contaminants from the F-Area NPDES discharges and from the Burial Ground Expansion Area and the Mixed Waste Management Facility. There are possible soft zones and carbonates underlying the site based on nearby data. There are no known faults within one-half mile of the footprint that disrupt the Gordon Aquitard although deeper faulting is suspected.

Site 5

Site 5 is located approximately 600 feet west of the F-Area boundary and immediately northwest of the Mixed Waste Management Facility. The overall orientation of the site trends northwest-southeast. Historically, the site was used as a debris or spoils pile location. Currently, the site contains an active ash disposal basin. Prior to SRS, the area was in agricultural use. The site slopes from a topographic high in the westward portion to a drainage in the northeastern portion of the site. The site is underlain by sediments of the Upland Unit. Surficial soils are generally Udorthents (disturbed soils).

Site 5 has a minor slope in the northeastern portion dipping eastward towards a tributary of Upper Three Runs. Locally, there are small areas that drain less quickly than other areas and the natural drainage at the facility footprint is nominal. Because of the debris piles and ash basin, the cut and fill requirements are considerable. There are no road or rail profiles of any consequence. Site 5 does not lie within the 100-year floodplain nor has there been localized flooding. The groundwater depth at Site 5 is generally greater than 60 feet. The site is hydrogeologically downgradient from potential contaminants emanating from the Mixed Waste Management Facility and may contain contaminants from the ash basin. Elevated levels of tritium and possibly trichloroethylene (TCE) are found in wells immediately up-gradient to and potentially projecting through the site. There are known soft zone carbonates underlying the footprint based on existing subsurface data near the area and carbonates have been mapped in adjacent areas. There are no known faults within one-half mile of the footprint that disrupt the Gordon Aquitard. There are several CPT data locations and monitoring wells located within the site.

Site 5 was not excluded from consideration because the ash basin is not considered a “high risk” waste site and the underlying contaminated groundwater plume lies well below the construction envelope of the proposed facilities.

Site 6

Site 6 is located approximately 1500 feet west/southwest of the F Area boundary. The overall orientation of the site trends northwest/southeast although the site boundary is irregular. Historically, the site was used as a wooded buffer area between F-Area operations and SRS Road C. Prior to SRS, the area was in agricultural use. The site is underlain by sediments of the Upland Unit. Surficial soils are generally Udorthents (disturbed).

Site 6 has a minor slope dipping southeastward towards a tributary of Fourmile Branch. Locally, there are small areas that drain less quickly than other areas and the natural drainage at the facility footprint is nominal. Because of the minor slope, the cut and fill requirements are minimal. There are no road or rail profiles of any consequence. Site 6 does not lie within the 100-year floodplain nor has there been localized flooding. The groundwater depth at Site 6 is generally 40 to 60 feet. The site is hydrogeologically downgradient from potential contaminants emanating from the F Canyon and F-Area Tank Farm. Elevated levels of tritium are known in the groundwater of the site. There are possible soft zones and carbonates underlying the site based on nearby data. There are no known faults within one-half mile of the footprint that disrupt the Gordon Aquitard although deeper faulting is suspected.

Site 7
Site 7 is located approximately 2500 feet west/southwest of F Area and west of SRS Road C. The overall orientation of the site trends west/southwest and the boundary is irregular. Historically, the site was used as a borrow pit and presently contains the Burma Road Rubble Pile Waste Unit. Prior to SRS, the area was in agricultural and woodland use. The site is situated along a topographic high, which is underlain by sediments of the Upland Unit. Surficial soils are generally Udorthents (disturbed soils) or soils of the Ailey (Aeb) and Dothan DoB) sands.

Site 7 generally has radial drainage. Locally, there are small areas that drain less quickly than other areas but the natural drainage at the facility footprint is generally good. Because of the borrow pit, the cut and fill requirements are considerable. There are no road or rail profiles of any consequence. Site 7 does not lie within the 100-year floodplain nor has there been localized flooding. The groundwater depth at Site 7 is approximately 40 to 60 feet. The site may contain groundwater contamination from the Burma Road waste unit. There are possible soft zones and carbonates underlying the site based on nearby data. There are no known faults within one-half mile of the footprint that disrupt the Gordon Aquitard although deeper faulting is suspected. There are several monitoring wells within the northern portion of the site associated with the Burma Road waste unit.

Site X
Site X is located immediately west of, and adjacent to, F Area. The overall orientation of the site trends northwest/southeast approximately aligned with SRS north. Historically, the site was used as a laydown area for F-Area construction activities. Prior to SRS, the area was in agricultural use, sloping eastward and northeastward into wooded lowlands. The site is situated along an eastward slope of a topographic high, which is underlain by sediments of the Upland Unit. Surficial soils are generally Udorthents (disturbed soils) or soils of the Blanton sand (BaB).

Site X has a slope dipping eastward towards a tributary of Upper Three Runs. Locally, there are small areas that drain less quickly than other areas but the natural drainage at the facility footprint is generally good. Because of the slope, the cut and fill requirements are nominal. There are no road or rail profiles of any consequence. Site X does not lie within the 100-year floodplain nor has there been localized flooding. The groundwater depth at Site X is varies between 20 and 60 feet, depending on the topographic elevation. The site is hydrogeologically sidegradient from potential contaminants emanating from F Area. There are possible soft zones and carbonates underlying the site, based on nearby data and site-specific exploration (WSRC, 1999). There are no known faults within one-half mile of the footprint that disrupt the Gordon Aquitard although deeper faulting is suspected. There are several CPT data locations within the site.

APSF Site
The APSF Site is located within the F-Area boundary and northward from the F Area processing facilities. The overall orientation of the site trends northwest-southeast approximately aligned with SRS north. Historically, the site was used as a laydown area for F-Area construction activities. Prior to SRS, the area was in agricultural use along a topographic high. The site is underlain by sediments of the Upland Unit. Surficial soils are generally Udorthents (disturbed soils).

The APSF site is relatively flat-lying and contains a large engineered excavation about 35 feet below existing grade. Locally, there are small areas that drain less quickly than other areas but the natural drainage at the facility footprint is generally good. Because of the excavation, the cut and fill requirements are considerable. There are no road or rail profiles of any consequence. The APSF site does not lie within the 100-year floodplain nor has there been localized flooding. The groundwater depth at the site is greater than 60 feet deep. The site is hydrogeologically side or downgradient from potential contaminants emanating from F Area. Elevated levels of tritium have been noted historically in monitoring wells immediately west of the site. There are known soft zone carbonates underlying the site, however, they are well characterized. There are no known faults within one-half mile of the footprint that disrupt the Gordon Aquitard. There are numerous borings and CPT data locations within the site.

4.2.4 Engineering

Scoring the sites in the Engineering category focused on critical distances of material transport and construction, and operational suitability. The eleven engineering criteria were given equal weights in the Engineering category. Therefore the raw scores correlate to the ranking of the sites in their suitability to the Pu missions. Scoring for the engineering criteria are presented in Table 2 and narrative summaries of key elements of the engineering evaluations presented below.

Site 1
Site 1 scored highest in the Engineering category with the best possible score in four criteria. Site 1 is the closest site to the F Canyon and ETF tie-ins, has the most convenient tie-in to the sanitary plant and has best access for construction equipment. Site 1 had no serious engineering drawbacks although the 115KV power line to F Area must be relocated to make the site useable.

Site 2
Site 2 had the second highest score in the Engineering category, primarily due to its being scored above average on most criteria and only having one significant weakness, that being a low average elevation likely requiring a lift station for the sanitary line tie-in. Site 2 was closest to an existing NPDES outfall.

Site 3
Site 3 had the lowest overall engineering score, being the most remote of the sites in terms of existing utilities and improvements. Site 3 scored lowest in four engineering criteria: distance to ETF tie-in, access to existing utilities, proximity to primary road and rail and proximity to NPDES outfall and second lowest for security response time. Site 3 was not seen to have any significant strengths in the engineering category.

Site 4
Site 4 scored third lowest of the nine sites in the engineering category. Site 4 had moderate scores for four criteria but is distant from the ETF tie-in, has a long response time for protective force, has a large number of monitoring wells requiring relocation and scored lowest for sanitary plant tie-in.

Site 5
Site 5 received the median score in the engineering category. This site would pose little disruption to existing infrastructure, is convenient to the sanitary tie-in and is relatively close to the primary road and rail line. However it is distant from the ETF tie-in, scores low in construction area suitability and only average in safeguards and security.

Site 6
Site 6 scored below the average score for all nine sites. Site 6 was distant from the F Canyon tie-in, would substantially disrupt existing infrastructure, had a long security response time and was remote from the other new Pu facilities and existing utilities. Its strengths were its proximity to the ETF and sanitary tie-ins, proximity to the primary road and rail line and suitability as a construction site.

Site 7
Site 7 received the second lowest score in the engineering category, scoring lowest or second lowest on five criteria: safeguards and security, distance to F Canyon tie-in, access to utilities, sanitary plant tie-in, construction equipment access and proximity the railroad spur.

Site X
Site X scored only slightly lower in the engineering category than Site 2. Its strengths were linkage to new Pu facilities, proximity to an NPDES outfall, construction site suitability and safeguards and security. Its most significant weakness was sanitary plant tie-in issues of distance and elevation.

APSF Site
The APSF site score fourth best of the nine sites. Its primary drawbacks are construction equipment access and construction site suitability due to its small size. The APSF site scored high for its proximity to F Canyon and the other new Pu facilities, good access to utilities and NPDES outfall and offered least disruption to the existing infrastructure.

5.0 CONCLUSIONS

All sites evaluated passed the exclusion criteria (screening test) and are, therefore, suitable for further consideration for the PuDF. Based on the ranked scores, Sites 1, X and 2 are preferable. Due to its small acreage, the APSF site should be considered for expansion of the current footprint of Site 2 or X, or the placement of support components for one or more of the proposed facilities.

Sites 5, 6 and 7 had intermediate scores, while Sites 3 and 4 were clearly the least preferred sites. While the application of screening criteria results in all sites being useable, lower scores are generally indications of increased costs or potential delays in project implementation. Such is the case with Site 5 where current land uses do not preclude redevelopment for PuDF, but cost and schedule issues associated with this site must be considered.

For this report, each individual site was evaluated on its own merit as an integral unit with generic specifications and requirements. As facility designs and requirements become better defined, there are significant opportunities to optimize facility placement relative to the sites that have been evaluated. For example, although Site 1 scored highly in the ranking, its relocation to the west makes it more distant from Sites 2 and X. In addition, its use will be somewhat restricted by a limited ability to connect to other PuDF facilities that would require underground piping or services because of the presence of the Process Sewer line. Additionally, adjacent land parcels that may, or may not, have been evaluated in this study should be examined for optimization purposes. Although the northern end of Site 4 poses significant challenges for use, the southern portion may be more acceptable. Examination of the areas west of Site 5 (between the currently identified boundary and the F-Area fence) might identify land suitable for facility placement resulting in a substantial land parcel equivalent to Site 5, but oriented east-west, rather than north-south. Although evaluation of such options is beyond the scope of this study, they represent significant opportunities for the PuDF program to increase efficiency, reduce costs and minimize environmental impacts.

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APPENDIX A

Preliminary Dose Estimates for Plutonium Disposition Facility Site Selection

WSRC-RP-2000-00391
Rev. 1
November 2, 2000

WESTINGHOUSE SAVANNAH RIVER COMPANY

INTER-OFFICE MEMORANDUM

SRT-ETS-990190

November 29, 2000

Technical Reviewer

TO: L. WIKE, 773–42A
ENVIRONMENTAL SCIENCE & TECHNOLOGY

FROM: P. L. LEE, 773–42A (5-3280)
ENVIRONMENTAL SCIENCE & TECHNOLOGY

PRELIMINARY DOSE ESTIMATES FOR PLUTONIUM DISPOSITION FACILITY SITE SELECTION

Summary

Nine locations on the Savannah River Site (SRS) have been identified as potential sites for the placement of the Plutonium Disposition Facility. As part of the site selection criteria, doses to the maximally exposed offsite individual (MEI) have been determined for each location. Doses have also been determined for nearest onsite individual and the individual at each potential site exposed to a nearby process (291-F Canyon stack). Using the scoring system provided in Attachment 1, each site was assigned a score for the human health portion. *From a human health perspective, no one site is superior to any of the others.* ***(will be a sentence the reflects what these results show)***

Dose Determination

AXAIRQ (Simpkins 1995a and 1995b) was used to determine fifty-year committed effective dose equivalents (CEDEs). AXAIRQ is used at the Savannah River Site to model atmospheric transport and radiological dosimetry for postulated atmospheric releases of short duration. The code strictly adheres to the guidance in USNRC Regulatory Guide 1.145 (USNRC 1982). Meteorological data from 1992-1996 and ICRP 30 dose factors were used (USDOE 1988a and 1988b). The release height was assumed to be ground level, and the release was assumed to occur over a two-hour period. AXAIRQ does not take into account plume rise due to buoyancy or momentum.

Each potential site location is shown in Figure 1. The site coordinates and a brief description of the location of the proposed sites are shown in Table 1. Distances to the site boundary for the maximally exposed individual (MEI), the nearest onsite population and between the site and a nearby process are shown in Table 2 for all locations. The worker and onsite process distances were determined by estimates from a site map and the boundary distances are calculated by AXAIRQ.

Table 1. Proposed Plutonium Disposition Facility Locations

Location	Description	Easting Coordinate (ft)	Northing Coordinate (ft)
1		53453	80056
2		55356	80269
3		57423	79780
4		56589	78295
5		55800	77323
6		50187	76698
7		51590	77293
X		55841	78744
ASPF		54885	79279

Table 2. Distances to Various Locations for Plutonium Disposition Facility

Location	Boundary Distance for MEI (m)	Worker Distance (m)	Process Distance (m)
1	8790	160	466
2			519
3			937
4			665
5			413
6			599
7			865
X			426
ASPF			414

Source terms for worst case accidents from the Plutonium Disposition Facility have been estimated in an Environmental Impact Statement (EIS). Analysis indicates that four grams of plutonium could potentially be released to the environment from the Mixed Oxide Fuel (MOX) facility. (USDOE 1999). Since the objective of this document is to compare the health effects of the various sites, the amount of the release is not important, but rather the comparison of the resulting doses. For comparison, four grams of plutonium (isotopic composition in Table 3) in the form of MOX powder is assumed to be released through the building ventilation as a result of a design based earthquake. Resulting doses cannot be compared to regulatory limits since specific source terms have not been developed at this time.

Table 3. Isotopic Composition of Plutonium (USDOE 1999).

Isotope	**Composition (%)**
Plutonium-238	0.03
Plutonium -239	92.2
Plutonium -240	6.46
Plutonium -241	0.05
Plutonium -242	0.1
Americium -241	1.0

AXAIRQ was executed with the appropriate worker and process distances for each of the release locations. The resulting CEDEs are shown in Table 4 for meteorological conditions for which doses are not exceeded 99.5% of the time in the particular sector. Doses for the nearest onsite individual and the site worker due to exposure to the nearby processes were scaled (using relative air concentrations) from the worst sector doses produced by AXAIRQ for the assigned distance.

Table 4. CEDE for Potential Atmospheric Releases Resulting from Plutonium Disposition Facility for 99.5% Meteorological Conditions

Site Location	MEI Offsite Dose (rem)	Nearest Onsite Worker Dose (rem)	Site Worker Dose from Nearest Onsite Process (rem)
1	.824	183	
2			
3			
4			
5			
6			
7			
X			
ASPF			

Scoring of Human Health Effects

Using the scoring system shown in the attachment, scores have been assigned to the various human health effects categories and are shown in Table 5. The score for offsite risk was selected to be a perfect score of thirty for each of the locations since all proposed release locations are centrally located with respect to the site boundary. The effect on SRS workers was determined by looking comparatively at the doses that were reported in Table 4. The effect from existing facilities was qualitatively assigned by looking at location with respect to existing onsite processes and prevailing wind direction for SRS. As seen in the attachment, these scores must be added to the emergency preparedness scores to determine the overall Human Health score.

Table 5. Human Health Effects Scoring

Score (Each out of 20)				
Site	**Offsite Risk**	**Effect from Nearby Facilities**	**Effect on Nearby Facilities**	**Total Score (60 possible)**
1				
2				
3				
4				
5				
6				
7				
X				
ASPF				

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cc: J.B. Gladden ,773–42A
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ES&T File, 773–42A

Attachment 1. Criteria for Scoring for Each of the Four Potential Sites for the Plutonium Disposition Facility

Criteria Scoring Sheet with Weights

Category	Weight	Criteria	Weight	Site A	Site B	Site C	Site D
Ecology	15						
		Terrestrial	20				
		Wetlands	40				
		Aquatic	40				
Human Health	20						
		Risk to Offsite Population	30				
		Effect on SDF Workers from Nearby Facilities	30				
		Effect of SDF on Workers in Nearby Facilities	30				
		Emergency Response/Preparedness	10				
Geoscience	30						
		Topography	15				
		Surface Hydrology	15				
		Subsurface Hydrology and potential contamination	30				
		Geology	30				
		Seismology	10				
Engineering	35						
		Distance to the Line From Late Wash to the Low Point Pump Pit (SPF Feed)	10				
		Distance to the Decontaminated Plutonium Solution Transfer Line	10				
		Disruption to Existing Infrastructure/Utilities	10				
		Access to Utilities	10				
		Ability to Share Existing Infrastructure (building 980-S, cold-feeds)	10				
		Sanitary Plant tie-in	2				
		Proximity to NPDES Outfall	3				
		Construction Site Suitability	15				
		Proximity to Primary Road	3				
		Archaeology	2				
		Distance to low point pump pit	25				

APPENDIX B

Sensitivity Analyses of Site Selection for Surplus Plutonium Disposition Facilities at the Savannah River Site

WSRC-RP-2000-00391
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Westinghouse Savannah River Company
Savannah River Technology Center
Aiken, SC 29808

Sensitivity Analyses of Site Selection for Surplus Plutonium Disposition Facilities at the Savannah River Site (U)

Key Words: High Level Waste, Sensitivity Analysis, Site Selection, Plutonium Disposition, Weighted Criteria

Retention Period: Permanent

S.P. Harris

June 28, 2000

S.P. Harris, Author	**Date**
R.C. Tuckfield, Manager SRTC/ES&T/SCS	**Date**
E.P. Shine, Technical Reviewer	**Date**

Abstract

S. P. Harris, SRTC/SCS

Sensitivity Analyses of Site Selection for Surplus Plutonium Disposition Facilities at the Savannah River Site (U)

Sensitivity analysis has demonstrated that Site 1, 2, APSF and X and are best suited over widely varying error ranges in primary weights. The primary weights representing the relative importance of ecology, human health, geoscience and engineering present the greatest potential for variability. Secondary weights representing the criteria within the categories were considered to be of lesser variability since category experts determined them. They were not varied. The primary weights were simultaneously varied from 10% to 40% using the method of extreme vertices. Statistical analysis of the resulting weighted scores confirmed the robustness of the site selection.

WSRC-RP-2000-00391
Rev. 1
November 2, 2000

Sensitivity Analyses of Site Selection for Surplus Plutonium Disposition Facilities at the Savannah River Site (U)

S. P. Harris

Summary

A site selection study was conducted to evaluate locations for the proposed Surplus Plutonium Disposition Facilities[1]. Presented in this report is a sensitivity analysis that demonstrates the robustness of the site evaluations.

Sensitivity analysis has demonstrated that Site 1, 2, APSF and X and are best suited over widely varying error ranges in primary weights. Primary weights representing the relative importance of ecology, human health, geoscience and engineering were simultaneously varied over a wide range in order to demonstrate the robustness of the selection process. The primary weights represent the greatest potential for variability. The statistical results were conditional on the scores within each category given by an expert panel. Secondary weights representing the criteria within the categories were considered to be of lesser influence were not varied. Individual site criteria scores were held constant in the sensitivity analysis.

Background

An expert panel identified, assessed and ranked potential sites for the proposed Plutonium Disposition Facilities (PuDF) complex at the Savannah River Site (SRS). The panel employed a decision making process based on the Nominal Group, Delphi and Decision analysis process[2]. The members included subject matter experts knowledgeable in the areas of facility engineering, regulatory compliance (NEPA) and environmental sciences.

The panel established categories, rating criteria, and weighting factors for ranking potential sites. Nine locations in the vicinity of F-Area were considered for the proposed facilities. The evaluation categories included ecological, human health, geoscience and engineering considerations. The subject matter experts then established the rating criteria within each category. Finally the weights and utility function values (UF) were established within each category (Table 1) for nine potential sites. The utility function values are the sum of weighted scores within each of the nine evaluation categories. Presented in this report is a statistical sensitivity analysis that demonstrates the robustness of their evaluation.

Statistical Approach

A strategy for sensitivity analysis for alternative methods for site selection is presented. The primary weights were varied between categories because it was felt that they represent the greatest potential for variability. The utility function values within each category were not varied because they are considered to have low variability since they reside within each category

of expertise. The sensitivity analysis was conducted using SAS[3] as the primary tool. The data were analyzed using Statgraphics[4].

The primary category weights, as recorded from the Site Assessment Matrix (Table 1) are shown in Chart 1. In addition, the minimum and maximum values corresponding to a 10% to 40% decrease or increase are also shown.

Typically, in a sensitivity study, we would review the impact on the site ranking using all 2^4 combinations of minimums and maximums. However, we are further constrained by the fact that the sum of the primary weights must equal unity. Therefore, the proper selection of weight combinations will lie on the hyperplane defined by $\sum_i W_i = 1$. The final weighted score for each site is calculated as $WSCORE = \sum_i W_i \sum_j UF_j$ where i is the category and j is the criteria within each category.

The extreme vertices of this region were selected, i.e.: points on the edges of the hyperplane defined by the constraints in addition to the centroid. This was implemented using the SAS ADXINIT and ADXXVERT macros[5] and resulted in 39 different combinations of primary weights for use in each potential site's sensitivity analysis (Table 2). The final weighted score is also shown.

Chart 1

Sensitivity Ranges for Percent Change in Primary Weight

Category	Primary Weight	10%		20%		30%		40%	
		Min	Max	Min	Max	Min	Max	Min	Max
Ecology	10	9	11	8	12	7	13	6	14
Human Health	25	22.5	27.5	20	30	17.5	32.5	15	35
Geoscience	30	27	33	24	36	21	39	18	42
Engineering	35	31.5	38.5	28	42	24.5	45.5	21	49

The weights in Table 2 were evaluated using Statgraphics[4]. The resulting graphics are included in Plot 1 and statistical summary statistics are shown in Table 3.

Analyses of Weighted Scores

The Box-and Whisker Plots (Plot 1) show the range and variation in total weighted score for each of the alternative sites. The average total weighted score, the median and standard deviation are shown for each alternative in Table 3.

Each Box-and-Whisker plot displays the minimum and maximum values, the 25th, 50th (median) and 75th percentiles. The box is aligned vertically and encloses the interquartile range (the 25th to 75th percentile). The upper part of the box represents the 75th percentile while the lower part represents the 25th percentile. Extreme points will also be shown extending from the box.

The Box-and-Whisker Plots of site scores show that Sites 1, 2, APSF and X are the best suited for the proposed missions based on their total weighted scores over widely varying primary weights from up to 10% to 40%. Sites 3 and 4 are the least favorably disposed for the missions. Sites 5 and 6 possessed intermediate scores. These conclusions are reinforced by the analysis of ranks (Table 4).

Statistical Software

Two software packages are employed in deriving the sensitivity analysis results namely SAS Release 6.12 and Statgraphics Version 4.0. SAS is a commercial 4th generation computer programming language and Statgraphics is a desktop statistical package. Both programs are commercially available off the shelf software. Both programs are statistical tools that have been previously employed to perform statistical analyses at SRS. In this application, the programs perform standard statistical and arithmetic base functions and algorithmic functions.

A verification of the correctness of algorithm functions was performed[(6),(7)]. A validation of the software performance was accomplished by analyzing a representative sample of input data and comparing output data to a hand calculated output of the sensitivity analyses. This calculation by alternative method also verified the SAS and Statgraphics base functions. The justification for the sample selection was verified and difference between the results was then verified to lie within an acceptable error band suitable for this application.

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Table 1

Evaluation Categories, Criteria, Weights and Utility Function Values for Site Selection

Category	Wt	Criteria	Weight	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site X	APSF
Ecology	**10**											
		Terrestrial	20	20	20	15	15	20	20	20	20	20
		Wetlands	30	30	30	20	20	30	30	30	30	30
		Aquatic	50	50	30	25	25	50	50	30	50	50
		Total		100	80	60	60	100	100	80	100	100
		Weighted Total		*10*	*8*	*6*	*6*	*10*	*10*	*8*	*10*	*10*
Human Health	**25**											
		Risk to Offsite Population	20	20	20	20	20	20	20	20	20	20
		Effect on Workers in Nearby Facilities	20	17	20	20	20	20	16	20	19	15
		Effect on Workers from Nearby Facilities	20	20	20	20	20	20	20	20	20	20
		Emergency Response/Preparedness	40	35	35	30	35	35	25	25	35	35
		Total		92	95	90	95	95	81	85	94	90
		Weighted Total		*23*	*24*	*23*	*24*	*24*	*20*	*21*	*24*	*22.5*
Geoscience	**30**											
		Topography	15	10	9	11	6	7	11	9	10	13
		Surface Hydrology	15	14	13	14	13	13	15	13	14	15
		Subsurface Hydrology	30	18	25	20	5	15	15	23	23	21
		Geology	30	8	11	11	8	10	13	13	13	16
		Seismology	10	6	6	6	6	6	6	6	6	6
		Total		56	64	62	38	51	60	64	66	71
		Weighted Total		*17*	*19*	*19*	*11*	*15*	*18*	*19*	*20*	*21.3*
Engineering	**35**											
		Distance to F Canyon tie in	12	10.8	8.4	3.6	4.8	6.6	2.4	1.2	6.6	9.6
		Distance to ETF tie in	8	7.2	5.6	0.8	1.6	2.4	6.4	4.8	3.2	4
		Disruption to Existing Infrastr/Utilities	7	3.5	4.2	4.9	1.4	5.6	2.1	4.2	2.8	6.3
		Access to Utilities (oper and const)	12	10.8	7.8	1.2	4.8	6	3.6	1.2	7.8	9.6
		Linkage to Other New Pu Facilities	6	3	4.2	1.8	3.6	2.4	1.2	1.2	5.4	4.8
		Sanitary Plant Tie-In	8	7.2	1.6	3.2	0.8	5.6	6.4	4	4.8	2.4
		Proximity to NPDES Outfall	5	2	4.5	0.5	3	2.5	1.5	2.5	3.5	4
		Construction Equipment Access	5	3.5	3	0.5	1	2.25	4	3.5	2.25	1.5
		Suitability for Construction	12	6.6	8.4	3.6	6.6	4.8	10.8	10.8	9.6	1.2
		Proximity to Primary Road and Rail	8	4	2.8	0.8	4.8	5.6	6.8	1.6	2.8	2.8
		Archaeology	2	2	0	0	2	2	1	1	0	2
		Safeguards and Security	15	10.5	9	3.75	6	7.5	3.75	3	10.5	10.5
		Total		71.1	59.5	24.7	40.4	53.3	50	39	59.3	58.7
		Weighted Total		*25*	*21*	*8.6*	*14*	*19*	*18*	*14*	*21*	*20.5*
Wt Score				**74.7**	**71.8**	**55.7**	**55.3**	**67.7**	**65.7**	**62.1**	**74**	**74.3**
Rank				**1**	**4**	**8**	**9**	**5**	**6**	**7**	**3**	**2**

Table 2

Extreme Vertices for Evaluation of Primary Weights Assuming up to a 10% Change

WSCORE= Final Weighted Score

Row	Site	P1	P2	P3	P4		U1	U2	U3	U4	WSCORE
1	**1**	0.11	0.275	0.270	0.345		100	92	56	71.1	75.950
2	**1**	0.11	0.275	0.300	0.315		100	92	56	71.1	75.497
3	**1**	0.11	0.225	0.330	0.335		100	92	56	71.1	73.999
4	**1**	0.11	0.225	0.280	0.385		100	92	56	71.1	74.754
5	**1**	0.11	0.245	0.330	0.315		100	92	56	71.1	74.417
6	**1**	0.11	0.235	0.270	0.385		100	92	56	71.1	75.114
7	**1**	0.09	0.275	0.270	0.365		100	92	56	71.1	75.372
8	**1**	0.09	0.275	0.320	0.315		100	92	56	71.1	74.617
9	**1**	0.09	0.225	0.330	0.355		100	92	56	71.1	73.421
10	**1**	0.09	0.225	0.300	0.385		100	92	56	71.1	73.874
11	**1**	0.09	0.265	0.330	0.315		100	92	56	71.1	74.257
12	**1**	0.09	0.255	0.270	0.385		100	92	56	71.1	74.954
13	**1**	0.09	0.225	0.315	0.370		100	92	56	71.1	73.647
14	**1**	0.09	0.275	0.295	0.340		100	92	56	71.1	74.994
15	**1**	0.11	0.225	0.305	0.360		100	92	56	71.1	74.376
16	**1**	0.11	0.275	0.285	0.330		100	92	56	71.1	75.723
17	**1**	0.09	0.265	0.270	0.375		100	92	56	71.1	75.163
18	**1**	0.09	0.245	0.330	0.335		100	92	56	71.1	73.839
19	**1**	0.11	0.255	0.270	0.365		100	92	56	71.1	75.532
20	**1**	0.11	0.235	0.330	0.325		100	92	56	71.1	74.208
21	**1**	0.09	0.270	0.325	0.315		100	92	56	71.1	74.437
22	**1**	0.09	0.240	0.285	0.385		100	92	56	71.1	74.414
23	**1**	0.11	0.260	0.315	0.315		100	92	56	71.1	74.957
24	**1**	0.11	0.230	0.275	0.385		100	92	56	71.1	74.934
25	**1**	0.10	0.225	0.330	0.345		100	92	56	71.1	73.710
26	**1**	0.10	0.275	0.270	0.355		100	92	56	71.1	75.661
27	**1**	0.10	0.225	0.290	0.385		100	92	56	71.1	74.314
28	**1**	0.10	0.275	0.310	0.315		100	92	56	71.1	75.057
29	**1**	0.10	0.245	0.270	0.385		100	92	56	71.1	75.034
30	**1**	0.10	0.255	0.330	0.315		100	92	56	71.1	74.337
31	**1**	0.09	0.253	0.303	0.353		100	92	56	71.1	74.415
32	**1**	0.11	0.247	0.297	0.347		100	92	56	71.1	74.955
33	**1**	0.10	0.225	0.310	0.365		100	92	56	71.1	74.012
34	**1**	0.10	0.275	0.290	0.335		100	92	56	71.1	75.359
35	**1**	0.10	0.260	0.270	0.370		100	92	56	71.1	75.347
36	**1**	0.10	0.240	0.330	0.330		100	92	56	71.1	74.023
37	**1**	0.10	0.265	0.320	0.315		100	92	56	71.1	74.697
38	**1**	0.10	0.235	0.280	0.385		100	92	56	71.1	74.674
39	**1**	0.10	0.250	0.300	0.350		100	92	56	71.1	74.685
40	**2**	0.11	0.275	0.270	0.345		80	95	64	59.5	72.733
41	**2**	0.11	0.275	0.300	0.315		80	95	64	59.5	72.868

42	**2**	0.11	0.225	0.330	0.335		80	95	64	59.5	71.228
43	**2**	0.11	0.225	0.280	0.385		80	95	64	59.5	71.003
44	**2**	0.11	0.245	0.330	0.315		80	95	64	59.5	71.938
45	**2**	0.11	0.235	0.270	0.385		80	95	64	59.5	71.313
46	**2**	0.09	0.275	0.270	0.365		80	95	64	59.5	72.323
47	**2**	0.09	0.275	0.320	0.315		80	95	64	59.5	72.548
48	**2**	0.09	0.225	0.330	0.355		80	95	64	59.5	70.818
49	**2**	0.09	0.225	0.300	0.385		80	95	64	59.5	70.683
50	**2**	0.09	0.265	0.330	0.315		80	95	64	59.5	72.238
51	**2**	0.09	0.255	0.270	0.385		80	95	64	59.5	71.613
52	**2**	0.09	0.225	0.315	0.370		80	95	64	59.5	70.750
53	**2**	0.09	0.275	0.295	0.340		80	95	64	59.5	72.435
54	**2**	0.11	0.225	0.305	0.360		80	95	64	59.5	71.115
55	**2**	0.11	0.275	0.285	0.330		80	95	64	59.5	72.800
56	**2**	0.09	0.265	0.270	0.375		80	95	64	59.5	71.968
57	**2**	0.09	0.245	0.330	0.335		80	95	64	59.5	71.528
58	**2**	0.11	0.255	0.270	0.365		80	95	64	59.5	72.023
59	**2**	0.11	0.235	0.330	0.325		80	95	64	59.5	71.583
60	**2**	0.09	0.270	0.325	0.315		80	95	64	59.5	72.393
61	**2**	0.09	0.240	0.285	0.385		80	95	64	59.5	71.148
62	**2**	0.11	0.260	0.315	0.315		80	95	64	59.5	72.403
63	**2**	0.11	0.230	0.275	0.385		80	95	64	59.5	71.158
64	**2**	0.10	0.225	0.330	0.345		80	95	64	59.5	71.023
65	**2**	0.10	0.275	0.270	0.355		80	95	64	59.5	72.528
66	**2**	0.10	0.225	0.290	0.385		80	95	64	59.5	70.843
67	**2**	0.10	0.275	0.310	0.315		80	95	64	59.5	72.708
68	**2**	0.10	0.245	0.270	0.385		80	95	64	59.5	71.463
69	**2**	0.10	0.255	0.330	0.315		80	95	64	59.5	72.088
70	**2**	0.09	0.253	0.303	0.353		80	95	64	59.5	71.703
71	**2**	0.11	0.247	0.297	0.347		80	95	64	59.5	71.847
72	**2**	0.10	0.225	0.310	0.365		80	95	64	59.5	70.933
73	**2**	0.10	0.275	0.290	0.335		80	95	64	59.5	72.618
74	**2**	0.10	0.260	0.270	0.370		80	95	64	59.5	71.995
75	**2**	0.10	0.240	0.330	0.330		80	95	64	59.5	71.555
76	**2**	0.10	0.265	0.320	0.315		80	95	64	59.5	72.398
77	**2**	0.10	0.235	0.280	0.385		80	95	64	59.5	71.153
78	**2**	0.10	0.250	0.300	0.350		80	95	64	59.5	71.775
79	**3**	0.11	0.275	0.270	0.345		60	90	62	24.7	56.612
80	**3**	0.11	0.275	0.300	0.315		60	90	62	24.7	57.731
81	**3**	0.11	0.225	0.330	0.335		60	90	62	24.7	55.585
82	**3**	0.11	0.225	0.280	0.385		60	90	62	24.7	53.720
83	**3**	0.11	0.245	0.330	0.315		60	90	62	24.7	56.891
84	**3**	0.11	0.235	0.270	0.385		60	90	62	24.7	54.000
85	**3**	0.09	0.275	0.270	0.365		60	90	62	24.7	55.906
86	**3**	0.09	0.275	0.320	0.315		60	90	62	24.7	57.771
87	**3**	0.09	0.225	0.330	0.355		60	90	62	24.7	54.879
88	**3**	0.09	0.225	0.300	0.385		60	90	62	24.7	53.760
89	**3**	0.09	0.265	0.330	0.315		60	90	62	24.7	57.491
90	**3**	0.09	0.255	0.270	0.385		60	90	62	24.7	54.600

91	**3**	0.09	0.225	0.315	0.370		60	90	62	24.7	54.319
92	**3**	0.09	0.275	0.295	0.340		60	90	62	24.7	56.838
93	**3**	0.11	0.225	0.305	0.360		60	90	62	24.7	54.652
94	**3**	0.11	0.275	0.285	0.330		60	90	62	24.7	57.171
95	**3**	0.09	0.265	0.270	0.375		60	90	62	24.7	55.253
96	**3**	0.09	0.245	0.330	0.335		60	90	62	24.7	56.185
97	**3**	0.11	0.255	0.270	0.365		60	90	62	24.7	55.306
98	**3**	0.11	0.235	0.330	0.325		60	90	62	24.7	56.238
99	**3**	0.09	0.270	0.325	0.315		60	90	62	24.7	57.631
100	**3**	0.09	0.240	0.285	0.385		60	90	62	24.7	54.180
101	**3**	0.11	0.260	0.315	0.315		60	90	62	24.7	57.311
102	**3**	0.11	0.230	0.275	0.385		60	90	62	24.7	53.860
103	**3**	0.10	0.225	0.330	0.345		60	90	62	24.7	55.232
104	**3**	0.10	0.275	0.270	0.355		60	90	62	24.7	56.259
105	**3**	0.10	0.225	0.290	0.385		60	90	62	24.7	53.740
106	**3**	0.10	0.275	0.310	0.315		60	90	62	24.7	57.751
107	**3**	0.10	0.245	0.270	0.385		60	90	62	24.7	54.300
108	**3**	0.10	0.255	0.330	0.315		60	90	62	24.7	57.191
109	**3**	0.09	0.253	0.303	0.353		60	90	62	24.7	55.734
110	**3**	0.11	0.247	0.297	0.347		60	90	62	24.7	55.756
111	**3**	0.10	0.225	0.310	0.365		60	90	62	24.7	54.486
112	**3**	0.10	0.275	0.290	0.335		60	90	62	24.7	57.005
113	**3**	0.10	0.260	0.270	0.370		60	90	62	24.7	55.279
114	**3**	0.10	0.240	0.330	0.330		60	90	62	24.7	56.211
115	**3**	0.10	0.265	0.320	0.315		60	90	62	24.7	57.471
116	**3**	0.10	0.235	0.280	0.385		60	90	62	24.7	54.020
117	**3**	0.10	0.250	0.300	0.350		60	90	62	24.7	55.745
118	**4**	0.11	0.275	0.270	0.345		60	95	38	40.4	56.923
119	**4**	0.11	0.275	0.300	0.315		60	95	38	40.4	56.851
120	**4**	0.11	0.225	0.330	0.335		60	95	38	40.4	54.049
121	**4**	0.11	0.225	0.280	0.385		60	95	38	40.4	54.169
122	**4**	0.11	0.245	0.330	0.315		60	95	38	40.4	55.141
123	**4**	0.11	0.235	0.270	0.385		60	95	38	40.4	54.739
124	**4**	0.09	0.275	0.270	0.365		60	95	38	40.4	56.531
125	**4**	0.09	0.275	0.320	0.315		60	95	38	40.4	56.411
126	**4**	0.09	0.225	0.330	0.355		60	95	38	40.4	53.657
127	**4**	0.09	0.225	0.300	0.385		60	95	38	40.4	53.729
128	**4**	0.09	0.265	0.330	0.315		60	95	38	40.4	55.841
129	**4**	0.09	0.255	0.270	0.385		60	95	38	40.4	55.439
130	**4**	0.09	0.225	0.315	0.370		60	95	38	40.4	53.693
131	**4**	0.09	0.275	0.295	0.340		60	95	38	40.4	56.471
132	**4**	0.11	0.225	0.305	0.360		60	95	38	40.4	54.109
133	**4**	0.11	0.275	0.285	0.330		60	95	38	40.4	56.887
134	**4**	0.09	0.265	0.270	0.375		60	95	38	40.4	55.985
135	**4**	0.09	0.245	0.330	0.335		60	95	38	40.4	54.749
136	**4**	0.11	0.255	0.270	0.365		60	95	38	40.4	55.831
137	**4**	0.11	0.235	0.330	0.325		60	95	38	40.4	54.595
138	**4**	0.09	0.270	0.325	0.315		60	95	38	40.4	56.126
139	**4**	0.09	0.240	0.285	0.385		60	95	38	40.4	54.584

140	**4**	0.11	0.260	0.315	0.315		60	95	38	40.4	55.996
141	**4**	0.11	0.230	0.275	0.385		60	95	38	40.4	54.454
142	**4**	0.10	0.225	0.330	0.345		60	95	38	40.4	53.853
143	**4**	0.10	0.275	0.270	0.355		60	95	38	40.4	56.727
144	**4**	0.10	0.225	0.290	0.385		60	95	38	40.4	53.949
145	**4**	0.10	0.275	0.310	0.315		60	95	38	40.4	56.631
146	**4**	0.10	0.245	0.270	0.385		60	95	38	40.4	55.089
147	**4**	0.10	0.255	0.330	0.315		60	95	38	40.4	55.491
148	**4**	0.09	0.253	0.303	0.353		60	95	38	40.4	55.268
149	**4**	0.11	0.247	0.297	0.347		60	95	38	40.4	55.312
150	**4**	0.10	0.225	0.310	0.365		60	95	38	40.4	53.901
151	**4**	0.10	0.275	0.290	0.335		60	95	38	40.4	56.679
152	**4**	0.10	0.260	0.270	0.370		60	95	38	40.4	55.908
153	**4**	0.10	0.240	0.330	0.330		60	95	38	40.4	54.672
154	**4**	0.10	0.265	0.320	0.315		60	95	38	40.4	56.061
155	**4**	0.10	0.235	0.280	0.385		60	95	38	40.4	54.519
156	**4**	0.10	0.250	0.300	0.350		60	95	38	40.4	55.290
157	**5**	0.11	0.275	0.270	0.345		100	95	51	53.3	69.284
158	**5**	0.11	0.275	0.300	0.315		100	95	51	53.3	69.215
159	**5**	0.11	0.225	0.330	0.335		100	95	51	53.3	67.061
160	**5**	0.11	0.225	0.280	0.385		100	95	51	53.3	67.176
161	**5**	0.11	0.245	0.330	0.315		100	95	51	53.3	67.895
162	**5**	0.11	0.235	0.270	0.385		100	95	51	53.3	67.616
163	**5**	0.09	0.275	0.270	0.365		100	95	51	53.3	68.350
164	**5**	0.09	0.275	0.320	0.315		100	95	51	53.3	68.235
165	**5**	0.09	0.225	0.330	0.355		100	95	51	53.3	66.127
166	**5**	0.09	0.225	0.300	0.385		100	95	51	53.3	66.196
167	**5**	0.09	0.265	0.330	0.315		100	95	51	53.3	67.795
168	**5**	0.09	0.255	0.270	0.385		100	95	51	53.3	67.516
169	**5**	0.09	0.225	0.315	0.370		100	95	51	53.3	66.161
170	**5**	0.09	0.275	0.295	0.340		100	95	51	53.3	68.292
171	**5**	0.11	0.225	0.305	0.360		100	95	51	53.3	67.118
172	**5**	0.11	0.275	0.285	0.330		100	95	51	53.3	69.249
173	**5**	0.09	0.265	0.270	0.375		100	95	51	53.3	67.933
174	**5**	0.09	0.245	0.330	0.335		100	95	51	53.3	66.961
175	**5**	0.11	0.255	0.270	0.365		100	95	51	53.3	68.450
176	**5**	0.11	0.235	0.330	0.325		100	95	51	53.3	67.478
177	**5**	0.09	0.270	0.325	0.315		100	95	51	53.3	68.015
178	**5**	0.09	0.240	0.285	0.385		100	95	51	53.3	66.856
179	**5**	0.11	0.260	0.315	0.315		100	95	51	53.3	68.555
180	**5**	0.11	0.230	0.275	0.385		100	95	51	53.3	67.396
181	**5**	0.10	0.225	0.330	0.345		100	95	51	53.3	66.594
182	**5**	0.10	0.275	0.270	0.355		100	95	51	53.3	68.817
183	**5**	0.10	0.225	0.290	0.385		100	95	51	53.3	66.686
184	**5**	0.10	0.275	0.310	0.315		100	95	51	53.3	68.725
185	**5**	0.10	0.245	0.270	0.385		100	95	51	53.3	67.566
186	**5**	0.10	0.255	0.330	0.315		100	95	51	53.3	67.845
187	**5**	0.09	0.253	0.303	0.353		100	95	51	53.3	67.369
188	**5**	0.11	0.247	0.297	0.347		100	95	51	53.3	68.041

189	**5**	0.10	0.225	0.310	0.365		100	95	51	53.3	66.640
190	**5**	0.10	0.275	0.290	0.335		100	95	51	53.3	68.771
191	**5**	0.10	0.260	0.270	0.370		100	95	51	53.3	68.191
192	**5**	0.10	0.240	0.330	0.330		100	95	51	53.3	67.219
193	**5**	0.10	0.265	0.320	0.315		100	95	51	53.3	68.285
194	**5**	0.10	0.235	0.280	0.385		100	95	51	53.3	67.126
195	**5**	0.10	0.250	0.300	0.350		100	95	51	53.3	67.705
196	**6**	0.11	0.275	0.270	0.345		100	81	60	50	66.725
197	**6**	0.11	0.275	0.300	0.315		100	81	60	50	67.025
198	**6**	0.11	0.225	0.330	0.335		100	81	60	50	65.775
199	**6**	0.11	0.225	0.280	0.385		100	81	60	50	65.275
200	**6**	0.11	0.245	0.330	0.315		100	81	60	50	66.395
201	**6**	0.11	0.235	0.270	0.385		100	81	60	50	65.485
202	**6**	0.09	0.275	0.270	0.365		100	81	60	50	65.725
203	**6**	0.09	0.275	0.320	0.315		100	81	60	50	66.225
204	**6**	0.09	0.225	0.330	0.355		100	81	60	50	64.775
205	**6**	0.09	0.225	0.300	0.385		100	81	60	50	64.475
206	**6**	0.09	0.265	0.330	0.315		100	81	60	50	66.015
207	**6**	0.09	0.255	0.270	0.385		100	81	60	50	65.105
208	**6**	0.09	0.225	0.315	0.370		100	81	60	50	64.625
209	**6**	0.09	0.275	0.295	0.340		100	81	60	50	65.975
210	**6**	0.11	0.225	0.305	0.360		100	81	60	50	65.525
211	**6**	0.11	0.275	0.285	0.330		100	81	60	50	66.875
212	**6**	0.09	0.265	0.270	0.375		100	81	60	50	65.415
213	**6**	0.09	0.245	0.330	0.335		100	81	60	50	65.395
214	**6**	0.11	0.255	0.270	0.365		100	81	60	50	66.105
215	**6**	0.11	0.235	0.330	0.325		100	81	60	50	66.085
216	**6**	0.09	0.270	0.325	0.315		100	81	60	50	66.120
217	**6**	0.09	0.240	0.285	0.385		100	81	60	50	64.790
218	**6**	0.11	0.260	0.315	0.315		100	81	60	50	66.710
219	**6**	0.11	0.230	0.275	0.385		100	81	60	50	65.380
220	**6**	0.10	0.225	0.330	0.345		100	81	60	50	65.275
221	**6**	0.10	0.275	0.270	0.355		100	81	60	50	66.225
222	**6**	0.10	0.225	0.290	0.385		100	81	60	50	64.875
223	**6**	0.10	0.275	0.310	0.315		100	81	60	50	66.625
224	**6**	0.10	0.245	0.270	0.385		100	81	60	50	65.295
225	**6**	0.10	0.255	0.330	0.315		100	81	60	50	66.205
226	**6**	0.09	0.253	0.303	0.353		100	81	60	50	65.387
227	**6**	0.11	0.247	0.297	0.347		100	81	60	50	66.113
228	**6**	0.10	0.225	0.310	0.365		100	81	60	50	65.075
229	**6**	0.10	0.275	0.290	0.335		100	81	60	50	66.425
230	**6**	0.10	0.260	0.270	0.370		100	81	60	50	65.760
231	**6**	0.10	0.240	0.330	0.330		100	81	60	50	65.740
232	**6**	0.10	0.265	0.320	0.315		100	81	60	50	66.415
233	**6**	0.10	0.235	0.280	0.385		100	81	60	50	65.085
234	**6**	0.10	0.250	0.300	0.350		100	81	60	50	65.750
235	**7**	0.11	0.275	0.270	0.345		80	85	64	39	62.910
236	**7**	0.11	0.275	0.300	0.315		80	85	64	39	63.660
237	**7**	0.11	0.225	0.330	0.335		80	85	64	39	62.110

238	**7**	0.11	0.225	0.280	0.385		80	85	64	39	60.860
239	**7**	0.11	0.245	0.330	0.315		80	85	64	39	63.030
240	**7**	0.11	0.235	0.270	0.385		80	85	64	39	61.070
241	**7**	0.09	0.275	0.270	0.365		80	85	64	39	62.090
242	**7**	0.09	0.275	0.320	0.315		80	85	64	39	63.340
243	**7**	0.09	0.225	0.330	0.355		80	85	64	39	61.290
244	**7**	0.09	0.225	0.300	0.385		80	85	64	39	60.540
245	**7**	0.09	0.265	0.330	0.315		80	85	64	39	63.130
246	**7**	0.09	0.255	0.270	0.385		80	85	64	39	61.170
247	**7**	0.09	0.225	0.315	0.370		80	85	64	39	60.915
248	**7**	0.09	0.275	0.295	0.340		80	85	64	39	62.715
249	**7**	0.11	0.225	0.305	0.360		80	85	64	39	61.485
250	**7**	0.11	0.275	0.285	0.330		80	85	64	39	63.285
251	**7**	0.09	0.265	0.270	0.375		80	85	64	39	61.630
252	**7**	0.09	0.245	0.330	0.335		80	85	64	39	62.210
253	**7**	0.11	0.255	0.270	0.365		80	85	64	39	61.990
254	**7**	0.11	0.235	0.330	0.325		80	85	64	39	62.570
255	**7**	0.09	0.270	0.325	0.315		80	85	64	39	63.235
256	**7**	0.09	0.240	0.285	0.385		80	85	64	39	60.855
257	**7**	0.11	0.260	0.315	0.315		80	85	64	39	63.345
258	**7**	0.11	0.230	0.275	0.385		80	85	64	39	60.965
259	**7**	0.10	0.225	0.330	0.345		80	85	64	39	61.700
260	**7**	0.10	0.275	0.270	0.355		80	85	64	39	62.500
261	**7**	0.10	0.225	0.290	0.385		80	85	64	39	60.700
262	**7**	0.10	0.275	0.310	0.315		80	85	64	39	63.500
263	**7**	0.10	0.245	0.270	0.385		80	85	64	39	61.120
264	**7**	0.10	0.255	0.330	0.315		80	85	64	39	63.080
265	**7**	0.09	0.253	0.303	0.353		80	85	64	39	61.927
266	**7**	0.11	0.247	0.297	0.347		80	85	64	39	62.273
267	**7**	0.10	0.225	0.310	0.365		80	85	64	39	61.200
268	**7**	0.10	0.275	0.290	0.335		80	85	64	39	63.000
269	**7**	0.10	0.260	0.270	0.370		80	85	64	39	61.810
270	**7**	0.10	0.240	0.330	0.330		80	85	64	39	62.390
271	**7**	0.10	0.265	0.320	0.315		80	85	64	39	63.290
272	**7**	0.10	0.235	0.280	0.385		80	85	64	39	60.910
273	**7**	0.10	0.250	0.300	0.350		80	85	64	39	62.100
274	**A**	0.11	0.275	0.270	0.345		100	90	71	58.7	75.172
275	**A**	0.11	0.275	0.300	0.315		100	90	71	58.7	75.541
276	**A**	0.11	0.225	0.330	0.335		100	90	71	58.7	74.345
277	**A**	0.11	0.225	0.280	0.385		100	90	71	58.7	73.730
278	**A**	0.11	0.245	0.330	0.315		100	90	71	58.7	74.971
279	**A**	0.11	0.235	0.270	0.385		100	90	71	58.7	73.920
280	**A**	0.09	0.275	0.270	0.365		100	90	71	58.7	74.346
281	**A**	0.09	0.275	0.320	0.315		100	90	71	58.7	74.961
282	**A**	0.09	0.225	0.330	0.355		100	90	71	58.7	73.519
283	**A**	0.09	0.225	0.300	0.385		100	90	71	58.7	73.150
284	**A**	0.09	0.265	0.330	0.315		100	90	71	58.7	74.771
285	**A**	0.09	0.255	0.270	0.385		100	90	71	58.7	73.720
286	**A**	0.09	0.225	0.315	0.370		100	90	71	58.7	73.334

287	**A**	0.09	0.275	0.295	0.340		100	90	71	58.7	74.653
288	**A**	0.11	0.225	0.305	0.360		100	90	71	58.7	74.037
289	**A**	0.11	0.275	0.285	0.330		100	90	71	58.7	75.356
290	**A**	0.09	0.265	0.270	0.375		100	90	71	58.7	74.033
291	**A**	0.09	0.245	0.330	0.335		100	90	71	58.7	74.145
292	**A**	0.11	0.255	0.270	0.365		100	90	71	58.7	74.546
293	**A**	0.11	0.235	0.330	0.325		100	90	71	58.7	74.658
294	**A**	0.09	0.270	0.325	0.315		100	90	71	58.7	74.866
295	**A**	0.09	0.240	0.285	0.385		100	90	71	58.7	73.435
296	**A**	0.11	0.260	0.315	0.315		100	90	71	58.7	75.256
297	**A**	0.11	0.230	0.275	0.385		100	90	71	58.7	73.825
298	**A**	0.10	0.225	0.330	0.345		100	90	71	58.7	73.932
299	**A**	0.10	0.275	0.270	0.355		100	90	71	58.7	74.759
300	**A**	0.10	0.225	0.290	0.385		100	90	71	58.7	73.440
301	**A**	0.10	0.275	0.310	0.315		100	90	71	58.7	75.251
302	**A**	0.10	0.245	0.270	0.385		100	90	71	58.7	73.820
303	**A**	0.10	0.255	0.330	0.315		100	90	71	58.7	74.871
304	**A**	0.09	0.253	0.303	0.353		100	90	71	58.7	74.077
305	**A**	0.11	0.247	0.297	0.347		100	90	71	58.7	74.613
306	**A**	0.10	0.225	0.310	0.365		100	90	71	58.7	73.686
307	**A**	0.10	0.275	0.290	0.335		100	90	71	58.7	75.005
308	**A**	0.10	0.260	0.270	0.370		100	90	71	58.7	74.289
309	**A**	0.10	0.240	0.330	0.330		100	90	71	58.7	74.401
310	**A**	0.10	0.265	0.320	0.315		100	90	71	58.7	75.061
311	**A**	0.10	0.235	0.280	0.385		100	90	71	58.7	73.630
312	**A**	0.10	0.250	0.300	0.350		100	90	71	58.7	74.345
313	**X**	0.11	0.275	0.270	0.345		100	94	66	59.3	75.129
314	**X**	0.11	0.275	0.300	0.315		100	94	66	59.3	75.330
315	**X**	0.11	0.225	0.330	0.335		100	94	66	59.3	73.796
316	**X**	0.11	0.225	0.280	0.385		100	94	66	59.3	73.461
317	**X**	0.11	0.245	0.330	0.315		100	94	66	59.3	74.490
318	**X**	0.11	0.235	0.270	0.385		100	94	66	59.3	73.741
319	**X**	0.09	0.275	0.270	0.365		100	94	66	59.3	74.315
320	**X**	0.09	0.275	0.320	0.315		100	94	66	59.3	74.650
321	**X**	0.09	0.225	0.330	0.355		100	94	66	59.3	72.982
322	**X**	0.09	0.225	0.300	0.385		100	94	66	59.3	72.781
323	**X**	0.09	0.265	0.330	0.315		100	94	66	59.3	74.370
324	**X**	0.09	0.255	0.270	0.385		100	94	66	59.3	73.621
325	**X**	0.09	0.225	0.315	0.370		100	94	66	59.3	72.881
326	**X**	0.09	0.275	0.295	0.340		100	94	66	59.3	74.482
327	**X**	0.11	0.225	0.305	0.360		100	94	66	59.3	73.628
328	**X**	0.11	0.275	0.285	0.330		100	94	66	59.3	75.229
329	**X**	0.09	0.265	0.270	0.375		100	94	66	59.3	73.968
330	**X**	0.09	0.245	0.330	0.335		100	94	66	59.3	73.676
331	**X**	0.11	0.255	0.270	0.365		100	94	66	59.3	74.435
332	**X**	0.11	0.235	0.330	0.325		100	94	66	59.3	74.143
333	**X**	0.09	0.270	0.325	0.315		100	94	66	59.3	74.510
334	**X**	0.09	0.240	0.285	0.385		100	94	66	59.3	73.201
335	**X**	0.11	0.260	0.315	0.315		100	94	66	59.3	74.910

336	**X**	0.11	0.230	0.275	0.385		100	94	66	59.3	73.601
337	**X**	0.10	0.225	0.330	0.345		100	94	66	59.3	73.389
338	**X**	0.10	0.275	0.270	0.355		100	94	66	59.3	74.722
339	**X**	0.10	0.225	0.290	0.385		100	94	66	59.3	73.121
340	**X**	0.10	0.275	0.310	0.315		100	94	66	59.3	74.990
341	**X**	0.10	0.245	0.270	0.385		100	94	66	59.3	73.681
342	**X**	0.10	0.255	0.330	0.315		100	94	66	59.3	74.430
343	**X**	0.09	0.253	0.303	0.353		100	94	66	59.3	73.786
344	**X**	0.11	0.247	0.297	0.347		100	94	66	59.3	74.324
345	**X**	0.10	0.225	0.310	0.365		100	94	66	59.3	73.255
346	**X**	0.10	0.275	0.290	0.335		100	94	66	59.3	74.856
347	**X**	0.10	0.260	0.270	0.370		100	94	66	59.3	74.201
348	**X**	0.10	0.240	0.330	0.330		100	94	66	59.3	73.909
349	**X**	0.10	0.265	0.320	0.315		100	94	66	59.3	74.710
350	**X**	0.10	0.235	0.280	0.385		100	94	66	59.3	73.401
351	**X**	0.10	0.250	0.300	0.350		100	94	66	59.3	74.055

Table 3
Summary Statistics

10% Change in Primary Weights

Code	Count	Average	Median	Standard Deviation
1	39	74.6854	74.685	0.62484
2	39	71.7754	71.775	0.660588
3	39	55.7454	55.745	1.33784
4	39	55.29	55.29	1.05016
5	39	67.7054	67.705	0.851512
6	39	65.75	65.75	0.654126
7	39	62.1	62.1	0.941092
A	39	74.3454	74.345	0.636898
X	39	74.0554	74.055	0.678809
Total	351	66.828	67.705	7.32596

20% Change in Primary Weights

Code	Count	Average	Median	Standard Deviation
1	39	74.685	74.685	1.24966
2	39	71.775	71.775	1.32117
3	39	55.745	55.745	2.67567
4	39	55.29	55.29	2.10032
5	39	67.705	67.705	1.703
6	39	65.75	65.75	1.30828
7	39	62.1	62.1	1.88219
A	39	74.345	74.345	1.27377
X	39	74.055	74.055	1.35762
Total	351	66.8278	67.984	7.47168

30% Change in Primary Weights

Code	Count	Average	Median	Standard Deviation
1	39	74.6854	74.685	1.8745
2	39	71.7754	71.775	1.98176
3	39	55.7454	55.745	4.01351
4	39	55.29	55.29	3.15049
5	39	67.7054	67.705	2.55452
6	39	65.75	65.75	1.96241
7	39	62.1	62.1	2.82329
A	39	74.3454	74.345	1.91067
X	39	74.0554	74.055	2.03643
Total	351	66.828	68.388	7.70867

40% Change in Primary Weights

Code	Count	Average	Median	Standard Deviation
1	39	74.685	74.685	2.49933
2	39	71.775	71.775	2.64234
3	39	55.745	55.745	5.35134
4	39	55.29	55.29	4.20065
5	39	67.705	67.705	3.40602
6	39	65.75	65.75	2.61654
7	39	62.1	62.1	3.76438
A	39	74.345	74.345	2.54756
X	39	74.055	74.055	2.71524
Total	351	66.8278	68.405	8.02849

Table 4
Analysis of Weighted Score Ranks

10% Change in Primary Weights

Rank	Site									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**APSF**	**X**	
1	24	0	0	0	0	0	0	15	0	39
2	9	0	0	0	0	0	0	24	6	39
3	6	0	0	0	0	0	0	0	33	39
4	0	39	0	0	0	0	0	0	0	39
5	0	0	0	0	39	0	0	0	0	39
6	0	0	0	0	0	39	0	0	0	39
7	0	0	0	0	0	0	39	0	0	39
8	0	0	25	14	0	0	0	0	0	39
9	0	0	14	25	0	0	0	0	0	39
	39	39	39	39	39	39	39	39	39	351

20% Change in Primary Weights

Rank	Site									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**APSF**	**X**	
1	24	0	0	0	0	0	0	15	0	39
2	2	0	0	0	0	0	0	15	22	39
3	13	0	0	0	0	0	0	9	17	39
4	0	39	0	0	0	0	0	0	0	39
5	0	0	0	0	39	0	0	0	0	39
6	0	0	0	0	0	39	0	0	0	39
7	0	0	0	0	0	0	39	0	0	39
8	0	0	24	15	0	0	0	0	0	39
9	0	0	15	24	0	0	0	0	0	39
	39	39	39	39	39	39	39	39	39	351

30% Change in Primary Weights

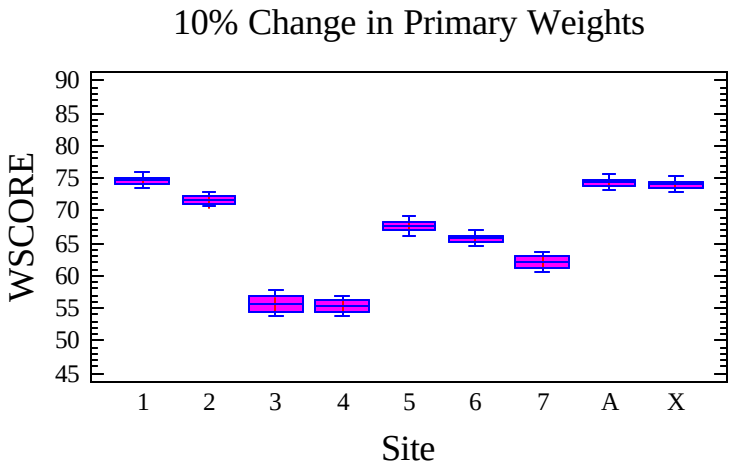
Rank	Site									
	1	2	3	4	5	6	7	APSF	X	
1	24	0	0	0	0	0	0	15	0	39
2	1	0	0	0	0	0	0	12	26	39
3	14	0	0	0	0	0	0	12	13	39
4	0	39	0	0	0	0	0	0	0	39
5	0	0	0	0	38	1	0	0	0	39
6	0	0	0	0	1	38	0	0	0	39
7	0	0	0	0	0	0	39	0	0	39
8	0	0	23	16	0	0	0	0	0	39
9	0	0	16	23	0	0	0	0	0	39
	39	39	39	39	39	39	39	39	39	351

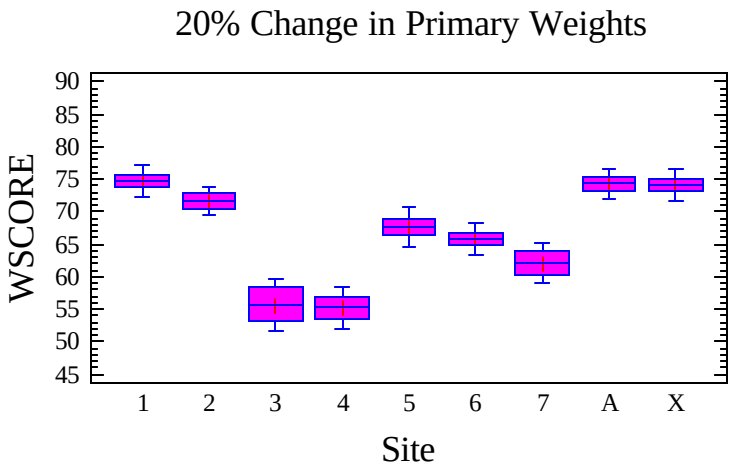
40% Change in Primary Weights

Rank	Site									
	1	2	3	4	5	6	7	APSF	X	
1	24	0	0	0	0	0	0	14	1	39
2	0	0	0	0	0	0	0	13	26	39
3	12	3	0	0	0	0	0	12	12	39
4	3	36	0	0	0	0	0	0	0	39
5	0	0	0	0	35	4	0	0	0	39
6	0	0	0	0	4	35	0	0	0	39
7	0	0	0	0	0	0	39	0	0	39
8	0	0	22	17	0	0	0	0	0	39
9	0	0	17	22	0	0	0	0	0	39
	39	39	39	39	39	39	39	39	39	351

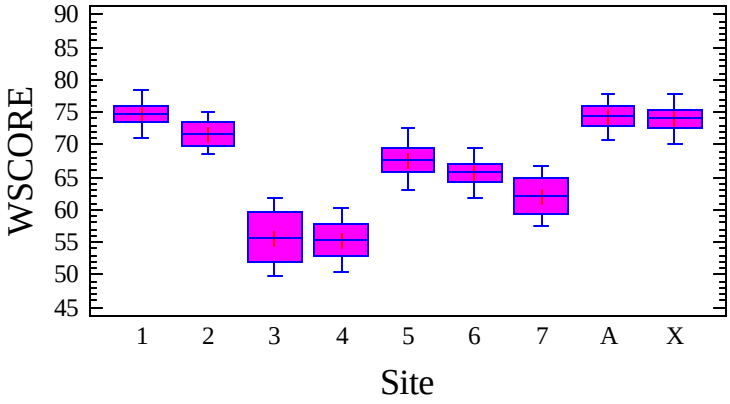
Plot 1
Box-and Whisker Plots

A: APSF





30% Change in Primary Weights



40% Change in Primary Weights