CHAPTER A-1

SITE DEVELOPMENT

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CHAPTER A-1

SITE DEVELOPMENT

1.1 GENERAL.

1.1.1 Scope of Work. This chapter states criteria requirements and guidance for the site development portion of the project's civil design. Site development includes all proposed site improvements, excluding utilities other than storm drainage, installed outside the 1.5 m line of the building(s) or structure(s). These improvements include, but are not limited to: demolition/removal and salvage; clearing and grubbing; site grading, paving, and storm drainage; grassing; erosion control; fencing; and landscaping, when required. When required, the landscaping design shall be comprehensive and be coordinated with pertinent aspects of the overall site development, including user requirements and the architecture of adjacent existing and proposed structures. The site development will be accomplished in accordance with appropriate technical requirements contained herein, and pamphlets and other basic criteria referenced in Section 6, Appendix A of Specific Instructions to the Architect-Engineer (A-E). There will be no exceptions, other than as approved through the District Project Manager in conjunction with the Savannah District's Site Development Section (CESASEN-GD).

1.1.1.1 Quality of Design. It is the purpose of the Savannah District to obtain excellent siting and civil design resulting in efficient and economical site development conditions.

1.1.2 Specific Requirements.

1.1.2.1 Field Trip Report. At the beginning of project design, the A-E designer shall make a site inspection to determine what impact the site development portion of the project design will have on the existing site conditions. A report of this field trip, including documentary photographs, shall be prepared in the suggested format of Exhibit 5, Vol. I of this manual, and included with the site development portion of the Concept (35 Percent) Design Submittal.

1.1.2.2 "Site Adapts." Site adaptations of similar project designs approved for other locations are acceptable, provided the site adapt complies with the technical requirements contained herein.

1.1.2.3 Coordination During Design. To assure no conflict(s) arise with other design disciplines during project design, the A-E designer shall coordinate the site development portion of the project design as explained more thoroughly in paragraph 1.6c(1).

1.2 APPLICABLE PUBLICATIONS.

1.2.1 Army/Air Force Basic References.

Army: Architectural and Engineering Instructions (AEI), "Design Criteria," 3 July 1994 or later Edition

Army Reserve: DG 1110-3-107, Design Guide for U.S. Army Reserve Facilities

Army/Air Force: DG 1110-3-204, Design Guide for Army & Air Force Airfields, Pavements, Railroads, Storm Drainage, and Earthwork

Air Force: AFR 88-15, Criteria and Standards for Air Force Construction

All Services: Uniform Federal Accessibility Standards (UFAS), published in the Federal Register on 7 Aug 84.

1.2.2 Department of the Army Technical Manuals(TM's)/Air Force Manuals(AFM's).

TM 5-630/AFM 126-2	Natural Resources Land Management (Tri-Services Manual)
TM 5-800-1	Construction Criteria for Army Facilities
TM 5-803-4	Planning of Army Aviation Facilities
TM 5-803-5/AFM 88-43	Installation Design (Superseded TM 5-822-3)
TM 5-830-2/AFM 88-17/2	Establishment of Herbaceous Ground Covers w/Rev.
TM 5-830-3/AFM 88-17/3	Dust Control for Roads, Airfields, and Adjacent Areas
TM 5-830-4/AFM 88-17/4	Planting and Establishment of Trees, Shrubs, Ground Covers and Vines

1.2.2.1 Storm Drainage - Airfields and Roads.

TM 5-820-1/AFM 88-5/1	Surface Drainage Facilities for Airfields and Heliports
TM 5-820-2/AFM 88-5/2	Drainage and Erosion Control Subsurface Drainage Facilities for Airfield Pavements
TM 5-820-3/AFM 88-5/3	Drainage and Erosion-Control Structures for Airfields and Heliports
TM 5-820-4/AFM 88-5/4	Drainage for Areas Other Than Airfields w/Rev.

1.2.2.2 Roads and Streets.

TM 5-337	Paving & Surfacing Operations
TM 5-623	Pavement Maintenance Management

TM 5-818-2/AFM 88-6/4	Pavement Design for Seasonal Frost Conditions
TM 5-822-2/AFM 88-7/5	General Provisions and Geometric Design for Roads, Streets, Walks, and Open Storage Areas
TM 5-822-4/AFM 88-7/4	Soil Stabilization for Roads and Streets Pavements
TM 5-822-5/AFM 88-7/3	Engineering and Design Flexible Pavements for Roads, Streets, Walks, and Open Storage Areas, Supplement: "Design of Gravel Surfaced Hardstands," dated 20 March 1985, and ETL 1110-1-140, dated 15 Jul 88.
TM 5-822-6/AFM 88-7/1	Engineering and Design Rigid Pavements for Roads, Streets, w/Rev Walks, and Open Storage Areas, w/ETL's 1110-1-140 & 141, dated 28 Nov 84, 29 Jan and 15 Jul 88.
TM 5-822-7/AFM 88-6/8	Standard Practice for Concrete Pavements
TM 5-822-8/AFM 88-6/9	Bituminous Pavements Standard Practice
TM 5-822-9/AFM 88-6/10	Repair of Rigid Pavements Using Epoxy Resin Grouts, Mortars, and Concretes
TM 5-822-10/AFM 88-6/6	Standard Practice for Pavement Recycling

1.2.2.3 Army Airfields and Heliports.

TM 1-1520-250-23-1	General Tie-Down and Mooring Technical Manual-Aviation Unit and Intermediate Maintenance
TM 5-803-4	Planning of Army Aviation Facilities
TM 5-803-7/AFR 86-14	Civil Engineering Programming Airfield and Heliport Planning Criteria
TM 5-818-3/AFM 88-24/4	Pavement Evaluation For Frost Conditions
TM 5-823-2,w/Rev	Army Airfield - Heliport Flexible Pavement Design
TM 5-823-3,w/Rev	Army Airfield - Heliport Rigid and Overlay Pavement Design
TM 5-823-4,w/Rev	Marking of Army Airfield - Heliport Operational and Maintenance Facilities

TM 5-824-4	Airfields Other than Army Airfield Operational and Maintenance Facilities
TM 5-827-1/AFM 88-24/1	Airfield Pavement Evaluation Concepts
TM 5-827-2/AFM 88-24/2	Flexible Airfield Pavement Evaluation w/Rev

1.2.2.4 Airfield Pavements (Air Force and Air National Guard).

TM 5-818-3/AFM 88-24/4	Pavement Evaluation for Frost Conditions
TM 5-824-1/AFM 88-6/1	General Provisions for Airfield Pavement Design
TM 5-824-2/AFM 88-6/2	Airfield Flexible Pavements - Air Force
TM 5-824-4,w/Rev	Airfields other than Army Airfield Operational & Maintenance Facilities
TM 5-825-2/NAV DM	Flexible Pavement Design for Airfields (Tri-Services Manual) 213/AFM 88-6/2 w/ETL 1110-1-140 dated 29 Jan 88
TM 5-825-3/AFM 88-6/3 dated	Rigid Pavements for Airfields, w/ETL's 140 & 141 29 Jan. w/Rev & 15 July 88
TM 5-825-3-1/AFM	Rigid Pavement Design for Airfields Elastic Layered 88 6/3 Method

1.2.2.5 Railroads.

TM 5-850-2/AFM 88-7/2	Railroad Design and Construction at Army and Air Force w/Rev Installations
TM 5-627/AFM 91-33	Maintenance of Trackage (Tri-Services Manual)

1.2.2.6 Playgrounds and Recreation Areas.

EM 1110-1-400	Recreation Planning and Design Criteria
EM 1110-2-410	Design of Recreation Areas and Facilities
TM 5-803-10/AFR 88-33	Planning and Design of Outdoor Sports Facilities
TM 5-803-11/NAVY	Children's' Play Outdoor Areas P-383/AFM 88-30
TM 5-803-12	Planning of Outdoor Recreation Areas

TM 5-635/AFM 126-5	Natural Resources-Outdoor Recreation & Cultural Values

1.2.3 Huntsville Division Design Manuals for Ranges.

HNDM 1110-1-5	Design Information for Infantry Rifle Marksmanship Ranges
HNDM 1110-1-6	Design Information for Multipurpose Range Complex
HNDM 1110-1-7	Design Information for Military Operations In Urbanized Terrain (MOUT) Training Complex
HNDM 1110-1-8	Design Information for Multipurpose Range Complex, Light Infantry
HNDM 1110-1-9	Design Information for Range Control Facility
HNDM 1110-1-10	Design Information for Battle Simulator Centers
HNDM 1110-1-15	Design Information for Remoted Target System (RETS) Equipped Ranges

1.2.4 Military Standards.

MIL-STD-619B	Unified Soil Classification System for Roads, Airfields, Embankments and Foundations
MIL-STD-620A	Test Methods for Bituminous Paving Materials
MIL-STD-621A	Subgrade, Subbase and Test Method for Pavement Base-Course Materials

NOTE: A-E designers shall request that the District Project Manager furnish the latest revision/edition of the above manuals (TM's, HNDM's, etc) for project design.

1.2.5 National, State and Local Standards.

Georgia
Manual for Erosion and Sediment Control in Georgia
Department of Transportation State of Georgia Standard
Specifications Construction of Roads and Bridges

North Carolina
North Carolina Erosion and Sediment Control Planning and Design Manual
North Carolina Department of Transportation Standard Specifications for Roads and Structures

South Carolina
South Carolina Storm Water Management and Sediment Control
Handbook for Land Disturbance Activities
Guide to Site Development and Best Management Practices and Storm Water Management and Sediment Control
South Carolina State Highway Department Standard Specifications for Highway Construction

National
A Policy on Geometric Design of Highways and Streets (1994 or Latest Edition)

NOTE: A-E designers shall request that the District Project Manager furnish the latest revision/edition of the above manuals (TM's, HNDM's, etc) for project design.

1.3 **CODE 3 DESIGN REQUIREMENTS.**

1.3.1 Submittal. Submittal content and format shall be as described in TI 802-01, "Technical Instructions for Code 3 Design with Parametric Estimating". Site specific instructions to be provided in specific instructions for contract or delivery order.

1.4 **PRECONCEPT SUBMITTAL REQUIREMENTS.**

1.4.1 Requirements for Site Surveys.

1.4.1.1 General.

a. The survey of the project site is intended to furnish complete information and data for design purposes; therefore, every effort should be made to make it thorough and not merely of a preliminary nature. Usually, a topographic map of the estimated project area is furnished the A-E by the District Project Manager. However, when the A-E is instructed to make the site survey, or to extend the survey due to site relocations, the work shall be performed under the supervision of a registered land surveyor, preferably registered in the State in which the project site is located.

b. Topographic surveys will usually be done by plane table methods at a scale of 1m = 400 m, unless otherwise directed. No feature shall vary more than 1/10 horizontal scale, except where distortion of scale is required to show a particular feature. Horizontal control for surveys will be based on localized datum(s) unless otherwise directed, and shall be of at least third order accuracy. Survey base lines shall be established throughout the project area with a minimum of two semi-permanent monuments shown on each baseline (B/L). The location and distance between these monuments will be shown. Vertical control (BM's/TBM's) for surveys shall be based on either USGS or USC & GS mean sea level (MSL) datum, unless otherwise directed, and shall also be of third order accuracy. A minimum of <u>two</u> temporary bench marks will be established for each final survey sheet. Existing ground elevations shall be shown to 0.01 (1/100) of a meter, and the density pattern of spot elevations shall be sufficient to ensure accurate interpolation of contours.

Elevations on all paved areas shall be shown to 0.01 (1/100) of a meter. Surveys shall be plotted on dimensionally stable material such as Cronaflex or glass cloth. Line weights and symbolization will be compatible with map scale and consistent with accepted drafting practices. (Reference Chapter A-10). Scale of the survey and contour interval will be as specified in the following paragraphs, unless otherwise directed.

(1) Surveys of road complexes and ranges, especially range complexes, may be plotted at a scale of 1 m = 500 m or even 1 m = 1000 m to reduce the total number of sheets required in the final contract drawings. However, the topography around the assembly and parking areas, building sites, etc, shall be shown at the preferred scale of 1 m = 400 m or 250 m to assure clarity of the final grading plan, especially at 1/2 size reduction. (This may be done photogrammetrically when preparing the individual site plan C-Plates described in paragraph 1.6.2).

(2) When endangered species, such as the Red Cockaded Woodpecker (RCW) are believed/known to inhabit the proposed project site, this information shall be coordinated with the user (PWBC or BCE). The location of nesting or den trees shall be plotted and clearly identified on the topographic map, as these locations will definitely affect the final location of the proposed project.

c. Obstruction surveys usually include a topographic survey within the prescribed limits of the easement area(s); establishing property lines and ownership; placing tags on trees considered to be obstructions; determining the elevation of obstructions with pertinent information for clearing requirements which shall be recorded in duplicating field books. These surveys are usually plotted at the same scale as the topographic survey, unless otherwise instructed.

1.4.1.2 Minimum Data Required.

a. Topographic Survey. (Scale of 1 m = 400 m preferred. 1 m = 250 m may be used for small sites, and 1 m = 500 m or more for the "downrange" portion of firing ranges, unless otherwise directed).

(1) Survey of area (show property lines and ownership, and location(s), elevation(s) and descriptions of BM's/TBM's).
(2) Limits beyond project area, as required (see special instructions).
(3) Finished floor elevations (FFE) of existing building(s) on or adjacent to project site.
(4) Heights, type, and characteristics of existing structures, including bldg. nos.
(5) Roads, streets, and trails; sidewalks; and paved areas.

(a) Typical roadway section(s).
(b) Profile of roadway centerline (C/L).
(c) Limits of right-of-way (R/W).
(d) Type of construction (gravel, asphalt, etc.).
(e) Condition of surface (cracked, potholed, etc.).
(f) Street names: township, county, state and federal highway numbers.

(g) Culverts: size, type, invert elevations, and condition.
(h) Bridges: size, type, material, and condition.
(i) Guardrail: location, and type of material.
(j) Distance from storm drain inlets to trunk line.
(k) Sidewalks, w/spot elevations.
(l) Trails.
(m) Curbs: type, spot elevations along gutter line and top of curb.
(n) Joint layout of "existing" airfield/hardstand pavements, with spot elevations at joints.

(6) Railroads.

(a) Alignment of track and location of road crossings.
(b) Number of tracks and weight of steel rail.
(c) Elevations along base of rail.
(d) Locations of turnouts and sidings (station point of switch and turnout number).
(e) Drainage structures: size, type, invert elevation and condition.
(f) Width of right-of-way (R/W).
(g) Name of serving company (Southern Systems, etc.).
(h) Distance and direction to nearest station(s) or milepost.

(7) Utilities.

(a) Water.

(i) Alignment of pipeline(s) within the project area.
(ii) Type (CI, PVC, etc.) and size of pipe.
(iii) Depth below existing ground line.
(iv) Storage capacity of tank(s).
(v) Location of fire hydrants.
(vi) Valve locations.

(b) Sanitary Sewer Collection.

(i) Alignment of pipeline(s) within the project area.
(ii) Type (RCP, DIP, etc.) and size of pipe.
(iii) Depth below existing ground line.
(iv) Manholes: size and top and invert elevations.

(c) Sewage Disposal Facilities.

(i) Location and size.
(ii) Elevations at top and bottom of structure(s).
(iii) Elevations of inlet and outlet pipes.

(d) Storm Drainage.

(i) Alignment of pipe lines within the project area.
(ii) Type (CMP, RCP, etc.) and size of pipe.
(iii) Depth below existing ground line.
(iv) Manholes: size and top and invert elevations.
(v) Profile of open ditches above and below culverts and surface inlets.
(vi) Inlets: top and invert elevations, and number and size of grates. For curb type inlets with no grate, give length of opening, invert elevation at throat (gutter line), and top elevation of structure directly over the opening.
(vii) Dimensions of inlet structure(s).
(viii)Delineate extent of drainage areas (for drainage area map in design analysis).
(ix) Headwalls: give type, dimensions, pipe diameter(s) and invert elevation(s) at end(s) of pipe.
(x) Where pipe terminates in ditch without a headwall, indicate if flared end section (FES) or end of pipe is in good condition or damaged. Also, if ditch is stabilized or eroded.
(xi) Where storm drainage pipe extends beyond survey limits, secure length and invert elevation of pipe at next structure upstream or downstream to determine percent slope of pipe.

(e) Fuel Dispensing and Storage.

(i) Type, source and capacity of tanks, if available.
(ii) Alignment of fuel lines, depth, type, pipe size and pressure.
(iii) Name of serving company.

(f) Electrical Power.

(i) Alignment of powerlines (aerial or underground) within the project area.
(ii) Pole locations and heights.
(iii) Transformers: Number and size.
(iv) Service lines: Number of wires, size and material; voltage and phase; height of line above existing ground line.
(v) Name of serving company.

(g) Telephone Communication.

(i) Alignment of lines, (aerial or underground) within the project area.
(ii) Pole locations and heights.
(iii) Number of wires, size and material; height above existing ground line at pole.
(iv) Name of serving company.

(8) Ground Covers.

(a) Type of Crop, where applicable.
(b) Grass.
(c) Brush.
(d) Trees: species, diameter, height, condition, location of all hardwood and other trees 4 inches and larger in diameter to be retained on the project site.

(9) Fencing.

(a) Type and location (alignment), including location(s) and size of gates.
(b) Number of barbed wires on extension arm, where applicable.
(c) Height and type of fabric.
(d) Kind of posts and condition.
(e) General condition of fence as a whole.

(10) Endangered Species Habitat.

(a) Show location(s) of nesting or den trees.
(b) Prominently mark/identify trees for Contractor's ease in preserving same during construction operations.

(11) Maps and Drawings. Copies of all existing pertinent maps and "as-built" drawings, furnished by the appropriate using service (DEH or BCE).

b. Obstruction Survey. (Scale same as for Topographic Survey, unless otherwise directed).

(1) Topographic map of prescribed area.
(2) Elevations of all existing structures and other topographic features.
(3) Show all property lines and ownership.
(4) Place tags on trees which are obstructions and submit the following information recorded in duplicating field book(s):

(a) Species of tree(s) and diameter breast high (DBH).
(b) Ground elevation at base of tree(s).
(c) Elevation of top of tree(s).
(d) Number of feet to be removed.
(e) Obstruction number.

c. Boundary and Easement Surveys. (Scale same as for Topographic Survey, unless otherwise directed).

(1) Install iron pins for horizontal control, showing locations and coordinates.
(2) Indicate ties to existing base lines, land corners, and either the installation's or state plane coordinate system, when applicable.
(3) Show property line locations with distances and bearings, when applicable.

d. Safety Requirements, All Surveys. Locate and describe all features, to the extent appropriate. Indicate the existence of all permanent features, constructed work, etc., which might constitute a hazard to Contractor(s) personnel who will be working in the area.

e. Special Requirement for Ft. Bragg, N.C. The survey will be registered to the North Carolina State Plane Coordinate System – Zone 3200 – NAD83 -- U.S. Survey Feet. Elevation units will be MSL GRS80 U.S. Survey Feet.

f. Special Requirement for Utility Information on Topographic Surveys. The chief of the survey party shall coordinate with the installation's Engineer (PWBC, DPW, or BCE) concerning all existing utility lines shown on the plane table sheets to ensure that every effort has been made to obtain correct and complete information regarding utility locations.

g. Field Check of Plane Table Survey. When required by specific instructions during completion of final design, a field check shall be made to determine the accuracy of the plane table sheets. The cross sections shall be taken where indicated on the drawings, marked in red, and the changes in existing ground levels recorded at maximum 30 meter intervals along each cross section. These cross sections shall be spaced at approximately 60 meter intervals, unless otherwise shown, with a minimum of two cross sections to each plane table sheet. The original cross section check level notes shall also be submitted with the plotted survey data.

1.4.1.3 Final Preparation.

a. Plot final topographic drawings for submittal as outlined in Drawings Section. Contour intervals shall be 0.25 meter, unless otherwise directed. Drafting shall be in accordance with requirements contained in Chapter A-10 of this manual. The title block shall have no entries made therein, except for the installation name and location, and the horizontal scale.

b. Include the following statement to the left of the title block.

"Topographic survey for (Specific Title of Project) by (Name of Firm), surveyed (Date of Survey)."

1.3.1.4 Submittal.

a. As soon as possible after completing the survey (i.e., with the first required design submittal), the A-E shall submit the following documents to the District Project Manager:

(1) Reproducible copies of the completed and traced topographic survey map(s).
(2) All original field survey notes and/or plane table sheets, appropriately marked and dated.

b. The reproducible topography described in subparagraph 1.3.1.4a(1) above is in addition to that required to be included in the contract drawings as the "Existing

Topography Plan," described in paragraph 1.6.2.3. If plane table sheets were furnished by the Government, the A-E shall return same to the District Project Manager.

1.4.2 Ten Percent Design Submittal Requirements. See Vol. 1, paragraph 1.3, Part A, of this manual for general requirements for this submittal. For site development, also furnish the following items:

a. A location plan with vicinity map, as per paragraph 1.4.2.1.

b. A sketch of the proposed project site showing the "existing" topography, scale, spot grades, etc. Identify any bordering/adjacent roads and streets, also any "existing" structures, utility lines, or other site feature(s) that may impact the proposed project.

1.5 CONCEPT OR EARLY PRELIMINARY (35 PERCENT) DESIGN SUBMITTAL REQUIREMENTS.

1.5.1 Concept Design Analyses. The site development portion of the Concept Design Brochure shall include a brief narrative covering the following items, as applicable to project design.

1.5.1.1 General.

a. Location of and access to the proposed project site, with brief explanation of objectives and factors influencing siting decisions.

b. General overview of major planned site features, including: building orientation; surface drainage patterns; traffic circulation; parking provisions and pedestrian access, including provisions for the handicapped; security requirements; etc.

c. Impact of new construction on existing facilities and considerations for future expansion.

d. Existing site features, including: general topography, tree cover, acreage, boundaries, unusual subgrade conditions, etc.

e. Former use of the site when major removals, demolition, and salvage are required.

f. Requirements for flood protection, if applicable.

1.5.1.2 Demolition and Removals.

a. Specific items requiring removal, relocation, or demolition and salvage.

b. Disposition of salvaged or waste materials.

1.5.1.3 Site Geometry.

a. Rationale for locating major site elements.

b. Specific clearance or setback requirements (reference the "Installation Design Guide" for the particular military installation, or TM 5-803-5 or Force Protection Requirement for project whichever is greater).

c. Roads (Location and Layout).

(1) Traffic volume (no., type, and size of anticipated vehicles), secured from DEH/BCE.

(2) Particular AASHTO design vehicle for which turning movements are to be provided, and corresponding minimum turning radius required.

(3) Maximum design speed, degree of curvature, control grades, and sight distance requirements for road networks, when required.

(4) Lane and shoulder widths and cross slopes, as per the applicable TM/AFM.

(5) Roadfill embankment slopes and back slopes in cut. (Refer to paragraph 1.6.2.6 for guidance).

(6) Requirements for curbs, sidewalks, guardrail, traffic signs and markings, fencing, etc, as specified in applicable TM/AFM.

(7) Intersection(s) or connection(s) to existing roads, streets or parking areas.

(8) Surface drainage features, both existing and proposed.

(9) Easements and rights-of-way.

(10) Traffic routing during construction.

d. Parking (POV or MEP) and Open Storage Areas.

(1) Size, type, and number of vehicles to be accommodated, as estimated by user. (Refer to paragraph 1.6.1.2 for guidance).

(2) Number and size of individual parking spaces to be provided, including pedestrian access and number and location of handicapped parking spaces, when required.

(3) General location of parking or storage areas, including location of entrance and exit drives.

(4) Use of 90-degree, 60-degree, or 45-degree parking spaces and relation to anticipated traffic operation.

e. Miscellaneous Site Features.

(1) Concrete curbing and curbs and gutters (locations and types).

(2) Sidewalks - Estimated volume of pedestrian traffic, required width and locations, as specified in applicable TM/AFM.

(3) Fencing - justification, type, height, size and location of gates.

(4) Traffic signs - types and locations.

(5) Pavement markings - type(s), locations, spacing, and whether or not reflectorized striping will be required.

(6) Guardrail and wheel stops - location, length, and type of material(s).

f. Railroads, when specified in project design.

(1) Type of service for which track will be provided.

(2) Anticipated volume of rail traffic.

(3) Maximum grade(s) and degree of curvature, as per applicable TM.

(4) Features of track construction such as: thickness and type of ballast, weight of rail, dimensions of cross ties, size of turnouts, etc.

(5) Special requirements for track scales, bumpers, signals, grade crossings, derailers, etc., as required.

1.5.1.4 Site Grading.

a. Existing site features affecting grading, such as: buildings, streets, curbs, walks, fences, water courses, ponds, elevation of anticipated high water, rock outcrop(s), etc.

b. Design flood frequency and minimum finished floor elevation (FFE) required to provide the desired level of flood protection.

c. Unusual excavation requirements and rough estimate of cut and fill quantities, plus slope stability analysis (cut and fill) and justification for any slopes steeper than 4:1, except as described in paragraph 1.6.2.6.

1.5.1.5 Storm Drainage Design.

a. Select design values to be used in the storm drainage design calculations, including: rainfall intensity, based on the appropriate 10-year, 1 hour storm frequency, unless otherwise instructed; surface runoff and retardance coefficients, etc, as listed in paragraph 1.7.1.1.

b. Selected storm drainage plan with respect to planned connections to the existing storm drainage system, when applicable.

c. Alternate schemes considered in arriving at selected storm drainage plan.

d. Considerations for future expansion and change in land use within the watershed, particularly above the project site.

e. Principal means of collection and disposal of storm water in the new storm drainage system. Include "brief" calculations for runoff and estimated sizing of pipe and drainage structures. (Reference paragraph 1.7.1.1).

f. Method proposed for handling roof runoff from gutter downspouts (splash blocks or roof drain collector system).

g. Connections of building's mechanical drains to outside drainage system, where applicable, and cross referencing to the appropriate section and design discipline, when required. (Reference paragraph 1.7b(1)).

h. Locations and features of special storm drainage structures, when required.

i. Types of materials to be specified for storm drains, culverts and drainage structures, allowing full range of options of suitable materials for each installation.

j. Easement requirements, when applicable.

1.5.1.6 Pavement Design. Pavement and base course thicknesses given in the Project Development Brochure/Air Force Project Book shall not be accepted verbatim by the A-E. The required pavement thickness shall be determined by a pavement design analysis in accordance with procedures specified in the applicable design manuals (TM's/AFM's) which are available on request from the District Project Manager. (See paragraph 1.7.1.2 for additional guidance).

a. Brief description of general soil conditions on the project site.

b. Design Thickness of Vehicular Pavements.

(1) Specific design values for which pavement thickness is based, including: the anticipated number, type, frequency and maximum weight(s) of vehicle axle loads; category of traffic; class of road or street; and assumed design index (DI).

(2) Flexible Pavements -- required thickness of base (150 mm minimum) and surface courses, based on the assumed subgrade CBR and design index "DI" values, as noted above. (Reference paragraph 1.7.1.2).

(3) Rigid Pavement -- required thickness of nonreinforced portland cement concrete (150 mm minimum) having a minimum 28-day flexural strength of 4480 Kpa and the assumed modulus of subgrade reaction "K," also described in paragraph 1.7.1.2.

c. Design Thickness of Airfield Pavements.

(1) Flexible Pavement - specific design values for which pavement thickness is based include: the airfield class, type of traffic area, gross weight of aircraft, number of passes, assumed subgrade CBR, and resulting minimum thickness of base and surface courses.

(2) Rigid Pavement - specific design values for which the pavement thickness is based include: the type of aircraft; gear configuration and design load; modulus of subgrade reaction "K" or resultant modulus of both subgrade and base courses; flexural strength of concrete; and resulting minimum thickness of base and surface courses.

1.5.1.7 Erosion Control. Include a short paragraph in the site development narrative stating what practices/measures are proposed for the project site. Also, reference the applicable State Design Manual containing the erosion control requirements for the state in which the proposed project is located. (See paragraphs 1.6.1.3 and 1.6.2.7).

1.5.1.8 Landscape Design. When required, the landscape design narrative shall include an analysis of existing site conditions, including an indication of existing plant materials that are to remain on the project site. The narrative shall indicate specific site problems related to proposed development and the rationale for proposed plant selection and locations. (See paragraph 1.4.2.3). The narrative may also include a list of suggested types and sizes of plant materials which are to be used, based upon the approved plant list, and the designated functional and visual criteria requirements from the applicable Installation Design Guide (IDG).

1.5.1.9 Berm Design (For Ranges). A brief design analysis, consistent with criteria in the applicable HNDM from paragraph 1.2.3, and based on the appropriate design parameters presented at the Predesign Conference, shall be included for all range projects. (See paragraph 1.6.1.3).

1.5.2 Concept Design Drawings. Site development's portion of the Concept Design Brochure shall include the following:

1.5.2.1 Location Plan. This shall consist of an appropriate portion of the Military Installation's General Site Plan and Vicinity Map furnished by the Savannah District's Project Manager, on which the proposed location of the facility being designed will be shown. Indicate location of project site, Contractor's designated access and haul routes to

the site, and the designated borrow and disposal areas. (Drawing should be complete for 35 percent design submittal).

1.5.2.2 Project Site Plan (Geometry). Normally, this consists of a "composite" drawing(s) of Plates C-2 through C-5 described in paragraph 1.6.2, at the same scale (1 m = 400 m or 1 m = 250 m) and covering the same area as the topographic survey sheets. Show the foundation plan outline (footprint) of all structures (existing and proposed, including building numbers), on or immediately adjacent to the site, and all trees determined by field survey to be worth saving/incorporating into the project design. Show actual ground contours existing on the project site at the same contour interval as the topographic survey sheets. Show the proposed finish grade contours tied into the existing ground contours indicating the extent of anticipated grading and area disturbed by construction to the existing site terrain and tree cover. All future structures and associated facilities within a reasonable proximity of the project site shall also be shown. Show all existing and proposed utility lines and structures required to serve the project, including: water, sanitary sewer, storm drainage, electric power, gas service, fuel service, high temperature and chilled water. If applicable, all telephone and other communication lines, and any and all other utility support items shall also be shown. These utility lines and structures shall be sized in the best judgment of the design engineer at this concept stage without making a complete design analysis. Each utility shall be appropriately identified by a symbol in a legend on the drawing(s). The drawing(s) shall show all existing and proposed driveways, parking areas, can washer locations, garbage storage and pick-up pads, and any other items necessary for functional and operation adequacy, including typical roadway and pavement sections. Emphasize the erosion control measures proposed, including a note stating that a "complete" Erosion Control Plan, complying with requirements of the applicable State Erosion Control Manual, will be included with the Preliminary (60 Percent)/Final (100 Percent) Design Submittal."

a. Show the proposed geometry of the project site plan using a minimum scale of 1 m = 400 m, unless otherwise instructed. Provide sufficient geometric information to adequately locate all new site elements. Include any "existing" topography that will remain after construction is completed.

b. Show and identify all existing buildings, utilities and other facilities on/immediately adjacent to the project site.

c. Use symbols differentiating between new and existing sitework, in accordance with the sample legend in Fig 1, Exhibit A-1-1, and the District's Drafting Standards Manual (See Chapter A-10 herein).

d. Show bench mark locations and list horizontal and vertical control data for each, as per page 14-2 in the District Drafting Standards Manual.

e. Include a north arrow, with site preferably oriented with North arrow pointing to top of the sheet, as per page 7-1 in the District Drafting Standards Manual.

f. Show the complete storm drainage system, using either finished grade contours or slope arrows and estimated size(s) of storm drain pipe, as per paragraph 1.4.1.5.

g. Show the proposed finished floor elevation (FFE) of all new buildings and critical finish grade spot elevations at building corners, along sidewalks, edges of paved areas, etc., to assure positive drainage away from buildings/structures and to storm drain inlets.

h. Show proposed locations of and include a note stating that the appropriate erosion control measures will comply with the applicable State Publication(s), as per paragraph 1.6.2.7.

i. Include existing utilities with the site topography. If necessary for clarity, show removals, relocations, and new work for utilities other than storm drainage on separate plan(s).

j. The thickness of typical flexible/rigid pavement sections shall be based on assumed compacted subgrade CBR/K values that, in the designer's best judgement, will provide adequate support for the type of pavement being designed, based on estimates from the using service (PWBC or BCE) of the vehicles anticipated to be using the roads, drives, parking area(s), etc. of the proposed facility. (See paragraph 1.4.1.6).

k. For site development, the term "Site Plan" applies only to the Concept/Early Preliminary (35 Percent) Design Submittal. For the subsequent Preliminary (60 Percent) and Final (100 Percent) Design Submittals, the "composite" Site Plan will be expanded into "separate" plates, as described in paragraph 1.6.4, unless otherwise instructed in Appendix A, Section 6 of the Specific A-E Design Instructions. (See paragraph 1.6.2 for additional guidance).

1.5.2.3 Landscaping Plan. When required, this shall consist of a narrative including a list of the major plant types to be used in the project design and a drawing (Plate L-1) showing a small portion (at least one building and one open area) of the project site to indicate the Landscape Architect's ideas or intent. The overall design approach, as applicable, shall depict factors which affect existing site features and influence subsequent design proposals. The concept drawing(s) shall be prepared at the same scale and shall include an appropriate legend, north arrow and graphic scale, same as the project site plan. (Reference paragraph 1.6.2.9 for additional guidance).

1.5.3 Outline Specifications. A list of outline specifications to be utilized in the site development portion of the project design shall be selected from the list of guide specifications included in paragraph 1.10 of this chapter. (See Exhibit A-1-9 and Chapter A-11 for additional guidance).

1.5.4 Estimated Sitework Quantities. A list of estimated quantities of sitework for the site development portion of the project design for both Army and Air Force projects shall be included in the A-E's cost estimate submitted with the concept design submittal. The estimated sitework quantities shall be presented in a format similar to the appropriate sample included in Chapter A-9 of this manual. (See Exhibit A-9-4).

1.5.5 Survey Data. Topographic site survey data will be submitted with this design submittal, as described earlier in paragraph 1.3.1.4.

1.5.6 Additional Information. A tabulation by the A-E designer of any design data he has not received that, in his judgment, he will need to proceed to completion of final design and preparation of "complete" bidding documents without interruption or delay, when so directed by the District Project Manager.

1.6 **PRELIMINARY (OVER THE SHOULDER) DESIGN SUBMITTAL REQUIREMENTS.** See Vol. I of this manual for requirements for this design submittal.

1.7 **PRELIMINARY (60 PERCENT) DESIGN SUBMITTAL REQUIREMENTS.**

a. The site development portion of a Preliminary Design Submittal shall include the following items:

(1) Fairly complete site plan (C-Plate) drawings, including landscaping (L-Plates) when required.

(2) Design analyses for storm drainage and pavement design.

(3) Outline/draft project specifications covering all items of site development work shown on the drawings.

(4) Estimated sitework quantities of all items for site development that are shown on the drawings and included in the project specifications.

(5) Any additional technical requirements not already furnished by the District Project Manager.

The above items are more thoroughly described in the following subparagraphs 1.6.1 through 1.6.5.

b. General. The A-E designer shall proceed from concept to final project design, incorporating comments received from review of the Concept Design Submittal. Grading, paving, storm drainage and landscaping considered in the preliminary design stage shall consider the following items:

(1) Economical development of suitable building sites.

(2) Preservation of the natural character (aesthetics) of the project site by minimum disturbance to existing ground levels to conserve trees and reduce extent of potential erosion.

(3) Satisfactory collection and disposal of surface runoff to retard erosion.

(4) Reasonable balance of cut and fill to reduce cost of removal and disposal of excessive excavation, or securing additional borrow material to avoid unsightly earthfills that will unnecessarily increase the height of the building foundations, and require costly erosion-control measures.

(5) Avoiding wavy profiles in streets and walks.

(6) Avoiding excessive grades or steps in sidewalks, whenever possible.

(7) Where rock is encountered close to the surface, keep the finished grade(s) as high as practicable to reduce cost of excavating utility trenches.

c. Specific.

(1) Coordination. All phases of the project design, (i.e., architectural, structural, mechanical, sanitary sewage, water and electrical) shall be closely coordinated with the site development (grading and paving layout). Locations of sidewalks, drives and parking areas, as well as finish grade elevations around building(s)/structure(s) shall tie into the requirements shown on the architectural (A-Plate) drawings. Unless otherwise instructed, concrete pads, electrical substations, cooling towers and other such items as required in the project layout must be shown on the Grading Plan to assure a complete grading design.

(2) Special Ft. Bragg, N.C. Layout Plan Requirements.

- A single model file or map of the entire site indicating the location of all existing and proposed utilities and other constructions to include the footprint of structures, paving (including curbing), sidewalks, and other relevant planimetric features at the completion of the project. Provide a separate file for base bid and options.
- See Para 1.4.1.3.e for specific survey requirements.
- Due North on the map will be as viewed from the bottom of the map. Rotations will not be allowed nor will orientation to Magnetic North.
- The map will contain a labeled coordinate grid with spacing appropriate to the map extents. For instance, a map scale of 1″=30′ will have coordinates labeled at 100′ intervals north/south and east/west.
- A minimum of four tie-in points will be labeled on the map located near the four corners of the map. The tie-in points will show a symbol at the location of the point and a label indicating the Northing and Easting of each point.
- All utilities on the map will be clearly labeled as to size and material. Where utilities are to be enclosed in conduits or duct work, a section of the duct will be shown clearly indicating the dimensions and material of the duct, the contents of the duct such as wire size and type of conductor, whether conductor is primary or neutral, number of conductors, hot water supply or return, pipe size, insulation type and thickness, etc.
- The map will show the invert elevation of all manholes as well as the invert of each pipe joining a manhole as well as the invert and character of all outfalls.

(3) Landscape design, when required, shall consist of preparing landscape plan studies and complete drawings and specifications for the project. The design shall be based on all general and specific criteria (drawings, manuals, etc.) contained or referenced elsewhere in this chapter.

(4) The "Checklist for A-E's Review" included in Chapter A-1, Volume III of this manual is not intended to contain all the design requirements cited herein. However, it is intended to emphasize the important technical requirements items that can cause problems, if not included in this and subsequent design submittals. The A-E designer shall use the checklist as a guide to assure that each of the listed items is included in both the Preliminary and especially the Final design submittals of the site development portion of project design. (See Exhibit A-1-10).

1.7.1 Preliminary Design Analyses. Expand the Concept Design Analyses to support the preliminary design submittal, showing complete detailed analyses, date of initial preparation and names of preparer and checker. Include the following in booklet format (see Exhibit A-1-3, Vol III), as applicable to project design:

1.7.1.1 Storm Drainage Design.

a. Complete storm drainage design calculations consistent with the requirements of the applicable TM's/AFM's, based on the design values presented in the Concept Design narrative and incorporating review comments from the Concept Design Submittal.

b. Design Analysis. Design of the storm drainage system and culverts shall conform to the criteria and references specified herein. The procedures for design and preparation of the complete storm drainage design analysis are given in detail in "Storm Drainage Design Instructions for Roadways and Built-Over Areas," included as Exhibit A-1-2, Vol. III of this manual. A sample format containing the "minimum" data required for a complete design analysis is included as Exhibit A-1-3, in Vol. III of this manual.

(1) Technical Requirements.

(a) Design Storm. For the design storm index, use the 10-year 1 hour frequency intensity curve illustrated in TM 5-820-1, Figure 1, Chapter 1, applicable to the area in which the project is located. Round off to the nearest one-tenth (1/10) inch. Ten-year design storm frequencies for most of the major military installations are listed as follows:

(i) Georgia:

a. Fort Benning	2.8
b. Fort Gordon	2.6
c. Fort Stewart	3.0
d. Hunter Army Airfield	3.0
e. Moody Air Force Base	2.9
f. Dobbins Air Force Base	2.6
g. Robins Air Force Base	2.7
h. Kings Bay Military Ocean Terminal	3.0

(ii) North Carolina:

a. Fort Fisher	3.0
b. Fort Bragg and Pope Air Force Base	2.8
c. Seymour Johnson Air Force Base	2.9
d. Wilmington, NC and Sunny Point MOT	3.0

(iii) South Carolina:

a. Fort Jackson	2.6
b. McEntire Air National Guard Base	2.7

(b) Determination of Runoff.

Rational Method Formula; Q = CIA
Q = Runoff in cubic feet per second (cfs)
C = Imperviousness factor
= Average rainfall intensity in inches per hr.
A = Drainage area in acres

(c) Adopted Imperviousness Factors.

C = 1.0 (paved); C = 0.40 (turfed)

(d) Length of Runoff corrected to 1.0 percent for determining Time of Concentration (t_c). (See TM 5-820-1, App B, Figure 9).

(e) Time of Concentration (t_c). Select from any of the Supply Curves from TM 5-820-1, App. B, Figures 10 through 17.

(f) Intensity. Inches/hour (I) determined from TM 5-820-1, Figure 2.

(2) Computations for Enclosed Pipe Systems.

(a) Tables. Table I, CESAS Form 1178 (Exhibit A-1-4), and Table II, SAS Form 1155 (Exhibit A-1-6) are used in tabulating the drainage design computations. Form 1178 is completed first by determining the drain-inlet capacities, based on the design storm criteria and drainage area map. Form 1155 follows, showing the accumulation of runoff, based on the data listed in Form 1178. Table III, SAS Form 1156 (Exhibit A-1-7) is

then used to compute the hydraulic gradient of the entire storm drainage system to determine the hydraulic gradient(s) at all inlets and manholes. If the gradient rises above the midpoint between top of pipe and top of manhole or inlet, the size of pipe or the pipe slope(s) should be increased throughout the downstream portion of the system to lower the hydraulic gradient. The hydraulic gradient line shall appear only on the pipe profile(s) in the design analysis, not on the drafted profiles included in the contract drawings. (Full size copies of the above forms (Tables I, II, and III) are available on request from the District Project Manager.)

(b) Time of Concentration (t_c). Time of concentration is established as outlined in the manual referenced above. In all but exceptional cases, other than roof drain collector system, the minimum t_c for paved areas is 10 minutes; t_c for roof drain collector system is 5 minutes. (A roof drain collector system includes all storm drain pipe inside the 5-foot building line from the downspouts to the point of discharge at an inlet or manhole). For turfed area(s), the t_c is based on the combined length of overland and channelized flow on the turfed area(s). This length is corrected to a 1.0 percent slope using a retardance coefficient "N" equals 0.40 in the left hand chart of Figure 9, TM 5-820-1 and reading the corrected slope for the actual ground slope on the right hand chart of Figure 9. This corrected length is then entered in any of the supply curves, Figures 10 through 17. The duration of supply in minutes is the value read at the intersection of the corrected length (L) and the dotted curved line. This value is then entered at the bottom of Figure 2 and the rainfall intensity read to the left of the intersection of duration in minutes with the design storm index given above. When the storm drainage pipe system extends more than 300 feet, the A-E designer shall determine whether the computed design discharge will be less as a result of the time of flow in pipe, as outlined in Chapter 2 of "Storm Drainage Design Instructions for Roadways and Built-Over Areas" (Exhibit A-1-2). For computing flow time in the pipe, enter in column 6 of Form 1155 the value of 3 feet per second, which may be assumed for all cases. The drain time in minutes under column 7 will be the length of pipe divided by the product of 3 feet per second and 60 seconds per minute. To simplify computations, the accumulative amount to be entered in column 8 should be to the closest minute or, in the case of larger systems to the nearest 5-minute interval.

(3) Types and Sizing of Pipe and Structures. Except as noted herein, pipe structures shall be selected in accordance with TM 5-820-4, Chapters 3 and 4, and pipe sizes for enclosed storm drain systems determined in accordance with Appendix B, Figures 25 and 27 of TM 5-820-1. Use "n" = 0.012 for concrete, clay, or fully bituminous coated, fully paved (Type "D") galvanized steel, aluminum alloy, or aluminized steel (Type 2) corrugated metal pipe (CMP). Use "n" = 0.024 for fully bituminous coated (Type "A") galvanized steel, aluminum alloy, or aluminized steel (Type 2) CMP. (See Exhibit A-1-2 for full description of Type "A" and Type "D" pipe.) The A-E designer shall design for the "optional" use of concrete, clay, or CMP; using Figure No. 39, Exhibit A-1-1 to record the required data in the contract drawings. (NOTE: Due to the corrosive action of the soils, do <u>not</u> use aluminum pipe in the Fort Stewart and Kings Bay Military Ocean Terminal, Georgia projects nor the Sunny Point Military Ocean Terminal, North Carolina project). Although acceptable for pipe culverts, Type "A" CMP is <u>not</u> to be installed in "enclosed" storm drain systems under paved areas. In addition, the A-E designer should also note that, in specifying Type "A" CMP, the diameter in most cases will be larger than the

required size of concrete, clay, or Type "D" CMP. However, do not specify pipe in 27- or 33-inch sizes, since they are not commonly available. All inlet, grate, or weir openings must be checked for size to be certain that the opening(s) will pass the calculated storm run-off draining to each inlet. Pipe strength (D-load for rigid pipe and gauge for corrugated metal pipe (CMP)) is usually determined from the tables in Appendix C, TM 5-820-4. However, for pipe diameters less than 84" and fill heights of 10 ft or less, use the following minimum gauges for corrugated metal pipe in lieu of gauges given in TM 5-820-4:

CORRUGATED METAL PIPE, TYPE I (CIRCULAR)
67 mm x 12.7 mm Corrugations

Galvanized Steel and Aluminized Steel, Type 2		Aluminum Alloy	
Pipe Diam	Gauge	Pipe Diam	Gauge
300 mm thru 600 mm	16	300 mm thru 600 mm	16
1200 mm thru 1350 mm	14	750 mm thru 900 mm	14
1500 mm thru 1650 mm	12	1050 mm thru 1350 mm	10
*1800 mm	10	1500 mm thru 1650 mm	10
1950 mm thru 2400 mm	8	1800 mm thru 2100 mm	8

*For 1800 mm diameter pipe, the designer has the option of using 14-gauge steel pipe having 75 mm x 25 mm corrugations. (If used, revise "n" factor to 0.027 instead of 0.024 for Type "A" pipe.)

For pipe diameters larger than 2100 mm and fills exceeding 3 m in height, use the appropriate tables in Appendix C, TM 5-820-4.

For conditions other than trench and positive projecting conduits and other conditions differing from those given in the tables, the design and detail analysis shall be made in accordance with Appendix B of TM 5-820-4. If the appropriate table is not referenced, the methods used and the computations for determining pipe strength shall be included in the storm drainage design analysis. Provide watertight joints for storm drainage pipe under all pavements (aircraft and vehicular), especially when the pipe is placed in soils with fluctuating water tables. Minimum pipe diameter for roof drain collector system(s) shall be 150 mm. Minimum pipe diameter for enclosed storm drain system shall be 300 mm.

(4) Calculations and Drainage Area (DA) Map. Complete calculations and drainage area map for the design analysis must be submitted on reproducibles at same time drawings are submitted for review and comments. The DA map, at an approved scale (for small projects the scale is usually the same as the Grading Plan), shall show the limits of

the entire drainage area, the acres of both turfed and paved areas, location of each storm drain line and structure, numbered designation of each structure, pipe sizes, invert elevations and direction of flow. The DA map shall be attached at the end of the Storm Drainage Design Analysis. Depending upon site topography, portions of the drainage area may lie outside the proposed project limits. If so, these off site areas must also be included to prevent possibility of the new SD system being inadequate to handle the resulting surface runoff. If not included in the topographic site survey, use USGS Quad Sheets, etc. to determine extent of off site areas. Sketches and calculations showing proposed head, waterway areas and capacities in cubic feet per second (cfs) for inlets (i.e., grates, weirs, throats, etc.) must also be included in the design analysis. A factor safety of 1.5 is used for paved areas. In vegetated areas where grass clippings and trash may clog the inlets, use a safety factor of 2. The drainage area (DA) map, layout sketch of storm drainage system, and design computations are not a part of the contract drawings and, therefore, should be referenced separately. See "Storm Drainage Design Instructions for Roadways and Built-Over Areas" (Exhibit A-1-2).

(5) Trunk Lines. In cases where sizing a large, critically important trunk line becomes complicated because of several lateral lines and extensive upstream drainage areas in rolling or hilly terrain, a composite hydrograph showing the resultant t_c and it's Q will also be developed from the principle illustrated in Figure 8, Appendix B of TM 5-820-1, taken with the t_c's developed on CESAS Form 1178 or SAS Form 1154 (Exhibits A-1-4 and A-1-5). Drainage areas involved must be carefully determined and outlined on a reproducible topographic map at the same scale as the Grading Plan, except for the off site drainage areas mentioned above. Careful consideration must be given to accurately determine the lengths and slopes of channelized flow because of their influence in reducing the effective length of flow.

(6) Culverts. In the case of culverts, and also the outfall pipe of any enclosed pipe system, pipe sizes must be determined by the appropriate procedure and culvert formula given in Appendix B of TM 5-820-4. (To allow for sediment deposition, the "minimum" vertical diameter of cross drain culverts shall be 450 to 600 mm, using the respective State DOT's culvert design form, or Exhibit A-1-8 for the design). The A-E designer shall also inspect the outfall channel or drainage way below each outlet to determine if the outfall ditch should be protected with either riprap, ditch paving, or other suitable energy dissipator to prevent erosion, especially if outlet velocities exceed the maximum permissible mean velocities in Table 4-1, TM 5-820-4. The analysis <u>must</u> include calculations showing that outlet velocities have been reduced to permissible levels <u>before</u> being considered complete.

(7) Inlets and Other Structures.

(a) Inlets. Grated inlets (and occasionally weir inlets) are used in grassed areas. Curb type inlets are used when combination curb and gutter sections are used around paved vehicle parking areas. When curb inlets are located in the sag point of intersecting grades, the various inlets listed below are capable of passing the discharges shown, subject to other requirements specified hereinafter:

Type A*, single grate (600 mm x 900 mm) in grassed area
(120 mm Head, with F.S. of 2) = 4.0 c.f.s.
Type A, single grate (600 mm x 900 mm) in paved areas
(120 mm Head, with F.S. of 1.5) = 5.0 c.f.s.
Type B* (curb inlet, single trough) = 3.5 c.f.s.
Type B (curb inlet, double trough) = 6.5 c.f.s.
Type C* (curb inlet) = 1.4 c.f.s.

*See Exhibit A-1-1, Vol.III, for standard details of these inlets.

The capacity and spacing of the above inlets shall be selected and designed to adequately drain the project area in accordance with the requirements given in TM 5-820-4. When curb inlets are located on a slope, the capacity of the opening shall also be determined as specified in TM 5-820-4. The A-E designer shall include computations in his storm drainage design analysis indicating that the capacity and spacing of the curb type inlet(s) and the capacity of the grated type inlet(s) are satisfactory to prevent the design storm water runoff from either topping the curb, or building up to an objectionably wide area of flow along the gutter line and adjoining pavement.

(b) Other Structures. Headwalls shall be designed and detailed in accordance with job requirements and TM 5-820-4. Discharge/outlet channels shall be protected from possible erosion, as described above for culverts. All necessary protection shall conform to the requirements covered in the above referenced TM and appropriate detail sketches included in the site details of the contract drawings.

(8) When designing an enclosed storm drainage system for airfields, a 2-year design storm is usually required instead of the 10-year storm. In such cases, refer to Appendix A, Section 6, Specific Instructions to A-E, for further instructions. Also, refer to Fig. 1, Appendix B, TM 5-820-1 to determine the appropriate 2-year storm frequency, and substitute Table 1A, SAS Form 1154 (Exhibit A-1-5) for CESAS Form 1178 (Exhibit A-1-4) in the tabulation tables in the design analysis, following the procedure outlined in Appendix C, TM 5-820-1. It is important to remember that ponding <u>may be permitted</u>, but <u>only</u> when so stated in the Specific A-E Design Instructions.

(9) If applicable, also identify any state or local requirements for which the storm drain design must comply.

1.7.1.2 Pavement Design.

a. Complete flexible and rigid pavement design calculations consistent with requirements of the applicable TM's, based on the various design values presented in the Concept Design narrative and incorporating comments from review of the Concept Design submittal.

b. Present complete calculations for pavement options, describing the nature of the materials to be used in each pavement structure.

c. A Pavement Design Analysis is required to determine the thickness of flexible (bituminous) or rigid (concrete) pavements comprising drives, streets, parking areas, major highways, motor pool service areas, hardstands, aircraft parking aprons, taxiways, runways etc., when these features are indicated on the site plan. The format of the analysis shall follow, in general, the sample format included in Section A-1, Vol. III of this manual. (See Part I, Exhibit A-1-3.)

(1) Type of Pavement. Flexible pavement having a minimum thickness of 40 mm bituminous surface course (hot-plant mix), and 150 mm stabilized aggregate base course is usually specified for driveways and minor streets subject to light traffic and for passenger car (POV) parking areas. Thicker surface and base courses are required for the higher class roads, streets, drives and vehicle parking areas subjected to considerable truck traffic with heavy loads, and shoulders of airfield runways and taxiways. Rigid pavement is used for tactical equipment shop hardstands, aircraft parking aprons and all service areas where spillage of solvents (gasoline, oil and grease) occurs as a result of service and repair of vehicles, aircraft, and airfield runways and taxiways. (Reference the applicable technical manual (TM) listed in paragraph 2.2, concerning the type of pavement design required for the project.)

(2) Traffic. The A-E shall inspect the project site and confer with the using service (DEH/BCE) to secure an estimate of the type and size of vehicle(s) and the total number of vehicles anticipated to use the proposed pavements. The estimated traffic volume and type, except for pavement features noted in the TM's, are necessary to determine the design index (D.I.) to use in Figure 3 of TM 5-822-5 and the revised curves replacing Figure 1 of TM 5-822-6 for vehicle pavements, and the appropriate design curve(s) in the applicable TM/AFM covering airfield pavement design.

(3) Subgrade Soil Values. "CBR" and "k" values of the site soils are determined by the Government. For preliminary pavement design, the A-E will request a tentative CBR and K value from the District Project Manager. The values for final pavement design are usually furnished in the Foundation Design Report prepared by Soils Section (EN-GS) of the District's Geotechnical and Materials Branch (EN-G), upon receipt of final soil test results from the Division's Testing Laboratory. (See Chapter B-3.)

(4) Flexural Strength of Concrete. Rigid concrete pavements are designed for a minimum flexural strength of 4480 kPa in 28 days for vehicles and 4830 kPa at 90 days for aircraft. No other strengths will be acceptable, unless otherwise specified in Appendix A, Specific Instructions to the A-E.

(5) Aggregate Surfacing of Range Roads. Determine the thickness of crushed aggregate surfacing required for tank trails and other range roads, parking areas, etc. by following the same format as the design examples in the appropriate HNDM Range Design Manual or Supplement to TM 5-822-5, entitled "Design of Gravel Surfaced Hardstands." (See paragraph 1.2.2.2.)

(6) Compaction Requirements. Designate the minimum depths of required compaction, based on procedures described/illustrated in the applicable TM/AFM or HNDM.

Include sketches similar to those shown in the HNDM, TM, or the sample design analysis format (Exhibit A-1-3) referenced earlier.

1.7.1.3 Erosion Control.

a. General. Many different types/brand names of materials are available on today's market to aid in preventing soil erosion until the installed vegetation becomes well established. Generally, these protective measures are considered to be either short-term or long-term:

(1) Short-Term. Short-term or temporary measures to be considered during the construction period of the contract shall include, but not be limited to: phasing exposed soil areas and time of year; reducing the period of exposure by hydroseeding, planting or paving quickly; using straw/hay bale barriers/silt fences; mulches; matting; or settling ponds. In addition to the straw/hay bales, the mulches and matting may also consist of material that is bio/photodegradable.

(2) Long-Term. Long-term or permanent erosion control measures to be considered as part of the final project design may include, but not be limited to: grading, with the proper percent of slope to distance; any areas not paved/surfaced being established with permanent turf/grass; reducing the extent of grading to leave existing plants standing; installing ground covers/woody plants that will resist erosion; terracing; diversion channels, water bars, and ditching. Mats made of synthetic materials provide reinforcement that remains in place after the turf becomes fully established. Stone riprap, paved ditches, ditch checks, detention ponds, etc. may also be used, if erosion cannot be controlled as described by any of the above items. Additional "permanent" measures to consider include: concrete grids/interlocking pavers, grout-filled fabric mats (in lieu of stone riprap), and concrete block systems. Geocells/geonets, often incorporating a layer of geotechnical fabric, are other synthetic measures currently in use to stabilize cut/fill slopes and enhance drainage. (See paragraph 1.6.2.7.)

b. Specific. The A-E designer shall furnish a "complete" analysis consisting of a narrative describing <u>all</u> protective measures proposed, plus calculations to document/"back up" how the protective measures were sized. (The designer shall refer to the appropriate chapter in the applicable State Design Manual referenced in paragraph 1.6.2.7 and comply accordingly.)

1.7.1.4 Landscaping Design. When landscaping is required, the descriptive narrative, list of plant materials, and cost estimate from the concept design submittal shall be revised to correspond with the development of the preliminary planting plan. The A-E designer shall prepare the outline specification(s) and approximate grassing and plant list quantities for the preliminary design submittal utilizing the recommended Plant List for the appropriate military installation and incorporating review comments from the concept design submittal. The quantities of grassing and plant materials shall be included in the preliminary cost estimate. (See paragraph 1.6.2.9).

1.7.1.5 Berm Design (For Ranges).

a. Present complete design of protective target and transformer berms, consistent with the requirements of the applicable HNDM and pertinent design values presented at the Predesign Conference, and incorporating any review comments from the Concept Design Submittal.

b. Include complete design calculations and sketches for both homogeneous and composite target berm options, in the same format as the design examples in the appropriate HNDM.

1.7.2 Preliminary Design Drawings. Unless otherwise instructed in Appendix A, Section 6, of the "Specific A-E Instructions," the Concept Design Submittal's "composite" Site Plan shall be expanded into the following separate site plans for this and subsequent Final (100 Percent) design submittals:

a. Existing Topography Plan (Plate C-2).

b. Removal Plan (Plate C-3).

c. Layout Plan (Plate C-4).

d. Grading, Paving, and Storm Drainage Plan (Plate C-5).

e. Erosion Control Plan (Plate C-6).

Although the major items of work should be shown separately, different items of sitework may be shown on the same sheet, provided the presentation is sufficiently clear to permit legible reproduction at half-scale.

1.7.2.1 Index of Drawings. Normally, the "Index of Drawings" is a separate sheet (Plate X-1) listing plate numbers and titles. However, for some projects, the index information may be placed on the Location Plan, if space is available. (See Chapter A-10 for additional guidance.)

1.7.2.2 Location Plan. (Normally completed by the 60 percent design submittal, based on incorporation of comments from the concept design review.) The Location Plan (Plate C-1) shall show the location of the project site in relation to the overall military reservation, and is usually drawn to a scale of 1 m = 10000 m to 1 m = 40000 m. When projects are located on an established Government reservation, the District Project Manager shall furnish a reproducible Installation Site Plan for the A-E to use in preparing the Location Plan. (The A-E should request the Savannah District Project Manager to furnish the reproducible drawing, which usually includes a Vicinity Map.) This plan will also be used to indicate the location(s) of permissible/designated access and haul routes through the reservation, and show designated earth borrow, disposal, or waste areas, when required for the project. Configuration of the new work, with line item designation, shall be drafted prominently thereon. The A-E shall contact the Base Civil Engineer (BCE) of the Air Force Installation, or the Director of Engineering and Housing (DEH) of the Army Installation

where the project is located and request the designated haul route(s) to the project, and the location of a suitable borrow or disposal area, if available on the Government reservation. Also, if needed for the project, indicate the permissible haul route(s) from the project site to these areas, and the area designated for Contractor's material storage and field office adjacent to or on the project site. (See paragraph 1.9.2.) If borrow and disposal areas are not available on the military reservation, appropriate General Notes shall be added for information purposes. In addition to the DEH/BCE, also show location(s) of nearest fire and police/security station(s), including building and telephone numbers.

1.7.2.3 Existing Topography Plan. The Existing Topography Plan (Plate C-2), shall consist of a drawing or drawings prepared from the topographic survey sheets at the same scale as the composite "Site Plan" in the Concept Design Submittal. (Preferably 1 m = 400 m, but 1 m = 250 m is also acceptable for small project sites.) This plan should show all existing site features (topography, contours, structures, utilities, roads, etc.), with contours extended a minimum of 15 m outside site boundaries to show surface drainage. The date and origin of the survey shall also be shown near the title block. (See paragraph 1.3.1.3). In addition, include a legend showing all items of sitework and reference same on all subsequent Site Plan C-Plates.

1.7.2.4 Removal/Demolition Plan (Plate C-3). To assure clarity of the Grading, Paving and Storm Drainage Plan, an additional site plan showing removal, relocation, demolition and removal/salvage of existing buildings, roads, drainage structures, etc. shall be included. Preferably, this plan shall also be at the same scale as the "Existing Topography Plan." If not delineated on the Removal Plan, include a note stating the Grading Plan shows the limits of clearing and grubbing/the extent of area to be disturbed (construction limit line (CLL)) by the Contractor's construction operations.

1.7.2.5 Layout Plan (Plate C-4).

a. Complete a geometric layout of all items of new sitework, using offset dimensions from existing structures or a referenced construction base line (B/L) to be located in the field by the Contractor and maintained throughout the life of the project. If necessary, use coordinates for locating new work, especially major road networks and buildings complexes. (See paragraph 1.9.5 for additional guidance.)

b. Locate or reference monuments for horizontal control for Contractor's use in laying out the project.

c. Include references to standard figures, or reference particular details in the "Site Details" C-Plates for specific items of sitework. Unless modified herein, all handicapped requirements shall comply with the "Uniform Federal Accessibility Standards (UFAS)."

d. Complete the legend (para. 1.6.2.3) to include symbols for all items of sitework shown on the Layout Plan. Symbols should be consistent between successive C-Plate drawings. (Refer to Figure 1, Exhibit A-1-1 for sample legend and District Drafting Standards for additional symbols.)

e. On large projects, preferably exclude contour lines for ease of review.

1.7.2.6 Grading, Paving, and Storm Drainage Plan (Plate C-5).

a. Indicate all items of new work, superimposed on the existing topography, including soil boring locations and designations from the boring location plan furnished by Savannah District's Soils Section (EN-GS). Specific instructions concerning soils data for structures will be provided in the Foundation Design Report also furnished by EN-GS, as discussed in Chapter B-3.

b. In general, the Grading, Paving and Storm Drainage Plan for each project site shall be developed on the existing topography at a scale of 1 m = 400 m or 1 m = 250 m, with the scale shown in the title block and also by graphic or bar scale.

(1) This plan shall exclude all new work involving sanitary sewage, water supply, electrical distribution, steam distribution and other exterior utilities, other than storm drainage. These utilities, excluding storm drainage, shall be shown on the appropriate drawings of the other design disciplines. However, all existing utilities and features, must be indicated or identified by appropriate symbol in the legend. (For depicting grading, paving and storm drainage items, refer to sample legend furnished in Figure 1, Exhibit A-1-1.)

(2) Earth shoulders of appropriate width should generally slope 13 mm per meter. Cut and fill slopes for overall sitework shall not be steeper than 4 horizontal to 1 vertical (4:1), except for unusual conditions or cases where steeper slopes are necessary to prevent encroachment on existing structures, or perhaps in remote outfall ditch areas. For roadway projects, the cut and fill slopes shall be based on using 4:1 for fill heights up to 1.8 m, 3:1 for heights of 1.8 m to 3 m, and 2:1 for fill heights over 3 m. (Unless otherwise approved by the Savannah District's Site Development Section (EN-GD), in no case shall earth slopes be steeper than 2:1.)

(3) The Construction Limit Line (CLL) denotes the limits of clearing and grubbing and extent of disturbed area (usually 3 m beyond top of back slope of cut or toe of fill slope).

(4) At least one BM/TBM convenient to the construction site must be shown and described on each sheet of the Grading, Paving, and Storm Drainage Plan. Indicate the finished floor elevation (FFE) of all new building(s) and provide finish grade spot elevations at building corners, along sidewalks, edges of paved areas, etc, to prevent ponding and assure positive drainage away from the structure(s) to/toward inlets to the storm drainage system.

(5) Differentiate clearly between new and existing contours, as shown in the District Drafting Standards. New contour lines are to be heavy and tie into the appropriate existing contours. Existing contours over earth and paved areas are properly drafted free hand. Top of new pavements (T.P.), finished earth grades (F.G.), top of new curb grade (T.C.), etc, must be shown at all strategic grading points such as storm drain inlets, grade breaks,

pavement corners, at P.C. or P.T. of pavement radii, along sidewalks, and at all points necessary to establish the new grading pattern.

(6) Channelized storm water runoff over sidewalks must be avoided by providing diversions, inlets, or cross drain pipe to intercept the runoff. Transverse runoff originating from extensive earth areas shall not be permitted across paved parking areas at <u>any</u> time. Such runoff <u>must</u> be intercepted before reaching the pavement.

(7) Maximum acceptable longitudinal grade on sidewalks is 15 percent, but grades steeper than 10 percent shall be avoided wherever possible (refer to TM 5-822-2 and 5-803-5). Transverse grades shall not be less than 7 mm per meter, nor more than 13 mm per meter. Where steps are required in sidewalks and eight or more risers are required, the steps should be split into separate groups with landings between. (Additional design information concerning steps in sidewalks is covered in TM 5-803-5.) When sidewalks are to also serve as driveways, the minimum thickness shall be increased accordingly or reinforcing steel added to support the anticipated vehicle wheel loadings.

(8) Radii at roadway and street intersections and turnouts shall usually be dimensioned to back of curb, unless noted otherwise. Existing spot grade elevations at intersections of existing and new pavements <u>must</u> be indicated to assure designing smooth tie-ins.

(9) Where the grading layout extends over more than one sheet, neat match lines shall be used to indicate breaks in topography. Overlaps, overruns, or repetitions in the layout will not be permitted.

(10) The A-E designer shall visit the site during the design period to assure that new and existing grading, paving, and storm drainage work are properly coordinated with other design disciplines, as referenced earlier in paragraph 1.6c(1). During the site inspection, the A-E shall also determine the feasibility of preserving existing trees and the natural terrain's compatibility with other site grading requirements and landscaping, when required.

(11) Grading and Surface Drainage.

(a) Site grading shall be designed to avoid/reduce erosion where possible, yet assure protection to buildings and pavements by providing controlled runoff of surface water. Finished earth grades adjacent to buildings and pavements shall be sloped away from the immediate area at a rate of at least 2 percent in 3 m. Site conditions and facility requirements will govern exact site grading requirements in open areas, but graded earth slopes should not be less than 1 percent before channelization occurs, except on special occasions. Steep earth grades around splash blocks and riprapped storm drain outlets shall be avoided at all times to prevent soil erosion. Large open graded areas and extensive back slopes may require further protection with interceptor and diversion terraces, ditches and inlets.

(b) Grading for roadway pavement transverse slopes shall be a minimum of 7 mm per meter, except at transition points with intersecting roadways where the slopes must vary as a function of the roadway design grade(s).

(c) Parking Areas. Surface grades in parking areas shall be held to the minimum required for drainage, but shall be not less than 1 percent, measured perpendicular to the finished grade contours. For safety reasons, the maximum cross slope grades for parking areas designed for 90-degree parking are 8 percent along the aisles through the area and 1-1/2 percent for the transverse slope. For parking areas designed for 60-degree and 45-degree parking, the maximum cross slope grades are 5 percent along the aisles through the area and 1 percent for the transverse slope. Combination curb and gutter shall usually be used around all vehicle parking area(s) and also along approach drives to control surface drainage, provide vehicle barriers and present a neat appearance. The curb and gutter shall be sloped a minimum of 0.30 percent to prevent ponding and assure positive drainage to curb inlets. Parking spaces shall be 2.8 m wide and 5 m long with overhand measured to face of curb or 5.5 m long without overhang. Aisles and access lanes will be 7.3 m wide. Light fixtures require concrete pedestals to prevent vehicle damage to the light poles. (Additional data is contained in TM 5-803-5, "Installation Design.")

(d) Locate the new storm drainage system using the symbols included in the legend and indicate the direction of pipe and surface flow. Identify drainage structures with number designations corresponding to same used in the storm drainage design analysis and the pipe and structure schedule (Figure 39, Exhibit A-1-1) included in the drawings details.

(12) Paving. The above paragraphs specify the basic grading requirements. For vehicle roads and parking areas, flexible pavement shall be designed in accordance with procedures specified in TM 5-822-5, and rigid pavement in accordance with procedures specified in TM 5-822-6. (Refer to paragraph 1.6.1.2). Both rigid and flexible airfield paving shall be designed in accordance with applicable revised design curves furnished with the ETL's to the applicable airfield design TM/AFM listed in paragraph 1.2.

(13) Pavement Markings. Double parking stripes shall be painted in parking areas, unless otherwise specified. (See Fig 26, Exhibit A-1-1). Also, when specified, traffic arrows and other markings shall comply with requirements in the "Manual on Uniform Traffic Control Devices," published by the Federal Highway Administration of the U.S. Department of Transportation.

(14) Grassing. All newly graded earth areas, slopes, ditches, and other disturbed areas shall be grassed. A temporary winter cover crop shall be specified in the event the finish grading is anticipated to be completed during seasons unfavorable to establishment of permanent grasses.

1.7.2.7 Erosion Control Plan (Plate C-6). Except for modifications or additions specified in Appendix A, Section 6, of the Specific A-E Design Instructions, Erosion Control Plans showing <u>all</u> protective measures recommended to retard/prevent soil erosion/retain

sedimentation on the project site shall be prepared in accordance with criteria contained in the following applicable State Publications:

a. Georgia. MANUAL FOR EROSION AND SEDIMENT CONTROL IN GEORGIA, 1996 or later Edition. (Chapter 3 of this manual contains "sample" Erosion Control Plans.)

b. North Carolina.

(1) EROSION AND SEDIMENTATION CONTROL PLANNING AND DESIGN MANUAL, September 1994 or later Edition. (Chapter 7 of this manual also includes a Sample Erosion and Sedimentation Control Plan and checklist.)

(2) GUIDE FOR SEDIMENT CONTROL ON CONSTRUCTION SITES, Aug. 79 or later revision. (This publication has been superseded by the above manual.)

c. South Carolina.

(1) A Guide to Site Development and Best Management Practices for Storm Water Management and Sediment Control (1992)

(2) Storm Water Management and Sediment Control Handbook for Land Disturbance Activities, 1995

The above referenced manuals outline the specified procedures and practices to be followed, and contain "sample" Erosion and Sedimentation Control Plans, details, etc. However, do <u>not</u> submit the Erosion Control Plan to the State Agency specified in either of these manuals.

1.7.2.8 Miscellaneous Site Details. Drawings shall include the following details, as applicable:

a. Standard Details. Standard details (See Exhibit A-1-1) shall include: Typical pavement section(s); curb and gutter and surface inlet(s); manhole frame(s) and cover(s); grate cover(s); headwalls; and sidewalks, as required. Generally, where concrete curb and gutter is used to control surface drainage, curb and gutter inlets will be used to intercept runoff from vehicular pavements. Grate or weir type inlets shall be used in turfed areas, but <u>only</u> grated inlets in aircraft pavements.

b. Minimum pavement thickness and depth of compaction requirements, same as shown in the pavement design analysis, unless compaction requirements included in tabular form in the applicable site grading specification.

c. A concrete joint layout plan and joint details <u>must</u> be included for vehicle hardstands and aircraft parking areas showing the location, type of joint, and dimensions between joints. Joint details shall conform to the applicable details shown on Savannah District's "Non-Reinforced Vehicle/Airfield Pavement Details," based on OCE Standard Drawing Nos. 40-17-01 and 40-17-02, Sheet No 1. (Standard Joint Detail will be furnished upon request

to the District Project Manager.) The Joint Layout Plan is required for all rigid concrete pavements, unless instructed otherwise by the District's Site Development Section (EN-GD) in Appendix A, Section 6, of the Specific A-E Instructions.

d. Sidewalk width, and length of joint layout, with Installation Notes to Contractor (Figure 28, Exhibit A-1-1).

e. Storm Drain Pipe Profiles. Profiles for concrete, clay, or Type "D" corrugated metal pipe shall be included on the contract drawings. Show existing ground line, finished grades, drainage structures, invert elevations, pipe slope, sizes, and lengths, but not the hydraulic gradient. Profiles for the optional Type "A" corrugated metal pipe are also required when the pipe diameter and invert elevation(s) of the inlet(s) and manhole structure(s) are different from those indicated for concrete pipe. Intersecting sanitary sewers, water lines and other underground utilities crossing the storm drain line shall be shown on the profile(s) at their proper elevation. Pipes that conflict at crossings shall be adjusted. Any conflict with intersecting utility line crossings shall be appropriately adjusted with adequate details included. (For description of Type "D" and Type "A" corrugated metal pipe, see Exhibit A-1-2, "Storm Drainage Design Instructions for Roadways and Built-Over Areas.)" To simplify showing storm drainage data, a "Storm Drainage Pipe and Structure Schedule" (Figure 39, Exhibit A-1-1), including the appropriate Construction Notes shall also be included in the Site Details.

f. Dimensions of vehicle parking spaces, including handicapped parking when required (Figures 26A and 26B, Exhibit A-1-1).

g. Chain Link Fence. When required for general security, chain link fence normally shall be a height of 2.15 m, plus barbed wire top (Type FE-6). (Refer to Savannah District's Standard Fence Detail, based on OCE Standard Drawing No. 40-16-08. A reproducible is available on request from the Savannah District Project Manager, as specified in Chapter A-10.) For athletic fields, request copy of Standard Drawing 40-16-09 or TM 5-803-10. Standard Drawing 40-16-10 shows additional security requirements for ammunition storage areas and other areas where strict security requirements are desired.

h. Special Details.

(1) These shall include longitudinal profile grades which must show approximate existing ground line, P.C. P.I., and P.T.'s, gradients, intersecting drain pipes, and new top of pavement grade elevations. At intersections where pavement grades must be warped for proper drainage, a 1 m = 100 m scale detail with contours drawn at 30 mm or 60 mm intervals (depending on steepness and grades) shall be included.

(2) At least one typical/site section through the building and paved and graded areas should be included to illustrate the relationship of the FFE of the building(s) to the graded and paved slopes on the project site.

(3) Erosion Control Measures. Refer to the applicable State Design Manual listed in paragraph 1.6.2.7 and Figures 41-43, Exhibit A-1-1, Vol. III of this manual.

(4) Special Details for Airfields. When required, any additional data necessary for design of airfield storm drainage or paving will be included in Appendix A, Section 6, of the Specific A-E Instruction.

(5) Firing Lane C/L Profiles for all range designs.

(6) Details from State DOT Standard Drawings are also acceptable, when required to show details not included in Exhibit A-1-1.

1.7.2.9 Plan and Profile Sheets. When required, as specified in paragraph 1.9.5.

a. For a recreation area road complex or range trail design, show the construction centerline, right-of-way limits, and all important topographical features such as fences, buildings, stream and railroad crossings, etc., on the plan view.

(1) For Contractor's information, locate or reference monuments and bench marks (BM's) with both horizontal and vertical control to expedite construction operations.

(2) Provide complete survey information necessary for establishing the proposed roadway centerline including: computed bearings of all tangents; coordinates of all points of beginning (P.C.), points of ending (P.T.), points of tangent intersection (P.I.'s), and other curve data (I, E, L, etc.), for all horizontal curves in the proposed road alignment.

(3) Superelevation and widening details of roads, when required. When superelevation is required, include on the drawings a diagrammatic profile of how the superelevation is obtained; a table of shoulder slope(s) vs. cross slope(s) for the superelevated section; or, reference standard figures or tables included on the drawings.

(4) Note on the plan view the type and size of all "existing" drainage structures and the manner in which they are to be removed, utilized or otherwise affected by "new" work. Also, indicate locations of "new" cross drains, including inlet and outlet channels when required.

b. Plot the "proposed" centerline on the profile portion of the sheet at the same horizontal scale as the plan view. (Normally, use a vertical scale of 1 m = 200 m, or as appropriate to fit the site terrain.) Indicate the "existing" ground line at each centerline station on the profile, including both banks and channel bottom of stream crossings.

(1) Provide centerline (C/L) grade elevations at each 30 m station on tangents and each 10 m station in vertical curves.

(2) Indicate the degree (percent) and length of all vertical curves. Include layout data (V, PVC, PVT, etc.) for each curve.

(3) Indicate the percentage/degree of slope for all proposed grade lines and provide elevations at points where grade changes occur. Provide special information pertaining to

the profile and affecting the design, such as: curb grades, gutter grades, channel invert and top elevations of bridges, etc.

(4) Show correct locations and invert and top elevation(s) of both new and existing storm drainage structures on each profile. Indicate size and length of each structure.

1.7.2.10 Landscape Plan, (Plates L-1, L-2, etc).

a. A-E Qualifications. When landscaping is required, the prime A-E shall obtain the services of a qualified Landscape Architect who is experienced in site planning and planting design, and preferably registered in the State in which the work is to be done. In addition, the Landscape Architect should also be thoroughly familiar with the Technical Manuals, standards and specifications referenced herein.

b. The Preliminary Design Submittal shall expand the concept design by developing an overall planting layout. The A-E shall furnish the Landscape Architect with information indicating the proposed location of all exterior utilities prior to beginning landscaping design. The preliminary design drawings and all subsequent plans shall indicate both existing and proposed buildings, paved areas, signs, light standards, transformers, dumpster pads, storm drainage lines, and other utilities and structures. Foundation plantings, shrubs, and ground covers may be used to create a desirable setting, and to screen objectionable areas, but not to control traffic and other similar uses. All foundation planting(s) may be shown at a legible scale and shall indicate the location of doors and windows, and any other feature of the building influencing the landscaping design. Enlarged detailed plans of specific areas may be included as needed to clarify requirements. The preliminary plan(s) shall show the common name, exterior utilities, north arrow, legend, and scale on the L-Plate drawings.

c. The Landscape Plan shall be an integral part of the planning and construction of the proposed project. (See Paragraph 1.9.6.) In selecting plants, attention should be given to maintenance, hardiness, ultimate effect and grouping. The planting design shall be informal, simple and composed of plants native to the area, with emphasis on trees. The proposed Landscaping Plan shall indicate shade trees, evergreen trees, flowering trees, shrub masses, etc., according to designated functional and visual locations of plantings. The scale of the tree planting plan shall be at a legible scale such as 1 m = 400 m. This plan need not indicate wall openings. A plant list indicating the sizes of plants recommended for each of the above categories shall also be included. (See Exhibit A-1-1, Figures 44 through 49, as applicable.) Each plant shall be indicated as a mature plant by one size and name or type symbol throughout the project design, excluding ground cover(s) which may be indicated as a mass showing the area to be covered. On the plan, the plant name or key symbol for each plant type shall follow the quantity in a location or grouping; i.e., QP or 4-Willow Oak.

d. The Landscape Plan (Plate L-1), shall be included with the Preliminary (60 Percent) Design Submittal. (If "existing" and "proposed" contour elevations are considered critical to the landscaping layout, an overlay of the landscaping drawing(s) shall show both the "existing" and "proposed" spot grades and contour elevations.) Grassing limits or notes

shall be shown on Landscaping Plan(s) or, the areas to be grassed shall be indicated on both the Grading/Erosion Control Plan and the Landscaping Plan. Unless otherwise directed, the following additional items shall always be considered:

(1) Removal of existing trees shall be only as absolutely necessary for construction.

(2) The plant materials installed shall be hardy and require minimum care/upkeep to reduce overall maintenance costs of the new facility.

(3) The planting design should reduce noise and glare, modify wind and temperature, control dust and erosion, and be compatible with the proposed exterior lighting plan of the project site. Plants shall not block overhead streetlights nor exhaust vents of building ventilation and air conditioning systems.

(4) Plants should also not interfere with underground utility lines. Accordingly, major and minor trees should not be located closer than 7500 mm (25 feet) and shrubs closer than 1500 mm (5 feet) from sanitary sewer lines.

(5) Plants should not interfere with safe sight lines of either pedestrians or drivers at street, and road and driveway intersections.

e. Coordination. Landscaping plans shall also be coordinated with "existing" site conditions and the Removal, Layout, Grading, Paving, Storm Drainage, and Erosion Control Plans; architectural floor plans and elevations; and pertinent aspects of utilities (mechanical, plumbing, and electrical) drawings for proper location of items such as air compressors, fuel oil tanks, electrical transformers, meters, light standards, hose bibs and fire plugs. (Reference paragraph 1.6b.) Coordination of COE and Installation User (DEH/BCE) requirements shall be accomplished prior to beginning preliminary design. The A-E designer shall contact the local user and other installation personnel to substantiate the extent of design requirements and provide planting proposals, which correspond with available maintenance capabilities.

1.7.3 Outline/Draft Project Specifications.

a. If not approved in the Concept Design review, the preliminary outline specifications shall consist of a list of guide specifications from paragraph 1.10 considered applicable to site development of the proposed project design, with a brief description of deviations or omissions in compliance with Chapter A-11 of this manual. (See Exhibit A-1-9, Vol. III, for sample outline specification format.)

b. If approved in the Concept Design review, the A-E shall submit draft project specifications, as described in paragraph 1.7.3.

1.7.4 Preliminary Sitework Quantities and Unit Price Schedule(s).

All items of proposed sitework must be included in the Preliminary Cost Estimate by incorporating review comments from the Concept Design Submittal. See paragraph 1.9.4

for additional guidance, and Chapter A-9 for correct format and more detailed guidance in preparing estimated sitework quantities and unit price schedule(s).

1.7.5 State Erosion Control Plan

The State Erosion Control Plan will consist of a separate package that includes the erosion control drawings, erosion narrative, erosion design analysis and specifications pertaining to erosion controls required by the State Design Manual. (Reference paragraph 1.6.2.7). The A-E will provide five copies of the package to the Project Manager along with the preliminary design submittal or 60 days prior to the final submittal, if there is no preliminary submittal required. The State Erosion Control Plan package is to be submitted in abbreviated form with the concept submittal. The recommended locations of both temporary and permanent erosion control measures shall be shown on the ECP, with detail sketches of same included in the "Site Details" of the drawings.

1.8 **FINAL (100 PERCENT) DESIGN SUBMITTAL REQUIREMENTS.**

a. General. A-E designer shall advance project design to completion, complying with/incorporating comments received from review of the Concept/Preliminary Design Submittal(s). When submitted for review, final design submittals are supposed to be "Ready to Advertise" (RTA), when received by Savannah District.

b. Specific. Whenever the final design is to be based on an approved Concept (35 Percent) Design Submittal (Concept-Final), the A-E designer shall refer to paragraph 1.6, "Preliminary (60 Percent) Design Submittal Requirements" for guidance in preparing a complete design, including: developing detailed storm drainage, pavement, and erosion control design analyses, final drawings, draft project specifications, and final sitework quantities. Also, refer to paragraph 1.9 for additional guidance, and the "Checklist for A-E's Review" (Exhibit A-1-10, Vol.III of this manual).

1.8.1 Final Design Analyses. Update/revise previously submitted analyses to support final plans and specifications, as noted above. Assemble the analyses in booklet format, including both original and revised dates of preparation, when applicable, and showing the names of both preparer and checker. (Reference Exhibit A-1-3, Vol. III). If acceptable analyses were furnished with either the Concept/Preliminary Design Submittal, no additional analyses will be required.

1.8.1.1 Storm Drainage Design. If an acceptable analysis is not furnished and extensive revisions are required, due to incorporation of review comments, the A-E Designer must resubmit either all/or part of the analysis revised to comply with either the Concept or Preliminary Design review comments. Remember to include the DA Map at the end of the analysis booklet. (Reference paragraph 1.6.1.1b(4).)

1.8.1.2 Pavement Design. When revisions are required, the A-E designer must resubmit the analysis, same as noted above for the storm drainage design.

1.8.1.3 Berm Design (For Ranges). When revisions are required, the A-E designer must resubmit the revised analysis, same as noted above for the storm drainage design.

1.8.1.4 Erosion Control. Same as noted above for the storm drainage design. If a preliminary submittal was not required, a State Erosion Control Plan must be submitted 60 days prior to final design submittal due date. (Reference 1.6.5.)

1.8.1.5 Landscaping Design. When required by Appendix A, Section 6, "Specific A-E Instructions," landscaping design shall consist of preparing "complete" landscape studies, drawings, and specifications. The design shall be based on all general and specific criteria (standard drawings, manuals, etc.) referenced in paragraphs 1.6.2.9. and 1.9.6.

1.8.2 Final Design Drawings.

1.8.2.1 Preparation of final site plan drawings (P/L-Plates) for site development design shall be based on revising the concept or preliminary design drawings, as required, to develop Site Plan drawings with sufficient information to permit proper layout and construction. The final drawings shall reflect revisions resulting from incorporating the concept or preliminary design review comments, shall be uncluttered, neatly drawn and lettered, and capable of assuring clarity at half-size reproduction. All drawings not neatly rendered/not considered capable of clear half-size reproduction will not be accepted, but will be returned to the A-E for redrafting. The final P-Plate drawings shall also include all pertinent details such as: typical pavement sections, storm drainage inlets and manholes, curb and gutter sections, etc. Sample sketches from "Standard Detail Sketches - Grading, Paving, Storm Drainage and Landscaping" (Exhibit A-1-1), Vol. III of this manual, shall be used for these details. Drawings may be modified by the A-E designer when necessary to conform to specific field conditions, as specified in paragraph 1.6.2.8.

a. Add appropriate General Notes to each plate of the drawings, as required.

b. Provide adequate cross referencing between site plan drawings for appropriate details, sections, match lines, other design disciplines, etc.

c. Eliminate any possible conflicts (horizontal and vertical) between site development and architectural, structural, and utilities drawings by coordinating with other design disciplines, as specified in paragraph 1.6b(2).

1.8.2.2 Final site development drawings shall also include a P-Plate showing the location and type of all soil borings, identifying each type (auger/split spoon, etc.) in the legend, and including the note referencing Appendix A of the specifications. (Generally, the Site Grading Plan is preferred for this purpose, as noted in paragraph 1.6.2.6 and Chapter B-3.)

1.8.2.3 Final Landscape Drawings (L-Plates) shall indicate proposed plants by a (+) mark for the plant location and a circle scaled at approximately 2/3 the ultimate canopy growth spread (diameter) of trees and shrubs. Also, include a "complete" schedule or plant list of materials listing both botanical and common name(s), plan symbols, quantities, sizes and condition furnished. Final drawings shall also include the basic detail sketches for

installation of tree, shrub and ground cover plantings, plus any other applicable details for clarification of specific project requirements. (See Exhibit A-1-1, Figures 44 through 49, as applicable.) Pertinent notes, applicable to construction requirements, in addition to standard notes, shall also be included. The final landscape plan, plant schedule, details, notes, specifications, and cost estimate shall all agree.

1.8.3 Final Draft Project Specifications.

a. Before beginning preparation of draft project specifications, the A-E designer shall refer to the "Supplement to District Guide Specifications" (Exhibit A-11-16), and request copies of the latest guide specifications from paragraph 1.10, covering all items of anticipated sitework before beginning final design. Periodically, some of the guide specifications are revised/updated, sometimes between the time the A-E first begins project design and the District Project Manager requests preparation of the draft project specifications. (Reference Chapter A-11, Vol. II, and Exhibit A-11-3, Vol. III of this manual.)

b. Ensure consistency of terminology between drawings and specifications for specific items of work by appropriate notations on drawings.

c. Check to assure adequate referencing to standard detail sketches included in the site details for construction, as per paragraph 1.6.2.8. Details for site development are never included in the specifications, only in the drawings. The applicable figures from the "Supplement to District Guide Specifications" (Exhibit A-11-16) shall be inserted at the end of the appropriate specification section(s), as explained in Chapter A-11.

d. When required, landscape specifications shall be based upon the current Standard Specification edited for specific project requirements, the IDG for the particular military installation, and the applicable TM/AFM listed in paragraph 1.2.

e. To expedite EN-GD's review of the draft project specifications covering all proposed items of site development, the A-E shall include the "marked up" guide specification sections, as specified in Chapter A-11, and Exhibit A-11-3.

1.8.4 Final Sitework Quantities.

a. The A-E shall furnish the District Project Manager clear copies in reproducible form of all computations, cross sections, backup sheets, and takeoff of estimated quantities for all items of sitework applicable to site development.

b. For general building sites, including vehicle parking areas and drives, earthwork quantities (excavation, borrow, or combination of both) resulting from site grading shall be estimated by cross sections plotted to suitable scale at 30 m intervals or less, in accordance with the requirements of paragraph 1.9.5. Since the Site Grading Plan normally includes both existing and finished grade contours, it is not necessary to include earthwork cross sections with the contract drawings to be issued to bidders, except for project designs containing a road network complex. (See paragraph 1.9.5.) Therefore,

these cross sections shall be considered as work sheets for computation purposes only, and preparation in heavy pencil on reproducible cross section paper will be satisfactory. Proper compaction shrinkage factors shall be applied to both fill and backfill quantities. Suitable allowance shall be made for subsidence when considered necessary, and the excavation and earthfill quantities shall be adjusted for removal and replacement of unsatisfactory soils, as may be required by the Foundation Design Report prepared by Savannah District's Soils Section (EN-GS). End areas shall be shown, as well as subtotals and totals of the earthwork on each sheet. The use of Standard State Highway/DOT cross-section sheets will be acceptable.

c. The A-E may elect to utilize Computer Aided Design and Drafting (CADD) equipment for plotting cross-sections and calculating earthwork quantities. If so, these computer programs must be based on "established" methods of design, (i.e. "Average End Area Method") for volume calculations. The A-E shall, with the CADD printouts/plots, submit sufficient "raw" data to enable noncomputer oriented personnel to reproduce either all or part of the analysis without the aid of computer equipment. In addition, the A-E shall submit a minimum of one "manual" calculation iteration that "checks" the computer analysis. (Also, reference paragraph 1.9.5g.)

d. When it is apparent that the quantity of site grading is small (less than 3800 cubic meters excavation and borrow), the A-E may compute the earthwork by other conventional methods, if approved by the Savannah District's Site Development Section (EN-GD), and backup data is furnished for the District Project file.

e. When designing airfield pavements and extensive vehicle roadway networks, earthwork quantities shall be computed from plotted cross sections in accordance with paragraph 1.9.5.

f. To ascertain the scope of the project, a complete list of estimated sitework quantities shall be prepared for each project site, consisting of but not limited to the following standard items and units:

Item of Work	Unit
Unclassified Excavation	CM
Unclassified Borrow	CM
Excavating Topsoil from Stockpiles	CM
Stabilized Aggregate Base Course	SM
Bituminous Prime Coat	L
Bituminous Tack Coat	L
Bituminous Surface Course (Hot-Plant Mix)	SM.
Seeding Temporary Cover	HA (Hectare)
Storm Drain Pipe (size and type)	LM
Inlet or Manhole	Each
Concrete Curb and Gutter	LM
Concrete Sidewalks	SM
Turf Establishment (Grassing)	HA

Mulching	HA
Removals (list individual items)	Each
Fencing (Type and Height)	LM
Erosion Control Measures	Each

g. The revised final takeoff of estimated sitework quantities for site development's portion of the project design shall reflect incorporation of EN-GD's review comments of the A-E's previous design submittal(s), and also show the original and revised dates of preparation, when applicable. (Refer to paragraph 1.9.4 herein and Chapter A-9 of this manual for detailed guidance.)

1.9 **CORRECTED FINAL DESIGN SUBMITTAL REQUIREMENTS.** The corrected final design submittal is not considered to be a "normal" design submittal, but will be required in those cases where the review comments of the final design indicate several revisions are necessary to correct A-E design error(s) or omission(s) in the Final (100 Percent) Design Submittal.

1.9.1 Corrected Final Design Analyses. Revise the analyses to support the corrected requirements for paving, storm drainage, erosion control, and protective berm designs for the project, by incorporating review comments received from the Final (100 Percent) Design Submittal.

1.9.2 Corrected Final Design Drawings. Revise thoroughly checked drawings, same as above for the design analyses. (See Chapter A-10 for detailed guidance.)

1.9.3 Corrected Final Project Specifications and Sitework Quantities. Same as above for design analyses and drawings. (See Chapters A-9 and A-11 for guidance.)

1.10 **MISCELLANEOUS DESIGN REQUIREMENTS FOR SITE DEVELOPMENT.**

1.10.1 Engineering Manuals. Paragraph 1.2 includes a list of the most commonly used design manuals (TM/AFM's), etc., applicable to designing the site development portion of military projects. The A-E designer shall request the District Project Manager to furnish the "latest" editions of the applicable design manuals at the beginning of project design.

1.10.2 Earthfill Borrow or Waste Materials. Insofar as possible, site grading shall be developed to achieve a balance of cut and fill in computing earthwork quantities. Suitable allowance shall be made for shrinkage of fill quantities due to specified compaction effort required. To establish the quantity of excavation necessary for the earthfill, the embankment (fill) should be increased by approximately 25 to 35 percent for cohesionless soils (sands) and 25 percent for cohesive soils, unless otherwise instructed.

a. For Projects Located on Government Reservations. The A-E designer shall determine whether earth borrow or disposal of surplus earthfill and other waste material will be required, and the quantity of material involved. The grading specification(s) shall be written to indicate whether earthfill borrow or disposal of waste material will occur on the military reservation. The designer should visit the site with the Director of Engineering and

Housing (DEH) or Base Civil Engineer (BCE) to determine the location and limits of borrow area containing suitable soils, disposal area, and permissible haul routes through the reservation. (The designated haul route(s) may not always be the most direct route.)

b. Unsuitable Soils. All unsuitable soils (gumbo, trash, organic soils, and highly plastic clay soils) determined by site inspection(s) and boring logs, shall be removed from areas within the limits of construction for both the building(s) and paved areas. The unsuitable soils shall be removed and disposed of as described above. The A-E designer shall determine and specify on the drawings the depth and limits of unsuitable soils to be removed. For determination and guidance in selecting the limits of removal, the A-E designer shall plot the boring log on the appropriate work cross section(s) or profile(s). To guide the Contractor in his removal operations, the limits and extent of the removals shall be shown by appropriate symbol(s) or notes on the finished profile(s) and cross section(s) in the final contract drawings.

1.10.3 Disposal of Existing Pavements. All pavements removed, including floor slabs, footings and chimneys, shall be broken into pieces measuring not more than 300 mm on any one side. If so approved, the broken pieces may be used as grouted riprap for ditch pavement as required to eliminate erosion. Material not used for this purpose may be placed in a 300 mm layer, uniformly tamped and leveled to present a satisfactory appearance on outfall ditch bottoms and side slopes in outlying areas. When ditch pavement or side slope protection is not required, place material in the disposal area shown on the Location Plan. The A-E designer should visit the project site to determine the location and limits of the disposal area, as described above.

1.10.4 Estimated Sitework Quantities and Unit Price Schedule. A list of estimated sitework quantities and unit price schedule shall be prepared and submitted for each project site. For site development (grading, paving, storm drainage, grassing, erosion control, landscaping, etc.), the list may include a tabulation similar to the following:

Item	Description	Est. Quantity	Unit
1.	Removal of Existing Pavement and Drainage Structures	Job	LS
2.	Unclassified Excavation	10,000	CM
3.	Unclassified Borrow	510	CM
4.	Storm Drainage:		
	(a) 12" standard strength concrete or clay pipe; or 16 gauge, type "D" C.M. pipe; or optional 15" 16 gauge, type "A" C.M. pipe.	220	LM
	(b) 15" class III concrete or clay pipe; or 16 gauge, type "D" C.M. pipe; or optional		

18" 16 gauge, Type "A" C.M. pipe.	120	LM
(c) Inlets, type "A"	4	Ea
(d) Inlets, type "B"	4	Ea
5. Bituminous Pavement	1,800	SM
6. Concrete Pavement (__" thickness)	525	SM
7. Concrete Sidewalk (4" thickness)	320	SM
8. Exterior Concrete Steps	Job	LS
9. Concrete Combination Curb and Gutter	600	LM
10. Concrete Curbing	85	LM
11. Turf - Bermuda Grass Sprigging/Seeding	2.3	HA
12. Nitrogen as Fertilizer	138	Kg
13. Mulching	2.3	HA
14. Seeding Temporary Fall Cover	2.3	HA
15. Solid Sodding	42	SM
16. Painting Parking Lines (3" width)	200	LM
17. Chain Link Fence (type FE-6), 8' high	300	LM
18. Erosion Control Measures	Job	LS

A list, similar to the above, shall normally be prepared to assure that all payment items are included in this portion of the project design. However, depending on the size of the particular project and unless otherwise instructed by the District Project Manager, the A-E will usually be instructed, before preparing final project specifications, to combine the estimated cost of all sitework into a job, lump sum payment item. (Refer to Chapter A-9 for additional guidance.)

1.10.5 Special Instructions for Designing a Large Building Complex, Major Road Network or Airfield Pavements. When a project design consists of: a large complex of buildings, major road network, or airfield pavements, the following additional instructions are also applicable:

a. In addition to general layout by dimensions from existing structures, key points must be referenced to a construction base line (B/L) tied into the installation's plane coordinate system. Unless otherwise specified in paragraph 1.3.1, the plane coordinate system shall be referenced to local datum(s) established for the particular project, using the monuments of the base line and other features such as centerline points of the existing road, etc., for the Contractor to re-establish control points in the field prior to laying out the proposed construction work.

b. The sitework for a large building complex shall show finished grade contours, as covered hereinbefore for general building sites. However, estimated earthwork quantities shall be computed from plotted cross sections for record purposes, in accordance with subparagraph e. below.

c. Unless otherwise instructed, where existing roadway pavement is specified to have overlay pavement, cross section elevations must be taken at station intervals not greater than 10 m along the centerline and also the edges of the pavement to establish the minimum and maximum depth of overlay pavement required and the finished profile grade(s). All "existing" potholes and badly cracked pavement sections shall also be located and indicated on the drawings, including details for patching and repair. Road profiles may be plotted at a scale of 1 m = 400 m horizontal and 1 m = 200 m or 100 m vertical. (The vertical dimension scale will be determined by the complexity of the existing topography.) Other scales may be considered, with prior approval of the Savannah Districts' Site Development Section (EN-GD).

d. Plan and profile drawings shall be required for all "major" road designs, including family housing, recreation areas, and range complexes. The plan view shall include topography taken along the centerline (C/L) of the proposed road and extending to either side a minimum of 15 m beyond the end of the estimated cut or fill slopes. Topography of intersecting drainage swales and ditches must be carried a sufficient distance (not less than 60 m from centerline of road) to show transition to/from the proposed culvert headwall, graded swales or roadside ditches. The scale of drawings for major road designs may be 1 m = 400 m, and must show existing contours on which the new road is to be placed. Finished grade contours will not be required on roadway projects except at road intersections and turnouts, at major buildings, or around major drainage structures. Roadway cross sections mentioned subsequently shall be included in the contract drawings and may serve in lieu of finished grade contours. However, if a roadway under design is of short length, upon EN-GD's approval, the A-E may use finished grade contours in lieu of including finished cross sections in the final contract drawings. In such cases, work cross sections (pencil form) to support calculations of total earthwork quantities and for determining balance points of cut and fill shall be furnished for the District's Project Record File, as specified in paragraph 1.7.4.

e. The preparation of cross section drawings for a large building complex and major road network, whether to be a part of the contract drawings issued to bidders or used as working drawings for the District's Project Record File, shall include the plotted end areas, sum of end areas, quantity of earthwork between full stations or plus stations and the subtotals at the top of each sheet. (Cross section stationing shall be plotted from the

bottom toward the top of the sheet.) Stripping and removal of unsuitable soils shall also be considered and appropriately indicated in the computed volume of excavation. To simplify establishing the limits of unsuitable material(s) to be excavated, the boring logs shall be plotted on either the work cross sections or the C/L profile(s). The final cross section sheet(s) shall give a tabulation of the total embankment, excavation, stripping, and when required, the excavation of unsuitable soils. A suitable shrinkage factor for compaction shall be applied to the embankment quantity of each individual section or to the total fill quantity, depending on whether or not balance points are being considered along the C/L profile to determine if borrow or waste is required. When portions of the stripped material can be processed and reused as topsoil, the final estimated earthwork quantities shall reflect this volume of soil used in the work. The shrinkage factor for swelling the embankment areas (paragraph 1.9.2) shall be carefully selected to be representative of the type and density of the soils anticipated to be encountered, and the degree of compaction to be specified. (In addition, reference paragraph 1.7.4c.)

f. Cross sections for airfield pavements shall be prepared in final form and included in the final contract drawings. Preparation of these cross sections shall be as specified in the preceding paragraphs, with the additional requirement of showing the boring logs located at the appropriate section(s). This will simplify the review of existing soil(s) upon which the pavements will be constructed, and readily determine the acceptability of the site soils and the extent of removal and replacement of unsatisfactory soils, if required.

g. The need for reasonably accurate earthwork quantities cannot be overemphasized. The A-E designer must inspect the site of the work and take into account the type of terrain (woods, swamp, pasture, cultivated) and soils, since all these items will have a bearing on the design engineer's judgment in making assumptions and applying the proper factors in estimating the total quantities of earthwork for the project. (Reference paragraph 1.7.4c.) When earthwork cross sections are furnished for review, the A-E shall also furnish all backup data and describe in sufficient detail on a specially prepared summary sheet separate from the cross sections the procedure used and the assumptions and reasons established in estimating the earthwork quantities. The summary sheet shall show all quantities in cubic yards, including significant data applicable to the particular project, such as:

(1) Stripping of topsoil, roots, etc., (indicate depth and limits).

(2) Removal of organic or other unsuitable soil (indicate depth and limits).

(3) Earthfill (embankments), including the appropriate shrinkage factor applied to embankment earthfill to compensate for compaction.

(4) Allowance for over-building as a result of subsistence of high fills (indicate depth).

(5) Allowance for backfilling of stump holes, if significant.

(6) Usable soil(s) available for earthfill from the general excavations on the project site.

(7) Location of earth borrow area(s), when sufficient material for earthfill is not available from the general excavations on the project site.

h. Gravel areas should not be used around any buildings where the gravel can be used to break items such as windows and globe type light fixtures.

1.9.6 Landscaping.

a. General.

(1) When landscaping is required in the project design, the A-E will make field investigation(s) to determine the location and type of existing plants and trees, verify location of sidewalks, drives and parking areas, overhead and underground utilities, and other information including user requests, deemed necessary for complete design of the project. Specific attention shall be given to emphasizing entrances to buildings, screening of utilities, and erosion control, as required by site characteristics.

(2) The final landscape design shall reflect incorporation of all review comments, user requests and/or recommendations resulting from review of all previous A-E design submittals.

(3) The items included herein for landscaping design will require a complete set of drawings be prepared in accordance with TM 5-803-5, TM 5-830-2, and TM 5-830-4. When available, the Installation's Design Guide(IDG) shall also be used.

(4) Contract specifications shall be developed primarily from District Specifications and CEGS Specifications.

(5) The A-E is reminded to take particular care with the quality of drafting, and design presentation to comply with the standards outlined in Chapter A-10.

b. Specific.

(1) The final Landscape Plan shall contain the following additional information:
(a) Existing plantings (to scale as near as possible).
(b) Key Plan (not to scale).
(c) Detailed Final Cost Estimate shall include Final Landscaping Quantities.
(d) Plant List or Schedule, giving botanical and common names, size, caliper (trees only), manner grown and prepared, and quantity.
(e) Graphic or bar scale.
(f) Irrigation plan (as requested by Installation).

NOTE: Cost of landscaping (excluding grading, seeding, or sodding) shall be limited to that shown in Appendix A, Section 6, of the Specific A-E Instructions.

(2) The following manuals, drawings, and specifications shall be used in preparing Landscape Plans:

(a) The "Installation Design Guide" (IDG) for the military installation where the proposed project is located.

(b) TM 5-803-5, "Installation Design," dated 1 March 1981; TM 5-830-2, "Establishment of Herbaceous Ground Cover;" and TM 5-830-4, "Planting and Establishment of Trees, Shrubs, Ground Covers and Vines."

(c) Districts specifications and CEGS Guide Specification.

(d) Site plans showing "as built" utilities (above and underground), or latest available design drawings furnished by the appropriate user (DEH or BCE).

(e) Floor plans and elevations of both "existing" and proposed buildings on the project site.

(3) For projects having 5 or more buildings, the A-E may:

(a) Prior to beginning concept design, and after detailed review of the requirements outlined above and included in TM 5-803-5, request that the Landscape Architect from Savannah District's Site Development Section (EN-DG) come to the A-E's office for a predesign conference.

(b) Submit a preliminary design containing "complete" tree planting and foundation plan(s) for at least three types of buildings, in accordance with subparagraph 1.10.6b(2) above, and other applicable requirements specified in paragraph 1.6.2.10.

(c) Final landscape design shall include all landscape documents required by the contract and shall reflect incorporation of all previous design review comments and instructions returned to the A-E designer through the Savannah District's Project Manager.

1.10.7 Erosion Control. Erosion Control Plans meeting specific requirements of State law are now required on projects on all military installations. (Reference paragraphs 1.7.1.3 and 1.7.2.7.)

1.11 DISTRICT GUIDE SPECIFICATIONS FOR SITE DEVELOPMENT.

1.11.1 Index of Guide Specifications for Military Construction (Army and Air Force). Internet address for CEGS specifications http://www.hnd.usace.army.mil/techinfo and following list of unique Savannah District guide specifications:

Division 2 - Sitework

District

Section No.	Title
02059	Removal of Building Foundations, Pavements, and Drainage Structures
02547	Bituminous Pavement with Base Course (Modified NC Department of Transportation Specifications) (for less than 1,000 Tons)
02936	Turf - Bermuda Grass Seeding (For Ft. Bragg and Pope AFB, NC only)
02937	Relocating Trees

The A-E shall pull the appropriate CEGS Guide from the CCB disk or the above internet address and request the District Section from the above list from the District Project Engineer.

CHAPTER A-1

SITE DEVELOPMENT

EXHIBITS

A-1-1 STANDARD DETAIL SKETCHES FOR SITE DEVELOPMENT

A-1-2 STORM DRAINAGE DESIGN INSTRUCTIONS FOR ROADWAYS AND BUILT-OVER AREAS

A-1-3 SAMPLE FORMATE-PAVEMENT AND STORM DRAINAGE DESIGN ANALYSES

A-1-4 STORM DRAINAGE, CESAS FORM 1178 (TABLE I)

A-1-5 STORM DRAINAGE, SAS FORM 1154 (TABLE IA)

A-1-6 STORM DRAINAGE, SAS FORM 1155 (TABLE II)

A-1-7 STORM DRAINAGE, SAS FORM 1156 (TABLE III)

A-1-8 STORM DRAINAGE, CESAS FORM 1179 - HYDRAULIC DESIGN DATA FOR CULVERTS

A-1-9 CHECKLIST FOR A-E's REVIEW OF DESIGN SUBMITTALS

STANDARD DETAIL SKETCHES

FOR

SITE DEVELOPMENT

Grading, Paving, Storm Drainage and Landscaping

U.S. ARMY CORPS OF ENGINEERS

SAVANNAH DISTRICT

(NOTE: This Exhibit is being revised, but is not in "final" form. Also, a "draft" CADD file named "SITEDTL" (in INTERGRAPH format), requiring some "minor" revisions, is currently available on request. Until either a "hard copy" or the CADD file is available in "final" form, request copy of Exhibit 6-1 from the District Project Manager).

INDEX OF STANDARD DETAIL SKETCHES

FIG. NO.	DESCRIPTION
1	LEGEND
2	DETAILS FOR MANHOLE OR TYPE "A" INLET
3	FRAME AND COVER DETAILS FOR CURB INLETS AND MANHOLES IN TURFED AREAS
3A	MANHOLE FRAME AND COVER DETAILS FOR VEHICULAR TRAFFIC AREAS.
4	TYPE "A" INLET - FRAME AND GRATE DETAILS (FOR SINGLE GRATE)
5	TYPE "A" INLET - FRAME AND GRATE DETAILS FOR HEAVY-DUTY VEHICULAR TRAFFIC
6	FRAME AND TYPE "E" GRATE DETAILS FOR TYPE "A" INLETS FOR TURFED AREAS ONLY

7	TYPE "D" INLET DETAILS
8	FRAME AND GRATE DETAIL FOR NON-TRAFFIC AREAS ONLY
9	SPECIAL INLET
I0A	TYPE "B" INLET DETAILS
I0B	TYPE "B" INLET DETAILS
II	TYPE "C" INLET DETAILS
I2	TYPE "A" INLET - HEAVY-DUTY (AIRFIELDS ONLY) FRAME AND GRATE DETAIL
I3	MANHOLE - HEAVY-DUTY (AIRFIELDS ONLY) FRAME AND COVER DETAILS
I3A	DETAIL OF WELDED STEEL GRATE AND REINFORCED CONCRETE CAP FOR AIRFIELDS
I3B	DETAIL OF REINFORCED CONCRETE INLET FOR WELDED STEEL GRATE
I4	WEIR INLET DETAILS
15	DETAIL - APRON PAVEMENT FOR INLETS IN TURFED AREAS
I6	WELDED LADDER DETAILS
I7	DETAILS OF CONCRETE COMBINATION CURB AND GUTTER
I7A	FEATHERING OF CURB AND GUTTER DETAIL
I8	DETAIL OF CONCRETE CURBING
I9	DETAIL OF CONCRETE ROLLOVER CURB AND GUTTER
20	DETAIL OF CONCRETE HEADER CURB
21	PLANTER FOR PARKING AREAS
22	BITUMINOUS PAVEMENT SECTIONS
23	DETAIL - INSTALLATION OF NEW CONCRETE COMBINATION CURB AND GUTTER ALONG EXISTING STREET

24	CONCRETE VALLEY GUTTER
25	CONCRETE WHEEL STOP DETAIL
26A	PAINTING VEHICULAR PARKING STRIPES
26B	PAINTING VEHICULAR PARKING STRIPES FOR THE PHYSICALLY HANDICAPPED
27	SIGN FOR THE PHYSICALLY HANDICAPPED
28	STANDARD JOINT LAYOUT FOR CONCRETE SIDEWALKS
29	DETAIL - TYPICAL CONCRETE STEP WITH HANDRAIL
30	CLEANOUT DETAILS - PLAN AND ELEVATION
31	SOLID SOD AROUND SPLASH BLOCKS
32	STAIGHT HEADWALL - TYPE I
33A	SLOPE PROTECTION AT HEADWALL
33B	SLOPE PROTECTION AT HEADWALL - PLAN AND SECTIONS
34	TYPICAL DETAIL FOR STEEL GRILL GUARD FOR HEADWALL

35A	STRAIGHT HEADWALL WITH DITCH PAVEMENT FOR 42" TO 85" PIPE CULVERTS
35B	DITCH PAVEMENT DETAILS
36A	"L" TYPE HEADWALL
36B	"L" TYPE HEADWALL
37	EXCAVATION DETAIL FOR INSTALLATION OF NEW PIPE BELOW EXISTING PAVEMENT
37A	REPLACING STREET AND ROADWAY PAVEMENT FOR UTILITY CUTS
38	STORM DRAINAGE STRUCTURE JOINT DETAIL FOR AIRFIELDS
39	STORM DRAINAGE PIPE AND STRUCTURE SCHEDULE
40	CONCRETE PROPERTY LINE MARKER
4l	TEMPORARY EROSION CONTROL - SEDIMENT BARRIER (HAY/STRAW BALES) AT STORM DRAIN INLET.
42	TEMPORARY EROSION CONTROL (DITCH CHECK)
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44	PLANTING DETAILS (SMALL TREE OR SHRUB)
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NOTE TO DESIGNER:

All "Construction Notes" shown on sketches are to be retained, but "Notes to Designer" shall be deleted from details included in Contract Drawings.

STORM DRAINAGE DESIGN INSTRUCTIONS
FOR
ROADWAYS AND BUILT-OVER AREAS

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SECTION 1 The Drainage Area

SECTION 2 The Drainage System

SECTION 3 Sample Design of Storm Drainage System for Built-Over Areas

Applicable Engineering Manuals referenced in Sections 1 and 2 of this Exhibit are as follows:

1. TM 5-820-1, dated Aug. '87
2. TM 5-820-3, dated Jan. '78
3. TM 5-820-4, dated Oct. '83 w/Change 1, dated 16 July '85
4. District's Design Manual(DM) for Military Construction, 3rd Edition

U.S. ARMY ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
P.O. BOX 889
SAVANNAH, GEORGIA 31402

OCTOBER 1981
(Revised Dec. 1988)
(Revised Aug. 1991)

STORM DRAINAGE DESIGN INSTRUCTIONS
FOR
ROADWAYS AND BUILT-OVER AREAS

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STORM DRAINAGE DESIGN INSTRUCTIONS
FOR
ROADWAYS AND BUILT-OVER AREAS

(Supplement to Technical Manual
TM 5-820-4/AFM 88-5, Chapter 4)

SECTION 1 - THE DRAINAGE AREA

1-01. SCOPE:

These instructions are intended to cover the essential requirements necessary for developing an adequate, economical, and desirable storm drainage design for roadways and built-over areas. These instructions are applicable to ground force installations and to housing, cantonment, and industrial areas at all military installations. The instructions contained herein are not applicable for designing an enclosed storm drainage system under airfield runways, taxiways, hangers, or aircraft parking aprons. (Refer to Appendix C, TM 5-820-1/AFM 88-5, Chapter 1, for guidance in designing enclosed storm drainage systems for airfields where "temporary" ponding is permissable).

1-02. BASIC CRITERIA:

Generally, design storms should be based on a frequency of 10 years. However, for conditions tending to induce severe damages from periodic flooding and for installations where flooding for short periods of time may be seriously detrimental to operational requirements, a 25-year design storm frequency should be used. In most cases, the 10-year, one-hour rainfall intensity-frequency data should be as indicated in the District's Design Manual (DM) for Military Construction, Volume II, Chapter B-2, paragraph 2.6.1.1b(1)(a). This paragraph lists the 1 hour rainfall in inches per hour for the adopted 10-year frequency for the appropriate military installation. For example, in selecting the 10-year design storm for a project to be designed at or in the geographical location or vicinity of Ft. Stewart Georgia, by referring to the paragraph specified above, it will be noted that the one-hour design rainfall
in inches per hour to be expected once in 10 years is 3.0 inches. (This is also the curve number in Fig. 2 of TM 5-820-1, which provides the rainfall intensity vs. the Time of Concentration for the frequency desired. A-E firms designing under contract to the Government may be furnished the correct intensity-frequency value for the 10-year design storm in the portion of Appendix A of their Specific A-E Instructions covering requirements for Site Development).

1-03. DETERMINATION OF RUNOFF :

The quantity of runoff in cubic feet per second (cfs) shall be determined by the RATIONAL METHOD FORMULA, as described herein. (Note: Ignore references to the Rational Formula and the "C" and "F" factors given in paragraph 2.4b, pages 2-2 and 2-3 of TM 5-820-4, and use the formula and factors as noted hereinafter). The Rational Method employed by the US Army Corps of Engineers (COE), Savannah District is expressed by the formula Q = CIA, in which:

Q = discharge in cubic feet per second (cfs) reaching the drain-inlet or

discharge point under consideration;
C = coefficient representing the ratio of peak runoff to average rainfall;
I = the average rainfall intensity in inches per hour during the Time of Concentration (T); and,
A = drainage area (DA) in acres.

The values for Time of Concentration (T) of a drainage area, corrections for length of runoff, and rate of rainfall at the Time of Concentration, are read directly from the applicable charts and hydrographs contained in TM 5-820-1 referenced in paragraph 1-02 above. In the following paragraphs, all pertinent components required to compute runoff using the Rational Method Formula will be discussed in relative sequence.

a. Runoff: The runoff coefficient, designated by the letter "C" in the Rational Formula, is the amount the runoff from the design storm is reduced by the transitory storage and absorption of rainfall on the ground surface(s) during a storm. For paved areas, no infiltration is assumed and a 100 percent rate of runoff is used. For average turfed sand-clay soils, an infiltration rate of 60 percent and runoff rate of 40 percent is the normal standard adopted by Savannah District. The quantity "AC" entered on CESAS Form 1178 is the sum of the total paved area multiplied by 100 percent (C = 1.0) and the total turfed area multiplied by 40 percent (C = 0.40).

b. Retardance Coefficients "n" for Overland Flow: For design purposes, a retardance coefficient of "n" = 0.40 is generally used for nonpaved areas. The adoption of "n" = 0.40 for the nonpaved areas is based on the assumption that all newly constructed earth areas will be grassed and are therefore considered as turf. Where occasional special consideration for other roughness coefficients is required, other values of "n" may be selected. This determination should be in accordance with TM 5-820-1, Appendix B, Table III; or TM 820-4, Appendix B, Table B-2.

c. Length of Runoff: Length of runoff determines the Time of Concentration (T_c) for the drainage area. The length of runoff as defined herein is the maximum distance measured along a line perpendicular to the topographic contours from the farthest point within a drainage area, including the summation of lengths of both overland and channelized flow. The distance is scaled from the drainage area (DA) map. In scaling this length, paved surfaces should normally be excluded. Inasmuch as the time required for water to run off the average paved area is very short, the length of the paved area can be disregarded or given very little weight in determining the effective length of runoff for a composite drainage area. Since the Time of Concentration is determined by the length of runoff and the time required for the runoff to flow along the actual length depends on the average ground slope and surface roughness/retardance coefficient(s), a correction must be applied to compensate for differences in roughness and average slope in the various drainage areas. The surface retardance coefficient for nonpaved areas will generally be "n" = 0.40 (reference paragraph 1-03b above). The average slope of the various drainage areas will usually vary. Under this method, the correction to be applied to the actual length of runoff

is determined from App. B, Figure B-6, of TM 5-820-1. The difference in retardance coefficient "n" and the average slope "S" is compensated as follows:

Assume the actual length of runoff to be 550 feet and the average slope to be 2.5 percent. On Chart A, Figure B-6 of the above referenced TM, locate the actual length (550 feet) along the graduated base line, and project this point vertically to the intersection with retardance coefficient "n" =40; then, extend this intersecting point horizontally across the chart to the intersection with slope = 2.5 percent in Chart B of Figure B-6; then, project this intersection down vertically to the graduated base line. The corrected length at this point (355 feet) is the length to be used in determining the Time of Concentration.

d. Time of Concentration: The Time of Concentration (T_c) is the time required for overland flow to reach the drain inlet or other point of concentration from the farthest extremity of the drainage area (DA). The minimum T_c for paved areas is 10 minutes and for small turfed areas is 20 minutes. Computations for length of runoff will not be required for these areas. A T_c of 5 minutes is used for sizing the gutters, downspouts, and roof drain collector pipe from within the 5-ft. building line to the first surface inlet or manhole. In the composite drainage system, roofed areas shall also be assigned a T_c of 10 minutes (same as for paved areas). Where length of runoff is required for the larger turfed areas, the T_c shall be determined as follows: The T_c in a drainage area is determined directly from supply curves included in Appendix B, Figures B-7 through B-14, of TM 5-820-1. Special attention should be given to the fact that any one of these curves may be selected, since the duration of supply in minutes does not vary materially when the corrected length of run off remains constant. Special attention should also be given to the fact that rates of runoff indicated along the left graduated margin of these supply curves are not applicable under this method of drainage design (Reference paragraph 1-03e below). Note that on each of these supply curves, a dashed line is drawn through each of the hydrographs and is indicated as T_c (Time of Concentration). Also, note that the hydrograph on each supply curve is designated as a length (L). The length (L) corresponds with and is the value determined for corrected length after compensating for retardance coefficient and slope, (Reference paragraph 1-03c). The T_c is then obtained by locating the corrected length of runoff at the applicable point along the dashed T_c line on either one of the supply curves. This intersecting point is then projected vertically down to the graduated base line (duration of supply in minutes). The time indicated at this point on the base line is the T_c for that drainage area. For example, if the corrected length (L) of 355 feet (as determined in paragraph 1-03c above) is located along the dashed T_c line of any one of the supply curves, the downward projection will intersect the time of 25 minutes. This time of 25 minutes is the time required for rainfall at the farthest extremity of the drainage area to reach the drain inlet or other point of total concentration. (Note: T_c for a storm drainage system where multiple drain inlets are involved, will be discussed in a later paragraph).

e. Rate of Rainfall (I) During Time of Concentration (T_c): The rate of rainfall in inches per hour during the Time of Concentration, used as "I" in the Rational Formula, is the average rate of rainfall in inches per hour during the adopted design storm frequency . By applying the Time of Concentration (T_c) for the drainage area (as determined in paragraph

1-03d above) the average rate of rainfall "I" during the specified/designated T_c is read directly from Figure 2, TM 5-820-1. The T_c (as determined in paragraph 1-03d) is located at the applicable point along the graduated base line. This point is extended vertically up to the intersection with the one-hour rainfall expected during the design storm. (Curve number 3.0 for Fort Stewart, Georgia and vicinity, from paragraph 1-02 above). Then, project this point of intersection horizontally to the left and it's intersection with the left side graduated line. The rainfall intensity in inches per hour is read directly along this left-hand margin. The value read at this point is the average rate of rainfall in inches per hour at the Time of Concentration, and is the value to be used for "I" in the Rational Formula Q = CIA referenced in paragraph 1-03 above). (Note: Using a T_c of 25 minutes, "I" equals 4.9 inches).

f. Discharge (Q) at Drain Inlet or other Point of Concentration: After the steps described above have been completed, factors comprising the Rational Method Formula are employed to determine the discharge in cubic feet per second (cfs) at the drain inlet or other point of concentration. Summarizing the preceding discussion, the units to be inserted in the Rational Method Formula must either be measured or calculated, as illustrated below:

(1) "A" - Area of paved surface (s) in the drainage area in acres (including roof surfaces). (1.5 acres assumed for the above example).

(2) "A" - Area of nonpaved surface (s) in the drainage area in acres. 5 acres assumed for the above example).

(3) "C" - Coefficient representing the ratio of runoff to rainfall. (For projects in the Savannah District, use "C" of 0.40 for turfed areas and "C" of 1.0 for paved areas, as described in paragraph 1-03a).

(4) "n" - Retardance factor or coefficient of roughness. (Assume 0.40 for average turf cover used in above example).

(5) "L" - Length of Runoff, adjusted for roughness and slope. (355 linear feet used in above example).

(6) "T_c - Time of Concentration - Time required for runoff from the farthest extremity of the drainage area to reach the drain inlet or other point of concentration. When necessary, T_c may be a total of both overland and channel flow. (25 minutes used in the example).

(7) "I" - Rate of Rainfall in inches per hour during Time of Concentration. (4.9 inches used in the example and obtained as shown above). To transform the above units to c.f.s. runoff from the drainage area using the Rational Method Formula, the required unit values assumed above are inserted in the formula Q = CIA as follows:

First,

Q = [(Paved Area in Acres x C) + (Turfed Area in Acres x C)] x
Rate of rainfall "I" in inches per hour during Time of Concentration.

Then,

Q = [(A x C for Paved Area) + (A x C for Turfed Area)] x I; Or,
Q = [(1.5 x 1.0) + (5.0 x 0.40)] x 4.9 = (1.5 + 2.0)x4.9

Then,

Q = 3.50 x 4.9 = 17.15 c.f.s.

g. Pipe Size(s) Required: The size of pipe required to discharge the computed c.f.s. at the point of concentration of the drainage area depends first of all, on whether the discharge pipe is an enclosed storm drain pipe or a pipe culvert.

(1) Storm Drain Pipe: Storm drain pipe is defined as a line of underground pipe connecting either: two inlets, an inlet with a manhole, two manholes, or a manhole or inlet with an outfall structure. The size of storm drain pipe required shall be determined by Manning's formula, shown in nomograph form in Appendix B, Figures B-22 and B-24, of TM 5-820-1. These nomographs are derived from the Manning formula,

$$V = \frac{1.486}{n} \times r^{2/3} \times s^{1/2}$$, used in the basic discharge formula Q = VA.

Definitions of the units in this formula are as follows:

Q = c.f.s. at point of concentration
V = Velocity in feet per second (fps)
A = Area of waterway opening in square feet
n = Roughness Coefficient of the pipe
r = Hydraulic Radius of the pipe
s = Slope of pipe in feet per foot

Therefore, by substitution, $Q = \frac{1.486}{n} \times r^{2/3} \times s^{1/2} \times A$

Diameters of enclosed storm drain pipe, determined in accordance with the above referenced nomograph and formulae, are the size required to discharge the computed c.f.s. instantaneously with the pipe flowing full. In enclosed storm drainage systems, where available head exists between the top of pipe and top of inlet or manhole, the pipe size(s) in some instances may be decreased, if the hydraulic gradient elevation(s) are within the limits specified hereinafter in paragraph 2-01d. Diameters of enclosed, underground pipe systems shall be not less than 12 inches, except that the minimum diameter of roof drain

collector pipe may be 6 inches. The "n" value or roughness coefficient to be used in the above referenced nomograph or formula shall be in accordance with the following:

(a) Concrete, Rigid PVC, and Vitrified Clay Pipe ---------- n = 0.012

(b) CMP, TYPE D: Fully Bituminous Coated, Fully Paved, Corrugated Steel; Aluminized Type 2 Corrugated Steel; and Corrugated Aluminum Alloy Pipe with Type "D" Coating. Also, Galvanized or Aluminized Type 2 Corrugated Steel Pipe with Concrete Lining and Type "A" Exterior Coating ---------- n = 0.012

(c) CMP, TYPE A: Corrugated, Aluminum Alloy, No Coating; Fully Bituminuous Coated Corrugated Steel and Aluminized Type 2 Corrugated Steel Pipe with Type "A" Coating --------- n = 0.024

NOTES: 1. Due to existing adverse soil conditions, do not specify aluminum pipe for projects at Fort Stewart/Kings Bay Naval Base, Ga., nor Sunny Point MOT, NC.

2. AASHTO M 190 Type "D" Coating is "same as" Fed. Spec. WW-P-405 Type "E" Coating.

(2) Pipe Culverts: A pipe culvert is defined as either a single or multiple line of pipe with or without headwalls or flared end sections,installed primarily under road, railroad, or other embankments. This differs from paragraph 1-03g(1) above. The size of the outfall pipe in any storm drainage system, from the outlet back upstream to the preceding manhole surface inlet shall also be considered as a pipe culvert in determining the hydraulic gradient at the upstream manhole or inlet. The size of pipe culvert(s) shall be determined in accordance with Appendix B of TM 5-820-4. To allow for sediment deposition, the minimum diameter of pipe culverts shall be not less than 18 - 24 inches, irregardless of the minimum length required. Adjustment of pipe sizes in conjunction with pressure head and velocities is further covered in Section 2 below.

SECTION 2 - THE ENCLOSED DRAINAGE SYSTEM

2-01. HYDRAULICS OF FLOW THROUGH THE ENCLOSED DRAINAGE SYSTEM:

a. General: As described in Section 1, an interval of time is involved in the flow of water from junction point to junction point along the enclosed drainage system. As also explained in Section 1, the greater the time required for water to flow from the farthest extremity of the drainage area to the point of concentration, the lower the intensity of runoff at the Time of Concentration (T_c). Therefore, the longer the drainage system, the greater the T_c and the lower the intensity. It is then obvious that, by adding the time of pipe flow to the T_c of the critical inlet, the computed design discharge in c.f.s. will be less as the water passes through the various downstream junction points than it would be if

pipe flow time were disregarded entirely. (Refer to TM 5-820-1, Appendix B, para. B-5a.1 for definition of the critical inlet).

b. Time of Concentration Along the Enclosed Drainage System: The time of concentration (T_c) at any point along the drainage system is the T_c of the critical inlet plus the pipe flow time from the critical inlet to the drainage junction point under consideration. In computing the T_c at downstream junctions, a "minimum" velocity of 3 feet per second (fps) along the pipeline(s) is usually assumed.

(1) Average Intensity at Drainage Junction or Other Point of Concentration along the drainage system is read directly from Figure 2, TM 5-820-1, in the same manner as described in Section 1, paragraph 1-03e, of these instructions. An increase in the T_c for downstream junctions shall be made in intervals of the closest minute. However, to simplify determining drain-inlet capacities in large or complex systems, the computed value of $T_c$may be rounded off to the nearest 5 minutes.

c. Hydraulic Gradient: For uniform flow in any pipe in which minor losses are neglected, the hydraulic gradient or grade line is considered as a straight line or series of straight lines between the upstream highwater level and the water level at the downstream inlet(s), manhole(s), or pipe outlet. In designing enclosed drainage systems for the Corps of Engineers, the computation of the hydraulic gradient is used primarily to determine upstream highwater elevations to avoid flooding upstream inlets and manholes or to hold the flooding within permissible limits. The hydraulic gradient is plotted on the pipeline profile, as shown on example sheet 4 of 4 in Section 3 of these instructions.

(1) Pipe Roughness Coefficients: Roughness coefficients "n" for the various types of pipe selected in the design shall be in accordance with Section 1, paragraph 1-03g(1) of these instructions. In designing an enclosed storm drainage system, minor losses along the pipeline should be neglected. However, loss of head at the drainage junction and/or changes in pipe cross-sectional area must be calculated and reflected in the computed hydraulic gradient/grade line.

(2) Loss of Head at Junctions and/or Changes in Cross-Section: Head loss (HL) in feet at junctions and/or changes in cross-sectional area is computed from the formula, $HL = Kv^2/2g$, in which:

"K" = a loss coefficient whose value depends on the geometrical shape of the junction (paragraph 2-01d of this section includes a listing of the most common values);

"v" = the velocity used to compute minor losses in the pipe is the mean velocity of pipe flow; and,

"g" = the acceleration of gravity (32.16) in feet per second^2.

The coefficient "K" is a variable factor; therefore, a diagnosis of each junction and/or change in cross-section must be made when assigning a "K" value for specific locations along the enclosed drainage system. The coefficient "K", as used in storm drainage design, pertains to minor losses due to turbulence, and varies as turbulence increases or decreases at the junction. The types of minor losses to be considered are: entrance losses, outlet losses, contraction losses, enlargement losses, or a combination of two or more of these losses.

d. Design of Enclosed Drainage System Using the Hydraulic Gradient: It is usually permissible to design the enclosed drainage system under slight pressure, utilizing the available elevation head between the top of pipe and the top of inlet or manhole. The trial design of the enclosed system should first be worked downstream by sizing the pipe from junction to junction, laying the pipe invert grade(s) on the hydraulic gradient between design points with the discharge pipe flowing full. This procedure should continue to the outfall structure. Then, the hydraulic gradient elevation at the outfall (pipe invert elevation plus depth of flow) should be computed upstream, from junction to junction along the main line to the most upstream inlet. In running the gradient upstream, the loss of head at each junction should be added to the rising gradient at each junction or change in pipe cross-sectional area. If the trial design has been made properly, the elevation of the hydraulic gradient at the upstream inlet should either be at the top of the pipe or not more than midway between the top of pipe and top of inlet. If the hydraulic gradient elevation is below the top of the pipe, this indicates that the system is overdesigned, and excessive pipe diameters exist along the downstream route. If, on the other hand, the elevation of the hydraulic gradient is above the midpoint mentioned above, the system is underdesigned. In this case, one or more downstream segments should either be increased in diameter or given steeper slopes.

(NOTE: The above procedure is applicable only for designing enclosed drainage systems which do not permit ponding at surface inlets).

HEAD LOSS COEFFICIENTS AT JUNCTIONS*

For no bends at junctions----------K = 0.20
For bends at junctions of 25 degrees----------K = 0.30
For bends at junctions of 45 degrees ----------K = 0.40
For bends at junctions of 90 degrees ----------K = 0.60
For junctions of three pipes ----------K = 0.80
For junctions of four or more pipes ----------K = 1.00

*(Reference: King's Handbook of Hydraulics, by Horace William King, Section 6, "PIPES")

e. Erosion Control and Protection of Outlet Ditches: If the calculated discharge velocity released into the storm drainage outfall ditch exceeds the values listed in Table 4-1 of TM 5-820-4, stream channel/ditch bank erosion or scour will occur, either at or

immediately downstream from the termination point of the storm drain outlet. To reduce this anticipated scour, some type of energy dissipating outlet structure, as described in Chapter 4, TM 5-820-4, or Chapter 3, TM 5-820-3/AFM 88-5, Chapter 3, will be required. In addition, all hydraulic structures, including paved chutes/outlet channels, discharging into excavated, vegetated channels should normally include some type of riprap protection and/or commercial ditch lining to prevent erosion. Design of stone riprap protection is covered in Chapter 10 of TM 5-820-3 and Chapter 5 of TM 5-820-4. However, at storm drain outlets installed in outlying/undeveloped areas, the installation of sand-cement bag riprap may also be considered in designing side slope and ditch bank protection. (Refer to Exhibit B-2-1, Fig. 33A and 33B, and State DHPT/DOT Roadway Design Standard Drawings for details and dimensions to determine the extent of either stone or sand-cement bag riprap required at these locations. Ft. Bragg DEH has stated specifically in writing that they prefer using grout-filled fabric mats in lieu of stone riprap).

SECTION 3 - SAMPLE DESIGN OF ENCLOSED STORM DRAINAGE SYSTEM FOR BUILT-OVER AREAS

The attached sheets (1 through 4) are furnished for guidance in: (1) designing an enclosed storm drainage system, and (2) completing the storm drainage design analysis. These sheets include sample tables and drawings details showing the "minimum" design information required, as follows:

a. Table I - CESAS Form 1178 (sheet 1 of 4) - Data determined by the procedures described in Section 1, paragraphs 1-02 through 1-03f. (Complete the blocks in upper righthand corner, i.e., name and location of project, and location of District and Division Offices).

b. Table II - SAS Form 1155 (sheet 2 of 4) - Data derived primarily by the procedure described in Section 2, paragraphs 2-01a and b. (Complete the blocks, same as for Table I above).

c. Table III - SAS Form 1156 (sheet 3 of 4) - Data derived by the procedure described in Section B1, paragraph 1-03g; and Section 2, paragraphs 2-01c and d. (Complete the blocks, same as Tables I and II above).

d. Plate P-1 (sheet 4 of 4) - A typical storm drain plan and profile showing the minimum information required for designing an enclosed storm drainage system. (The plan view is the DA Map).

(Note: To provide a clear example, the existing and finished grade contour lines have been omitted from plate P-1. However, when submitting the storm drainage design analysis for approval, the drainage area (DA) map must show the required finished grade contours to expedite the review. Hence, the DA map in the final design analysis for project design must be based on the final Grading Plan included in the contract drawings).

Sheet 1 of 4 Date 19 MAY 1960

Q = CIA
A = Area (Acres)
C = Imperiousness Factor
I = Intensity (In./Hr.)
DESIGN STORM 10 YR. (Intensity-Duration curve) 2.75 In./Hr.

Designed by D. L.T.
Checked by A.R.F.

TABLE 1 DRAINAGE (ROADWAYS AND BUILT-OVER AREAS)
DRAIN-INLET CAPACITIES
DRAINAGE SECTION: _____

PROJECT: WASHRACK
LOCATION: SAVANNAH, GA.
DIVISION OFFICE: ATLANTA, GA.
DISTRICT OFFICE: SAVANNAH, GA.

INLET NO.	DRAINAGE AREA (D.A.) IN ACRES: PAVED C=1.0	UNPAVED: BARE C=	UNPAVED: TURF C=0.40	TOTAL A C	AVERAGE ROUGHNESS FACTOR "n"	AVERAGE SLOPE "S" IN PERCENT	LENGTH L (FEET): Actual or Effective Length Feet	Equivalent L For n = 0.40 And S = 1%	Adopted L For t_c Computation	DRAIN-INLET CAPACITY: Critical Time, t_c Min.	Storm Intensity (I)	Rate of Supply c.f.s.	CRITICAL CONTRIBUTION TO SYSTEM: Critical Time, t_c Min.	Storm Intensity (I)	"Q" Rate of Supply c.f.s.	REMARKS
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
4	0.0		1.01	0.40		*	*	*170	170	17	5.3	2.12	18	5.2	2.08	
													19	5.1	2.04	
3	0.12		0.45	0.30		2.0	90	60	60	10	6.5	1.95	17	5.3	1.59	
													18	5.2	1.56	
													19	5.1	1.53	
2	0.08		0.45	0.26		3.5	190**	100	100	13	6.0	1.56	17	5.3	1.38	
													18	5.2	1.35	
													19	5.1	1.33	

* DA # 4 LENGTH OF OVERLAND FLOW = 130' @ 1.5%. EQUIVALENT LENGTH = 110', BASED ON USING RETARDANCE COEFFICIENT OF 0.4 (AVERAGE GRASS COVER) OVERLAND FLOW. LENGTH OF DITCH FLOW = 240' @ 1.0%. EQUIVALENT LENGTH = 60' BASED ON ESTIMATING RETARDANCE COEFFICIENT OF 0.10 FOR THE DITCH (EARTH) FLOW IN THIS EXAMPLE ∴ TOTAL L = 110' + 60' = 170'

** LENGTH OF OVERLAND FLOW PLUS VALLEY FLOW = 70' + 120' = 190'

NOTE TO AE:
IN LARGE OR COMPLEX AREAS THE COMPUTED VALUE OF T_c CONTRIBUTING TO THE SYSTEM MAY BE ROUNDED OFF TO THE NEAREST 5 MINUTES

CESAS FORM 1178
OCT 87

Sheet 2 of 4 | Date 19 MAY, 1960

FOR AIRFIELDS - SUPPLY CURVE NOS. (BASED ON DESIGN STORM INDEX, FIG 1 OF TM USING 2 YR. STORM)
For Paved Areas _____
For Bare Areas _____
For Turfed Areas _____

FOR ROADWAYS & BUILTOVER AREAS USE DESIGN STORM OF 2.75 in/HR, 10 YR. STORM, FIG 1 OF TM

DESIGNED BY D.L.J.
CHECKED BY A.R.F.

TABLE II AIRFIELD DRAINAGE, ROADS & BUILT OVER AREAS
SIZE AND PROFILE OF UNDERGROUND STORM DRAINS
DRAINAGE SECTION _____

PROJECT: WASHRACK
LOCATION: SAV. GA.
DIVISION OFFICE: ATL. GA.
DISTRICT OFFICE: SAV. GA.

POINT OF DESIGN			Critical Runoff Time To Produce Maximum Flow In Underground Drain							Rate of Inflow Into Underground Drains, In C.F.S., Corresponding To Adopted Value of t'_c (Column 10)														
	Distance, Feet					Drain Time, Min.				Inlet Number														
INLET OR JUNCTION NUMBER	From Main Outlet	From Preceding Inlet	Critical Inlet	Critical Inlet Time t_c Min.	Assumed Velocity In Pipe, Ft./Sec.	From Preceding Inlet	Accum. Total	Approx. t'_c (Col. 5) + Col. 8)	Adopted t'_c In Min.															Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
4	320	0	4	17	3.0	0	0	17	17	2.12														
3	175	145	4	17	3.0	0.8	17.8	18	18	2.08	1.56													
2	95	80	4	17	3.0	0.5	1.7	18.7	18	2.08	1.56	1.35												
1	0	95	4	17	3.0	0.5	1.7	18.7	19	2.04	1.53	1.33												

NOTES TO A.E.:

1. PIPE FROM STR. 4 TO 3 DESIGNED ON 2.12 C.F.S.
   PIPE FROM STR. 3 TO 2 DESIGNED ON 3.64 C.F.S.
   PIPE FROM STR. 2 TO 1 DESIGNED ON 4.99 C.F.S.

2. IN LARGE OR COMPLEX AREAS, THE ADOPTED T_c VALUE MAY BE ROUNDED OFF TO THE NEAREST 5 MINUTES

SAS FORM 1155
OCT. 84 Previous edition is obsolete.

Sheet 3 of 4
Date 19 MAY, 1960
Computed by D.L.J.
Checked by A.R.F.
Pipe "n" = 0.012 AND 0.024

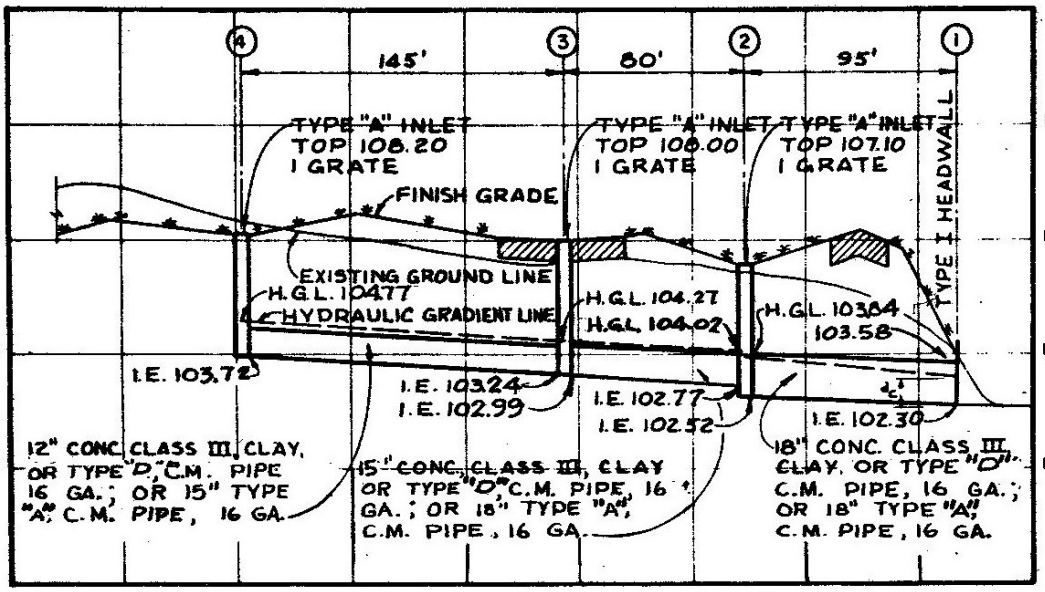
DESIGNED BY D.L.J.
CHECKED BY A.R.F.

TABLE III, AIRFIELD DRAINAGE, ROADS & BUILT OVER AREAS
SIZE AND PROFILE OF UNDERGROUND STORM DRAINS
DRAINAGE SECTION _____

PROJECT: WASHRACK
LOCATION: SAVANNAH, GA.
DIVISION OFFICE: ATLANTA, GA.
DISTRICT OFFICE: SAVANNAH, GA.

Inlet or Junction Numbers: From	To	Distance Between Design Points, in Feet, Measured to ℄ of Inlet or Junction	Design Discharge Capacity, in c.f.s.	Trial Design: Pipe Slope Between Design Points, Ft./Ft.	Trial Design: Mean Velocity of Design Discharge in Ft./Sec.	Trial Design: Required Size of Pipe, in Inches	Adopted Design: Selected Size of Pipe, in Inches	Hydraulic Grade Line Thru Pipe Length: Pipe Slope in Ft./Ft.	Hydraulic Grade Line Thru Pipe Length: Rise in Feet	Hydraulic Grade Line Thru Pipe Length: Elevation at ℄ of Upstream Design Point	Head Loss at Change in Section: Velocity of Inflow, (V) in Ft./Sec.	Head Loss at Change in Section: Velocity Head $\frac{V^2}{2g}$	Head Loss at Change in Section: Loss Coefficient, K	Head Loss at Change in Section: Head Loss, in Feet, $= K\frac{V^2}{2g}$	Elevation Hydraulic Grade Line, Col. 11, Plus Head Loss, Col. 15	Construction Data: Length of Pipe Between Design Points, in Feet	Elevation of Invert at Design Point, (Col. 2) in Feet: Incoming Pipe	Elevation of Invert at Design Point, (Col. 2) in Feet: Outgoing Pipe	Notes
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
				CONCRETE, CLAY OR TYPE "D" C.M. PIPE (N=0.012)															
	1																	102.30	(1) At Str. 2, $\frac{HW}{D}$ = 0.85
									(1)	(1)									or HW = 1.28' Above
1	2	95	4.99	.0023	3.4	18	18	(1)	(1)	103.80	3.4	.18	.20	.04	103.84	95	102.77	102.52	invert of Outgoing
																			pipe. (Computation by
	2														104.02	(2)			Inlet Control Figure
																			B-1 of TM5-820-4)
2	3	80	3.64	.0028	3.0	15	15	.0028	.22	104.24	3.0	.14	.20	.03	104.27	80	103.24	102.99	(2) New H.G.L. @ Str. 2,
																			Pipe between Str. 2 & 3
3	4	145	2.12	.0033	2.7	12	12	.0033	.48	104.75	2.7	.11	.20	.02	104.77	145		103.72	Flowing Full and H.G.L. =
																			102.77 + 1.25 = 104.02
							TYPE "A" C.M. PIPE (N=0.024)												
	1																	102.30	(3) At Str. 2, HW is
				(5)					(3)	(3)									computed by Outlet
1	2	95	4.99	.0075	2.8	18	18	(3)	(3)	104.18	2.8	.12	.2	.02	104.20	95	103.01	103.01	control. HW = h_o +
															(4)				H-Sol. $h_o = \frac{0.9+1.5}{2} = 1.2$
	2														104.51				
																			HW = 1.2 + 0.9 - 0.22
2	3	80	3.64	.0060	2.5	18	18	.0060	.48	104.99	2.5	.10	.2	.02	105.01	80	103.74	103.49	HW = 1.88
																			HG = 102.3 + 1.88 = 104.18
3	4	145	2.12	.0080	2.5	15	15	.0080	1.16	106.17	2.5	.10	.2	.02	106.19	145		104.90	
																			(4) New H.G. @ Str. 2.
																			Pipe between Str. 2 & 3
																			flowing full and H.G.
																			= 103.01 + 1.5 = 104.51
																			(5) Pipe slopes increased
																			to maintain min.
																			Velocity of 2.5
																			F.P.S.

SAS FORM 1156
OCT. 84 Previous edition is obsolete.

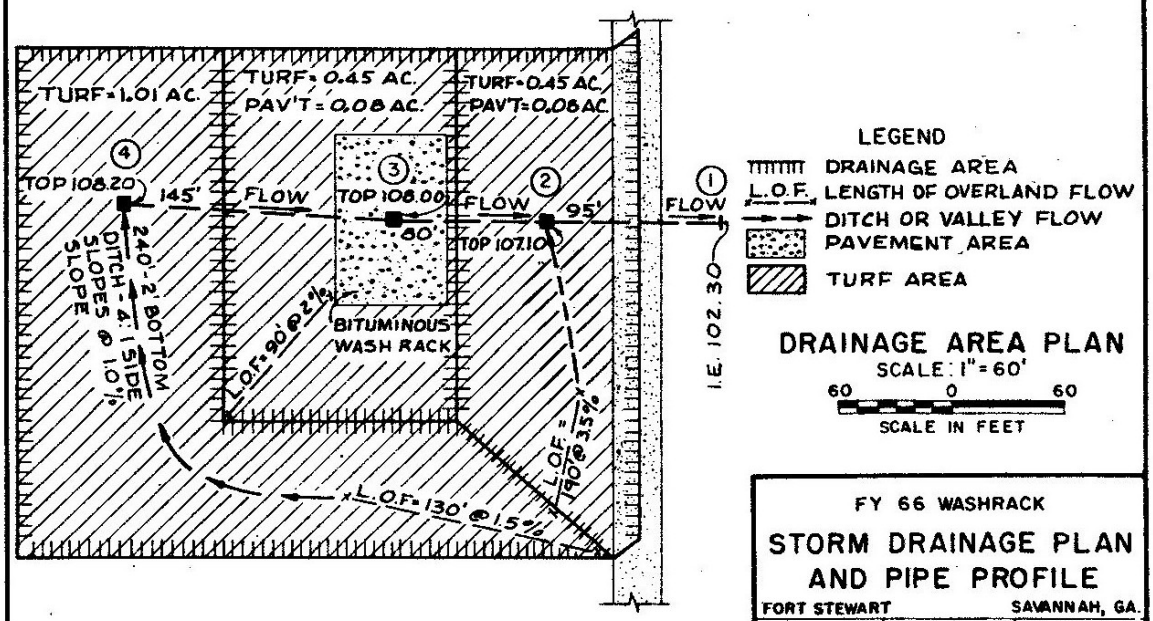


STORM DRAINAGE PIPE PROFILE

SCALE: 1" = 50' HORIZ
4' VERT

NOTES:

1. PIPE LENGTHS SHOWN ON PLANS ARE SCALE DISTANCES. ACTUAL LENGTHS OF PIPE NEEDED SHALL BE DETERMINED IN THE FIELD.
2. CLAY, OR NON-REINFORCED CONCRETE PIPE MUST MEET STRENGTH REQUIREMENTS FOR SAME SIZE REINFORCED CONCRETE PIPE.
3. PIPE CLASS IS BASED ON A D-LOAD, AS APPLIED TO REINFORCED CONCRETE PIPE AND THE TEST LOAD IN POUNDS PER LINEAR FOOT PER FOOT DIAMETER TO PRODUCE ULTIMATE FAILURE.
4. C.M. PIPE MAY BE EITHER GALVANIZED STEEL, ALUMINIZED STEEL, OR ALUMINUM ALLOY PIPE, AS COVERED IN THE JOB SPECIFICATIONS.
5. THE HYDRAULIC GRADIENT LINE (H.G.L.) SHOWN HEREON IS FOR CONCRETE PIPE. THIS GRADE LINE SHALL BE SHOWN IN THE PIPE PROFILE OF THE STORM DESIGN ANALYSIS BUT NOT ON THE CONSTRUCTION CONTRACT DRAWINGS.



FY 66 WASHRACK

STORM DRAINAGE PLAN AND PIPE PROFILE

FORT STEWART — SAVANNAH, GA.

PLATE P-1

4 OF 4

SAMPLE FORMAT

PAVEMENT AND STORM DRAINAGE DESIGN ANALYSES

FOR

CENTRAL PLANT
FY- , L.I.-
FORT BENNING, GEORGIA

PART I Pavement Design Analysis

PART II Storm Drainage Design Analysis

NOTE TO DESIGNER: The following pages contain "sample" Preliminary (60 Percent) Design Analyses, only to show the "minimum" design data required for a "complete" analysis. The design values (CBR, DI, etc.) shown are not to be inserted "verbatim" into any analysis, unless these values match the same values for that particular project. A-E designer is to select the appropriate values, based on the applicable technical requirements available.

PART I - PAVEMENT DESIGN ANALYSIS
FOR
CENTRAL PLANT
FY- , L.I.

FORT BENNING, GEORGIA

INDEX

Paragraph	Title
l.	Scope
2.	Type of Pavement
3.	Soil Characteristics *
4.	Design
5.	Pavement Thickness

Designed by: Date:
Checked by: Date:
Revised by: Date:
Approved by: Date:

*NOTE TO DESIGNER: Refer to the "NOTE TO DESIGNER" on previous page and comply accordingly, showing the "minimum" design data required. For the Final (100 Percent) Design Analysis, revise the appropriate paragraphs accordingly, especially when a difference in lab versus field analysis of the soils data requires different CBR/K values. (Delete "assumed" for Final (100 Percent) Design Submittal).

1. SCOPE: This analysis covers the design of pavement thickness required for the road and drives serving the project facility.

2. TYPE OF PAVEMENT: Flexible pavement is specified for all new vehicular pavements. This is based on the excellent serviceability of flexible pavement at this installation and the fact that flexible pavement can be constructed at
the least first cost.

3. SOIL CHARACTERISTICS:

a. Borings and soil investigations were made by the Government. The complete log of borings and lab test data shall be included in Appendix A of the Project Specifications, when assembled for issuance to bidders.

b. The soils were field classified in accordance with the Unified Soil Classification System. The log of borings indicates the top 5 feet contain soil layers in the classification range of SM and SC. Until laboratory test results are received, the silty sands are assumed to be cohensionless. If lab tests prove otherwise, this analysis will be revised accordingly. (Note to Designer: Secure data for this paragraph from the Foundation Report furnished by the Savannah District Soils Section (CESAS-EN-GS).)

4. DESIGN: Based on previous tests by the Government, similar soils in this general area required a CBR value of ___, which is assumed to be representative of the soils on the site.

(Note to Designer: Include a listing/discussion in this paragraph of the types and sizes of vehicles anticipated by either DEH/BCE to use the pavements of the proposed facility, as per para. 2.6.l.2c(2), Chapter B-2, Vol. II of this manual.)

5. PAVEMENT THICKNESS:

a. Design Index: Based on the above anticipated traffic data, received from DEH, and in accordance with TM 5-822-2 dated April l977 or later, and TM 5-822-5 dated October l980, the roads and drives are assigned the following values:

(l) Roads -
- (a) Class E
- (b) Group = 2
- (c) Category = 2
- (d) Design Index (Dl) = 2
- (e) CBR = 12 (Assumed)

From Encl. #3 of ETL 1110-1-140, dated 15 July '88, (which supersedes Figure 3 of TM 5-822-5), using a CBR of 12 and a Design Index of 2, the total pavement thickness (base and surface) is 7.4 inches. For construction, use 7.5 inches, consisting of l-l/2"

bituminous surface course (hot plant mix) and 6 inch stabilized aggregate base course. See Sketch No. 1 for typical pavement section.

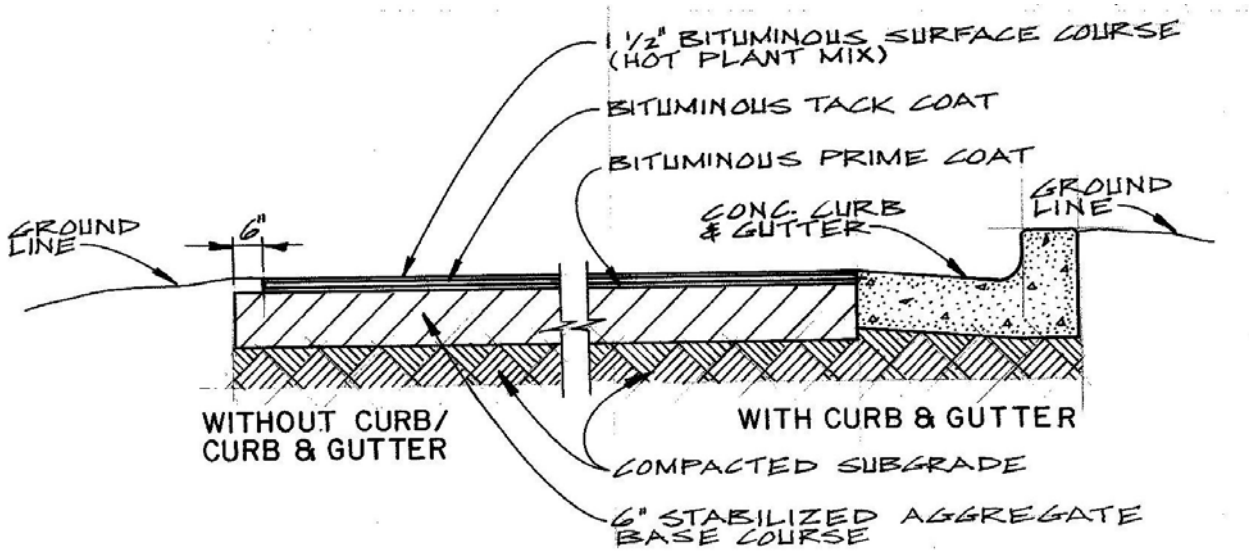
(2) Drives -
(a) Class F
(b) Group = 2
(c) Category = 2
(d) Design Index (DI) = 1
(e) CBR = 12 (Assumed)

(Note to Designer: Although TM 5-822-5 specifies a "minimum" of 4", the minimum thickness of aggregate base course specified by Savannah District is 6").

From Encl. #3 of ETL 1110-1-140, dated 15 July '88, using a CBR of 12 and a Design Index of l, the total pavement thickness (base and surface courses) is 6.4 inches. For construction, use 7.5 inches consisting of l-l/2" bituminous surface course (hot plant mix) and 6" stabilized aggregate base course. See Sketch No. 1 below for typical pavement section.

b. Compaction Requirements: From Figure 2 of TM 5-822-5, using a Design Index of 2, the depths of compaction required for each percentage of compaction are shown on Sketch No. 2.

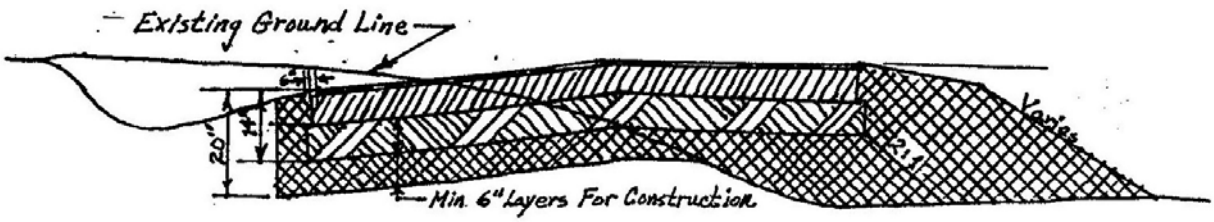
(Note to Designer: Sketches may be freehanded in the design analysis, but must be drafted for the contract drawings. Information in both sketches 1 and 2 shall be shown/included in drawings details).



SKETCH NO. 1

TYPICAL PAVEMENT SECTION

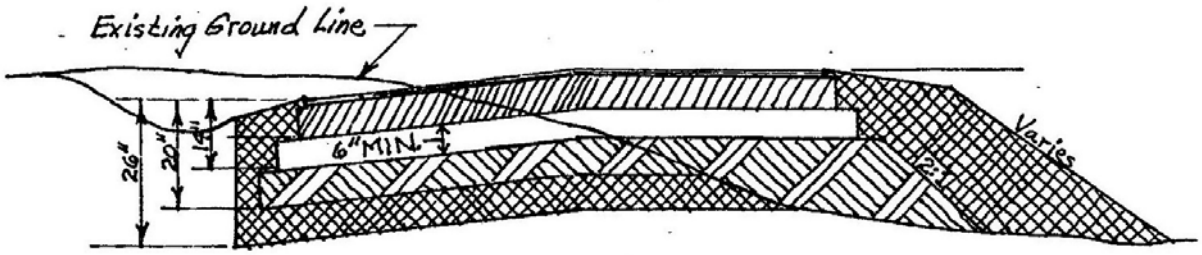
NOT TO SCALE



Half Section-Cut

Half Section-Fill

-COHESIVE SOIL-



Half Section-Cut

Half Section-Fill

- COHESIONLESS SOIL -

Note: All layers shall extend a minimum of 6" beyond overlying layer above on each end

- Bituminous Surface Course
- Aggregate Base Course - DENSITY AT LEAST 100%*
- Subbase Course - DENSITY AT LEAST 100%*
- Compacted Subgrade - DENSITY AT LEAST 95%*
- Compacted Earthfill - DENSITY AT LEAST 90%*

LEGEND - COMPACTION ZONES

*BASED ON LABORATORY MAXIMUM DENSITY (Reference CEGS-02210/02230)

COMPACTION REQUIREMENTS FOR ROADS AND DRIVES

(NOT TO SCALE)

SKETCH NO. 2

PART II - STORM DRAINAGE DESIGN ANALYSIS

FOR

CENTRAL PLANT
FY- , L.I.-
FORT BENNING, GEORGIA

INDEX

Paragraph	Title
1.	Scope
2.	Design
3.	Soil Characteristics
4.	Formulas
5.	Remarks

Computations:
a. Type "A" Inlet - Sheet l
b. Type "B" Inlet - Sheet l
c. CESAS Form 1178* (SAD 1976) - Sheet 2
d. SAS Form 1155* - Sheet 3
e. SAS Form 1156* - Sheets 4 and 5
f. Pipe Profiles - Sheet 6
g. Drainage Area Plan - Sheet 7

Designed by: Date:
Checked by: Date:
Revised by: Date:
Approved by: Date:

*Note to Designer: Full size copies of Forms ll78, ll55, and ll56 are available on request from the District's Project Manager.

1. SCOPE: This storm drainage design covers the area shown on the Drainage Area Map, Page ___ of ___ , enclosed.

2. DESIGN: The storm drainage design is based on criteria in Engineering Technical Manuals TM 5-820-1, 5-820-3, and 5-820-4, using the following criteria:

a. Design Storm - 10 year, l-hour
b. Intensity-duration Curve (I) - 2.8
c. Imperviousness factor (C) - 0.4 for turfed areas and l.0 for paved areas.
d. Roughness Coefficient "n" for pipe: 0.012 for concrete, clay and fully bituminous coated, fully-paved Type "D" C.M. Pipe; and 0.024 for fully bituminous coated Type "A" C.M. Pipe.

3. SOIL CHARACTERISTICS: Characteristics of site soils encountered is described in the "Pavement Design Analysis" for this project.

4. FORMULAS: Included in this analysis are computations for the following:

a. Rainfall runoff computed by the Rational Method Formula, Q = CIA (See tabulations on forms(Tables) attached).

b. Inlet Openings:

(1) Grate design for Type "A" inlets, the Weir Formula Q = CLH was used with a safety factor of 2.0 for grassed areas, where Q = capacity of inlet in cubic feet per second (cfs), C = Constant = 3.0, L = Gross perimeter of grate opening in feet, H = depth of water in feet. (See Sheet 3 for computations).

(2) For openings of curb type inlets along slopes, the Weir Formula $Q = 0.7L (a + y)^{3/2}$ was used for depth of flow up to 0.4', where Q = Capacity in c.f.s., L = Length of clear opening in feet, a = Depth of depression of flow line at inlet in feet, y = Depth of flow in approach channel in feet. (See Sheet 3 for computations).

c. Sizing of drainage pipe is based on the Manning Formula,

$$v = \frac{1.486}{n} \times r^{2/3} \times s^{1/2}.$$ (See tabulations on forms enclosed)

d. Sizing of culverts was based on the method given in TM 5-820-4.

e. Class of reinforced concrete pipe (RCP) was determined from Appendix C, TM 5-820-4, dated Oct 83. Gauge of corrugated metal pipe (CMP) was determined from chart in paragraph 2.6.l.lb(3), Chapter B-2, Vol. II of the District Design Manual (DM).

5. REMARKS:

(A-E designer to include any site peculiarities, etc., under remarks.)

COMPUTATIONS FOR INLET CAPACITY

a. Type "A" Inlet, I grate:

Weir formula, $Q = CLH^{3/2}$ (Fig. 3-3, Page 3-11 of TM 5-820-4)

$C = 3.0$, $L = 1.75 + 1.75 + 2.75 + 2.75 = 9.00'$, $H = 0.4'$

$Q = 3 \times 9.0 \times 0.4^{3/2} = 27 \times 0.253 = 6.8$ c.f.s.

Using Safety Factor of 2.0, capacity = 3.4 c.f.s.

Therefore; 1-Grate inlet is satisfactory, since maximum flow to Type "A" inlet is only 1.72 c.f.s. (See Table I, Col. 16).

b. Type "B" Inlet:

Weir formula $Q = 0.7\ L\ (a + y)^{3/2}$ (Fig. 3-4, Page 3-12 of TM 5-820-4)

$L = 9.0'$, $a = 0.12'$, $y = 0.25'$

$Q = 0.7 \times 9.0 \times (0.12 + 0.25)^{3/2} = 6.3 \times 0.225 = 1.42$ c.f.s.

Therefore; a Type "B" Inlet with 9.0' opening (throat) is satisfactory, since maximum flow is 0.67 c.f.s. (See Table I, Col. 16).

NOTES TO DESIGNER:

1. Computations may either be typed or neatly handwritten.

2. When "open" ditches are part of the design, refer to TM's 5-820-3 and 5-820-4 for open ditch design procedures. Show hydraulic calculations for determining size of ditch, and, if necessary, provide ditch protection (riprap, etc.) to prevent erosion when velocities exceed "maximum" velocities specified in Table 4-1, TM 5-820-4.

Sheet 2 of 7 | Date April 15, 1966

Q = CIA
A = area (acres)
C = imperviousness factor
I = intensity (in./hr.)
DESIGN STORM 10 YR. (intensity - duration curve) 2.8 in./hr.

TABLE 1 DRAINAGE (ROADWAYS AND BUILT-OVER AREAS)
DRAIN-INLET CAPACITIES

DRAINAGE SECTION: Sand Hill Area

PROJECT CENTRAL HEAT & REF. PLANT
LOCATION FT. BENNING, GA.
DIVISION OFFICE ATLANTA, GA.
DISTRICT OFFICE SAVANNAH, GA.

INLET NO.	DRAINAGE AREA (D.A.) IN ACRES: Paved (C=1.0)	Unpaved: Bare (C=)	Unpaved: Turf (C=0.4)	TOTAL AC	AVERAGE ROUGHNESS FACTOR "n"	AVERAGE SLOPE "S" IN PERCENT	LENGTH L (FEET): Actual or Effective Length Feet	Equivalent L for n = 0.40 and S = 15	Adopted L for t_c computation	DRAIN-INLET CAPACITY: Critical Time, t_c Min.	Storm Intensity (I)	Rate of Supply c.f.s.	CRITICAL CONTRIBUTION TO SYSTEM: Critical Time, t_c Min.	Storm Intensity (I)	Rate of Supply c.f.s.	REMARKS
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
2	0.04		0.16	0.10		5.0	80	40	40	10	6.6	0.77	30	4.2	0.32	Existing Inlet
3	0.16		0.01	0.16		—	—	—	—	10	6.6	1.06	30	4.2	0.67	
4	0.10		0.14	0.16		2.0	25	15	15	10	6.6	[illegible]	30	4.2	[illegible]	
5	0.21		0.50	0.41		4.0	130	60	60	10	6.6	2.[illegible]	30	4.2	1.72	
7	0.01		0.09	0.05		8.0	30	15	15	[illegible]	6.6	0.33	30	4.2	0.21	Existing Inlet
8	1.87		2.77	2.98		1.2	450	420	420	30	4.2	12.5				Exist. Inlet. C.f.s. computed from 3"=400' Gen. Storm Drainage Map
9	0.09		0.38	0.24		6.0	80	40	40	10	6.6	1.58	15	6.0	1.44	
													30	4.2	1.02	
10	0.14		0.46	0.32		3.5	210	110	110	15	6.6	1.92	30	4.2	1.34	
11	0.17		0.0	0.17		—	—	—	—	10	6.6	1.12	15	6.0	1.02	Roof Drainage
													30	4.2	0.71	

SAMPLE

ARMY-CE-SAVANNAH, GA DISTRICT

~~Replaces SASVE 149 and all similar local forms which are obsolete.~~
~~10 Nov 60~~
Superseded by
CESAS Form 1178, dated Oct. '87

Sheet 3 of 7 | Date Apr 15, 1966

~~FOR AIRFIELDS - SUPPLY CURVE NOS. (BASED ON DESIGN STORM OF 10 YR. STORM, FIG 1 OF EM 1110-2-1413)~~
~~For Paved Areas 10~~
~~For Bare Areas~~
~~Composited Areas 04~~

FOR ROADWAYS & BUILTOVER AREAS USE DESIGN STORM OF 2.8 "/HR. (10 YR. STORM, FIG 1 OF TM

TABLE II, AIRFIELD DRAINAGE, ROADS & BUILT OVER AREAS
SIZE AND PROFILE OF UNDERGROUND STORM DRAINS
DRAINAGE SECTION: Sand Hill Area

PROJECT CENTRAL HEAT & REF. PLANT
LOCATION FT. BENNING, GA.
DIVISION OFFICE ATLANTA, GA
DISTRICT OFFICE SAVANNAH, GA.

POINT OF DESIGN			Critical Runoff Time To Produce Maximum Flow In Underground Drain							Rate of Inflow Into Underground Drains, In C.F.S., Corresponding To Adopted Value of t'_c (Column 10)																				
	Distance, Feet					Drain Time, Min.				Inlet Number																				
INLET OR JUNCTION NUMBER	From Main Outlet	From Preceding Inlet	Critical Inlet	Critical Inlet Time. t_c Min.	Assumed Velocity In Pipe, Ft./Sec.	From Preceding Inlet	Accum. Total	Approx. t'_c (Col. 5 + Col. 8)	Adopted t'_c In Min.	8	7	5	4	3	10	11	9	2												Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
8		0	8	30	3.0	0	0	30	30	12.5																			12.5
7		50	8	30	3.0	0.3	0.3	30.3	30	12.5	0.21																		12.71
6		55	8	30	3.0	0.3	0.6	30.6	30	12.5	0.21																		12.71
5		0	5	10	3.0	0	0	10	10			2.71																	2.71
4		12	5	10	3.0	0	0	10	10			2.71	1.06																3.77
3		140	8	30	3.0	0.8	1.4	31.4	30	12.5	0.21	1.72	.67	0.67															15.77
10		0	10	15	3.0	0	0	15	15						.92														1.92
11		0	11	10	3.0	0	0	10	10							1.22													1.22
9		64	10	15	3.0	0.4	0.4	[illegible]	15						1.[illegible]2	1.02	1.44												4.38
2		46	8	30	3.0	0.3	1.7	31.7	30	12.5	0.21	1.72	0.[illegible]	0.67	1.34	0.71	1.02	0.42											19.26

SAMPLE

~~ENG FORM 1786~~ ARMY-CE-SAVANNAH, GA DISTRICT 49 14671

S/S by SAS Form 1155 OCT. '84

Sheet 4 of 7
Date April 15, 1966
Computed by A.R. Fraker
Checked by C.E. Melphus
Pipe "n" = 0.012

TABLE III, AIRFIELD DRAINAGE, ROADS & BUILT OVER AREAS
SIZE AND PROFILE OF UNDERGROUND STORM DRAINS
DRAINAGE SECTION Sand Hill Area

PROJECT CENTRAL HEAT & REF. PLANT
LOCATION FT BENNING, GA
DIVISION OFFICE ATLANTA, GA.
DISTRICT OFFICE SAVANNAH, GA.

HYDRAULIC DESIGN DATA ON UNDERGROUND STORM DRAINS

Inlet or Junction Numbers: From	To	Distance Between Design Points, in Feet, Measured to ℄ of Inlet or Junction	Design Discharge Capacity, in c.f.s.	Trial Design: PIPE SLOPE Between Design Points, Ft./Ft.	Mean Velocity of Design Discharge in Ft./Sec.	Required Size of Pipe, in Inches	Selected Size of Pipe, in Inches	Hydraulic Grade Line Thru Pipe Length: PIPE Slope in Ft./Ft.	Rise in Feet	Elevation at ℄ of Upstream Design Point	Adjusted Design: Head Loss at Change in Section: Velocity of Inflow, (v) in Ft./Sec.	Velocity Head $\frac{v^2}{2g}$	Loss Coefficient, K	Head Loss, in Feet, $= K\frac{v^2}{2g}$	Elevation Hydraulic Grade Line, Col. 11, Plus Head Loss, Col. 15	Length of Pipe Between Design Points, in Feet	Elevation of Invert at Design Point, (Col. 2): Incoming Pipe	Outgoing Pipe	Elevation of Ground Surface, in Feet: Natural Surface	Finished Grade	Depth of Cover Above Top of Pipe, in Feet: At Design Point (Col. 2)	Minimum in Line (If less than Col. 22)	Notes
1	3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
										"0" of 0.012													
1	2	56	19.26				36			*269.23	4.3	0.3	0.6	0.18	269.41 269.03 (New HG)		268.13	267.13					Existing 36" Conc Pipe. *From Plate I-1, Appen I. TM 5-820-4, Inlet Control HW = 1.6 HW = 2.1'
2	3	45	15.77	.005	4.8	24	24	.024	1.07	270.10	12	2.2	0.6	1.32	271.42		271.70	269.20					
3	6	140	12.71	.015	7.2	18	18	.015	2.10	273.52	7.2	0.8	0.4	0.32	273.84		272.00	271.86					
	7	55	12.71	.015	7.2	18	18	.015	0.83	274.67	7.2	0.8	0.2	0.16	274.83			272.83					
	3																271.3						
3	4	24	3.77	.0035	3.2	15	15	.006	0.15	271.45	5.0	0.4	0.2	0.08	271.53		271.7	[illegible]					
4	5	12	2.71	.006	3.5	12	12	.008	0.10	271.63	[illegible]	0.2	[illegible]	0.04	271.67			271.80					
	2														271.18		269.83						
2	9	85	4.38	.005	3.6	15	15	.005	[illegible]	[illegible]	3.[illegible]	0.2	0.6	0.12	271.72 271.22		270.60	270.35					New HG. Depth of flow in pipe is 0.62'
9	10	70	1.92	.003	2.5	12	12	.0057	0.40	[illegible]	3.[illegible]	0.1	0.2	0.	271.82			271.00					
	9														271.72 271.05		270.60						New HG. Depth of flow in pipe = 0.65'
9	11	120	1.22	.012	1.6	12	12	.0075	0.90	271.95	4.0	0.2	0.2	0.04	271.99			271.50					

NOTE: The slope of pipe shown in Col. 9 of this TABLE is the selected slope, and is also the slope to be shown on the construction plans.

SAMPLE

ARMY-CE-SAVANNAH, GA DISTRICT
[redacted]
S/S by SAS Form 1156 Oct. '84

Sheet 5 of 7
Date April 15, 1966
Computed by AR Fraker
Checked by CE Nielsen
Pipe "n" = 0.021

TABLE III, AIRFIELD DRAINAGE, ROADS & BUILT OVER AREAS
SIZE AND PROFILE OF UNDERGROUND STORM DRAINS
DRAINAGE SECTION Sand Hill Area

PROJECT CENTRAL HEATING PLANT
LOCATION FT BENNING, GA.
DIVISION OFFICE ATLANTA, GA.
DISTRICT OFFICE SAVANNAH, GA.

HYDRAULIC DESIGN DATA ON UNDERGROUND STORM DRAINS																CONSTRUCTION DATA							
INLET OR JUNCTION NUMBERS		Distance Between Design Points, in Feet, Measured to ℄ of Inlet or Junction	Design Discharge Capacity, in c.f.s.	Trial Design				Hydraulic Grade Line Thru Pipe Length			Adopted Design				Elevation Hydraulic Grade Line, Col. 11, Plus Head Loss, Col. 15	Length of Pipe Between Design Points, in Feet	Elevation of Invert at Design Point, (Col. 2) In Feet		Elevation of Ground Surface, in Feet		Depth of Cover Above Top of Pipe, in Feet		Notes
				PIPE SLOPE Between Design Points, Ft./Ft.	Mean Velocity of Design Discharge in Ft./Sec.	Required Size of Pipe, in Inches	Selected Size of Pipe, in Inches	PIPE Slope in Ft./Ft.	Rise in Feet	Elevation at ℄ of Upstream Design Point	Velocity of Inflow, (v) in Ft./Sec.	Velocity Head $\frac{v^2}{2g}$	Loss Coefficient, ξ	Head Loss, in Feet, $= \xi \frac{v^2}{2g}$			Incoming Pipe	Outgoing Pipe	Natural Surface	Finished Grade	At Design Point (Col. 2)	Minimum in Line (If less than Col. 22)	
From	To																						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	1																						* From Plate I-1 Appen. I TM 5-820-4, Inlet Control HW = 1.7 & HW = 2.1' Equiv. 36" Conc. Pipe Nomo 16. Depth of flow in pipe = 1.26
1	2	56	19.26				36			269.23	4.3	0.3	0.6	0.18	269.41		268.[illegible]	267.13					
															269.[illegible]								
2	3	45	15.77	.013	5.0	24	24	.024	1.07	271.46	7.0	0.8	0.6	0.48	271.94		269.[illegible]	269.20					
3	6	140	12.71	.015	5.2	21	21	.015	2.10	274.04	5.2	0.4	0.4	0.16	274.20		272.[illegible]	271.80					
6	7	55	12.71	.015	5.2	21	21	.015	2.10	274.04	5.2	0.[illegible]	[illegible].2	0.08	275.11			272.83					
	3														271.94		271.[illegible]						
															272.17								
3	4	24	3.77	.0035	2.2	18	18	.006	0.15	272.3[illegible]	[illegible].2	0.1	[illegible].2	0.0[illegible]	272.34		271.7	271.45					Nomo 16. Depth of Flow in pipe = 0.87'
															272.51								
4	5	12	2.71	.0046	[illegible]	15	15	.008	0.10	272.[illegible]	3.[illegible]	0.1	[illegible].2	0.0[illegible]	272.63			271.80					Nomo 16. Depth of Flow in pipe = 0.81
	2														271.43		269.93						
2	9	85	4.38	.05	2.5	18	[illegible]	.05	0.42	27[illegible].85	2.5	0.1	0.6	0.06	271.91		270.60	270.[illegible]					
9	10	70	1.92	[illegible]	[illegible].3	15	15	[illegible]	0.16	272.07	1.8	0.1	0.2	0.02	272.09			271.00					** H required to force water through pipe
	9														271.91		270.60						
9	11	120	1.22	.003	1.6	12	12	.0075	0.30	272.21	2.5	0.1	0.2	0.02	272.23			271.50					** H required to force water through pipe

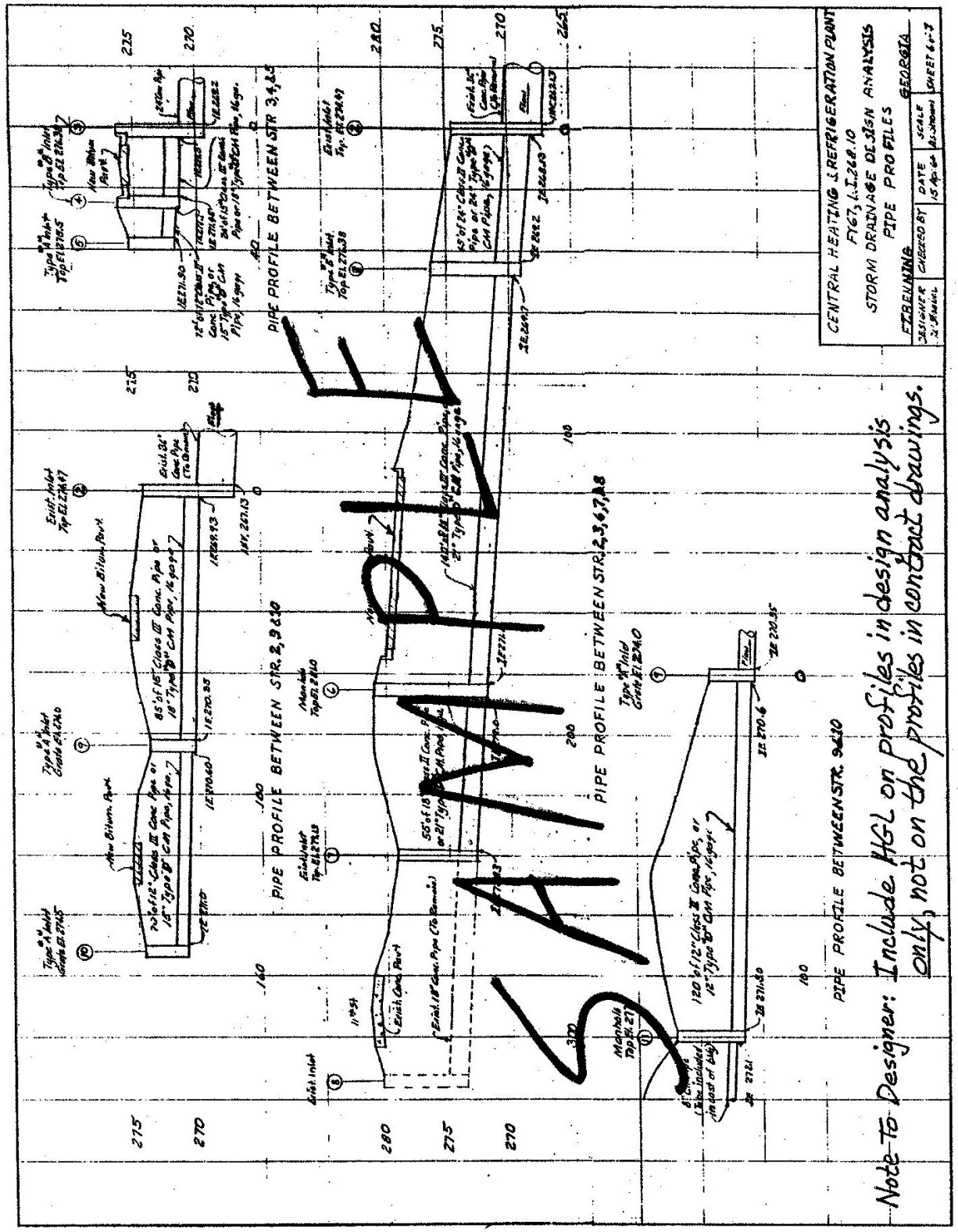
NOTE TO DESIGNER

The pipe slope shown under Col. 9 is the same slope to be specified on the construction plans

SAMPLE

[redacted] 5/5 by SAS Form 1156 OCT. '84

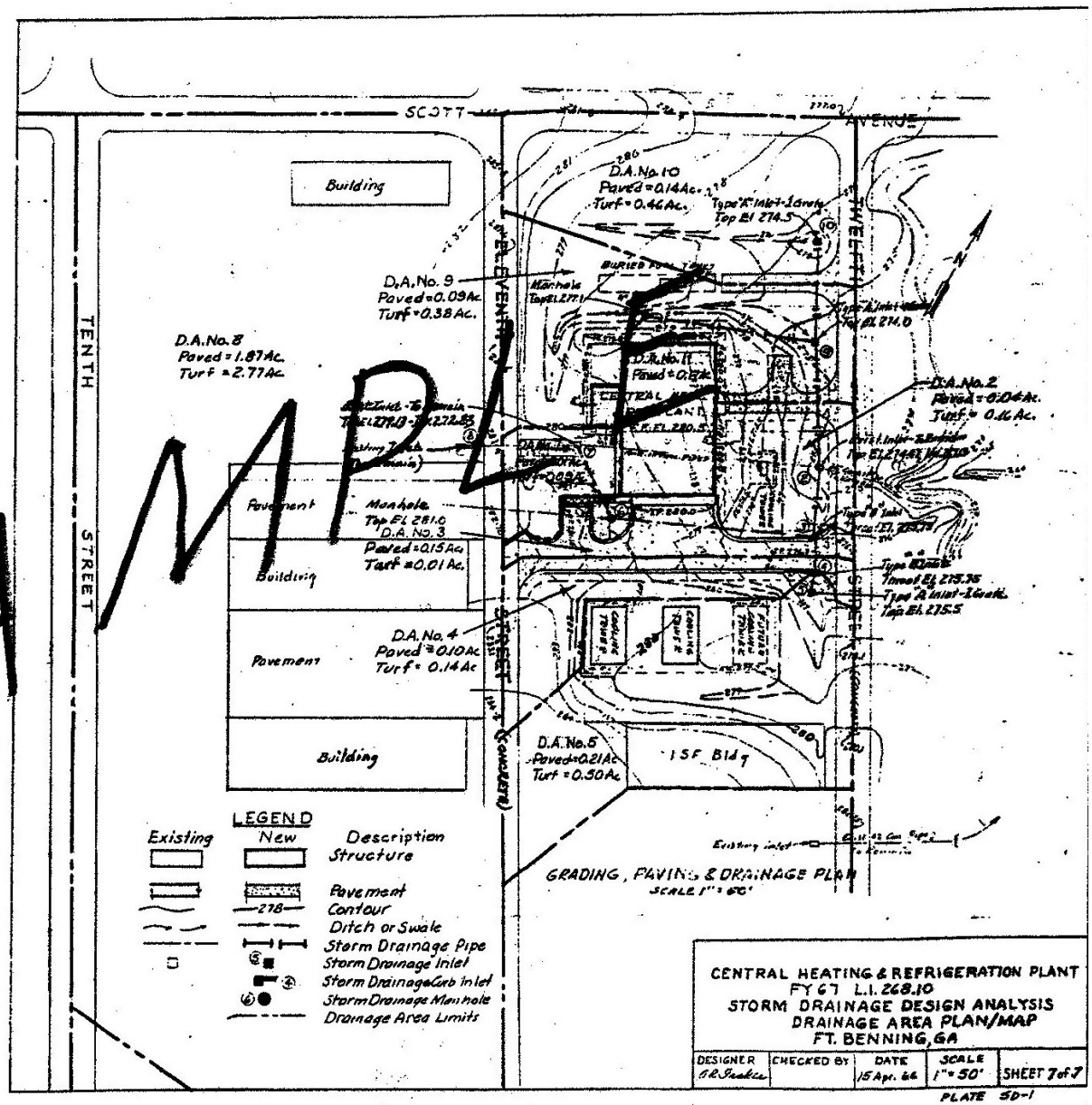
ARMY CE, SAVANNAH, GA DISTRICT


CENTRAL HEATING & REFRIGERATION PLANT
FY67, L.I.268.10
STORM DRAINAGE DESIGN ANALYSIS
PIPE PROFILES
GEORGIA
ETBENNING
ASSIGNED BY
CHECKED BY
DATE
SCALE
SHEET
PIPE PROFILE BETWEEN STR. 3,4,5
PIPE PROFILE BETWEEN STR. 2,9 & 10
PIPE PROFILE BETWEEN STR. 2,3,6,7,8
PIPE PROFILE BETWEEN STR. 9 & 10
Note To Designer: Include HGL on profiles in design analysis only, not on the profiles in contract drawings.

NOTES TO DESIGNER:

1. SITE TOPOGRAPHY MAY HAVE SURFACE DRAINAGE COMING ONTO SITE FROM OUTSIDE THE PROJECT'S CONSTRUCTION LIMITS. IF SO, THE DRAINAGE AREA (DA) MAP AND CALCULATIONS SHALL INCLUDE THIS RUNOFF AREA(S) TO PREVENT "NEW" STORM DRAINAGE SYSTEM FROM BEING UNDERDESIGNED.

2. THE DA MAP SHALL BE INCLUDED IN THE DESIGN ANALYSIS AS A "FOLD-OUT", BUT IS SHOWN HERE AS "PAGE SIZE" TO EXPEDITE MASS PRODUCTION.



SAMPLE

Sheet of	Date 19	Designed by	TABLE 1 DRAINAGE (ROADWAYS AND BUILT-OVER AREAS) DRAIN-INLET CAPACITIES	PROJECT
Q = CIA	A = Area (Acres) C = Imperiousness Factor I = Intensity (In./Hr.)	Checked by		LOCATION
				DIVISION OFFICE
DESIGN STORM 10 YR.	(Intensity-Duration curve) In./Hr.		DRAINAGE SECTION: _____	DISTRICT OFFICE

INLET NO.	DRAINAGE AREA (D.A.) IN ACRES			TOTAL A C	AVERAGE ROUGHNESS FACTOR "n"	AVERAGE SLOPE "S" IN PERCENT	LENGTH L (FEET)			DRAIN-INLET CAPACITY			CRITICAL CONTRIBUTION TO SYSTEM			
	PAVED	UNPAVED					Actual or Effective Length Feet	Equivalent L For n = 0.40 And S = 1%	Adopted L For t_c Computation	Critical Time, t_c Min.	Storm Intensity (I)	Rate of Supply c.f.s.	Critical Time, t_c Min.	Storm Intensity (I)	"Q" Rate of Supply c.f.s.	REMARKS
		BARE	TURF													
	C =	C =	C =													
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

CESAS FORM 1178
OCT 1987

NOTE: "Full Size" copies furnished on request to District Project Manager.

Sheet ____ of ____ Date ____, 19

STANDARD SUPPLY CURVE NOS. (BASED ON DESIGN STORM INDEX FROM FIG. I OF TM, USING 2 YR STORM)

For Paved Areas ____

For Bare Areas ____

For Turfed Areas ____

DESIGNED BY

CHECKED BY

TABLE 1A AIRFIELD DRAINAGE
DRAIN-INLET CAPACITIES REQUIRED TO LIMIT PONDING TO PERMISSIBLE VOLUMES

DRAINAGE SECTION ____

PROJECT

LOCATION

DIVISION OFFICE

DISTRICT OFFICE

INLET NO.	DRAINAGE AREA (D.A.) IN ACRES				PERMISSIBLE PONDING				Average Roughness Factor "n"	Average Slope "S" in Percent	LENGTH L (FT.)			STANDARD SUPPLY CURVE NO. x D.A.				Weighted Supply Curve (Col. 18 ÷ Col. 5)	DRAIN-INLET CAPACITY			CRITICAL CONTRIBUTION TO SYSTEM			NOTES
	Paved	Unpaved Bare	Unpaved Turf	Total	Depth At Inlet, Ft.	Pond Area, Thousands, of Sq. Ft.	Volume, Thousands of Cu. Ft.	Volume, Cu. Ft. Per Acre D.A.			Actual or Effective Length, Ft.	Equivalent L for n = .40 and S = 1%	L Adopted for Selecting Diagrams	Paved Areas	Unpaved Areas Bare	Unpaved Areas Turf	Total		t_c in Minutes	q_d in c.f.s. Per Acre of D.A.	Q_d in c.f.s. (Col. 21 x Col. 5)	t'_c in Minutes	q_d in c.f.s. Per Acre of D.A.	Q_d in c.f.s. (Col. 24 x Col. 5)	
	n=	n=	n=																						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26

SAS FORM 1154
OCT. 84 Previous edition is obsolete.

NOTE: "Full Size" copies furnished on request to District Project Manager.

Sheet of	Date , 19		DESIGNED BY	TABLE II AIRFIELD DRAINAGE, ROADS & BUILT OVER AREAS	PROJECT
FOR AIRFIELDS - SUPPLY CURVE NOS. (BASED ON DESIGN STORM INDEX, FIG 1 OF TM 5-ING 2 YR. STORM) For Paved Areas ____ For Bare Areas ____ For Turfed Areas ____	FOR ROADWAYS & BUILTOVER AREAS USE DESIGN STORM OF ____ n/HR, 10 YR. STORM, FIG 1 OF EM		CHECKED BY	SIZE AND PROFILE OF UNDERGROUND STORM DRAINS DRAINAGE SECTION ____	LOCATION / DIVISION OFFICE / DISTRICT OFFICE

POINT OF DESIGN			Critical Runoff Time To Produce Maximum Flow In Underground Drain							Rate of Inflow Into Underground Drains, In C.F.S., Corresponding To Adopted Value of t_c' (Column 10)														
	Distance, Feet					Drain Time, Min.				Inlet Number														
INLET OR JUNCTION NUMBER	From Main Outlet	From Preceding Inlet	Critical Inlet	Critical Inlet Time t_c Min.	Assumed Velocity in Pipe, Ft./Sec.	From Preceding Inlet	Accum. Total	Approx. t_c' (Col. 5) + Col. 8)	Adopted t_c in Min.															Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25

SAS FORM 1155
OCT. 84 Previous edition is obsolete.

NOTE: "Full Size" copies furnished on request to District Project Manager.

Exhibit A-1-6
(Page 1 of 1)

Sheet of
Date , 19
Computed by
Checked by
Pipe "n" =

DESIGNED BY
CHECKED BY

TABLE III, AIRFIELD DRAINAGE, ROADS & BUILT OVER AREAS
SIZE AND PROFILE OF UNDERGROUND STORM DRAINS
DRAINAGE SECTION _____

PROJECT
LOCATION
DIVISION OFFICE
DISTRICT OFFICE

INLET OR JUNCTION NUMBERS		Distance Between Design Points, in Feet, Measured to ℄ of Inlet or Junction	HYDRAULIC DESIGN DATA ON UNDERGROUND STORM DRAINS													CONSTRUCTION DATA			NOTES
				Trial Design			Adopted Design												
								Hydraulic Grade Line Thru Pipe Length			Head Loss at Change in Section						Elevation of Invert at Design Point, (Col. 2) in Feet		
From	To		Design Discharge Capacity, in c.f.s.	PIPE SLOPE Between Design Points, Ft./Ft.	Mean Velocity of Design Discharge in Ft./Sec.	Required Size of Pipe, in Inches	Selected Size of Pipe, in Inches	PIPE Slope in Ft./Ft.	Rise in Feet	Elevation of ℄ of Upstream Design Point	Velocity of Inflow, (V) in Ft./Sec.	Velocity Head $\frac{V^2}{2g}$	Loss Coefficient, K	Head Loss, in Feet, $= K\frac{V^2}{2g}$	Elevation Hydraulic Grade Line, Col. 11, Plus Head Loss, Col. 15	Length of Pipe Between Design Points, in Feet	Incoming Pipe	Outgoing Pipe	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

SAS FORM 1156
OCT. 84 Previous edition is obsolete.

NOTE: "Full Size" copies furnished on request to District Project Manager.

HYDRAULIC DESIGN DATA FOR CULVERTS (OTHER THAN AIRFIELDS)

DATE	SHEET OF
PROJECT	
LOCATION	
DESIGNED BY	CHECKED BY

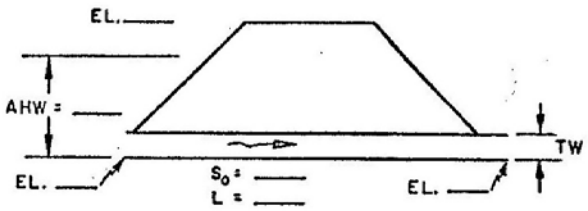
HYDROLOGIC AND CHANNEL INFORMATION

Q = _____ TW = _____

Q FROM COLUMN 14 OF TABLE "I"

SKETCH

STATION: _____



ALLOWABLE OUTLET VELOCITY = _____

CULVERT TYPE	Q	SIZE	HEADWATER COMPUTATION									CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			INLET CONT.		OUTLET CONTROL										
			$\frac{HW}{D}$	HW	K_e	d_c	$\frac{d_c+D}{2}$	h_o	H	LS_o	HW				

SUMMARY & RECOMMENDATIONS:

CESAS FORM 1179
OCT 87

NOTE: "Full Size" copies furnished on request to District Project Manager.

CHECKLIST FOR A-E'S REVIEW OF DESIGN SUBMITTALS

Location (Name of Military Installation)_____ Date of Review_____

Project _____

FY ___ L. I. No. _____ Preliminary Submittal _____ Final Submittal _____

REVIEW OF A-E CIVIL DESIGN
CHECK LIST
for
CONCEPT DESIGN

GENERAL	YES	NO	N/A
1. General site drawing requirements			
a. Are drawings clear and legible?	-----	-----	-----
b. Text size (1/8" min. height for full size drawings, 1/16 min. for 1/2 size drawings) (15 mm height for metric drawings)	-----	-----	-----
c. Is scale of drawing sufficient for clarity? (1" = 30' for plan sheets) (1:400 for metric plan sheets)	-----	-----	-----
d. Is North arrow indicated for plan sheets?	-----	-----	-----
e. Are match lines with sheet references indicated?	-----	-----	-----
f. Is a key plan for multiple plans shown?	-----	-----	-----
g. Is a bar scale provided on plan sheets?	-----	-----	-----
h. Do drawings comply with Savannah District Drafting Standards?	-----	-----	-----

CONCEPT DRAWINGS

1. Plate C-1, Location Plan with Vicinity map Is project site shown?	-----	-----	-----
2. Plate C-2, Topography plan	-----	-----	-----
a. Is note indicating surveying by whom and when provided?	-----	-----	-----
b. Are all existing utilities shown? (coordinated with master plans and field surveyed)	-----	-----	-----
c. Are invert elevations and top and bottom elevations for manhole structures shown?	-----	-----	-----
d. Are existing contours shown at proper interval? (1 foot interval for English units) (0.25 meter interval for metric units)	-----	-----	-----
e. Are all existing buildings with building numbers and finished floor elevation shown?	-----	-----	-----
f. Are all existing structures shown?	-----	-----	-----
g. Is pavement delineated and pavement types shown?	-----	-----	-----
h. Is curb or curb and gutter and sidewalk delineated ?	-----	-----	-----
i. Are existing vertical and horizontal survey controls shown? (2 control points per plan sheet)	-----	-----	-----
j. Are trees with size and kind indicated?	-----	-----	-----
k. Are grassed areas shown?	-----	-----	-----

l. Are existing easements, boundary lines, clearance zones and right of ways shown ? ----- ----- -----

3. Plate C-3, Removal plan
   a. Are items to be removed indicated on Topography plan? ----- ----- -----
   b. Are clearing limits delineated? ----- ----- -----
   c. Are utilities abandoned shown? ----- ----- -----
   d. Are construction limits indicated? ----- ----- -----
   e. Is phasing of the work to remove items needed, especially utilities? ----- ----- -----

Note: The Topography plan and removal plan may be combined where clarity is not impaired.

4. Plate C-4 Layout plan
   a. Is all new work shown and to scale? ----- ----- -----
   b. Does building orientation blend with the site? ----- ----- -----
   c. Does clearance requirement for site features meet force protection standard? ----- ----- -----
   (6 m minimum from bldg. to parking lot, 6 m minimum from parking lot to street)
   d. Is traffic circulation adequate? ----- ----- -----
   (sufficient radii, maneuver room for design vehicle, traffic flow)
   e. Is pedestrian circulation adequate? ----- ----- -----
   f. Is adequate parking for the type of facility provided? ----- ----- -----
   g. Does parking space size and isle meet standards? ----- ----- -----
   h. Was preservation of natural terrain and trees considered in the design? ----- ----- -----
   i. Was future expansion considered in the design? ----- ----- -----

5. Plate C-5 Grading & Drainage plan
   a. Are finished floor elevations set minimum of 0.5' above exterior grades? ----- ----- -----
   b. Are earth grades sloping away from bldg.'s? ----- ----- -----
   (minimum of 5.0% for 10')
   c. Are finished floor elevations set above 100 year flood elevation? ----- ----- -----
   d. Do earth grades comply with minimum (0.5%) and maximum (3:1) slopes? ----- ----- -----
   e. Do parking lot grades comply with standards? ----- ----- -----
   (1.5% max. traverse, 8% max. along aisle for 90 degree parking, 1.0% minimum)
   f. Does grading for drives, streets, and roads meet standards? ----- ----- -----
   g. Has offsite drainage coming onto the site been considered? ----- ----- -----
   h. Has grading been performed to prevent erosion? ----- ----- -----

i. Has balancing of earth work been considered? ----- ----- -----
j. Do number of storm drain inlets appear adequate? ----- ----- -----
k. Do storm drain pipe sizes shown appear adequate? ----- ----- -----

Note: The Concept Drawings are to be completed to a stage that a reasonable cost estimate can be obtained and the facility users/reviewers can determine what the intended final product would be. The design work is intended to be minimal, such changes at this stage of design would not result in significant lost effort.

NARRATIVE

1. Is a complete narrative provided? ----- ----- -----
   a. Is a brief description of project location provided? ----- ----- -----
   b. Is a description of the existing project site provided? ----- ----- -----
   c. Is a general overview of major planned site features provided? ----- ----- -----
   (Include: building orientation, drainage patterns, traffic circulation, pedestrian circulation, parking provision, handicapped provision, and security requirements)
   d. Is a brief description of planned storm drainage design provided? ----- ----- -----
   e. Is a brief description of pavement design provided? ----- ----- -----
   f. Is the anticipated thickness of the different pavement components shown? ----- ----- -----
   g. Is a list of anticipated specifications needed for the project provided? ----- ----- -----

REVIEW OF A-E CIVIL DESIGN
CHECK LIST
for
FINAL DESIGN

	YES	NO	N/A
GENERAL			
1. General site drawing requirements			
a. Are drawings clear and legible?	-----	-----	-----
b. Is North arrow indicated for plan sheets?	-----	-----	-----
c. Are match lines with sheet references indicated?	-----	-----	-----
d. Is a key plan for multiple plans shown?	-----	-----	-----
e. Is a bar scale provided on plan sheets?	-----	-----	----
f. Is a legend provided for the plan sheets?	-----	-----	----
g. Does drawings comply with Savannah District Drafting Standards?	-----	-----	-----

95% DRAWINGS

1. Plate C-1, Location Plan with Vicinity map			
a. Is project site shown?	-----	-----	-----
b. Is haul routes, borrow area and disposal area shown?	-----	-----	-----
(Add note to indicate disposal and borrow is to be provided by the contractor from an off base source, if not available on base)			
2. Plate C-2, Topography plan			
a. Does survey comply with Savannah District standards?	-----	-----	-----
3. Plate C-3, Removal plan			
a. Are items to be removed indicated on Topography plan?	-----	-----	-----
b. Are clearing limits delineated?	-----	-----	-----
c. Are utilities abandoned shown?	-----	-----	-----
d. Are construction limits indicated?	-----	-----	-----
e. Is phasing of the work to remove Items needed, especially utilities?	-----	-----	-----

Note: The Topography plan and removal plan may be combined where clarity is not impaired.

4. Plate C-4 Layout			
a. Are coordinates for corners of new buildings shown?	-----	-----	-----
b. Are dimension sufficient for layout?	-----	-----	-----
c. Does clearance requirement for site features meet standard?	-----	-----	-----
(6 m minimum from bldg. to parking lot, 6 m minimum from parking lot to street)			

d. Was traffic signage provided? ----- ----- -----
e. Does parking space size and isle meet standards? ----- ----- -----
f. Is a dumpster pad provided? ----- ----- -----
g. Was adequate turning room & radii provided for the design vehicle? ----- ----- -----
(Including access to dumpster pad)
h. Was curb and gutter provided? ----- ----- -----
i. Are security measures shown? ----- ----- -----
(Chain link fence, temporary fencing, etc.)
j. Has screening been provided for dumpster pads, electrical pads, and mechanical pads? ----- ----- -----
k. Are two existing coordinate control points shown per sheet? ----- ----- -----
l. Is pitched curb and gutter shown? ----- ----- -----
m. Has sidewalk been provided to all entrances to the buildings and coordinated with the building plans? ----- ----- -----
n. Are exterior steps required? ----- ----- -----
o. Are handicapped parking spaces and ramps provided? ---- ----- -----

5. Plate C-5 Grading & Drainage plan
a. Are finished floor elevations set minimum of 150 mm above exterior grades? ----- ----- -----
b. Are earth grade sloping away from buildings? ----- ----- -----
(minimum of 5.0% for 3 m)
c. Are finished floor elevations set above 100 year flood elevation? ----- ----- -----
d. Do earth grades comply with minimum (0.5%) and maximum (3:1) slopes? ----- ----- -----
e. Do parking lot grades comply with standards? ----- ----- -----
(1.5% max. Traverse, 8% max. along aisle for 90 degree parking, 1.0% minimum)
f. Does grading for drives, streets, and roads meet standards? ----- ----- -----
g. Has offsite drainage coming onto the site been considered? ----- ----- -----
h. Has grading been performed to prevent erosion? ---- ----- -----
i. Has balancing of earth work been considered? ---- ----- -----
j. Are number of storm drain inlets adequate for drainage? ----- ----- -----
k. Are storm drain outlets minimized and properly located? ----- ----- -----
l. Are storm drain pipes located to avoid conflict with other utilities? ----- ----- -----
m. Are surface drainage swales adequately protected to prevent erosion? ----- ----- -----
n. Has curb and gutter or other means been provide to prevent drainage over slopes? ----- ----- -----
o. Is a note indicating grassing for all disturbed finished earth areas disturbed by this contract shown? ----- ----- -----

p. Are two existing Bench Marks shown per plan sheet? ---- ----- -----
q. Are finished contours shown to 1 foot intervals or 0.25 meter intervals? ----- ----- -----
r. Are spot grades shown at the corners of buildings, corners of parking lots and at grade change points? ----- ----- -----
s. Are roof drains provided and shown? ----- ----- -----
t. Was storm water runoff over sidewalks avoided? ----- ----- -----
u. Are grades for sidewalk and ramps acceptable for handicap? ----- ----- -----

6. Plate C-6 Erosion Controls Plan
a. Are erosion controls designed to criteria of the State in which the project is located? ----- ----- -----
b. Has temporary or permanent channel lining been coordinated with channel design calculations and shown on the plans? ----- ----- -----
c. Has length, width and size of riprap for outlets been coordinated with outlet stability design calculations and shown on the plans? ----- ----- -----
d. Has a sediment basins been designed for large disturbed areas? ----- ----- -----
e. Has temporary slope protection been considered? ----- ----- -----
f. Are all inlets protected from sediment? ----- ----- -----
g. Are silt fences provided? ----- ----- -----
h. Are erosion controls designed to prevent sediment from leaving the site during all phases of construction? ----- ----- -----
i. Are general erosion control notes shown? ----- ----- -----

7. Plate C-7 Site Sections
a. Are general sections through site shown? ----- ----- -----

8. Plate C-8 Concrete Joint Layout
a. Was a concrete joint layout provided? ----- ----- -----
b. Was adequate joint spacing used for thickness of pavement? ----- ----- -----
c. Are contraction joint, construction joints and expansion properly located? ----- ----- -----
d. Are expansion joints provided at the interface of the concrete pavement and structures? ----- ----- -----
e. Are all odd shaped slabs and slabs containing structure (manholes, etc.) reinforced? ----- ----- -----
f. Was concrete joint layout coordinated with the location of drainage structures and other structures located in the pavement? ----- ----- -----
g. Are dowels and tie bars used in certain joints as required by standards? ----- ----- -----

h. Is a joint legend shown? ----- ----- -----

9. Plate C-9 Concrete Joint Details
   a. Are details provided for each type of joint used? ----- ----- -----
   b. Are sealant details provided? ----- ----- -----
   c Is a reinforcement detail provided? ----- ----- -----
   d. Was the proper size and length selected for dowels and tie bars? ----- ----- -----

10. Plate C-10 Storm Drain Profiles
   a. Have profiles been checked for minimum earth cover? ----- ----- -----
   b. Are all invert elevations and top of structure elevations shown? ----- ----- -----
   c. Are all new and existing utilities crossings shown at the proper location and elevation on the profiles? ----- ----- -----
   d. Have all conflicts with utilities lines and storm drainage lines been resolved? ----- ----- -----

11. Plate C-11 Pavement Details
   a. Are typical pavement sections shown and coordinated with the pavement design analysis? ----- ----- -----
   b. Are sidewalk details shown? ----- ----- -----
   c. Are curb & gutter details shown for normal and pitched curb and gutter? ----- ----- -----
   d. Are signage details shown? ----- ----- -----
   (stop sign, handicap signs, etc.)
   e. Is a tapered curb detail needed? ----- ----- -----
   f. Are some sidewalks designed for vehicular traffic and detail shown? ----- ----- -----
   g. Are typical parking space details provided? ----- ----- -----
   h. Are handicap parking and ramps provided? ----- ----- -----
   i. Are other pavement related details required? ----- ----- -----

12. Plate C-12 Drainage Details
   a. Are inlet details provided (including drop inlets, weir inlets, and curb inlets) ----- ----- -----
   b. Are manhole details provided? ----- ----- -----
   c. Are grate details provided for inlets and manholes? ----- ----- -----
   d. Are paved channel details provided? ----- ----- -----
   e. Are roof drain details provided? ----- ----- -----
   f. Are step inserts details provided for deep drainage structures? ----- ----- -----
   g. Are other drainage details required? ----- ----- -----
   h. Are head wall details provided? ----- ----- -----
   i. Are riprap outlet protection details provided? ----- ----- -----

13. Plate C-13 Dumpster Pad Details and Miscellaneous Details

a. Are dumpster details provided? ----- ----- -----

b. Are miscellaneous details needed? ----- ----- -----
(retaining walls, bollards, etc.)

Note: Savannah District Details are preferred in lieu of other details when available. The Corps of Engineers field personnel are familiar with the details. Also, The details have not cause modifications of the contract when used appropriately.

14. Plate C-14 Storm Drain Schedule

a. Are invert elevations, top and bottom of structure elevations, pipe types, and length of pipes shown? ----- ----- -----

b. Has the appropriate class of pipe or gage of pipe been selected and shown? ----- ----- -----

15. Plate C-15 Erosion Control Details

a. Is a construction schedule shown? ----- ----- -----

b. Is a construction entrance detail shown? ----- ----- -----

c. Are temporary channel lining details shown and coordinated with the channel design calculations? ----- ----- -----

d. Are temporary sediment basin details shown and coordinated with sediment basin design calculations? ----- ----- -----

e. Are inlet protection details shown? ----- ----- -----

f. Are silt fence details shown? ----- ----- -----

g. Are other erosion details needed? ----- ----- -----

h. Are the details acceptable to the State from which the permit is to be obtained? ----- ----- -----

Note: The Savannah District erosion control details are available to the AE. The Savannah District details were based on the North Carolina manual, but have been accepted by South Carolina and Georgia. It is the AE responsibility to provide details which are acceptable to the state in which the permit is to be obtained.

16. Plate C-16 Chain Link Fence Details

a. Was Savannah District Standard used? ----- ----- -----

Note: The above list of drawings are drawings that are common in most projects. The list of drawings are not intended to be conclusive.

DESIGN ANALYSIS

1. Pavement Design Analysis

a. Was the pavement design analysis provided and based on Corps of Engineers criteria? ----- ----- -----

b. Are the pavement thickness shown based on the California Bearing Ratio CBR or Modulus of Subgrade

Reaction (k) provided in the soils report? ----- ----- -----
c. Are the design vehicles shown in the analysis? ----- ----- -----
d. Was the minimum pavement thickness provided for POV parking? ----- ----- -----

2. Storm Drain Design Analysis
a. Was procedures and forms shown in exhibit A-1-2 followed? ----- ----- -----
b. Were inlet capacities checked? ----- ----- -----
c. Were the capacities of inlets on grade considered? ----- ----- -----
d. Is a drainage area map provided? ----- ----- -----
e. Was drainage from offsite considered? ----- ----- -----
f. Were roof drains designed for a 5 minute time of concentration? ----- ----- -----
g. Were culverts checked for both inlet and outlet control in the design? ----- ----- -----
(see Exhibit A-1-8)
h. Was the hydraulic grade line considered for each drainage structure? ----- ----- -----
i . Were the minimum pipe sizes used? ----- ----- -----
(300 mm minimum for storm drains, 450 mm minimum for culverts, 150 mm minimum for roof drains)

3. Erosion Control Analysis
a. Has the Erosion controls been designed to State criteria? ----- ----- -----
b. Are temporary and permanent channel design calculations provided? ----- ----- -----
c. Are outlet protection design calculations provided? ----- ----- -----
d. Are sediment basin design calculations provided? ----- ----- -----
e. Are other calculations as required by the State provided? ----- ----- -----

EROSION CONTROL PACKAGE

1. The content of the erosion control package is to be determined from the State erosion control manual, But will generally consist of the following:

a. Drawings:
1. Location Plan with Vicinity Map ----- ----- -----
2. Topography plan ----- ----- -----
3. Erosion control plan ----- ----- -----
4. Drainage Details ----- ----- -----
5. Erosion Control Details ----- ----- -----
b. Seeding Specifications or Seeding Schedule on plans ----- ----- -----
c. Erosion Control Narrative ---- ----- -----
d. Erosion control calculations ----- ----- -----

CHECK LIST
for
CONCEPT DESIGN

GENERAL

	YES	NO	N/A
1. General site drawing requirements			
a. Are drawings clear and legible?	-----	-----	-----
b. Text size (1/8" min. height for full size drawings, 1/16 min. for 1/2 size drawings) (15 mm height for metric drawings)	-----	-----	-----
c. Is scale of drawing sufficient for clarity? (1" = 30' for plan sheets) (1:400 for metric plan sheets)	-----	-----	-----
d. Is North arrow indicated for plan sheets?	-----	-----	-----
e. Are match lines with sheet references indicated?	-----	-----	-----
f. Is a key plan for multiple plans shown?	-----	-----	-----
g. Is a bar scale provided on plan sheets?	-----	-----	-----
h. Does drawings comply with Savannah District Drafting Standards?	-----	-----	-----

CONCEPT DRAWINGS

1. Plate W-1, Utility Site Plan (Water, Sanitary Sewer, Gas)			
a. Is project site shown?	-----	-----	-----
b. Are all existing utilities shown? (coordinated with master plans and field surveyed)	-----	-----	-----
c. Are inverts elevations and top & bottom elevations for manhole structures shown?	-----	-----	-----
d. Are existing fire hydrants used to protect project shown?	-----	-----	-----
e. Are all existing utility sizes and elevation shown?	-----	-----	-----
f. Has Standard legend Exhibit A-8-2 of Savannah District Design Manual been used?	-----	-----	-----
g. Are all items on drawing depicted using line weight 0 with the exception of new water, sewers, and gas line which shall be depicted using line weight 2?	-----	-----	-----
h. Are all items being removed been deleted from this drawing?	-----	-----	-----
i. Are all valves, fitting etc. being show on the drawing?	-----	-----	-----
j. Are elevations and slope for new sewers being shown?	-----	-----	-----
k. Is the sprinkler service line dedicated from main to building?	-----	-----	-----
l. Is the only valve on the sprinkler service line post			

indicator valve? ----- ----- -----

APPLICABLE PUBLICATION

1. Technical Manual
   a. Are the water line layout in accordance with TM5-813-5/AFM 88-10 Vol. 5? ----- ----- -----
   b. Has the fire demand been determine in accordance with Military Handbook 1008B ? ----- ----- -----
   c. Is the sanitary and industrial wastewater collection system in accordance with TM 814-1/AFM 88-11 Vol. 1? ----- ----- -----
   d. Is the sanitary and industrial pumping station and force mains in accordance TM 5-815-2/AFM 88-11 Vol. 2? ----- ----- -----
2. Industry Standards
   a. Is the oil water separator designed to API Standard? ----- ----- -----

DESIGN ANALYSIS AND NARRATIVE

1. Design Analysis is a complete design analysis provided? ----- ----- -----
   a. Has the building fire demand been determined? ----- ----- -----
   b. Has the existing water system been checked by a fire flow test to determine if the existing water system is adequate to meet the building fire demand? ----- ----- -----
   c. Has the service line been checked for velocity, flow, and pressure drop? ----- ----- -----
   d. Is the oil water separator designed to API standards? ----- ----- -----

2. Narrative is a complete narrative provided? ----- ----- -----
   a. Is a brief description of project location provided? ----- ----- -----
   b. Is a description of the existing utilities provided? ----- ----- -----
   c. Is a description of planned utilities and there adequacy for the project? ----- ----- -----
   d. Is a list of anticipated specifications needed for the project provided? ----- ----- -----

FINAL ENVIRONMENTAL DESIGN
CHECK LIST

GENERAL	YES	NO	N/A
1. General site drawing requirements			
a. Are drawings clear and legible?	-----	-----	-----
b. Text size (1/8 min. height for full size drawings, 1/16 min. for 1/2 size drawings) (15 mm height for metric drawings)	-----	-----	-----
c. Is scale of drawing sufficient for clarity? (1 = 30 for plan sheets) (1:400 for metric plan sheets)	-----	-----	-----
d. Is North arrow indicated for plan sheets?	-----	-----	-----
e. Are match lines with sheet references indicated?	-----	-----	-----
f. Is a key plan for multiple plans shown?	-----	-----	-----
g. Is a bar scale provided on plan sheets?	-----	-----	-----
h. Do drawings comply with Savannah District Drafting Standards?	-----	-----	-----

FINAL DRAWINGS

1. Plate W-1, Utility Site Plan (Water, Sanitary Sewer, Gas)			
a. Is project site shown?	-----	-----	-----
b. Are all existing utilities shown? (coordinated with master plans and field surveyed)	-----	-----	-----
c. Are inverts elevations and top & bottom elevations for manhole structures shown?	-----	-----	-----
d. Are existing fire hydrants used to protect project shown?	-----	-----	-----
e. Are all existing utility sizes and elevation shown?	-----	-----	-----
f. Has standard legend Exhibit A-8-2 of Savannah District Design Manual been used?	-----	-----	-----
g. Are all items on drawing depicted using line weight 0 with the exception of new water, sewers, and gas line which shall be depicted using line weight 2?	-----	-----	-----
h. Are all items being removed been deleted from this drawing?	-----	-----	-----
i. Are all valves, fitting etc. been show on the drawing?	-----	-----	-----
j. Are elevations and slope for new sewers been shown?	-----	-----	-----
k. Is the sprinkler service line dedicated from main to building?	-----	-----	-----
l. Is the only valve on the sprinkler service line post indicator valve?	-----	-----	-----
2. Plate W-2 Sanitary and Industrial Waste Profiles			
a. Is profiles provided for all sewers from building to existing			

sewer? ----- ----- -----
b. Are all interfering utilities shown? ----- ----- -----
c. Are finished and existing grades shown? ----- ----- -----
d. Are all structures and pavement shown? ----- ----- -----
e. Are all manhole, clean outs, and building line stationed? ----- ----- -----
f. Are all invert elevations shown? ----- ----- -----

3. Plate W-3 Details
a. Are complete water details provided? ----- ----- -----
b. Are complete sewer details provided? ----- ----- -----
c. Are treatment equipment and structures details provided ? ----- ----- -----
d. Are pipe layout for pump station provided? ----- ----- -----
e. Are lift station details been provided? ----- ----- -----

APPLICABLE PUBLICATION
1. Technical Manual
a. Are the water line layouts in accordance with TM 5-813-5/AFM 88-10 Vol. 5? ----- ----- -----
b. Has the fire demand been determine in accordance with Military Handbook 1008B ? ----- ----- -----
c. Is the sanitary and industrial wastewater collection system in accordance with TM-814-1/AFM 88-11 Vol. 1? ----- ----- -----
d. Is the sanitary and industrial pumping station and force mains in accordance TM 5-815-2/AFM 88-11 Vol. 2? ----- ----- -----
2. Industry Standards
a. Is the oil water separator designed to API Standard? ----- ----- -----

DESIGN ANALYSIS AND PERMITS

1. Design Analysis is a Complete design analysis provided? ----- ----- -----
a. Has the building fire demand been determine? ----- ----- -----
b. Has the existing water system been checked by a fire flow test to determine if the existing water system is adequate to meet the building fire demand ----- ----- -----
c. Have the service line lines been checked for velocity, flow, and pressure drop? ----- ----- -----
d. Is the oil water separator designed to API standards? ----- ----- -----

2. Are any Permits required for this project? ----- ----- -----
a. Has a county permit been obtained for septic tank system? ----- ----- -----
b. Have State permits been obtained for the required utility systems? ----- ----- -----

SPECIFICATIONS

1. Have all required specifications been provided? ----- ----- -----
   a. Have specifications been tailored to the job? ----- ----- -----

REVIEW OF A-E LANDSCAPE DESIGN
CHECK LIST
for
LANDSCAPE DESIGN

GENERAL	YES	NO	N/A
1. General site drawing requirements			
a. Are drawings clear and legible?	-----	-----	-----
b. Text size (1/8 min. height for full size drawings, 1/16 min. for 1/2 size drawings) (15 mm height for metric drawings)	-----	-----	-----
c. Is North arrow indicated for plan sheets ?	-----	-----	-----
d. Are match lines with sheet references indicated?	-----	-----	-----
e. Is a key plan for multiple plans shown ?	-----	-----	-----
f. Is a bar scale provided on plan sheets ?	-----	-----	-----
g. Does drawings comply with Savannah District Drafting Standards ?	-----	-----	-----

CONCEPT DESIGN

1. Is a concept landscape plan provided for the project? Does it show the Landscape Architect's intent for the overall project?	-----	-----	-----
2. Is a landscape narrative provided?	-----	-----	-----
3. Are all existing trees and grassed areas shown on the site plan and the landscape plan?	-----	-----	-----
4. Is a list of landscape specifications provided?	-----	-----	-----
5. Are the landscape quantities included in the cost estimate?	-----	-----	-----
6. Does the landscape plan follow the Base's Installation Design Guide?	-----	-----	-----
7. For Ft. Bragg Projects: Do they comply with the 1997 Project Criteria and Functional Requirements and include a tree?	-----	-----	-----

PRELIMINARY DESIGN

1. Is a fairly complete landscape plan for the entire site provided?	-----	-----	-----
2. Are existing trees preserved as much as possible? Show trees to be preserved on both the Removal and Landscape Plans	-----	-----	-----
3. Are all disturbed areas grassed or planted with appropriate grasses and plants?	-----	-----	-----
4. Are landscape quantities provided in the plant list?	-----	-----	-----
5. Does the landscape plan show all existing buildings to remain, all proposed buildings, paved areas, signs, transformers, chillers, and dumpster pads and their			

screening? ----- ----- -----
(Screening shall consist of screen walls, shrub hedges or berm with shrub plantings)

6. Is the design simple and low maintenance? ----- ----- -----
7. Does the plan use hardy, low maintenance plants, native to the area ? ----- ----- -----
8. Does the plan emphasize trees? ----- ----- -----
9. Is the foundation planting plan at (1□=20□) or (1:250)? ----- ----- -----
10. Is the tree planting plan at (1□=30□) or (1:400)? ----- ----- -----
11. Do the parking lots have sufficient shade trees? ----- ----- -----
(1 min per 5,000 sf or 500 sm at Ft. Bragg)
(1 min per 18 stalls at all other bases)
12. Are the trees and shrubs drawn at their mature size ? ----- ----- -----
13. Does the design:
a. Reduce noise and glare? ----- ----- -----
b. Modify wind and temperature? ----- ----- -----
c. Control dust and erosion? ----- ----- -----
d. Provide compatibility with the lighting plan? ----- ----- -----
e. Avoid causing dangerous sight lines at road intersections, for drivers and pedestrians? ----- ----- -----
f. Avoid conflicts with underground utilities? ----- ----- -----

14. Has the landscape plan been coordinated with all civil, erosion and utility plans? ----- ----- -----
15. Does the landscape plan and the erosion control plan use the same grass? ----- ----- -----
16. Are draft landscape specifications submitted? ----- ----- -----

FINAL DESIGN

1. Is a complete plant list provided with quantities, common and botanical names, sizes (caliper or container size), spacing, and special requirements? ----- ----- -----
2. Is the current American Standard for Nursery Stock ANSI Z 60.1-1997 being followed? ----- ----- -----
3. Are street shade trees provided at 30-40□ (9-12m) on center along the street? ----- ----- -----
4. Are the proposed plants shown on the drawings by a (+) mark and a circle drawn at the mature size of the plant? ----- ----- -----
5. Are tree, shrub, and ground cover planting details provided? ----- ----- -----
(No staking should be shown.)
6. Is tree protection fence shown around existing trees to be saved ? Is there a detail of the tree protection fence? ----- ----- -----
7. Are final specifications provided? ----- ----- -----
8. Does the grassing specification provide the appropriate permanent and temporary grass species? ----- ----- -----

9. Does the final landscape plans, specs, and plant list all agree in quantities, symbols and species ? ----- ----- -----
10. Provide a note to the bottom of the plant list stating that "When discrepancies occur between quantities on the plant list and those on the plan, use what is shown on the plan." ----- ----- -----
11. Is irrigation for the landscaping provided? ----- ----- -----
12. Does the planting mix include Agrosoke Crystals or equal? (Ft. Bragg requirement only) ----- ----- -----