FINAL
BASIS OF DESIGN REPORT

SUNRISE POWERLINK

230kV & 500kV ACCESS ROADS & MAINTENANCE PADS

Prepared for:

San Diego Gas & Electric Company
8316 Century Park Blvd, Bldg CP52G
San Diego, CA 92123-1548

Prepared by:

Bureau Veritas North America, Inc.
11590 West Bernardo Court, Suite 100
San Diego, CA 92717-1624

April 2, 2009
Updated April 21, 2009
Updated August 6, 2010

Sunrise Powerlink
230kV & 500kV Access Roads & Maintenance Pads

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LIST OF REFERENCES
(Under Separate Cover)

REFERENCE NO.	DESCRIPTION
1	SDG&E Transmission Engineering Construction Specification General Requirements Specification No. TE-0100
2	SDG&E Transmission Engineering Construction Specification Site Preparation and Access Roads Specification No. TE-0101
3	Project Blasting Preparation and Protection Plans SDG&E Requirements for Review Package Submittal
4	SDG&E Water Quality Construction Best Management Practices Manual dated December 2002
5	California Regional Water Quality Control Board – San Diego Region – Order NO. R9-2007-0001, NPDES no. CAS0108758 Waste Discharge Requirements for Discharges of Urban Runoff
6	California Stormwater Quality Association – Stormwater Best Management Practice Handbook – Construction dated January 2003
7	California Stormwater Quality Association – Stormwater Best Management Practice Handbook – Industrial and Commercial dated January 2003

Sunrise Powerlink
230kV & 500kV Access Roads & Maintenance Pads

APPENDICES

SECTION NO.	DESCRIPTION
A	Sunrise Powerlink Plan Preparation – CADD Standards
B	Civil 3D Guidelines
C	SDG&E Civil/Structural Engineering Design & Procedure Manual for Transmission Line Access Roads
D	Condor Maintenance Vehicle
E	Draft Sunrise Powerlink EIR/EIS Mitigation Design Standards Access Roads
F	County Of San Diego Hydrologic Reference Material
G	County Of Imperial Hydrologic Reference Material
H	Hydraulic Reference Material

1. PURPOSE

This report supports and documents the basis of design for the final design work performed for San Diego Gas and Electric Company's (SDG&E) Sunrise Powerlink 500kV Access Roads and Structure Pads.

This report presents design objectives and approaches, and the controlling factors that influenced the final design product. As well, it establishes the design parameters to be used, and variations from the design criteria.

This Basis of Design Report is the foundation for the work on the access roads and structure pads on the Sunrise Powerlink Project.

2. AUTHORIZATION

San Diego Gas and Electric Company's (SDG&E) has contracted with Bureau Veritas North America, Inc. (BV) for engineering consulting services on the Sunrise Powerlink 230kV and 500kV Access Roads and Maintenance Pads. The contract states:

"The Consultant shall perform, at its own proper cost and expense, in the most substantial and skillful manner, to the satisfaction of the Company, engineering services which include, but are not limited to: project scoping, conceptual design, development of P&ID'S, engineering design, geotechnical investigation, geotechnical design, Storm Water Permitting, other miscellaneous permit processing, and construction support, all as further described in each Release issued by the Company hereunder"

This work program has been structured such that the overall design contract and scope of work has been agreed upon. However, BV will perform the work based on individual task authorizations called "Releases". Each release has scope, schedule, products, and fee defined in writing and approved by SDG&E for each separate Release.

SDG&E has divided the length of the project into 17 sections as shown in Table 1.

This Basis of Design Report covers the Sections 4A through 10B and includes the access roads, structure maintenance pads, tower staging access pad, pull sites, construction yards, rehabilitation of existing roads and a bridge design for the Sunrise Powerlink Project.

3. PROJECT DESCRIPTION

The SDG&E Sunrise Powerlink Project is planned to increase electrical power supply and options for the San Diego area. It is roughly a 150 mile electrical transmission line extending from the Penasquitos Substation in San Diego easterly to the Imperial Valley Substation near El Centro **(Figure 1)**. The general purpose of the this contract with Bureau Veritas is to provide engineering support and to provide construction drawings and documents (i.e., wall profiles, cost estimates, controls, etc.) for the transmission line access roads and structure maintenance pads.

SDG&E has divided the length of the project into sections and numbered the tower locations. **Table 1** summarizes the sections and tower numbers. In addition, SDG&E

has combined sections into links for construction purposes. There are five links identified as follows:

Link 1 – Sections 9B, 9C, 10A, 10B
Link 2 – Sections 8A, 8B, 8C, 8D, 8E, 9A
Link 3 – Suncrest Substation
Link 4 – Section 6
Link 5 – Sections 4A, 5, 7

Link 3 - Suncrest Substation is not in BV's scope of work. In addition, Link 4 – Section 6 is the underground section and is not a part of BV's scope of work except for the access roads and maintenance pad to the cable poles. Cable poles are the transition from underground to overhead transmission.

The voltage differs through various sections of the line. The 230kV section is from Segment 4A to Segment 7 while the 500kV section is from Segment 8A to Segment 10B.

The structures constructed will be either lattice tower or steel pole. The structures are also categorized as tangent, angle or deadend towers as determined by the angle created by the incoming and outgoing line at the structure. These designations are provided by SDG&E.

The sequence of construction is unknown at this time.

SDG&E provided mapping to Bureau Veritas for the entire 150 mile Sunrise Powerlink. SDG&E has performed survey to set the tower centerline and stake each leg at the tower site.

SDG&E has performed right-of-way survey and mapping on the project. This survey and mapping includes Assessor Parcel Numbers (APN), Property Line (P/L), right-of-way (ROW), streams, existing roads and structures, etc.

SDG&E has contracted with a consulting geotechnical firm to conduct geotechnical investigation for the Sunrise Powerlink. This geotechnical investigation will provide design parameters required for retaining wall, access road, pad grading and other site work and include preliminary recommendations for any remedial grading, slope stability, retaining devices and site drainage.

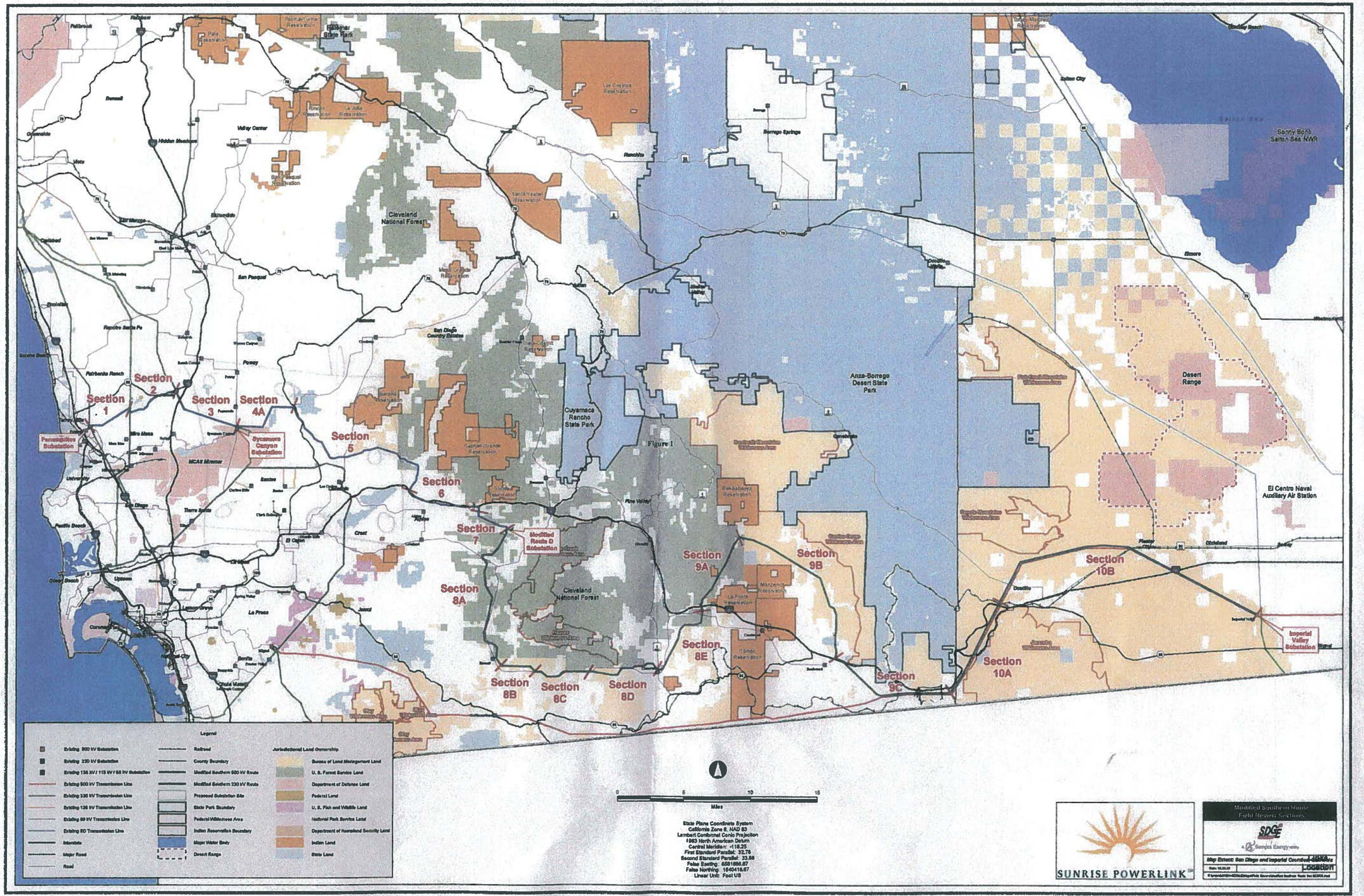

Section 1
Section 2
Section 3
Section 4A
Section 5
Section 6
Section 7
Section 8A
Section 8B
Section 8C
Section 8D
Section 8E
Section 9A
Section 9B
Section 9C
Section 10A
Section 10B
Modified Route D Substation
Penasquitos Substation
Sycamore Canyon Substation
Imperial Valley Substation
Figure 1
Cleveland National Forest
Anza-Borrego Desert State Park
Cuyamaca Rancho State Park
Desert Range
Sonny Bono Salton Sea NWR
El Centro Naval Auxiliary Air Station
MCAS Miramar
Legend
Existing 500 kV Substation
Existing 230 kV Substation
Existing 138 kV / 115 kV / 69 kV Substation
Existing 500 kV Transmission Line
Existing 230 kV Transmission Line
Existing 138 kV Transmission Line
Existing 69 kV Transmission Line
Existing RD Transmission Line
Interstate
Major Road
Road
Railroad
County Boundary
Modified Southern 500 kV Route
Modified Southern 230 kV Route
Proposed Substation Site
State Park Boundary
Federal Wilderness Area
Indian Reservation Boundary
Major Water Body
Desert Range
Jurisdictional Land Ownership
Bureau of Land Management Land
U. S. Forest Service Land
Department of Defense Land
Federal Land
U. S. Fish and Wildlife Land
National Park Service Land
Department of Homeland Security Land
Indian Land
State Land
0 5 10 15
Miles
State Plane Coordinate System
California Zone 6, NAD 83
Lambert Conformal Conic Projection
1983 North American Datum
Central Meridian: -118.25
First Standard Parallel: 32.78
Second Standard Parallel: 33.88
False Easting: 6561666.67
False Northing: 1640416.67
Linear Unit: Feet US
SUNRISE POWERLINK
Modified Southern Route
Field Review Sections
SDGE
Map Extent: San Diego and Imperial Counties
Location

FIGURE 1

Table 1

Section Details

Link No.	Section No.	Section Description	Sites Numbers
		Sections 1 – 7 (230kV)	
	1	-	-
	2	-	-
	3	I-15 & SR 56 to Sycamore Canyon Substation	-
5	4A	Sycamore Canyon Substation to SR 67 (near Poway Parkway)	3 – 29
5	5	SR 67 & Foster Truck Trail to I-8 & Arnold Way (near Alpine)	31 -86
4	6	I-8 (near Alpine) to I-8 (near Viejas Indian Reservation)	Underground Section
5	7	I-8 & South Grade road to Japatul Road	98 – 109
		Sections 8 – 10 (500kV)	
2	8A	Southwestern corner of the Cleveland National Forest approximately from Barrett Junction to Japatul Road	1 -41
2	8B	Southwestern corner of the Cleveland National Forest (north of Barrett Junction to south of Barrett Lake)	42 - 47
2	8C	Potrero Creek and Mc Almond Canyons near the southern boundary of the Cleveland National Forest	48 - 67
2	8D	North of Big Potrero Truck Trail in the Cleveland National Forest	68 - 88
2	8E	I-8 & west of La Posta Truck Trail to Buckman Springs Road and west of the Campo Indian Reservation	89 - 120
2	9A	Eastern boundary of Cleveland National Forest (near Thing Valley) to I-8 & La Posta Indian Reservation	121 – 140
1	9B	I-8 & McCain Valley Road (near Boulevard) to Eastern edge of Cleveland National Forest (near Thing Valley)	141 - 215
1	9C	I-8 Split -Top of the Grade to I-8 & McCain Valley Road (near Boulevard)	217 - 269
1	10A	I-8 near Ocotillo to I-8 Split – Top of the Grade	270 – 281
1	10B	Imperial Valley Substation to I-8 near Ocotillo	291 - 363

Source: SDG&E April 2010

4. GENERAL CRITERIA

The services provided by Bureau Veritas to complete the final design of access roads and maintenance pads for the SDG&E Sunrise Powerlink Project shall be in accordance with the latest SDG&E standards, methods, procedures and policies for transmission line design and include the following:

- SDG&E Design and Procedure Manual for Transmission Line Access Roads, May 18, 2007
- SDG&E Construction Specifications General Requirements No TE-0100, December 15, 2006
- SDG&E Construction Specifications Site Preparation and Access Roads No. TE-0101, May 18, 2007
- Project Blasting Preparation and Protection Plans – SDG&E Requirements for Review Package Submittal, May 25, 2007
- San Diego County Drainage Design Manual
- San Diego County Hydrology Manual
- Imperial Valley Hydrology Manual
- San Diego Area Regional Standard Drawing
- Caltrans Highway Design Manual, Section 200
- Sempra Energy Utilities Water Quality Construction Best Management Practice Manual
- California Regional Water Quality Control Board Guidelines for Construction Practices
- California State Water Resources Control board Construction Storm Water General NPDES Permit

As standards are updated, the design may be modified based on discussion with SDG&E. Additionally, standards of local agencies and other utilities shall be adhered to, in so far as they are not in conflict with SDG&E standard design criteria or policy.

5. CADD CRITERIA

A Computer Aided Drafting and Design (CADD) standard titled "Sunrise Powerlink Plan Preparation" dated July 21, 2008 **(Appendix A)** was developed for the project in order to provide consistency in the creation of CADD drawings, maximum flexibility, productivity, and automated quality control. This was accomplished by defining template files, project directories and CADD file names, page setups and plotting, text styles, and layer names.

Naming conventions were established for the electronic drawing files, which allowed CADD users to organize and to provide clear structure for both sheet and reference drawing files within the project directories.

The CADD work for the project will be performed in Civil 3D Version 2008. In addition to the CADD standards, Civil 3D conventions **(Appendix B)** have also been developed to assist the designer.

Plan submittals will be full size sheets in pdf format. In addition, the final submittal will also include the Civil 3D files.

6. GRADING AND DRAINAGE CRITERIA

6.1 Description of Work

The plans, specifications, and cost estimate for the access roads and structure pads shall be prepared to the final level of completion. Plans shall include details, profiles, retaining wall profiles, notes, and control information. Plans shall be prepared for the needed modifications or new construction.

6.2 Design Approach

All proposed roadway grades, cross slopes, widths, and curvatures shall comply with SDG&E standard design practices as stated in the SDG&E Civil/Structural Engineering Design and Procedure Manual for Transmission Line Access Roads dated May 18, 2007 **(Appendix C)**. Any proposed improvements affecting roadways shall be shown. All structure pad grades, cross slopes, widths, and access requirements shall comply with SDG&E standard design practices.

For supplemental information, SDG&E Transmission Engineering has prepared specifications titled Construction Specification Site Preparation and Access Roads, Specification No. TE-0101 and Construction Specification General Requirements No. TE-0100. These are incorporated in by reference **(References 1 and 2)**.

Deviations from SDG&E standards shall be submitted in writing to SDG&E.

Plans shall be prepared on SDG&E sheets in conformance to SDG&E requirements and standards. Plans shall be prepared at a scale of 1 inch = 30 feet. Plans shall be submitted at the 50%, 90%, and Final levels of completion. In addition, supplemental submittals were made at 70% for construction bid purposes.

With respect to maintenance pads, SDG&E has noted that tower foundations can be constructed on local non-level areas. However, level areas immediately adjacent to the structures and accessible by spur roads are required.

To facilitate designers, a Reference Guide to the SDG&E Design and Procedure Manual in **Appendix B** is shown in **Table 2**.

When a portion of an access road is designed as a through cut road it shall be for a length no greater than 200-ft so that flow does not become concentrated and cause rutting through the life of a road. There are currently nine through cut roads that vary between 50-ft and 160-ft in length. Five of these roads provide access to temporary pull sites which will only be used during construction. Water bars and energy dissipators will be located at the end of each through cut road where they transition back to having a fill slope.

Table 2
Reference Guide
SDG&E Design & Procedure Manual

CRITERIA	SECTION REFERENCE	COMMENTS
A. Proposed Access Roads Design Criteria:		Access roads shall be placed on natural terrain that does not exceed 15% grades; variances may be acceptable pending governing agency approval. The roads shall also avoid rocks, trees, environmental sensitive areas, and cultural areas previously determined by the governing agencies.
1. Minimum width 14 feet for Crane Access roads and 12 feet for Truck only access roads.	5.2	Do not use roadside ditches
2. Maximum cross slope 4%.	5.2	Generally use 2% cross slope. Cross slope shall be directed towards the cut side (inside edge) of the road when grading over steep natural terrain. Using these criteria, the low points on the road will not be able to drain. To avoid ponding at these areas, the lowest edge of the road shall be raised and the opposite edge lowered maintaining the centerline elevation as designed. A 1% minimum crossfall shall be achieved.
3. Minimum curve radius 50'.	5.2	Revised criteria for minimum turning radius is based on new condor criteria
4. Roadway width with curve radius over 50': i. Radius 50'-100' Increase Width +6' ii. Radius 101' – 150' Increase Width +5' iii. Radius 151' – 200' Increase Width +4' iv. Radius 201' – 400' Increase Width +3' v. Radius over 400' Increase Width +2'		Revised criteria for minimum turning radius is based on new condor criteria

CRITERIA	SECTION REFERENCE	COMMENTS
5. "Y" type or circular turnaround	5.2	
6. Grades 12% - 20%, limited to 250' in length.		
7. Maximum Grades - 12%	5.3	Continuous grade
8. Maximum Grades – 12% to 20%	5.3	Limit to 250' in length
9. Maximum vertical grade break 6% without vertical curve	5.3	
10. Alignment and length		For access roads greater than 500' in length, provide Y-type or T-type (75' in length perpendicular to access road) or adequate for truck and emergency vehicles. The turnaround may be located where terrain allows within the 500' length, preferably near pad. **(See Figure 6)**
11. Water bar spacing requirements i. <5% – 300' ii. 5% – 125' iii. 10% – 75' iv. 15% - 60' v. 20% - 50' vi. 25% - 40'	5.6	Do not drain over fill slopes unless prefabricated down drains are provided. In addition, water bars shall be placed at low points to avoid ponding.
12. Site Distance	5.3	
13. Grades take precedence over drainage crossing	5.3	Minimized drainage crossings preferred.
14. Hydrology, codes, & regulations	4.4.6, 4.5.3, 4.6.3, 5.3, 5.5	
15. Energy dissipators		Provide 5 feet x 5 feet rip rap pads at the outlet of any concentrated flows. Place rip rap pads where the discharge will not erode proposed grading.
16. Down drains		Provide pre-fabricated metal or concrete down drains when conveying water down slopes.
17. Brow ditches		Provide concrete brow ditch above cut slopes when drainage area warrants it.
18. Minimum cut slopes at 2:1. Fill slopes typically at 1.5:1, minimum at 2:1	5.4	Contour grade slopes higher than 50 feet

CRITERIA	SECTION REFERENCE	COMMENTS
19. Minimum cut slope in rock ½:1 or as recommended by the Geotechnical Engineer.	5.4	
20. Fill slopes require keys when existing slope is > 5:1	5.4	
21. Repair existing access roads	4.3.1 & 4.4.3	
22. Minimize impacts outside of Right-of-Way	5.2	In general, do not grade outside the Right-of-Way except to connect to existing access road.
23. Details	7.0	
24. Earthwork		Balance earthwork at each site whenever possible; allow 10-20% additional cut material over fill material quantity for shrinkage. Cut and fill sources and location should also be considered to minimize hauling.
25. Roadway Profiles		Provide centerline stations on road centerlines. Use sections to show road centerline, road cross section, and pad cross section. Show major features of site, i.e. walls, cut slopes, fill slope, drainage.
B. Pad design criteria:		Pads shall be placed on natural terrain that does not exceed 15% grades; variances may be acceptable pending governing agency approval. The area shall also avoid rocks, trees, environmental sensitive areas, and cultural areas already determined by such agencies. Pads shall be located to blend in with the existing natural terrain as much as possible following contour lines and other natural features.
1. Maximum cross slope 2%.	5.2	Provide sheet flow across the pad not concentrated flow. Provide earth berm at top of fill slope.
2. Minimize impacts to outside of Right-of-Way	5.2	In general, do not grade outside the Right-of-Way except to connect to existing access road. Walls, brow ditches and other structures shall not be placed outside of the ROW.

CRITERIA	SECTION REFERENCE	COMMENTS
3. Pad sizes & configurations	7.0	Provide rectangular pad whenever possible. Provide 35' x 75' pad(s) at tangent, angle and dead end structures. **(See Figures 2, 3, 4 & 5)** Retaining walls limited to a maximum of 20 feet in height.
4. Existing Towers		Provide maximum 1' fill and no cut around existing towers.
5. Pad design		Use sharp angles or radii to blend in with terrain. Provide berm on top of fill slopes.
6. Sections		Show major features of site, i.e. walls, cut slopes, fill slope, drainage. Show pad cross section.
7. Walls	5.2 & 5.5	Drain pads away from fill walls towards the cut slope, typically use swale where the flow line is 5' offset from cut wall/toe of cut slope and the swale flow line slopes between 1% -2%. The 5' offset distance can vary with respect to site parameter. Provide eight (12') maximum wall height on cut slope. (vertical wall – masonry construction)
8. Energy Dissipators		Provide 5 feet x 5 feet rip rap pads at the outlet of any concentrated flows. Place rip rap pads where the discharge will not erode proposed grading.
9. Downdrains		Provide concrete down drains when conveying water down slopes.
10. Brow Ditches		Provide concrete brow ditch above cut slopes when drainage area warrants it.
11. Slopes		Maximum cut slope 2:1 or as recommended by Geotechnical Engineer. Typical fill slope 1.5:1, maximum 2:1

6.2 Design Approach (cont'd)

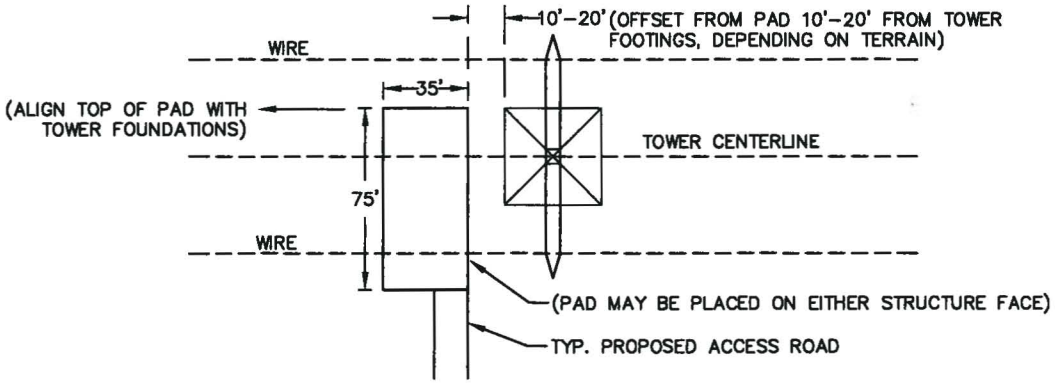
Maintenance pads for tangent and light angle towers are a flat space of approximately 35 feet by 75 feet and graded adjacent to the road **(Figures 2, 3 & 4)**. One edge of the pad must be lined up with the tower foundation. The pad should be located immediately adjacent to the tower within 10 to 20 feet of nearest tower leg. Generally, the maintenance vehicles will enter the site and back down the road. **Appendix D** contains information such as weight, dimensions, operating envelope, turning diameter, and features on the Condor Maintenance Vehicle that SDG&E uses. Pads should be oriented to facilitate the positioning of maintenance vehicles to access the towers for the purpose of washing the insulators. This is a permanent impact area that must be kept within the ROW.

Deadend tower maintenance pads are dual flat areas approximately 35 feet by 75 feet **(Figure 5) at both sides of the tower**. The ROW is generally 200 feet wide and the pad and slopes must be kept within the ROW since this is a permanent impact area.

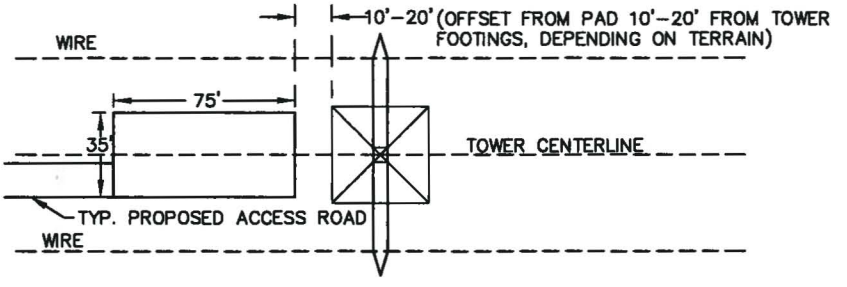
If a structure site is naturally sloped less than 4 percent it will be designated as a "no grading" site and will just be cleared and grubbed within the same space limitations stated above, according to the structure type. An access road is required to each structure designated as a non-helicopter site even if the pad is going to be only cleared and grubbed.

When an access road is over 500 feet in length and travel to the tower is back and forth along the same route, please provide a Y-type, T-type or circular type turn around adequate for truck and emergency vehicles. The maintenance vehicles will enter the access road to the tower and back out after washing the insulators. If the road length exceeds 500 feet, the vehicles need a place to turnaround. If a Y-type or T-type is used, a 75 foot minimum road length perpendicular to the access road is required **(Figure 6)**. If a circular turnaround is used, then the minimum turning radius outlined in the access road design specification is required. The turnaround can be placed where the terrain allows along the 500-foot road length but preferably placed near the structure to avoid long backing distance.

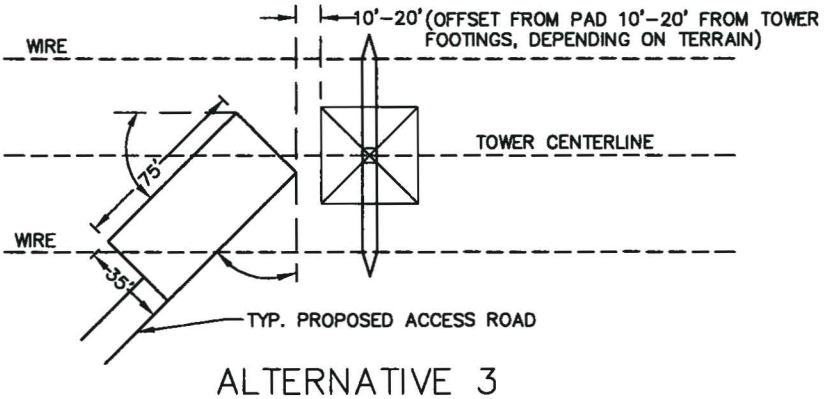
In such cases where blasting is required, SDG&E has developed a submittal review package "Project Blasting Preparation and Protection Plans – SDG&E Requirements for Review Package Submittal". This is incorporated in by reference **(Reference 3)**.



ALTERNATIVE 1



ALTERNATIVE 2



ALTERNATIVE 3

ALTERNATIVE 1 IS THE PREFERED CONFIGURATION.

* DEPENDING ON THE ACCESS ROAD CONNECTION, THE PAD MAY BE ROTATED AS SHOWN IN ALTERNATIVE 2 AND 3.

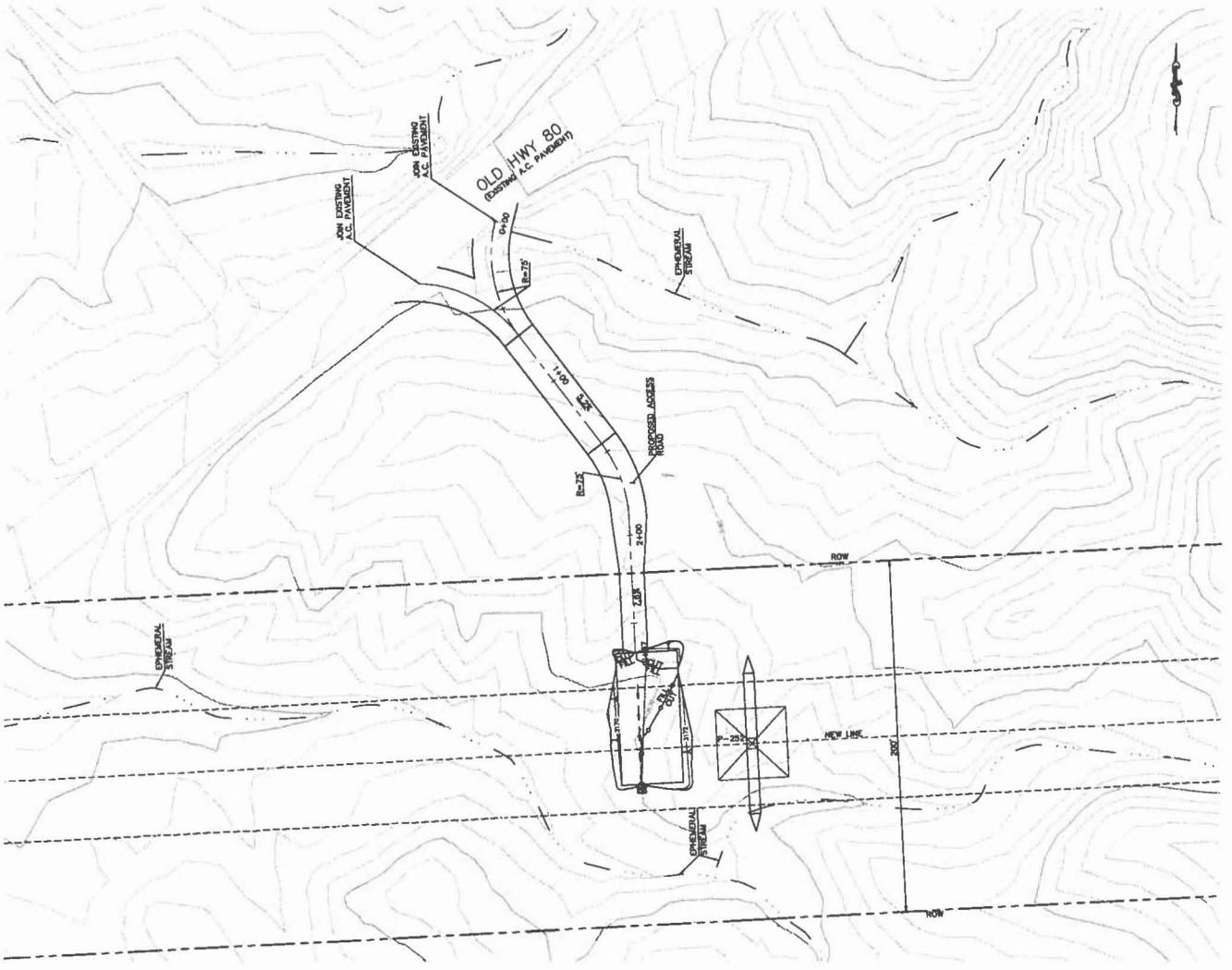
11590 West Bernardo Court Suite 100
San Diego, CA 92127-1624
Tel: (858) 451-6100 Fax: (858) 451-2846
www.us.bureauveritas.com

SAN DIEGO GAS & ELECTRIC COMPANY
SAN DIEGO, CALIFORNIA

SUNRISE POWER LINK

DRAWN BY:	DATE:	SCALE: 1"=50'	W.O.	REV.
CHECKED BY:	DATE:			
APPROVED BY:	DATE:			
CAD NO.:	PLOT SCALE:			

FIGURE 2



NUMBER	NORTHING	EASTING	ELEVATION
P-252	1809484.29	6600637.97	3174.24

STRUCTURE NUMBER	STRUCTURE TYPE	STRUCTURE LINE ANGLE	TOWER HEIGHT
P-252	500 KV EMTX Lattice Tangent Tower	0.00	169.5

EARTH QUANTITIES:
CUT: 61 CY.
FILL: 65 CY.
NET: 4 CY.

DISTURBED AREA:
PAD: 3,396 SF
ROAD: 0 SF
TOTAL: 3,396 SF

NOTE: ACCESS ROAD WILL BE GRADED WHEN PAD LOCATION IS APPROVED.

TOWER P-252 PLAN
SCALE: 1" = 30'

GRAPHIC SCALE
30 0 30 60
1"=30'

REVISIONS

NO.	WORK DONE	DATE	BY	APP'D

SAN DIEGO GAS & ELECTRIC COMPANY
SAN DIEGO, CALIFORNIA

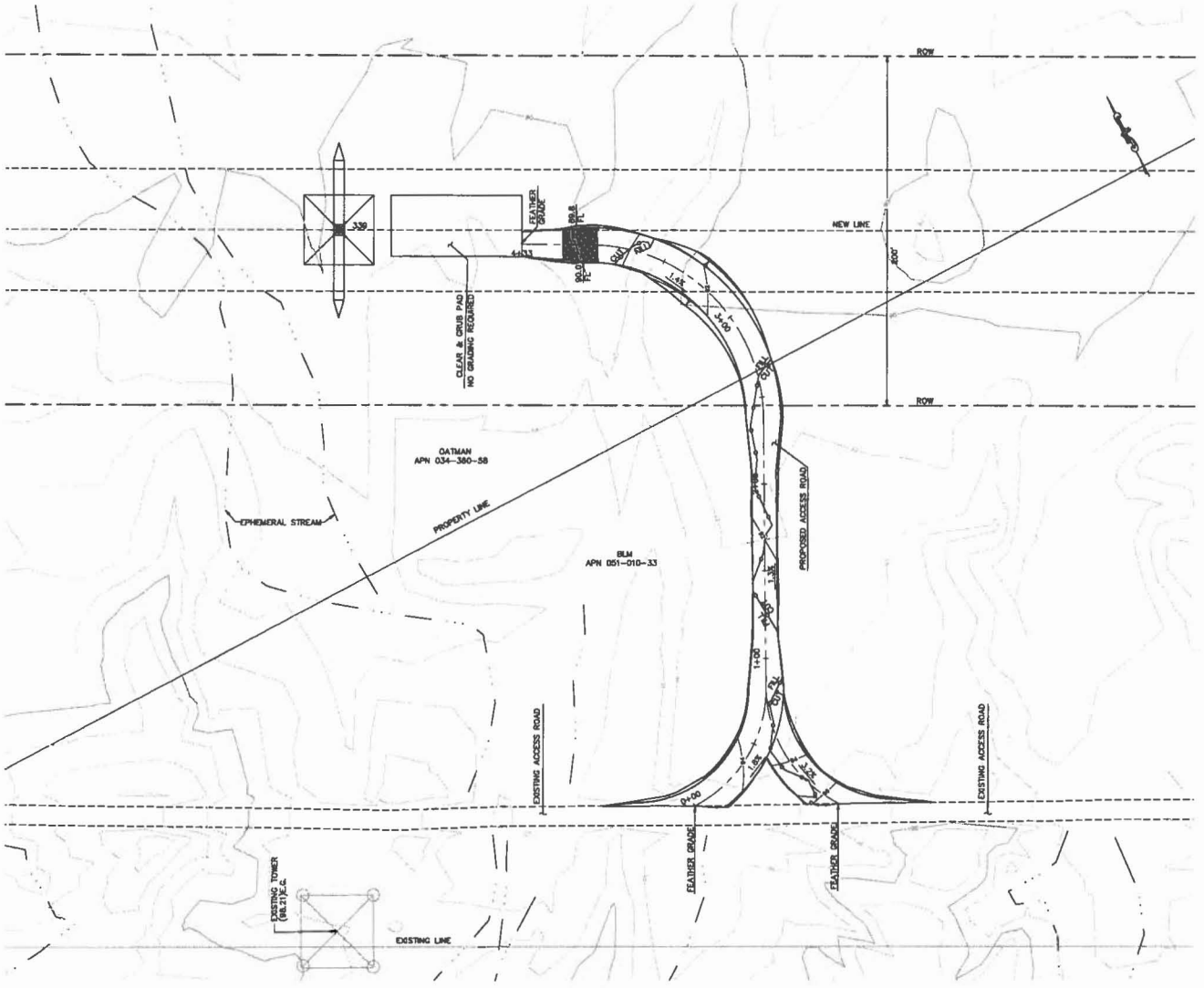
SPL-9C
SITE P-252

DRAWN BY: DD | DATE: | SCALE: 1" = 30' | WA | REV. 0
CHECKED BY: | DATE:
APPROVED BY: | DATE:
END NO.: | PLOT SCALE: 1 = 1

76

13

FIGURE 3



NUMBER	NORTHING	EASTING	ELEVATION
339	1880119.19	6888533.29	90.54

STRUCTURE NUMBER	STRUCTURE TYPE	STRUCTURE LINE ANGLE	TOWER HEIGHT
339	500 KV EMT Lattice Tangent Tower	0.00	154.5

EARTH QUANTITIES:
CUT: 40 CY.
FILL: 142 CY.
NET: 102 CY.

DISTURBED AREA:
PAD: 2,625 SF.
ROAD: 10,198 SF.
TOTAL: 12,823 SF.

TOWER 339 PLAN
SCALE: 1" = 30'

GRAPHIC SCALE
30 0 30 60
1"=30'

REVISIONS

NO.	WORK DONE	DATE	BY	APP'D.

SAN DIEGO GAS & ELECTRIC COMPANY
SAN DIEGO, CALIFORNIA

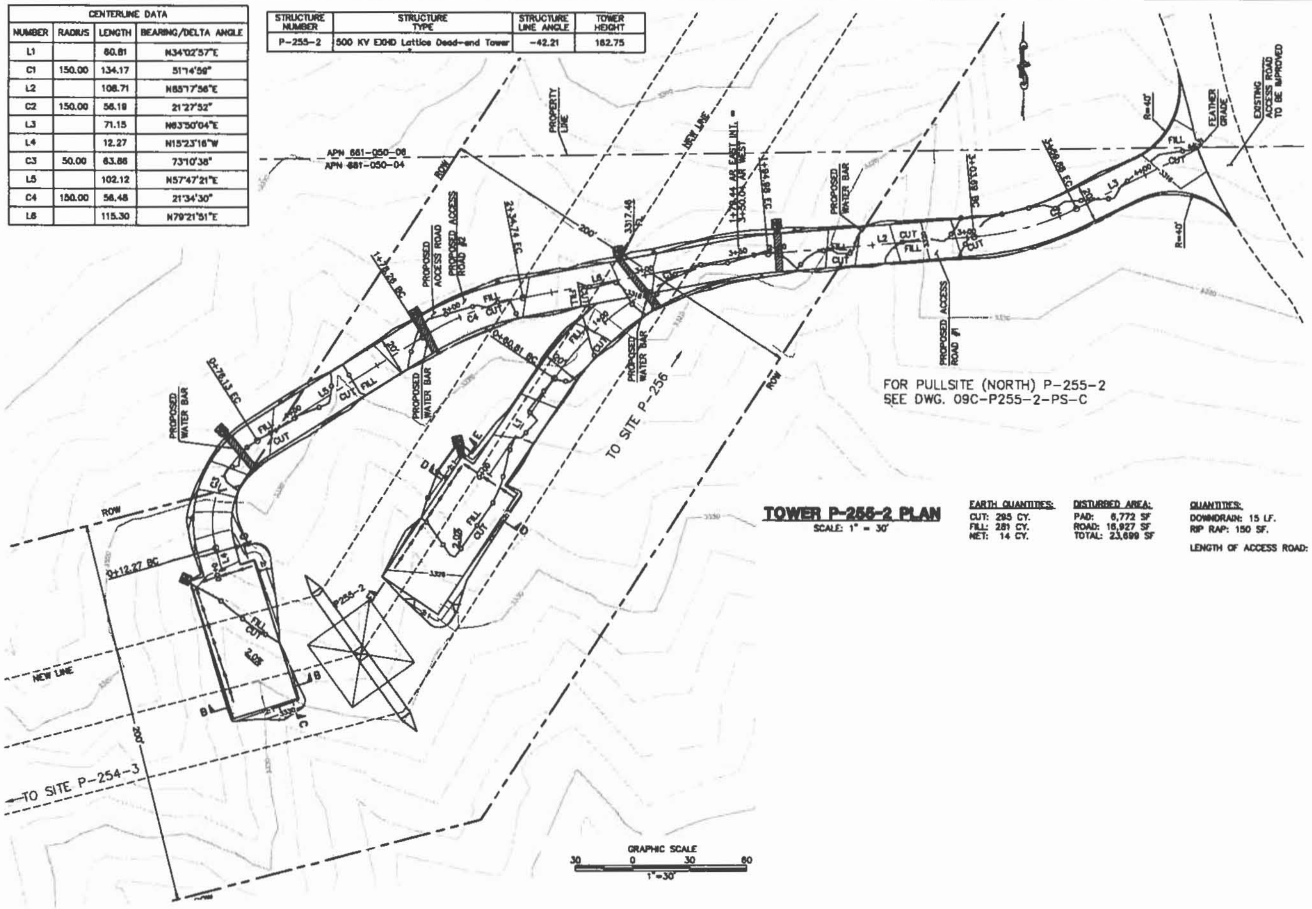
SPL-10B
SITE 339

DRAWN BY: DS | DATE: | SCALE: 1" = 30' | SHEET NO. | REV. 0
CHECKED BY: | DATE:
APPROVED BY: | DATE:
CAD NO.: | PLOT SCALE: 1 = 1

FIGURE 4

CENTERLINE DATA			
NUMBER	RADIUS	LENGTH	BEARING/DELTA ANGLE
L1		80.81	N34°02'57"E
C1	150.00	134.17	51°14'59"
L2		108.71	N85°17'56"E
C2	150.00	56.19	21°27'52"
L3		71.15	N63°50'04"E
L4		12.27	N15°23'16"W
C3	50.00	63.86	73°10'38"
L5		102.12	N57°47'21"E
C4	150.00	56.48	21°34'30"
L6		115.30	N79°21'51"E

STRUCTURE NUMBER	STRUCTURE TYPE	STRUCTURE LINE ANGLE	TOWER HEIGHT
P-255-2	500 KV EXHD Lattice Dead-end Tower	-42.21	182.75



TOWER P-255-2 PLAN

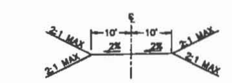
SCALE: 1" = 30'

EARTH QUANTITIES:
CUT: 295 CY.
FILL: 281 CY.
NET: 14 CY.

DISTURBED AREA:
PAD: 6,772 SF
ROAD: 16,927 SF
TOTAL: 23,699 SF

QUANTITIES:
DOWNDRAIN: 15 LF.
RIP RAP: 150 SF.

LENGTH OF ACCESS ROAD: 781 LF



TYPICAL ACCESS ROAD CROSS SECTION
STA 0+00.00 TO 4+31.03
STA 0+00.00 TO 3+50.04
N.T.S.

Bureau Veritas North America
11860 West Bernardo Court Suite 100
San Diego, CA 92127-1624

REVISIONS

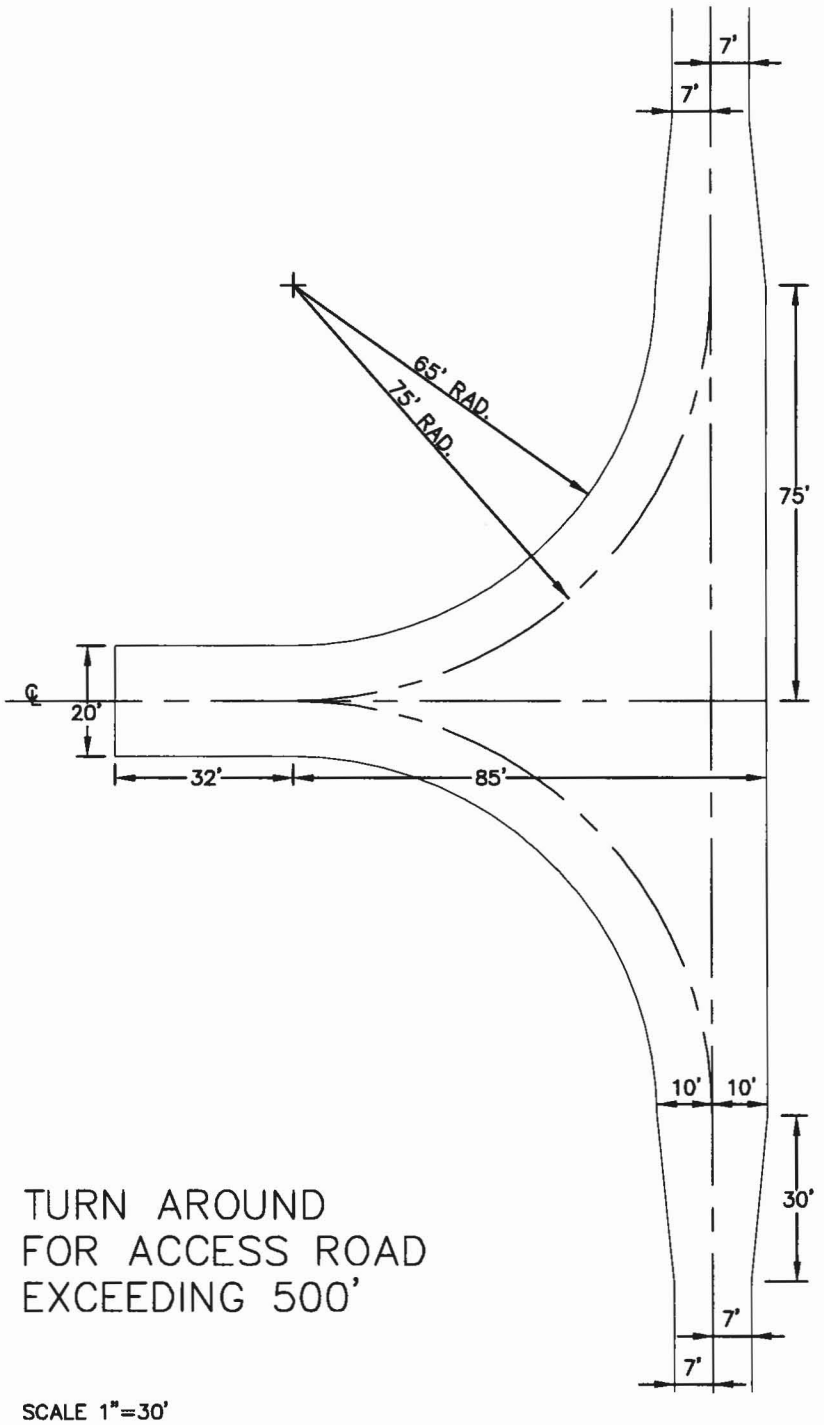
SAN DIEGO GAS & ELECTRIC COMPANY
SAN DIEGO, CALIFORNIA

SPL-9C (LINK 1)
SITE P-255-2

SCALE: 1" = 30'
REV. 0

09C-P255-2-S1

FIGURE 5



TURN AROUND
FOR ACCESS ROAD
EXCEEDING 500'

SCALE 1"=30'

BUREAU VERITAS

11590 West Bernardo Court Suite 100
San Diego, CA 92127-1624
Tel: (858) 451-6100 Fax: (858) 451-2846
www.us.bureauveritas.com

SAN DIEGO GAS & ELECTRIC COMPANY
SAN DIEGO, CALIFORNIA

SUNRISE POWER LINK

DRAWN BY:	DATE:	SCALE: 1"=1'	W.O.	REV.
CHECKED BY:	DATE:			
APPROVED BY:	DATE:			
CAD NO.:	PLOT SCALE:			

FIGURE 6

6.3 Tower Staging/Access Pad

Tower Staging/Access Pad (TSAP) are permanent helicopter landing areas which will be required for those sites inaccessible by roads. All TSAPs will be partially or completely located outside the SDG&E right-of-way and require a 100' diameter easement with the landing location centered in the easement. The landing area is a 20' by 20' square.

Generally, the maximum walk-in distance between the tower and TSAP location is 300 feet. In most cases, the TSAP is located a minimum of 85 feet from the centerline of the transmission line to avoid flying too close to the wires. There are exceptions to both rules, especially when there are limited suitable landing locations in steep terrain.

The TSAP are field located by a team which includes SDG&E, BV, biological monitor, cultural monitor and surveyors. The BV and SDG&E members locate the TSAP based on maintenance/engineering requirements then the biological and cultural monitor approves or rejects the site based on biological/cultural impacts. If the site is rejected, the BV and SDG&E members look for another suitable location and the process continues until a site suitable for all parties is found. If the site is approved, the surveyors survey a 100' by 100' grid, a walking path between the tower and TSAP and the four corners of the landing area. Other terrain features may also be surveyed such as boulders, large rock outcroppings and trees.

BV will provide site plans that designate the type and location of the TSAPs. The TSAPs will be either clear and grub or graded. The criteria for each designation is determined by the slope (or angle) of the existing terrain as follows:

-Existing slope < 8% (5 degrees) is a clear and grub site.
-Existing slope >8% (5 degrees) is a graded site

Clear and grub sites will not require grading but simply be cleared and grubbed within the 20' by 20' square area. The remaining area between the pad and the 100' diameter easement will have the vegetation trimmed to 24" above the ground.

Graded sites will have pads graded at 2% across the 20' by 20' square area and draining towards the fill slope. No drainage structures will be required since the pad and graded area is relatively minimal. Cut slopes will follow the geotechnical recommendations however will never be graded steeper than 1:1. All fill slopes will be 1.5:1. The earthwork will be balanced so that there will be 15%-20% more cut material than fill material to allow for shrinkage. The remaining area between the grading daylight and the 100' diameter easement will have the vegetation trimmed to 24" above the ground.

6.4 EIR/EIS Mitigation Design Standards

SDG&E has issued a Draft Sunrise Powerlink EIR/EIS Mitigation Standards for Access Roads dated August 25, 2008 **(Appendix E).** These mitigation standards focus on measures that will direct the design of temporary and permanent access roads to Sunrise Powerlink facilities.

All access road design shall adhere to the mitigation standards as outlined. Where a conflict or deviation occurs, it shall be presented to SDG&E for their approval and disposition.

Highlights from the Mitigation Standards include:

- Avoid vernal pools
- Access roads at right angles to watercourses
- Restrictions on construction time and location
- Minimize disturbance at waterways
- Avoid watercourses to the extent possible
- Construction routes to avoid and minimize disturbance to stream channels
- Avoid new disturbance, erosion and degradation
- Restoration of temporary roads
- Avoid sensitive features
- Mitigate for loss of trees
- Provide restoration of loss of sensitive features
- Reduce in-line view of scars
- Reduce visual/color contrast
- Minimize vegetation removal
- Reduce land scarring
- Prepare and implement Scenery Conservation Plan
- Avoid and protect culturally significant cultural resources
- Protect desert pavement

6.5 Right-of-Way

For temporary or permanent construction land impacts beyond SDG&E's right-of-way (ROW), acquisitions or easements would be required. Although ROW can be obtained, it is time consuming and costly. Previous work to date has not identified any additional ROW. Therefore, SDG&E has directed that designs are to be maintained with in existing SDG&E ROW.

However, SDG&E also recognizes that the potential for an illogical, costly design with the existing ROW as an absolute parameter. If such a case would occur, it shall be presented to SDG&E for evaluation and approval.

SDG&E has also noted that military land and open County land is particularly difficult to obtain and would prefer that an engineering solution be determined rather than obtain any ROW.

6.6 Erosion Control

Erosion control will be addressed as outlined in the SDG&E Design and Procedures Manual, Section 6.2 **(Appendix C)**. Additionally, the Sempra Utilities "Water Quality Construction Best Management Practices Manual dated December 2002 is incorporated herein by reference **(Reference 4).**

A Storm Water Pollution Prevention Plan (SWPPP) will be written for the project in accordance with the California Water Resource Control Board General Construction Storm Water Permit and local Regional Water Quality Control Board (RWQCB) guidance or directives **(References 5, 6, & 7).**

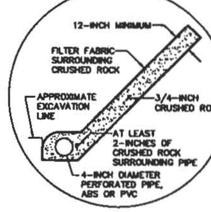
7. RETAINING WALL CRITERIA

7.1 Description of Work

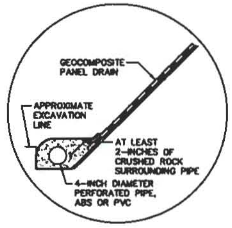
The plans, specifications, and cost estimate for the access roads and structure pads shall include any necessary retaining walls for the project and shall be prepared to the Final level of completion. Plans shall include retaining wall plan, sections, details, notes, and control information.

7.2 Design Approach

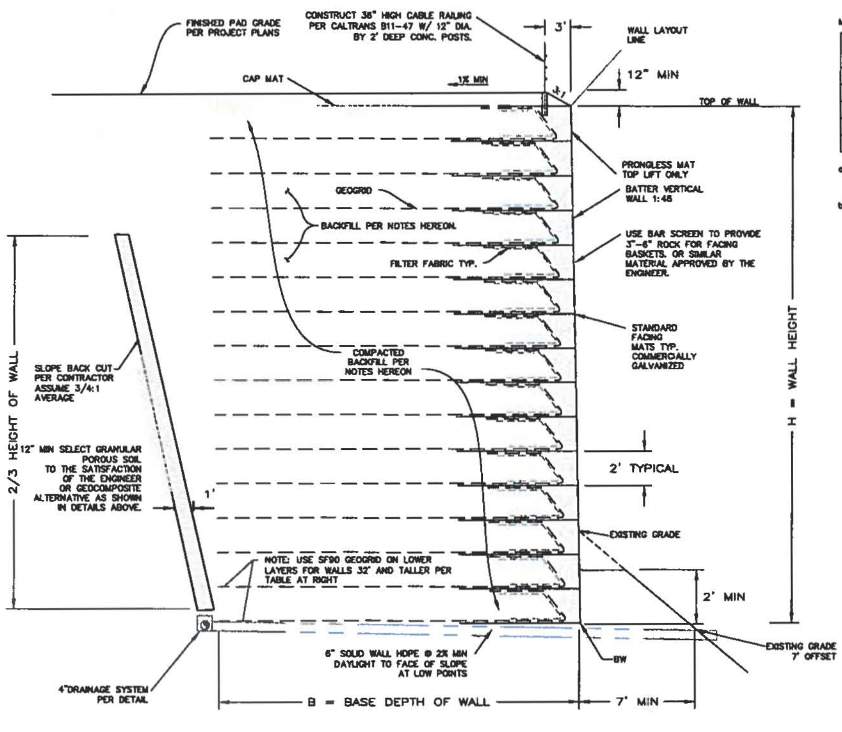
SDG&E has directed retained fill walls shall use Hilfiker Retaining Walls Welded Wire Walls. A typical section was developed for Segment 4A and is shown in **Figure 7.** The National Cooperative Highway Research Program, Report 556, Design and Construction Guidelines for Geosynthetic-Reinforced Soil Bridge



ROCK BLANKET ALTERNATIVE



GEOCOMPOSITE PANEL ALTERNATIVE



TYPICAL HILFIKER WELDED WIRE WALL SECTION (1)

NTS

WALL BACK DRAINAGE NOTES:

1. PERFORATED PIPE SHOULD OUTLET THROUGH A SOLID PIPE TO A FREE GRAVITY OUTFALL AT MAX 100' SPACING. PERFORATED PIPE AND OUTLET PIPE SHOULD HAVE A FALL OF AT LEAST 2%.
2. FILTER FABRIC SHOULD CONSIST OF MIRAFI 140N, OR SIMILAR APPROVED PRODUCT. FILTER FABRIC SHOULD BE OVERLAPPED PER MANUFACTURES INSTRUCTIONS.
3. DRAIN INSTALLATION SHOULD BE OBSERVED BY THE GEOTECHNICAL ENGINEER PRIOR TO BACK FILLING.
4. SUBSURFACE BACK DRAINAGE MAY BE REDUCED IF THE SOILS USED IN THE REINFORCED AND RETAINED ZONES ARE RELATIVELY "FREE DRAINING" AS APPROVED BY GEOTECHNICAL ENGINEER. CONTRACTOR TO ASSUME 20 PERCENT OF WALL SQUARE FOOTAGE REQUIRES BACK DRAINAGE.
5. IF ROCK BLANKET BACK DRAIN ROCK IS SUBSTITUTED WITH CALTRANS CLASS II PERMEABLE AGGREGATE THE FILTER FABRIC CAN BE ELIMINATED.

MSE WALL BACKFILL NOTES:

1. CONTRACTOR IS ADVISED THAT MOST ONSITE SOILS WILL BE VIABLE FOR MSE WALL BACKFILL UTILIZING 3" TO 4" BAR SCREEN TO CONFORM SOILS TO FOLLOWING TABLE BELOW CARE SHOULD BE TAKEN TO SELECT BACKFILL MATERIAL THAT IS FREE OF EXCESSIVE FINES AND ORGANIC MATERIAL.
2. CONTRACTOR TO OBTAIN GEOTECHNICAL APPROVAL OF BOTTOM CUT AND 7' OFFSET FROM SLOPE FACE PRIOR TO PLACEMENT OF ANY GEOGRID OR WIRE MATS. MSE RETAINING WALLS SHOULD BE FOUNDED ON PROPERLY COMPACTED OR RELATIVELY UNDISTURBED WEATHERED GRANITIC ROCK MATERIALS AS APPROVED BY THE GEOTECHNICAL ENGINEER.
3. GEOTECH ENGINEER AND MANUFACTURER'S REPRESENTATIVE SHALL OBSERVE AND APPROVE BACKFILL MATERIALS AND PROCEDURES DURING BACKFILL AND CONSTRUCTION

MSE WALL BACKFILL GRADATION REQUIREMENTS

SEIVE SIZE	RECOMMENDED GRADATION PERCENT PASSING BY WEIGHT
100mm (4 INCH)	100-75
4.76mm (NO. 4)	20-100
0.425mm (NO. 40)	0-60
0.075mm (NO. 200)	0-35
PLASTICITY INDEX (PI)	< 20

a. A PI < 8 IS RECOMMENDED TO MINIMIZE EXPANSIVE POTENTIAL AND PROVIDE SUITABLE DRAINAGE CHARACTERISTICS

b. mm - MILLIMETERS

MSE WALL GEOGRID LENGTHS

PRELIMINARY MIN. SOIL DESIGN PARAMETERS Ø =|35°	DENSITY < 130 PCF
HEIGHT (FT)	B= BASE DEPTH OF WALL
8'	8'
10'	8'
12'	10'
14'	12'
16'	13'
18'	15'
20'	18'
22'	18'
24'	20'
26'	21'
28'	23'
30'	24'
32'	28'-2-14*

* B DIST. - BOTTOM GRIDS WITH SF90 GEOGRID
- TOP REMAINING GRIDS WITH SF65 GEOGRID

MSE WALL GEOGRID SPECIFICATIONS

WWW.SYNTEEN.COM, OR EQUAL APPROVED BY ENGINEER

SF 90
SOIL REINFORCEMENT GEOGRID
UNIAXIAL GEOGRID
THE STRENGTH IS IN THE LENGTH DIRECTION

SF 90 IS COMPOSED OF HIGH MOLECULAR WEIGHT, HIGH TENACITY MULTIFILAMENT POLYESTER YARNS THAT ARE WOVEN INTO A STABLE NETWORK PLACED UNDER TENSION. THE HIGH STRENGTH POLYESTER YARNS ARE COATED WITH A PVC MATERIAL. SF SERIES GEOGRIDS ARE INERT TO BIOLOGICAL DEGRADATION AND ARE RESISTANT TO NATURALLY ENCOUNTERED CHEMICALS, ALKALIS AND ACIDS. SF SERIES GEOGRIDS ARE TYPICALLY USED FOR SOIL REINFORCEMENT APPLICATIONS SUCH AS RETAINING WALLS, STEEPENED SLOPES, EMBANKMENTS, SUBGRADE STABILIZATION, AND EMBANKMENTS OVER SOFT SOILS AND WASTE CONTAINMENT APPLICATIONS.

TENSILE PROPERTIES	TEST METHOD	MARV VALUES (LBS/FT)
ULTIMATE STRENGTH	ASTM D 6637	8500
CREEP LIMITED STRENGTH	ASTM D 5262	5483
T_A = LONG TERM DESIGN STRENGTH	NCMA 97 *	4747
APERTURE SIZE (INS.)	MEASURED	0.75 x 0.75 OR SITE SPECIFIC AS REQUIRED

REDUCTION FACTOR FOR CREEP 1.55, REDUCTION FACTOR FOR DURABILITY 1.10 REDUCTION FACTOR FOR INSTALLATION DAMAGE (TYPE 3 SOIL) 1.05

FHWA/AASHTO REDUCTION FACTOR FOR CREEP 1.55, REDUCTION FACTOR FOR DURABILITY 1.15, REDUCTION FACTOR FOR INSTALLATION DAMAGE (TYPE 3 SOIL) 1.03

GRI GC48 REDUCTION FACTOR FOR CREEP 1.75, REDUCTION FACTOR FOR DURABILITY 1.10 REDUCTION FACTOR FOR INSTALLATION DAMAGE (TYPE 3 SOIL) 1.05

WWW.SYNTEEN.COM, OR EQUAL APPROVED BY ENGINEER

SF 65
SOIL REINFORCEMENT GEOGRID
UNIAXIAL GEOGRID
THE STRENGTH IS IN THE LENGTH DIRECTION

SF 65 IS COMPOSED OF HIGH MOLECULAR WEIGHT, HIGH TENACITY MULTIFILAMENT POLYESTER YARNS THAT ARE WOVEN INTO A STABLE NETWORK PLACED UNDER TENSION. THE HIGH STRENGTH POLYESTER YARNS ARE COATED WITH A PVC MATERIAL. SF SERIES GEOGRIDS ARE INERT TO BIOLOGICAL DEGRADATION AND ARE RESISTANT TO NATURALLY ENCOUNTERED CHEMICALS, ALKALIS AND ACIDS. SF SERIES GEOGRIDS ARE TYPICALLY USED FOR SOIL REINFORCEMENT APPLICATIONS SUCH AS RETAINING WALLS, STEEPENED SLOPES, EMBANKMENTS, SUBGRADE STABILIZATION, AND EMBANKMENTS OVER SOFT SOILS AND WASTE CONTAINMENT APPLICATIONS.

FEBRUARY, 2006

TENSILE PROPERTIES	TEST METHOD	MARV VALUES (LBS/FT)
ULTIMATE STRENGTH	ASTM D 6637	6000
CREEP LIMITED STRENGTH	ASTM D 5262	3871
T_A = LONG TERM DESIGN STRENGTH	NCMA 9T	3373
APERTURE SIZE (INS.)	MEASURED	0.75 x 0.75

RF CREEP - 1.55
RF DURABILITY - 1.10
RF INSTALLATION DAMAGE (SOIL TYPE 3) - 1.05

P:\16919 SDG&E SPL\Basis of Design\Basis of Design Report\update 2010.8.6\04A-DETAIL 3OF5-FIGURE 7.dwg\Aug-06-2010\0:47

Bureau Veritas North America
11090 West Bernardo Court Suite 100
San Diego, CA 92127-1624
Tel. (858) 451-6100 Fax: (858) 451-2846
www.us.bureauveritas.com

[redacted]

REVISIONS

SAN DIEGO GAS & ELECTRIC COMPANY
SAN DIEGO, CALIFORNIA

SPL-04A (LINK 5)

Detail Sheet 3 OF 5

SCALE NTS REV. 0

SPL-04A-005

FIGURE 7

Abutments with a Flexible Facing dated 2006 provide the guidelines for the design of this type of wall.

Cut slopes shall be retained with a solid grouted masonry wall with a maximum back slope of 2:1.

To facilitate designers, **Table 3** outlines general guidelines for retaining walls. **Figure 8** is a diagram that shows the retaining wall design guidelines.

Table 3
Retaining Wall Guidelines

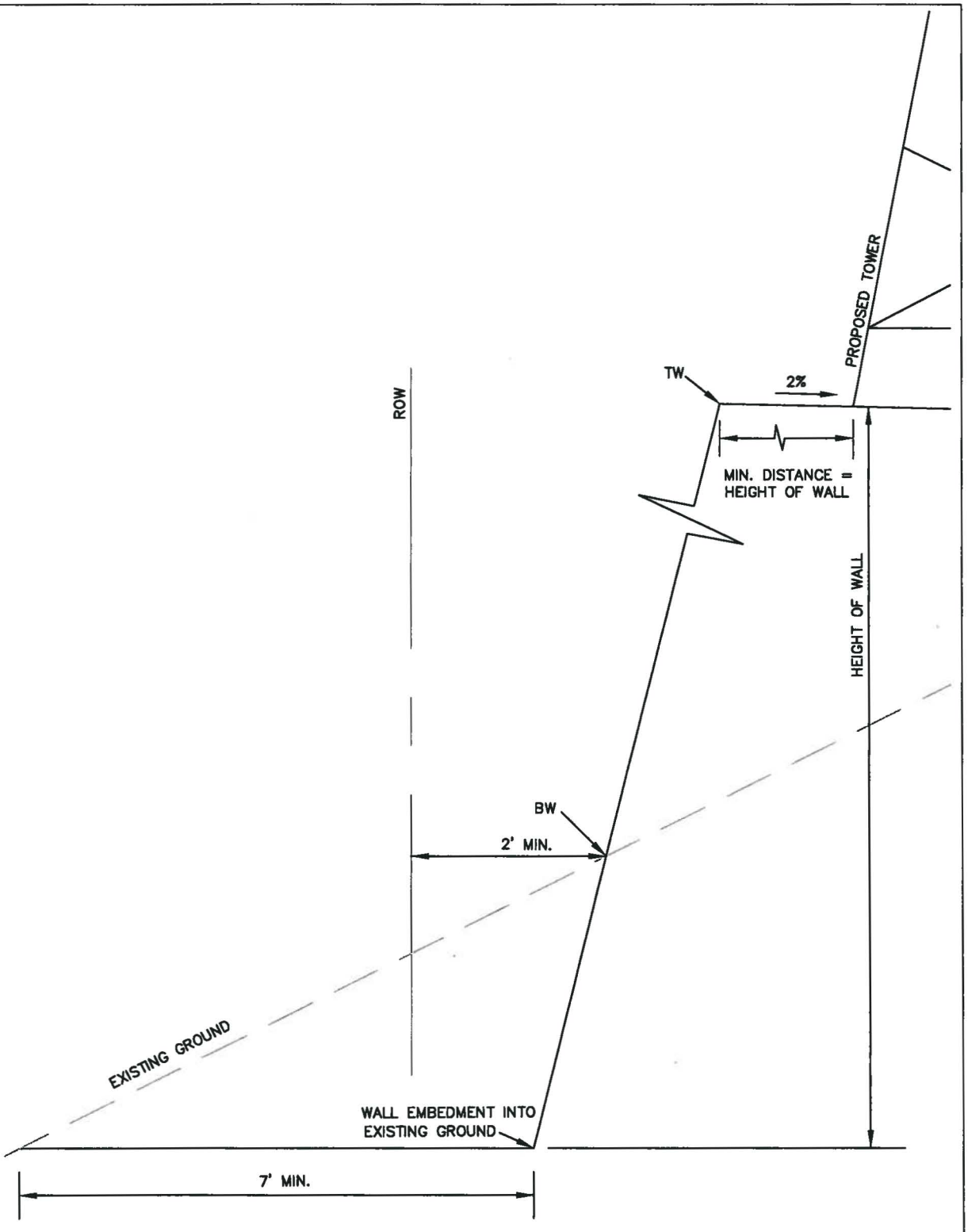
1	Provide twenty feet (20') maximum wall height on fill slope, (Obtain SDG&E approval for wall heights greater than 20 feet)
2	Provide twelve feet (12') maximum wall height on cut slope. (vertical wall-masonry)
3	Provide bench and daylight for fill walls as shown in **Figure 8**
4	Place fill walls at a minimum of X' distance from the proposed tower legs, where X is equal to the wall height, **(See Figure 8)**
5	Use bottom of walls for horizontal control, especially fill walls.

7.3 Walls Considered But Not Used

The following wall types were presented to SDG&E for their consideration,

- Saint Louis Retaining Wall Company - Reinforced Soil Slopes with Hard Armor Facing, Hercules and Neptune Modules
- Strata Systems, Inc. - Reinforced Soil Slopes and Embankments
- Soil Retention Systems, Inc. – Verdora Plantable Retaining Walls

However, these walls were not selected for further consideration.



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SAN DIEGO, CALIFORNIA

SUNRISE POWER LINK

DRAWN BY:	DATE:	SCALE: 1"=1'	W.O.	REV.
CHECKED BY:	DATE:			
APPROVED BY:	DATE:			
CAD NO.:	PLOT SCALE:			

FIGURE 8

8. QUALITY CHECK

8.1 Quality Overview

All work shall be checked in accordance with the Bureau Veritas Quality Program. The "Green Sheet" **(Figure 9)** shall document the quality check for each submittal.

Plans shall be submitted at the 50%, 90%, and Final levels of completion. Each level requires a quality check.

Due to the project size and multiple offices performing work, the quality checks will be tracked by the Quality Manager to ensure quality checks are performed and consistency in work product to our client. Upon completion of a quality check, the checker shall notify the Quality Manager.

8.2 Plan Check

The first line check is with designer. To assist the designer, a checklist is provided for the designer's use and shown in **Table 4**.

8.3 Deviation from Standard

Deviations from SDG&E standards shall be submitted in writing to the Project Manager and SDG&E for approval. Use the form shown in **Figure 10**.

Quality Assurance/Quality Control Commitment

Date of Submittal: _____

Project Title: _____

Client: _____
Client PM: _____
Consultant: _____

Submittal: _____
(65%,95%,100%,etc)

	PLANS QA/QC Commitment Person	Check-list	Date	SPECIFICATIONS QA/QC Commitment Person	Check list	Date	ESTIMATE QA/QC Commitment Person	Check list	Date
QA/QC Officer:	Name: Signature:			Name: Signature:			Name: Signature:		
Project Manager:	Name: Signature:			Name: Signature:			Name: Signature:		
Project Engineer:	Name: Signature:			Name: Signature:			Name: Signature:		
Designer/ Drafter:	Name: Signature:								

Number of Submittal Copies: _____
Include Comments Log & Responses (Yes/No)? _____
Include Check Prints(Yes/No)? _____

Checklist Legend: B=Bureau Veritas
C=County of San Diego
O=Specify Permitting/Review Agency_____

Figure 9

OFFSITE ROAD DESIGN CRITERIA

To help mitigate the overall impacts of the Sunrise Powerlink Project, existing offsite roads will be utilized to gain access to many of the proposed tower locations. In some cases the existing roadways will be improved so that larger vehicles, such as the crane, will be able to safely travel throughout the project area. The table shown below will guide designers to meet the design criteria for the offsite roads.

CRITERIA	COMMENTS
A. Offsite Access Roads design criteria:	
1. Minimum width 12'.	Only use 12' width for straight roads on flat ground
2. Maximum cross slope 8%.	
3. Minimum curve radius 50'.	Only when turn is < 90 degrees
4. Designed Condor road width with curve radius over 50': i. Radius 50'-100' Increase Width to 20' ii. Radius 101' – 150' Increase Width to 19' iii. Radius 151' – 200' Increase Width to 18' iv. Radius 201' – 400' Increase Width to 17' v. Radius over 400' Increase Width is 16'	
5. Designed Truck road width with curve radius over 50': vi. Radius 30'-50' Increase Width to 15' vii. Radius 51' – 90' Increase Width to 14' viii. Radius 91' – 120' Increase Width to 13' ix. Radius over 120' Width is 12'	
6. Preferred Grades 12% - 20%, limited to 250' in length.	
7. Maximum Grades allowed to 25%	Follow existing terrain as much as possible to avoid greater impacts.
8. Maximum vertical grade break 7% without vertical curve	

CRITERIA	COMMENTS
9. Water bar spacing requirements x. <5% – 300' xi. 5% – 125' xii. 10% – 75' xiii. 15% - 60' xiv. 20% - 50' xv. 25% - 40'	Do not drain over fill slopes unless prefabricated down drains are provided.
10. Grades take precedence over drainage crossing	Minimized drainage crossings preferred.
11. Drainage design	Culverts should be used instead of dip sections whenever possible
12. Energy dissipators	Provide 5 feet x 5 feet rip rap pads at the outlet of any concentrated flows. Place rip rap pads where the discharge will not erode proposed grading.
13. Down drains	Provide pre-fabricated metal or concrete down drains when conveying water down slopes.
14. Brow ditches	Provide brow ditch above cut slopes when drainage area warrants it.
15. Impacted streams	Impact to existing channel/streams should always be less than ½ acre
16. Minimum cut slopes at 2:1 unless otherwise specified by Geotechnical Engineer. Fill slopes typically at 1.5:1, minimum at 2:1	Contour grade slopes higher than 50 feet
17. Minimum cut slope in rock per Geotechnical Engineer recommendations.	
18. Fill slopes require keys when slope of existing terrain Is > 5:1	
19. Earthwork	Balance earthwork at each site whenever possible; allow 10-20% additional cut material over fill material quantity for shrinkage. Cut and fill sources and location should also be considered to minimize hauling.
20. Roadway Profiles	Provide centerline stations on road centerlines. Use sections to show road centerline, road cross section, and pad cross section. Show major features of site, i.e. walls, cut slopes, fill slope, drainage.

INTRODUCTION

The Sunrise Powerlink Project consists of proposed access roads, pads, and towers that cross existing streams, requiring hydrologic and hydraulic analysis to be performed at each stream crossing being impacted by the project. Since the project is located in both the County of San Diego and Imperial County an appropriate hydrologic methodology needed to be applied for drainage crossings in each respective county as shown in more detail below. Dip sections and culverts have also been sized to safely convey the runoff across many of the proposed access road and pads. The methodology used to size each dip section and culvert in the project is also shown below.

HYDROLOGIC MODELING METHODOLOGY – COUNTY OF SAN DIEGO

The runoff calculation methodology utilized for hydrologic calculations conforms to commonly accepted practices utilized in the San Diego region as amended by the County of San Diego. The County's Hydrology Manual was used to determine flow rates within the project vicinity. The following subsections describe the rationale behind each of the parameters used in the peak discharge calculation using the rational method as well as the National Resources Conservation Service (NRCS) hydrologic method. Supporting reference materials, including excerpts from the San Diego County Hydrology Manual, dated June 2003, can be found in Appendix F.

Basin Delineation

Drainage basin limits were obtained through the use of topographic mapping, conventional field surveying, site inspection, and/or topographic maps obtained from the U.S. Geologic Survey (USGS).

Runoff Coefficients

The rational method runoff coefficients used to determine the discharge for all contributing areas are based on the County's Hydrology Manual (refer to Tables 3-1 in Appendix F). A runoff coefficient of 0.35 has been used for all of the drainage basins within the project area since the land use of the basins primarily consists of undisturbed natural terrain with varying amounts of vegetation.

Runoff Curve Numbers

The NRCS method runoff curve numbers used to determine the discharge for the drainage area was based on the County's Hydrology Manual (refer to Table 4-2 in Appendix F). The table used to calculate the composite CN uses the worksheet headers shown in Table 4-9 of the County's Hydrology Manual which is shown in Appendix F. Once the composite CN has been determined it will be adjusted based on the appropriate precipitation zone number (PZN) condition according to the drainage basin's location within the County of San Diego (refer to Figure C-1 and Appendix F).

Rational Method - Time of Concentration

The time of concentration (T_c) for the rational method was determined by calculating the travel time for flow from the most remote point of the drainage basin to reach its outlet. A minimum of 5-minutes was used for basins with calculated T_c's less than 5-minutes. The County of San Diego's approach to calculate the time of concentration was used.

For rural or natural areas, the T_c was calculated using the following equation (refer to Figure 3-4 in Appendix F):

$$Tc = \left[\frac{11.9 \times L^3}{H} \right]^{0.385}$$

Where, T_c = Time of Concentration, hours
L = Length of drainage course, miles
H = Difference in elevation from further most point of design, feet

NRCS Method - Corps Lag Time

The lag time (T_l) for the NRCS method was determined as the elapsed time from the beginning of effective rainfall to the instant the discharge at the point of the concentration reaches 50% of ultimate discharge. The T_l was calculated using the following equation:

$$T_l = 24\ n\ ((L \times L_c) / s\ 0.5)^m$$

Where, Corps T_l = Lag Time, hours
L = Length to longest watercourse, miles
L_c = Length along longest watercourse, measured upstream to a point opposite the watershed centroid, miles
s = Overall slope of drainage area between the headwaters and the collection point, feet per mile
m = A constant determined by regional flood reconstitution studies, 0.38 for San Diego County
n = The average of the Manning's values of the watercourse and its tributaries

NRCS Method - Time to Peak

The time to peak (T_p) for the NRCS method was determined as the elapsed time from the beginning of unit effective rainfall to the peak flow for the point of concentration. T_p was calculated for the watershed based on Corps lag using the following equation:

$$T_p = 0.862\ \text{Corps}\ T_l$$

Where, T_p = Lag Time, hours
Corps T_l = Lag Time, hours

NRCS Method - NRCS Lag Time

The NRCS lag (NRCS T_l) has been determined as the time form the center of mass of excess rainfall to the time to peak of the unit hydrograph. Once calculated, this is the correct lag time to enter into the HEC-HMS software for the hydrologic analysis NRCS T_l was calculated for the watershed based on the time to peak and the period of effective rainfall selected for the analysis using the following equation:

$$NRCS\ T_l = T_p - D/2$$

Where, NRCS T_l = NRCS Lag Time, hours
T_p = Time to peak, hours
D = period of effective rainfall

Intensity

The rainfall intensity (I) for each storm frequency of interest was determined using the Intensity-Duration Design Chart from the San Diego County Hydrology Manual (refer to Figure 3-1 in Appendix F), or the equation below:

$$I = 7.44 P_6 D^{-0.645}$$

Where, I = Intensity, inches/hour
P_6 = 6-Hour Precipitation, inches
D = Duration, minutes (may be the T_i, T_t, or T_c)

NRCS Method - Total Rainfall Depth

For increments of duration less than 6 hours, total rainfall for the duration was calculated by multiplying the intensity by the duration, shown in the following equation:

$$P = I\ (D/60)$$

Where, P = Total rainfall depth, inches
I = Intensity, inches/hour
D = Duration, minutes

For increments of duration between six and twenty four hours, total rainfall depth was interpolated between the 6-hour and 24-hour rainfall values using log-log interpolation. The 6-hour and 24-hour values were determined using the isopluvial maps from the San Diego County Hydrology Manual (refer to Appendix F).

Flow Rate Calculations

Flow rates were calculated using the Rational Method and the NRCS method as required by the County's Hydrology Manual. The pre- and post-project flow rates will remain the same due to no changes in impervious areas throughout the project or changes in natural drainage courses. The flow rates determined by this analysis were used to provide dip section and culvert sizes.

HYDROLOGIC MODELING OF RESERVOIR AND CULVERT AT BAUER BRIDGE

Hydraulic analyses were performed to determine the maximum allowable flow through an existing culvert based on both inlet and outlet controlled conditions The most restrictive condition, allowing the lowest flow rate through the culvert, was used to model the upstream reservoir in the hydrologic model.

Inlet Controlled Culvert Calculations

Based on the maximum allowable headwater depth at the upstream end of the 15-ft structural plate pipe, the discharge it is able to convey was determined using the culvert sizing nomograph found in Chart 2B of the County's Drainage Design Manual (refer to Appendix H).

Outlet Controlled Culvert Calculations

Outlet flow conditions were calculated based on total amount of energy required to pass the flow through the pipe. The total amount of head was calculated using equations from the Hydraulic Design of Highway Culverts published by the Federal Highway Administration. Since the length

of the 15-ft pipe, 634-ft, falls outside the 500-ft maximum length shown in the culvert sizing nomograph found in Chart 7B of the County's Drainage Design Manual, the following equations were used to determine the discharge based on the maximum allowable headwater depth.

Total Energy Losses

The total energy (H_L) required to pass the flow through the culvert is made up the entrance loss (H_e), the friction losses through the pipe (H_f), and the exit loss (H_o). H_L was calculated using the following equation:

$$H_L = H_e + H_f + H_o$$

Where,
H_L = Total energy, feet
H_e = Entrance loss, feet
H_f = Friction losses, feet
H_o = Exit loss, feet

Entrance Loss

The entrance loss (He) is a function of the velocity head in the barrel, and can be expressed as a coefficient times the velocity head as shown in the following equation:

$$H_e = K_e (V^2 / 2g)$$

Where,
H_e = Entrance loss, feet
K_e = Entrance Loss Coefficient
V = Velocity in the pipe, feet/second
g = Acceleration due to gravity, 32.2 feet/second^2

Friction Loss

The friction loss (H_f) in the barrel is also a function of the velocity head. Based on Manning's equation, the friction loss was calculated using the following equation:

$$H_f = (K_u n^2 L / R^{1.33}) V^2 / 2g$$

Where,
H_f = Friction loss, feet
Ku = 29 in English units
n = Manning's roughness coefficient (Chart 7B in the San Diego County Drainage Design Manual
L = Length of culvert, feet
R = Hydraulic Radius of the culvert when full (A/P), feet
A = Cross-sectional area, feet^2
P = Wetted perimeter, feet
V = Velocity in the pipe, feet/second
g = Acceleration due to gravity, feet/second/second

Exit Loss

The exit loss (H_o) is a function of the change in velocity at the outlet of the culver. H_o is usually equal to the full flow velocity head in the pipe, as shown in the following equation:

$$H_o = (V^2 / 2g)$$

Where, H_o = Exit loss, feet
V = Velocity in the pipe, feet/second
g = Acceleration due to gravity, 32.2 feet/second^2

Headwater Depth

The headwater depth (HW) can be found by equating the total energy upstream and downstream of the culvert. When neglecting the up and downstream velocity heads the following equation can be used to calculate the headwater depth:

$$HW = TW + H_L$$

Where, HW = Headwater depth, feet
TW = Tailwater depth above the outlet invert, feet
H_L = Total losses, feet

HYDROLOGIC MODELING METHODOLOGY – IMPERIAL COUNTY

The runoff calculation methodology utilized for hydrologic calculations for the section of the project within Imperial County uses that County's Intensity-Duration-Frequency Chart as well as the Caltrans Highway Design Manual. The following subsections describe the rationale behind each of the parameters used in the peak discharge calculation. Supporting reference materials, including the County's Intensity-Duration-Frequency chart and excerpts from the Caltrans Highway Design Manual, dated May 2001, can be found in Appendix G.

Basin Delineation

Drainage basin limits were obtained through the use of topographic mapping, conventional field surveying, site inspection, and/or topographic maps obtained from the U.S. Geologic Survey (USGS).

Runoff Coefficients

Runoff coefficients used to determine the discharge for all contributing areas are based on the Caltrans Highway Design Manual (refer to Figure 819.2A in Appendix G). The runoff coefficients have been ascertained based on the topography, soil properties, and vegetation of each drainage basin in the project vicinity.

Time of Concentration

The time of concentration (T_c) for all contributing areas has been determined as the sum of the sheet flow travel time, shallow concentrated flow travel time, and channel flow travel time as shown in the Caltrans Highway Design Manual. The equations used to calculate these travel times are shown in greater detail below. A minimum of 10-minutes was used for basins with calculated T_c's less than 10-minutes and slopes less than 10%. A minimum of 5-minutes was used for basins with calculated T_c's less than 5-minutes and slopes greater than 10% (refer to page 810-10 of the Caltrans Highway Design Manual in Appendix G).

The sheet flow travel time has been determined by using the following equation (refer to page 810-10 of the Caltrans Highway Design Manual in Appendix G):

$$T_t = \frac{0.93 L^{3/5} n^{3/5}}{i^{2/5} S^{3/10}}$$

Where, T_t = Travel time, minutes
L = Length of flow path, feet
S = Slope of flow, feet per feet
n = Manning's roughness coefficient for sheet flow (refer to Table 816.6A in Appendix G)
i = Design storm rainfall intensity, inches per hour

The shallow concentrated flow travel time has been determined by using the following equations to calculate the average flow velocity and then the travel time (refer to page 810-11 of Caltrans Highway Design Manual in Appendix G):

$$V = k \times S^{0.5}$$

Where, V = Average flow velocity, feet per second
k = Intercept coefficient (refer to Table 816.6B in Appendix G), feet per second
S = Average slope from most remote point in drainage Area to low point, percent

The travel time was calculated using the following equation:

$$T_t = \frac{L}{60 \times V}$$

Where, T_t = Travel time, minutes
L = Length of drainage course, feet
V = Average flow velocity, feet per second

The channel flow travel time has been determined by using Manning's equation to calculate the average channel flow velocity and then the travel time (refer to page 860-7 of the Caltrans Highway Design Manual in Appendix G):

$$R = \frac{A}{WP} \qquad V = \frac{1.486}{n} R^{2/3} S^{1/2}$$

Where, V = Mean velocity, feet per second
n = Manning coefficient of roughness (refer to Table 864.3 in Appendix G)
S = Channel slope, foot per feet
R = Hydraulic radius, feet
A = Cross sectional flow area, square feet
WP = Wetted perimeter, feet

The travel time was calculated using the following equation:

$$T_t = \frac{V}{L}$$

Where, T_t = Travel time, seconds
V = Mean velocity, feet per second
L = Channel length, feet

Intensity
The rainfall intensity (I) for each storm frequency of interest was determined using the Intensity-Duration-Frequency Chart from Imperial County (refer to Appendix G).

Flow Rate Calculations
Flow rates were calculated using the Rational Method as required by the Caltrans Highway Design Manual. The pre- and post-project flow rates will remain the same due to no changes in impervious areas throughout the project or changes in natural drainage courses. The flow rates determined by this analysis were used to provide dip section and culvert sizes.

GENERAL HYDRAULIC MODELING METHODOLOGY

Proposed drainage improvements are coordinated based on the results of the hydrologic analysis described previously. Once 100-year peak discharge is determined, dip section and culvert sizing is performed.

Culvert Design
Using Manning's Equation, culvert pipe diameters were determined given discharge, Manning's n-value, and pipe slope. Based on information collected from the hydrologic modeling, the pipe diameters were determined. An n-value of 0.013 was utilized for all corrugated metal (CMP) fully asphalt lined pipes. The culvert sizing nomographs found in Figures 4-3 and 4-4 of the County of San Diego's Drainage Design Manual, located in Appendix H, were used to determine the headwater depth of each culvert based on both inlet and outlet controlled conditions. Pipe velocities were determined using Bentley FlowMaster computer software, which utilizes Manning's equation to determine the pipe velocities.

Dip Section Design
Using Manning's Equation, dip section lengths were determined given discharge, Manning's n-value, and longitudinal slopes along proposed roadways. An n-value of 0.033 was used for all dip sections. The normal depth, critical depth, and velocity of flow for each dip section has been determined using Bentley FlowMaster computer software to ensure that the runoff is safely conveyed through each dip section (refer to SDG&E Detail Sheet DR-2 in Appendix H).

BRIDGE MODELING HYDRAULIC METHODOLOGY

The water surface at the bridge was determined using the HEC-RAS computer software. User-defined cross sections were determined based on the ground topography and set at appropriate locations in accordance with the HEC-RAS User's Manual (Hydraulic Reference Manual).

Manning's Roughness Coefficient

Based on the ground cover along the channel a Manning's roughness coefficient of 0.040 was used for each cross section. After reviewing the photos of the creek, which can be found earlier in the report, as well as performing multiple field visits it was determined that the channel falls under the category "Dense Growth of Weeds, Depth of Flow Materially Greater Than Weed Height" found in Table A-5 of the County's Drainage Design Manual. This table can also be found in Appendix H.

Contraction and Expansion Losses

For each cross section used to model the flow in the channel contraction and expansion loss coefficients were selected from Table 5.1 in the HEC-RAS User's Manual. Contraction and expansion loss coefficients of 0.1 and 0.3 have been used to reflect cross sections with a gradual transition between them. Loss coefficients of 0.4 and 0.6 were used for cross sections up and downstream of the bridge to model the constriction of flow as well as the transitions between each cross section where there is a significant channel bend.

Left and Right Overbank Lengths

To determine the total conveyance at each cross section the flow was subdivided to include left and right overbank areas. The overbank stations for each section were placed along the edge of the main channel and extend into the channel's floodplain to properly model the flow.

Bridge Modeling Technique

In the vicinity of the proposed bridge four user-defined cross sections were used to model the energy losses due to the structure. The cross sections were placed in accordance to the general modeling guidelines discussed in chapter 5 of the HEC-RAS User's Manual. Two of the cross sections have been located sufficiently up and downstream from the bridge so that the flow is not affected by the structure and is fully expanded. Two of the cross sections were also placed a short distance up and downstream of the bridge to represent the effective flow area just outside the bridge. Ineffective flow areas have also been used to model the effective area of flow through the bridge opening.

Table 4
Sunrise Powerlink Plan Checklist

SEGMENT:_____BVNA JOB #: 16919 DESIGNER: _____DATE: _____

	50% Check	90% Check	Final Check	Comments
I. ALL SHEETS	---			
A. Use standard SDG&E title block and update each sheet appropriately.				
B. Clearly designate between existing conditions and work proposed.				
C. Consistently use Sunrise CADD standards, labels & layers				
D. Use drawing setting and drafting techniques which allows for proper display in PDF format, i.e., "send to back" grid, "send to front" text in profiles.				
II. TYPICAL DETAILS	---	---	---	
A. Fill slopes and slope benching – slope, labels, min/max				
B. Cut slopes – slope, labels, min/max				
C. Pad berm – dimensions, min height				
D. Retaining walls – geosynthetic, masonry, etc				
E. Road section – min width, cross slope, labels				
F. Dip section or water bar – width, spacing				
G. Drainage ditch – depth, width, min/max slope, concrete strength				
H. Culverts – size, material, % min slope				
I. Temporary erosion control (if required other than notes)				
J. Energy dissipator – rock size, depth, area, min/max				

K. Down drain – width, rebar, anchors, construct. notes				
L. Pad drainage layout – flow arrows, swale, energy dissipator, down drain, max/min grade				
III. SITE PLAN	---	---	---	
A. Tower number				
B. Earthwork quantities – cut & fill, difference, area of disturbance (pad, access road, & slopes)				
C. Structure number, type, angle, height				
D. Horizontal control and benchmarks				
E. Vertical and horizontal scales on profiles and cross sections (same as site plan)				
F. Contour elevations (existing & proposed – label major contours)				
G. North Arrow and scale				
H. Right-of-way/easements lines (Width of easements and Assessor Parcel Numbers (APN))				
I. Joining and termination of/to existing roads/pads (feather grade)				
J. Location of point data (number on table, coordinates & finish surface elevation, existing ground elevation, or flow line elevation)				
K. Location of sections (at locations that clarify design)				
L. Section reference (Label sections A-A, B-B, C-C, etc., match direction ash shown in profile)				
M. Vertical curve location in profile view - Elevations shown (BVC, EVC, PI, K)				
N. Road centerline stationing on plan				

O. Berm and pad slope				
P. Turnaround at road end or within 500' road length				
Q. Culverts at low points/trapped drainage				
R. Grading limits shown.				
S. Label cut/fill lines.				
T. Grade and flow line arrows shown on pad and access roads.				
U. Matchline and label shown to existing access roads or other plan sheet				
V. Flow line elevations				
W. Label streams, dip sections, waterbars, ditches, and downdrains				
X. Existing contours shown at 2' intervals and screened to background; 50' beyond construction boundary.				
Y. Riprap provided where drains discharge onto natural ground.				
Z. Retaining walls, drainage ditches, down drains in plan view.				
AA. TW / BW elevations along retaining walls on profiles. (Note: BW is where wall joins pad or meets existing ground)				
BB. Karat symbol on slopes (cut is open karat and fill is solid karat)				
III. EROSION CONTROL (NOTE: if required and cannot be covered by notes or details)	---	---	---	
A. Provide appropriate facilities to eliminate sediment & debris.				
B. Show all sediment control facilities:				
1. Dikes shown				
2. Fiber Rolls on slopes				

3. Hydro seeding on slopes				
IV. TITLE SHEET	---	---	---	
A. Correct project & segment name, line voltage				
B. Update General Notes				
C. Update Erosion Control Notes (per BMP)				
D. Update retaining wall notes				
E. Update and complete legend and abbreviations				
F. Key map for construction package				

Evaluation Legend: / = Acceptable; ? = Unclear, Provide more data; N/A = Not Applicable; X = Not Acceptable (provide reason for unacceptability in comment section)

FIGURE 10 - DEVIATION FROM STANDARD

Sunrise Powerlink
230kV & 500kV Access Roads & Maintenance Pads
DEVIATION FROM STANDARD

Date:_____
Line Segment:_____
Location: _____

1.	**Existing Conditions** Describe the existing conditions – grade, terrain, soil, access
2.	**Proposed Work and Non Standard Features** Describe work to be done - Tower, pole, access road, retaining wall, drainage facility, etc. Describe the non-standard design element that requires the deviation.
3.	**Standard for Which the Deviation is Required** Specify the criteria and source.
4.	**Cost Impact** Show order of magnitude of cost to make design standard.
5.	**Justification for Requesting Exception** Be brief but thorough. Some possible reasons may include: high cost, environmental sensitivity, right-of-way limitations.

Approved:
Bureau Veritas _____ **Date:**_____

SDG&E_____ **Date:**_____

APPENDIX A

CADD STANDARDS

SUNRISE POWERLINK
PLAN PREPARATION

CADD STANDARDS

Prepared for:

San Diego Gas & Electric Company
8316 Century Park, Bldg CP52G?
San Diego, CA 92123-1548

Prepared by:

Bureau Veritas North America, Inc.
11590 West Bernardo Court, Suite 100
San Diego, CA 92717-1624

July 21, 2008

SUNRISE POWER LINK PLAN PREPARATION

Computer Aided Drafting & Design (CADD) Standardization

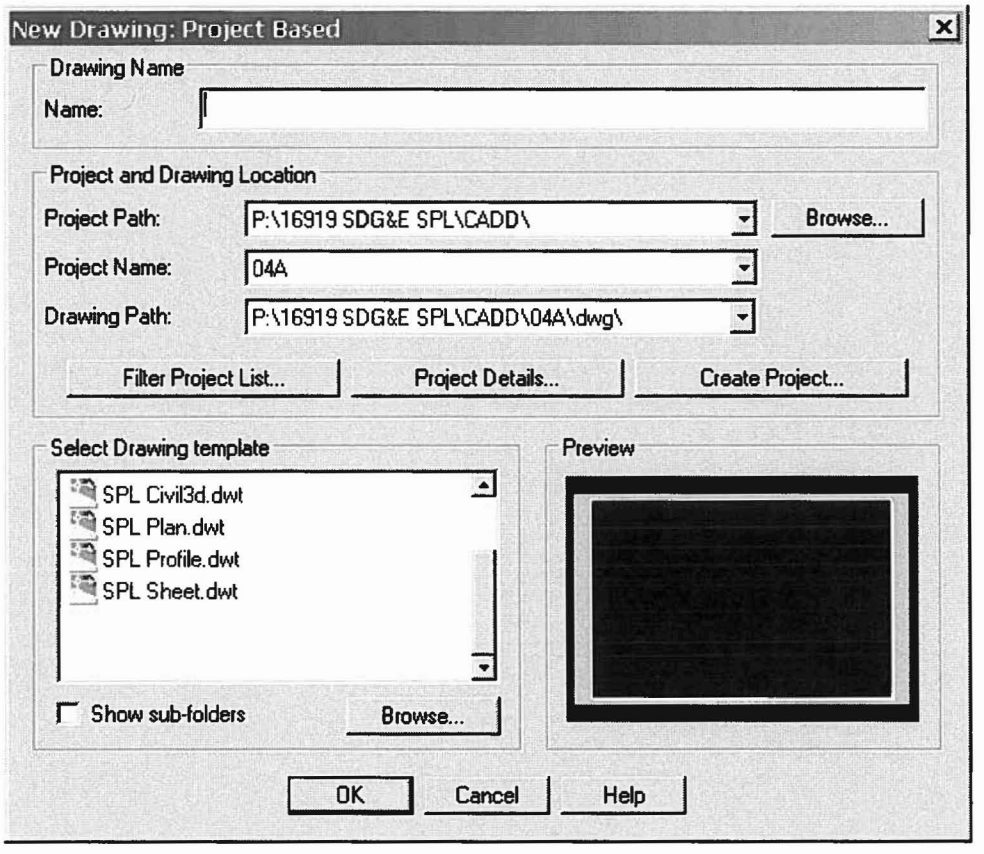
Table of Contents

AUTOCAD TEMPLATE (DWT) FILES

Below is a screen capture showing the LDT New Drawing dialogue box with the BV profile current. When creating a new drawing, CADD Operators should select one of the appropriate "Drawing templates" from the field to automatically load the SDG&E standard text styles, dimension styles, plotter/page setup and layer names & settings for this project.

Important: CADD Operators should refrain from implementing any commands or routines that "purge-all" unused layers, styles or linetypes without discriminating.

Note to CADD Operators Creating New Profile Drawings: Before creating a new "SDG&E profile" drawing, copy the file "*P:\$SUPPORT\ACAD\dwt\SDG&E profile.dfm*" to the project's "*dwg*" directory and rename it "[new profile drawing name].*dfm*"; click "OK" to overwrite the existing file.



LDT PROJECT DIRECTORY and CADD FILE NAMES

Due to the overall size, scope and number of CADD files generated for this project, Bureau Veritas standard directory and file naming conventions have been modified as follows:

Sample LDT Project Directory Names

Project Paths	Project Names	Descriptions
"*P:\16919 SDG&E SPL\CADD*"	"*04A*"	Segment 4A
"*P:\16919 SDG&E SPL\CADD*"	"*10A*"	Segment 10A

Standard "DWG" Subdirectory Names

Subdirectory Names	Descriptions
"plan"	*Plan and Profile Sheet Files and Annotation Files for the Project Segment*
"xref"	*Component Xreference Files Used to Compose the Plan and Profile Sheet Files for the Project Segment*
"workups"	*Working Design Files, such as Those Created by Civil 3D Software, for the Project Segment*
"exhibits"	*Exhibits Produced for the Project Segment*

Sample CADD Drawing File Names

Sheet Drawing File Names	Descriptions
"*SPL-04A-001.dwg*" thru "*SPL-04A-999.dwg*"	Segment 4A Sheet files
SPL-10B-001.dwg" thru "*SPL-10B-999.dwg*"	Segment 10B Sheet files

Sample CADD Drawing File Names (cont.)

Xreference Plan Drawing File Names	Descriptions
"*Border.dwg*"	Plan & Profile Sheet Border
"*Mapping.dwg*"	Property, Easement & Right-Of-Way Lines
"*Topo.dwg*"	Topography & Existing Conditions
"*Base.dwg*"	Proposed Hardscape
"*Grading.dwg*"	Proposed Contours & Grading Appurtenances

Xreference Profile Drawing File Names	Descriptions
"*Pf Co-31 A-A.dwg*"	Profile for Alignment "*Co-31 A-A*"

Sample LDT Alignment Names

Alignment Names	Descriptions
"*Co-31 A-A*"	Access Road Alignment for Site "*Co-31*"

Sample LDT Surface Names

Surface Names	Descriptions
"*Co-31* "	Finished Ground Surface for Site "*Co-31*"
"*CF Co-31* "	Cut Fill (Volume) Surface for Site "*Co-31*"

Project CADD Symbols

The CADD Symbols Library for this project can be found in the directory:

"P:\$SUPPORT\ACAD\BLOCKS\SPL Symbols Library"

A sheet plot of all the symbols in the library is attached as "Appendix 'A'" to this document.

PAGE SETUPS and PLOTTING

AutoCAD Page Setups

Standard 24"x 36" plotter page setups, and the approximately half sized (11"x 17") printer page setups, for the San Diego office load automatically when the AutoCAD Template (dwt) drawings are used to create new drawing files.

AutoCAD Pen Tables ("CTB" Files) and Line Weights

The Client has instructed us to use the AutoCAD Pen Table (ctb) file "CIVIL-STRUCT.ctb" when preparing and plotting the plan sheets for this project. This file loads automatically with the aforementioned Page Setups. A table of sample line weights is attached to this document and labeled "Appendix 'B'".

TEXT STYLES

The following are the names of text styles (with their properties) that SDG&E has instructed us to use when preparing the plan sheets for this project. These text styles will load automatically when the AutoCAD Template (dwt) drawings are used to create new drawing files.

Text Style Names and Appurtenant Information

Style Name	Font File	Plotted Height	Application
S1 annotations	simplex.shx	0.1"	plan & profile
ROMAND section titles	romand.shx	0.13"	table headings;
HM-LD	hm-ld.shx	0.19"	plan & profile titles

Note: All text styles shown above have a width factor of "1" and oblique angle of "0d0'0"". Title sheets, exhibits and other special drawings may use font files not listed above.

LAYER NAMES

Layers

Minimizing the number of layers and the simplification of layer naming in AutoCAD drawings is key to a successful project. Simplicity, without the loss of utility, should be the goal when deciding whether to, create a new layer or, use an existing layer already in the drawing file.

Sheet Drawing Layer Names

Layer Name	Used for:
$	Designer's Notes and Construction Lines (not shown on plan)
Text	Annotation; Titles
Dim	Leader Lines
Vport	Viewport
Xref	Xreference Drawings

Sample Plan Drawing Layer Names

Layer Name	Used for:
$	Designer's Notes and Construction Lines (not shown on plan)
Contour Major	Major Contours

Sample Plan Drawing Layer Names (cont.)

Layer Name	Used for:
Contour Minor	Minor Contours
Slope Indicators	Lines Delineating Tops and Toes of Slopes; Slope

Transmission Line	Power Transmission Alignment Line
Centerline	Access Road Control (Centerline)
Easement Line	Delineating Limits of Easements
Property Line	Delineating Limits of Fee Title
Curb	Concrete Curb
Berm	Asphalt Berm
Wall	Retaining Wall
HDPE	High Density Polyethylene Pipe
CMP	Corrugated Metal Pipe
RCP	Reinforced Concrete Pipe

Profile Drawing Layer Names

Note: The LDDT "create profile" routine will automatically create entities on the following layers if, before a profile drawing is created, the file "*P:\$SUPPORT\ACAD\dwt\SDG&E profile.dfm*" is copied to the project's "*dwg*" directory and renamed "[new profile drawing name].*dfm*".

Layer Name	Used for:
$	Designer's Notes and Construction Lines (not shown on plan)
Text	Profile Annotation
Existing Grades	Existing Grade Elevations
Grid	Profile Grid
Existing Ground	Existing Grade @ Centerline
Finished Ground	Finished Grade @ Centerline

Layers in the "base.dwg" drawing

$ - This layer contains everything you do not want to plot such as construction lines, design notes, and 3D faces if you choose to use them.

0 - This layer is automatically created by Land Desktop. There should be nothing on this layer.

Centerline - The centerline for every access road is placed on this layer. It is correct that lines drawn on this layer are yellow and continuous. Every road centerline should be placed in the base drawing.

CMP - This layer is automatically created in any new drawing that is created with the "SPL Plan" template drawing. This layer has not been used yet in the project. There should be nothing on this layer.

DCA_INFO - There should be nothing on this layer.

Defpoints - This layer is automatically created by Land Desktop. There should be nothing on this layer.

Down Drain - This layer is for the down drains coming off of the pads.

Easement Line - This layer indicates where SDG&E will be acquiring easements for the project outside of their right of way. Up to this point in project SDG&E has no easements so there should be nothing on this layer.

Fiber Roll - All fiber rolls should be drawn on this layer.

HDPE - This layer is automatically created in any new drawing that is created with the "SPL Plan" template drawing. This layer has not been used yet in the project. There should be nothing on this layer.

Hydroseed - All outlines for hydroseed hatching should be drawn on this layer.

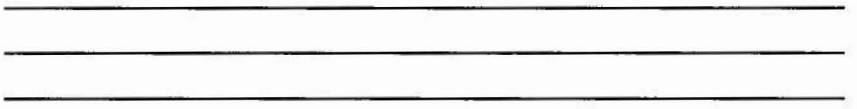
RCP - This layer is automatically created in any new drawing that is created with the "SPL Plan" template drawing. This layer has not been used yet in the project. There should be nothing on this layer.

Rip Rap - All outlines for rip rap hatching as well as the hatching to indicate rip rap should be drawn on this layer.

Transmission Line - This layer is for all proposed transmission lines.

Transmission Structure - This layer is for all proposed transmission poles and towers.

Wall - All retaining walls should be on this layer. The line work for a retaining wall should first consist of three parallel lines drawn .5 units apart from each other as shown below:



The middle line will need to be a polyline so it can be changed into the thick, dashed line that represents the wall. Through the properties dialogue box change the linetype of the middle line to "HIDDEN2" and the global width to 1.00.

Xref - Nothing should be drawn on this layer.

Layers in the "grading.dwg" drawing

$ - This layer contains everything you do not want to plot such as construction lines, design notes, and 3D faces if you choose to use them.

0 - This layer is automatically created by Land Desktop. There should be nothing on this layer.

CMP - This layer is automatically created in any new drawing that is created with the "SPL Plan" template drawing. This layer has not been used yet in the project. There should be nothing on this layer.

Contour Major – Proposed - All proposed major contours should be on this layer.

Contour Minor – Proposed - All proposed minor contours should be on this layer.

Daylight – All outside boundary lines where proposed grading meets the existing ground should be on this layer and the interior boundary of the proposed grading around pads and proposed access roads should also be on this layer.

DCA_INFO - There should be nothing on this layer.

Defpoints - This layer is automatically created by Land Desktop. There should be nothing on this layer.

Fiber Roll - All fiber rolls should be drawn on this layer.

Flow Line - All flow lines should be drawn on this layer and they should all be located in the grading file.

Grading Object - Nothing should be on this layer.

HDPE - This layer is automatically created in any new drawing that is created with the "SPL Plan" template drawing. This layer has not been used yet in the project. There should be nothing on this layer.

Hydroseed - All outlines for hydroseed hatching should be drawn on this layer.

RCP - This layer is automatically created in any new drawing that is created with the "SPL Plan" template drawing. This layer has not been used yet in the project. There should be nothing on this layer.

Slope - All cut and fill slope indicators should be on this layer and located in the grading file.

Wall - This layer is for all retaining walls. There should be nothing on this layer in the grading file. All retaining walls should be located in the base file.

Xref - Nothing should be drawn on this layer.

Profile Layers:

Layers in profile drawings

$ - This layer contains everything you do not want to plot such as construction lines, design notes, and 3D faces if you choose to use them.

0 - This layer is automatically created by Land Desktop. There should be nothing on this layer.

DCA_INFO - There should be nothing on this layer.

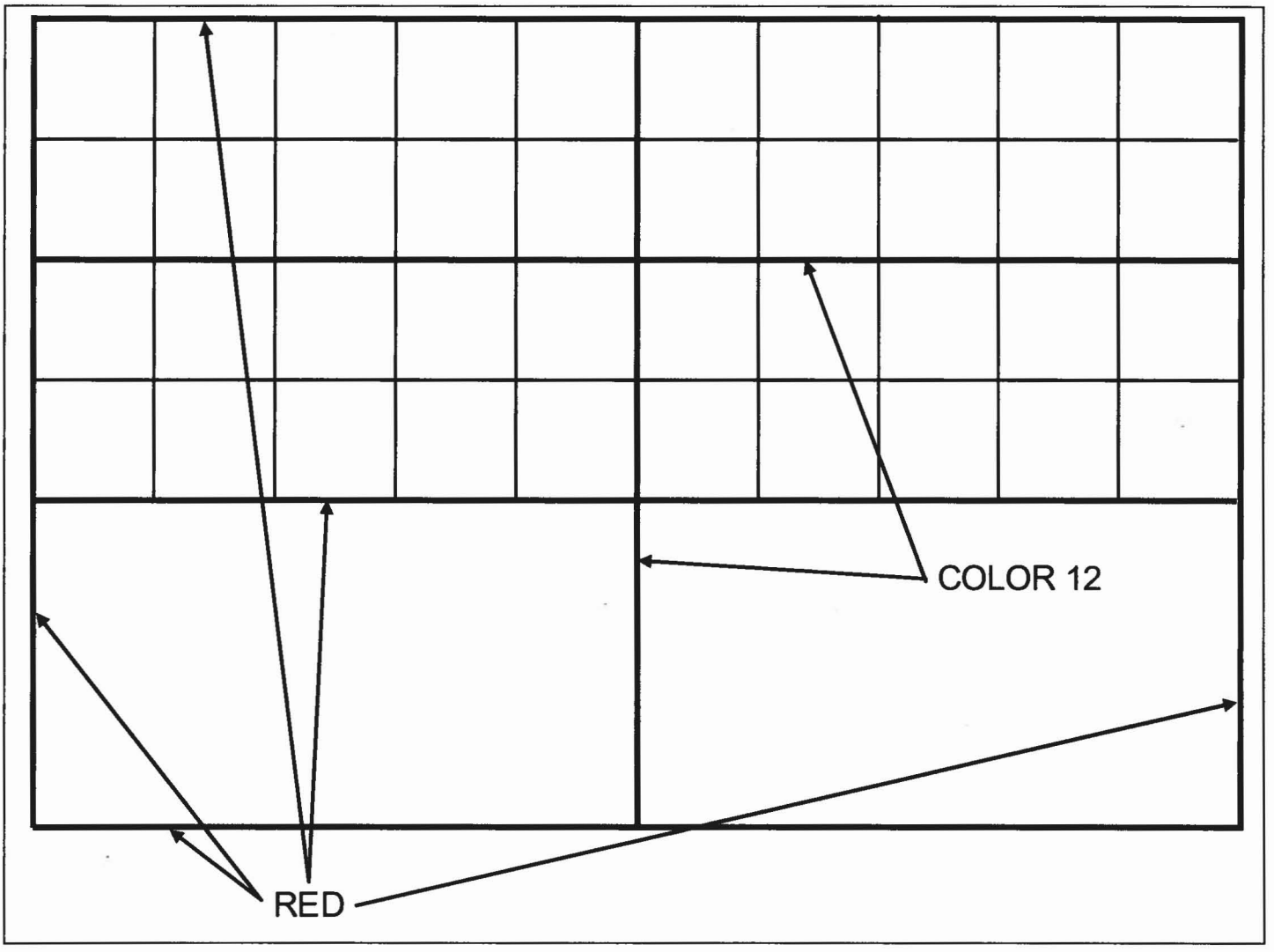
Defpoints - This layer is automatically created by Land Desktop. There should be nothing on this layer.

Existing Grades - The existing elevations shown at 25 foot intervals along the bottom of each profile are automatically created on this layer.

Existing Ground - The existing ground profile is automatically created on this layer.

PGRID - The entire profile grid should be on this layer and it should be set to color 11. When a profile is created the lines along the outside of the profile grid need to be changed to the color red. The horizontal line at the datum elevation of the grid will also need to be changed to the color red. All horizontal and vertical major gridlines will need

to be changed to the color 12, including vertical lines in the elevation banding at the bottom of the grid. All minor gridlines should remain the color 11. An example of how to set the colors for the profile is shown below:



Text – This layer is for all annotation text in the profile as well as the stationing and elevations.

The layers PBASE, PEGC, PEGCT, PFGCT, PGRID, PGRIDT, PROF_INFO, and PVGRID are all automatically created by Land Desktop. The only one of interest is the PGRID layer for the profile grids.

Layers in tx or annotation drawings

$ - This layer contains everything you do not want to plot such as construction lines, design notes, and 3D faces if you choose to use them.

0 - This layer is automatically created by Land Desktop. There should be nothing on this layer.

CMP - This layer is automatically created in any new drawing that is created with the "SPL Plan" template drawing. This layer has not been used yet in the project. There should be nothing on this layer.

Contour Major - Existing - There should be nothing on this layer.

Contour Minor - Existing - There should be nothing on this layer.

Contour Major - Proposed - There should be nothing on this layer.

Contour Minor - Proposed - There should be nothing on this layer.

DCA_INFO - There should be nothing on this layer.

Defpoints - This layer is automatically created by Land Desktop. There should be nothing on this layer.

Fiber Roll - There should be nothing on this layer.

HDPE - There should be nothing on this layer.

Hydroseed - There should be nothing on this layer.

RCP - There should be nothing on this layer.

Slope - There should be nothing on this layer.

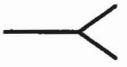
Transmission Line - There should be nothing on this layer.

Transmission Structure - There should be nothing on this layer.

Wall - There should be nothing on this layer.

Xref - There should be nothing on this layer.

Section Indicator
Symbol=indicator section.dwg



Cut Slope Indicator
Symbol=indicator cut slope.dwg

Fill Slope Indicator
Symbol=indicator fill slope.dwg

NUMBER	NORTHING	EASTING	ELEVATION
x	x	x	x
x	x	x	x

Coordinate Table
Symbol=table coordinate.dwg

Z NO.	SP. NO.	STRUCTURE TYPE	POLE HEIGHT
x	x	x	x

Structure Info Table
Symbol=table coordinate.dwg

EARTH QUANTITIES: AREA: xxxx SQ. FT.
CUT: xx CY.
FILL: xx CY.

Earthwork Table
Symbol=table earthwork.dwg

North Arrow
Symbol=label north.dwg

POLE x-xx PLAN
SCALE: 1" = xx'

Plan Label
Symbol=label plan.dwg

POLE x-xx PROFILE
SCALE: 1" = xx'

Profile Label
Symbol=label profile.dwg

NOTE:
Co-xx HAS BEEN REMOVED
I-xx HAS BEEN REMOVED

Note
Symbol=label note.dwg

SECTION x-x

Section Label
Symbol=label section.dwg

Coordinate Callout Label
Symbol=label coordinate callout.dwg

BUREAU VERITAS
11590 West Bernardo Court Suite 100
San Diego, CA 92127-1624
Tel: (858) 451-6100 Fax: (858) 451-2846
www.us.bureauveritas.com

SAN DIEGO GAS & ELECTRIC COMPANY
SAN DIEGO, CALIFORNIA

SUNRISE POWER LINK
SYMBOLS LIBRARY
APPENDIX "A"

APPENDIX "B"

CIVIL–STRUCT.CTB

COLOR (#)	COLOR PEN	WEIGHT (IN)	SCREEN
RED 1	1	0.017	100%
YELLOW 2	2	0.008	100%
GREEN 3	3	0.011	100%
CYAN 4	4	0.014	100%
BLUE 5	5	0.009	100%
MAGENTA 6	6	0.011	100%
WHITE 7	7	0.004	100%
DK GREY 8	8	0.027	100%
LT GREY 9	9	0.009	100%
10	10	0.069	100%
11	11	0.012	20%
12	12	0.016	30%
13	13	0.02	40%
14	14	0.03	40%
15	15	0.069	70%
16	16	0.014	100%
21	1	0.014	50%
30	30	0.014	7%
31	31	0.014	50%
40	30	0.014	100%
41	31	0.014	30%
50	30	0.014	12%
60	30	0.014	13%
70	30	0.014	14%
90	1	0.011	100%
120	1	0.011	10%
150	1	0.011	90%
151	2	0.008	100%
161	7	0.004	100%
240	1	0.011	100%
241	1	0.014	30%
252	1	0.014	30%
255	7	0.014	100%

APPENDIX B

CIVIL 3D GUIDELINES

SUNRISE POWERLINK
PLAN PREPARATION

Civil 3D Guidelines

Prepared for:

San Diego Gas & Electric Company
8316 Century Park, Bldg CP52G?
San Diego, CA 92123-1548

Prepared by:

Bureau Veritas North America, Inc.
11590 West Bernardo Court, Suite 100
San Diego, CA 92717-1624

March 17, 2009

Civil 3D Conventions

General:

- Create new drawing using the pre-set templates made for each segment. Templates are available at P:\$SUPPORT\ACAD\dwt c3d. These templates contain all the styles, corridors and settings needed for the project.
- Use SDG&E File naming conventions per SUNRISE POWER LINK PLAN PREPARATION, Computer Aided Drafting & Design (CADD) Standardization
- Use workups folder for temporary, intermediate design, and recovery drawings. Keep the design folder clean. Only design files which are XREFed (External Referenced) into the plan sheets should live in this folder.
- Place data short cuts in data short cut folder. Use default file name
- XML files for SDG&E should be placed in an XML folder
- When creating tables use the table style SPL-PNEZ. Tables are created by clicking on the Points pull down menu and selecting "Add Tables". The primary table created for this project will include control points for the site such as top of wall elevations, pad corners, begin of road centerlines etc.

Surface: (Also See Sites)

- When creating surfaces, place your initials and the date in the description box so that the designer and "age" of the surfaces can be identified. This is found in the dialogue box which appears when surfaces are created.
- Use SDG&E naming convention for the main surface (i.e., 9C 215) which contains the pasted road and pad surfaces; and also for the cut fill surface (CF 9C 215) which contains the cut fill lines for the main surface.
- For other surfaces use:
  - EX – for existing topography
  - PAD – for pad grading only
  - Access A-A , Access B-B, etc.– for access roads

Profiles:

- Do not twist view in model space
- Use SDG&E naming convention for profile
- Use default profile view name
- Use SPL Profile – for profile view style
- Use SPL Band – for band set

Sites:

- Use only one site per design.
- Use default site name.
- Use default group name.

Corridors:

- Name corridors using the following format: Access 'section' such as Access A-A, Access B-B etc.

Assembly:

- Use SPL 14 Road assembly which was provided by the template when the drawing was created.
- If you need to create additional assemblies, preface name with SPL, then selected name (i.e., SPL selected name).

XREFs:

- Bring in XREF drawings as an overlay with "relative path" not "full path" setting on the XREF layer.

Submittals:

- Submittals will be full size PDF format. Be sure the drawing order is as follows:
  - Existing features – sent to back
  - Proposed feature – bring to front
  - Profile grids - sent to back

APPENDIX C

SDG&E CIVIL/STRUCTURAL ENGINEERING DESIGN & PROCEDURE MANUAL FOR TRANSMISSION LINE ACCESS ROADS

SDGE

A Sempra Energy utility

SAN DIEGO GAS & ELECTRIC
CIVIL/STRUCTURAL ENGINEERING

DESIGN AND PROCEDURE MANUAL
FOR
TRANSMISSION LINE ACCESS ROADS

May 18, 2007

Prepared By: Cori Marsalek Date: 5/18/07
Corinna L. Marsalek
Engineer I, Civil/Structural Engineering

Reviewed By: T. L. Moore Date: 7/22/07
Tim Moore
Team Lead, Civil/Structural Engineering

Approved By: J. Bret Ball Date: 7/22/07
Bret Ball
Manager, Transmission Construction and Maintenance

Approved By: Samuel J. Harris Date: 9/05/07
Samuel J. Harris
Manager, Civil/Structural Engineering

Table of Contents

1.0 Purpose

This manual provides design criteria for the design of SDG&E transmission line access roads and structure pads. The access roads and structure pads provide access for a number of different vehicle types, for the purpose of foundation construction, structure delivery and erection, conductor stringing operations, and future maintenance. These access roads and structure pads must be designed to accommodate all phases of construction and maintenance. Access road and structure pad designs shall be tailored to the topography, soil conditions, and overall site drainage.

Many considerations are involved in determining the access road and structure pad locations such as physical, environmental, cultural, property ownership, and Right-of-Way (ROW) availability. Each factor must be considered to establish an alignment providing the best possible access to the structure sites at the least cost to build and maintain. Special consideration shall be made for the safety of construction and maintenance crews.

It is not possible to prescribe standards applicable to every situation encountered for access road and structure pad design. The Manager of SDG&E's Civil/Structural Engineering Department and the Manager of SDG&E's Transmission Construction and Maintenance Department (TCM) shall be made aware of and approve any exceptions to the design criteria in 4.0.

This manual is divided into three general categories: Inputs, Procedure and Coordination, and Design Criteria.

2.0 Reference Documents

2.1 SDG&E Specification No TE-0101 – Construction Specification Site Preparation and Access Roads

2.2 San Diego County Drainage Design Manual

2.3 San Diego County Hydrology Manual

2.4 San Diego Area Regional Standard Drawings

2.5 City of San Diego Standard Drawings

2.6 Caltrans Highway Design Manual, Section 200

2.7 Sempra Energy Utilities "Water Quality Construction Best Management Practice Manual"

2.8 California Regional Water Quality Control Board "Guidelines for Construction Practices"

2.9 California State Water Resources Control Board's Construction Storm Water General NPDES Permit

2.10 Applicable Municipal Ordinances (Counties, Cities, Special Districts)

3.0 Inputs Required

The following minimum information is required to design access roads and structure pads. This information will be provided by SDG&E to consultants performing this work.

3.1 Coordinates of all structures including structure type (wood, steel, pole, tower, tangent, deadend, vault, vault size), height, and voltage level (see 4.2.1)

3.2 Available aerial photos and contours (see 4.2.1)

3.3 Right of Entry permits (see 4.2.2)

3.4 Right of Way information (see 4.2.2)

3.5 Restrictions and limitations due to environmental, archaeological, and paleontological constraints (see 4.2.3)

3.6 Geotechnical information obtained by SDG&E at structure sites, including depth to groundwater, if available

4.0 Procedure and Coordination Requirements

It is the responsibility of the SDG&E Project Manager to coordinate all responsibilities and project design activities between the involved parties. This is essential to avoid locating roads or structure pads in sensitive areas, on property that is not available, or in a manner that is physically difficult to construct and/or use. Proper project coordination will keep the project design on track and avoid misunderstandings and miscommunications that could result in inappropriate designs, project delays, cost overruns, and construction difficulties.

During the design process, the designer shall spend an ample amount of time in the field to become completely familiar with the terrain and existing conditions. Contact the SDG&E Project Manager assigned to the project to ensure permission, in the form of a Right-of-Entry (ROE) permit, is granted to access private property, and to ensure sensitive areas have been cleared by SDG&E Environmental Management for entry.

Outlined below is the design procedure to follow when developing a set of access road and structure pad grading plans.

4.1 Kickoff Meeting

A project design kickoff meeting should be arranged by the SDG&E Project Manager to discuss and define the project scope, establish design parameters and project goals, and assign project responsibilities and action items. The proposed transmission line and structure locations should be identified during or prior to the kickoff meeting.

4.2 Research

The following design input information shall be researched by appropriate SDG&E departments and made available to the designer. This information will be provided by SDG&E to consultants performing this work.

4.2.1 Transmission line location

- Coordinates and general information (see 3.1) of all structures from Transmission Engineering and Design (TE&D)
- Property owner maps and assessor parcel maps
- Aerial photos and contour maps
- USGS topographic maps for research purposes, if aerial photos and contour maps are not available

4.2.2 Availability of Right-of-Way outside the transmission line Right-of-Way provided by SDG&E ROW agent

- Determination of whether prescriptive rights give SDG&E access to any roadway not covered by recorded easements.
- The attitude of property owners toward the project.
- Determination of whether construction of access roads outside the transmission line easement is acceptable to the owner.
- The degree of difficulty of obtaining additional easements.

4.2.3 Environmental, Archaeological, and Paleontological provided by SDG&E's Environmental Management Department

An environmental report is typically started in the early stages of the project. Therefore, preliminary road and structure pad locations need to be identified using the constraints identified by the project environmental group. The following items will be provided:

- Locations of sensitive biological or cultural areas

- Locations requiring reduced or minimal visibility from houses and highways
- Locations of "no build" areas
- Locations of drainage crossings

4.3 Reconnaissance

Site reconnaissance shall take place to familiarize the project team with the existing conditions of the prospective sites and the surrounding areas. A site visit can be performed by vehicle, helicopter, and/or foot after preliminary structure staking is completed, ROE is obtained, and general potential environmental issues are identified. Representatives from the following shall attend the site reconnaissance: Civil/Structural Engineering, Environmental Management, Real Estate and Land Services, TCM, TE&D, and consultants, if used. If the site visit is conducted after researching available project information, feasible design scenarios can be pinpointed and unworkable design solutions eliminated.

The site visit also serves the purpose of verifying the accuracy and usefulness of the researched project information. During the course of the field visits, it may be determined that additional field data is required. This can be accomplished by the SDG&E Project Manager making a survey request and submitting it to the SDG&E Survey Department or submitting other data requests to applicable departments. If the design work is being performed by an outside consultant, their in-house survey staff could be utilized per the contract agreement. If additional control points or benchmarks are required, coordination with SDG&E's Survey Department is required.

Site reconnaissance can provide information and design direction for the following:

4.3.1 Identifying existing access that can be utilized to structure sites and determining additional access or modifications that may be required.

4.3.2 Terrain, geotechnical, and hydrological issues and constraints for access roads and structure pads.

4.3.3 Environmental/archeological/palentological issues and constraints.

4.3.4 Construction issues due to the existing or required easements (A SDG&E Right-of-Way agents should be involved in property and easement issues).

4.3.5 Photographic information taken during the site visit can be used for historical records, required public hearings, and as a reference for design work.

4.4 50% Preliminary Design Submittal Requirements

4.4.1 Determine the best possible scale for the appropriate level of detail. The drawings shall clearly depict the scope of work required including cut and fill slopes.

4.4.2 Using most recent survey data, plot structure locations and structure numbers, transmission line ROW, property lines, and existing locations. USGS and SDG&E GIS can be used if aerial photography and contours are not available in sufficient time.

4.4.3 Identify which existing roads may be used for access. Identify any improvements required.

4.4.4 Identify limitation areas of special consideration (environmentally sensitive areas, cultural sites, and areas of no or limited access) if any.

4.4.5 Lay out the proposed access roads and structure pads, including square footage of disturbance. Identify if it is not possible to keep within the boundary of the transmission line ROW while maintaining minimum design standards. Show locations of proposed retaining walls and other structures.

4.4.6 Show locations and types of major water crossings such as dip sections, culverts, etc. Show preliminary access road drainage flow direction including type and location of flow control devices (waterbars and energy dissipators, downdrains, diversionary structures, etc.).

4.4.7 Include notes on the Drawings to supplement the Specifications (see 4.7 and 6.1.1)

4.4.8 Drawings and Specifications shall be submitted to the SDG&E Project Manager to distribute to project team members for review.

4.5 90% Preliminary Design Submittal Requirements

4.5.1 Revise the drawings to reflect any changes to the road and structure pad designs based on input from all appropriate departments and other consultants.

4.5.2 Show profiles, sections, area of disturbance, grading quantities, north arrow, scales, and a horizontal control table for all roads and structure pads.

4.5.3 Show location and provide design calculations and detail drawings for culverts, drainage pipes, energy dissipators, retaining walls, stabilized slopes, and other design features.

4.5.4 Show vicinity map, legend, and general and erosion control notes.

4.5.5 Show location and detail drawings for waterbars (see Detail Drawing DR-2), gates (see Detail Drawings MS-1 – MS-3), and all other drainage and construction items.

4.5.6 Prepare preliminary cost estimate.

4.5.7 Drawings and Specifications (see 4.7 and 6.1.1) shall be submitted to the SDG&E Project Manager to distribute to project team members for review.

4.6 Final Design Submittal Requirements

4.6.1 Revise the drawings and Specifications to reflect any changes to the road and structure pad designs based on input from SDG&E and consultants.

4.6.2 Finalize grading quantities and construction cost estimate. Care shall be taken to include costs associated with overexcavation, bulking or shrinkage of soils, pumping, geotechnical investigation, geotechnical monitoring, construction surveying, construction management, drainage structures, earth retaining structures etc.

4.6.3 List of access roads structures and other construction structures and their GIS location that require post-construction maintenance (culverts, retaining walls, rip rap, etc.).

4.6.4 Stamped final design drawings, detail drawings, specifications, and cost estimates shall be submitted to SDG&E's Civil/Structural Engineering Manager and the Project Manager (See 4.8).

4.7 Specifications

If necessary prepare and submit construction specifications with 50%, 90%, and final submittals (see 4.4, 4.5, 4.6, and 6.1.1). SDG&E Specification TE-0101 "Construction Specification – Site Preparation and Access Roads" shall be included by reference (see 6.1.1). TE-0101 shall be supplemented by any additional or revised items as necessary to describe all materials and construction requirements not included in TE-0101.

4.8 Document Delivery

Upon completion of the final design, specifications, and cost estimate, documents for agency permitting and Contractor bidding shall be delivered to the SDG&E Project Manager in both electronic and hard copy formats.

4.8.1 Electronic files and format shall be as follows:

- All drawing files shall be in AutoCAD (2004 or newer), Land Development Desktop (LDD), and/or Civil 3D, as approved by the SDG&E Civil/Structural Engineering Representative.
- All LDD and Civil 3D project files shall include horizontal and vertical alignments, digital terrain files, points files, etc.
- All text document files shall be in Microsoft Word 2000 or newer.
- Spreadsheet documents shall be in Microsoft Excel 2000 or newer.

4.8.2 Typical hard copy deliverables include:

- Reproducible plans shall be on vellum
- Hardcopy sets per SDG&E Project Manager's request
- Geotechnical reports
- Hydrology studies
- Structural calculations
- Construction specifications
- Cost estimates

5.0 Design Criteria

Many of SDG&E's transmission lines are located in rural areas, requiring construction of access roads in natural, rolling, mountainous, rocky, or desert terrain.

SDG&E uses a number of different structures to support transmission lines (overhead and underground). They consist of, but are not limited to, wood poles, steel poles, H-frame structures, lattice towers, and underground vaults. Each type of structure requires a foundation of native soil, gravel backfill, cement slurry, or cast in place concrete. Each foundation is individually excavated either by hand or powered equipment; therefore the

access roads and structure pads must accommodate a wide variety of heavy construction vehicles. Each type of structure also requires different maintenance methods; therefore different access road and structure pad requirements.

This section contains design criteria for the design of access roads and structure pads in terms of horizontal alignment, vertical alignment, grading considerations, and drainage requirements. Variance from these guidelines shall have approval of SDG&E's Civil/Structural Engineering Manager and the TCM Manager. Specific state, county, and/or city requirements for grading shall be researched. The more stringent requirement shall be followed.

5.1 Topographic Surveying

Prior to any design work, a topographic survey shall be performed with two (2) foot contours. The limits of the topographic survey shall extend to at least 100 feet beyond the limits of the transmission ROW. Extensions beyond 100 feet may be necessary where geological or hydrological features potentially affect the design. For larger projects, where it may not be practical or cost effective to survey from the ground, an aerial topography shall be flown. Orthographic photos shall also be taken in conjunction with the aerial topography. All orthographic photos shall have a minimum resolution of 1 pixel equals 0.25 feet.

For critical work and areas where the aerial topography is inaccurate, a ground topographic survey shall also be performed. At this time Lidar surveying technology shall not be used for access road and structure pad design.

5.2 Horizontal Alignment

It is preferred to construct roads along the same route as the transmission line thereby increasing the accessibility to each tower, decreasing additional ROW costs, and decreasing the total disturbed area. Typically the horizontal alignment is established by the terrain and the location of major drainages. In steep and hilly terrain the roads may meander in and out of the transmission ROW in order to conform to maximum vertical grades as outlined in 5.3. If access roads or structure pads need to be located outside of the transmission ROW, additional easements requirements shall be addressed. The access roads and structure pads shall also be designed and located to minimize the major drainage and stream crossings and the proximity to drainages and streams. It shall be brought to the attention of TE&D if structures or structure pads are located in or near drainage or stream crossings. TE&D will determine if the structure can be moved to avoid or minimize the impact to the drainage or stream crossing.

Roads shall have maximum cross slope of 4%. Structure pads shall have a maximum cross slope of 2%. Roads shall be sloped horizontally to affect sheet flow runoff to the downslope side away from interior slope wall whenever practical.

Existing access roads shall be utilized wherever possible to reduce construction costs, unless other mitigation costs and/or environmental factors preclude their use. All curves shall have a radius of curvature of not less than 75 feet, measured at the centerline of the usable road surface. The minimum usable width of all access roads shall be 14 feet and shall be increased on curves by the distance shown in Table 5.2 in order to accommodate tracking by longer vehicles.

Table 5.2: Additional Road Width Requirements

Radius of Curvature	Additional Road Width
75-100'	6'
101-150'	5'
151-200'	4'
201-400'	3'
0ver 400'	2'

Dead-end stub roads over 500 feet in length shall be provided with a Y-type or circle type turnaround whenever possible. Turnarounds shall be located to avoid close proximity to drainages and steep slopes whenever possible. When not possible, additional consideration shall be given to permanent erosion and sediment controls.

Structure pads shall be designed to prevent runoff directly towards a structure, onto a fill slope, or towards a retaining structure. Properly sized riprap energy dissipators or other required storm water control structures shall be specified at the location the water exits the structure pad if necessary.

Structure pads shall be in accordance with attached drawings GD-4 through GD-6. If it is impractical to meet these minimum requirements, the largest pads that can be practically constructed shall be designed. SDG&E's Civil Structural Engineering Manager and TCM Manager will determine if such reduced sizes are acceptable. If construction of an access road and structure pad is impractical, the site may be designated as a helicopter construction site by SDG&E Civil Structural Engineering Manager and TCM Manager.

5.3 Vertical Alignment

The maximum grade for continuous access road lengths is 12%.

Grades of 12% to 20% shall be limited to a length of 250' maximum.

Where alternate routes for access roads allow similar access to structure pads, the routing that minimizes the percent grade and drainage crossings shall be preferred. When percent grade is within acceptable limits, minimization of drainage crossings is then preferred.

Typically, vertical curves are not necessary in the design and construction of access roads. However, where grade breaks over 6% occur, the resulting profile shall be evaluated against intended vehicle use to ensure that high centering and tail dragging conditions do not exist.

Adequate stopping sight distance shall be provided at all intersections with other roadways, public or private. Site distance shall be based on roadway classification, use, and speed of vehicles on the intersecting roadway (applies to vertical and horizontal alignment). Comply with Caltrans Highway Design Manual, Section 200, for adequate stopping sight distance.

Where access roads intersect paved city or country roads or highways, the design shall minimize vehicle tracking of mud or sediment onto the paved surface.

5.4 Grading Considerations

Grading requirements are given by reference to TE-0101 and any supplemental requirements (see 4.7 and 6.1.1)

Existing roads shall be utilized to the greatest extent possible to reduce construction costs and construction time. Whether grading new roads or retrofitting existing roads, profiles shall be designed to balance cut/fill earthwork within each roadway section whenever possible.

Cut slopes shall be minimum 2:1 in soils (see Detail Drawing GD-1). If the geotechnical investigation shows solid rock, a minimum ½:1 cut slope shall be permitted. Care shall be taken to specify solid rock slopes on the drawings. Fill slopes shall be a minimum 2:1. Fill slopes shall require keys when the natural slopes are steeper than 6 horizontal to 1 vertical (see Detail Drawing GD-2). A geotechnical investigation shall be performed to determine the depth of the key. Applicable slope erosion and sediment control requirements shall be incorporated into the design when necessary. Designs shall accommodate vegetation of all slopes, except those designated as rock slopes.

Local grading ordinances shall be followed if stricter than these requirements.

5.5 Drainage Considerations

The general principal of drainage design for access roads is that runoff shall be conveyed over, under, or along the roadway without rutting or causing erosion. There shall be no diversion from the historic runoff. Access road and structure pad designs shall consider minimization of channelized flow of storm water and emphasize sheetflow runoff whenever possible.

Where it is not possible to avoid major drainage or stream crossings or to minimize proximity to drainages or streams, additional permanent erosion and sedimentation controls shall be designed.

Applicable State Water Resources Control Board General Construction Storm Water Permit and Municipal Storm Water Ordinance requirements shall be incorporated into the access road and structure pads slope designs. These requirements are concerning linear pre- and post-construction runoff requirements, and prohibitions or minimization of construction hydromodification of drainages and streams.

The San Diego County Hydrology Manual and the San Diego County Drainage Design Manual shall be used in determining rainfall intensity, coefficient of runoff, pipe sizes, energy dissipator sizes, etc.

There are several accepted methods used to manage rainfall runoff including the construction of dip sections (see Detail Drawing DR-2), culverts, downdrains, fords, geosynthetic materials, etc. Care shall be taken with each design to minimize impact to the drainage crossing. Performing work in crossings shall be avoided if possible due to the environmental permitting required. Design emphasis shall be placed on cost effective long term maintainability of the access roads and structure pads. The San Diego Area Regional Standard Drawings and the City of San Diego Standard Drawings shall be utilized whenever possible.

5.6 Waterbars

If sheet flow off access roads is not practical, waterbars shall be placed to prevent the buildup of runoff in a given length of roadway by conveying runoff to the side of the roadway, through energy dissipating riprap at the road edge, and then into a vegetated buffer area before entering a natural watercourse. Drainage flows from waterbars shall not be directed onto fill slopes but onto natural, vegetated, undisturbed slopes or into brow ditches if necessary. Alternate methods may be implemented where grainy, erosive soils make the required compaction difficult to obtain.

Each waterbar shall have a continuous, firm berm of soil at least 6 inches above the normal road grade and parallel to the waterbar cut, which is at least 6 inches below normal road grade (see Detail Drawing DR-1). Additionally, the ridge of each waterbar shall be maintained at an elevation at least 6 inches above the adjacent depression. All waterbars shall be open at the lower end to allow water to drain out easily. Energy dissipators shall be required at the open end of all waterbars. The energy dissipator construction shall consist of rock, filter fabric, and in some cases an end sill. The exact requirements for the energy dissipators shall be determined on the basis of discharge velocity, volume, and slope of terrain. All waterbars shall be approximately 30 to 45 degrees to the transverse

section of the road as shown in Detail DR-2. Waterbar spacing shall comply with Table 5.6

Table 5.6: Waterbar Spacing Requirements

Average Road Grade (%)	Maximum Waterbar Spacing
<5%	300 ft
5%	125 ft.
10%	75 ft.
15%	60 ft.
20%	50 ft.
25%	40 ft.

6.0 General Drawings Requirements

The following notes shall be included with all grading plans

6.1 General Notes

6.1.1 "All work shall comply with Specification No. TE-0101: Construction Specification Site Preparation and Access Roads." If it is necessary to revise or add to TE-0101 to describe all materials and construction requirements not described in TE-0101, prepare a supplement(s) to TE-0101 and revise this note to say: "All work shall comply with Specification No. TE-0101: Construction Specification Site Preparation and Access Roads and the Supplements to TE-0101."

6.1.2 "Neither the owner nor the engineer of work will enforce safety measures or regulations. The contractor shall design, construct, and maintain all safety devices, including shoring. The contractor shall be responsible for conforming to all local, state, and federal safety and health standards, laws, and regulations."

6.1.3 "Grading shall be done within a tolerance of ±0.1' of the grades and elevations shown on these plans and all slopes shall be constructed within ±0.5' of the location shown on these plans. In no way shall the above tolerances relieve the contractor of the responsibility of providing a finish surface that shall not pond water."

6.1.4 "All areas to be graded shall be cleared and grubbed only within the area to be graded."

6.1.6 "The Contractor shall grade all excavated and filled surfaces to provide positive drainage and prevent ponding of water. The Contractor shall control surface water to avoid damage to adjoining properties or to finish work on the site. The Contractor shall take remedial measures to prevent

erosion of freshly graded areas, and until such time as permanent drainage and erosion control measures have been installed. After grading is completed and the Geotechnical Engineer has finished the observations of the work, no further excavation or filling shall be done, except under the observation of the Geotechnical Engineer."

6.1.6 "Any quantities indicated on these plans are engineer's estimates only and are not to be used by contractor for bidding purposes."

6.1.7 "The Contractor shall verify existing conditions in the field and bring discrepancies to the attention of the SDG&E representative prior to starting construction."

6.2 Erosion Control Notes

6.2.1 "Tops of all fill slopes to be diked to prevent water from flowing over the crest. All roads and structure pads shall be constructed to prevent water from causing erosion."

6.2.2 "It is the responsibility of the Contractor to hydroseed and install erosion control blankets on all cut and fill slopes. The seed mix will include native or drought tolerant plant species and will be specified by SDG&E."

6.2.3 "All cut and fill slopes shall be temporarily protected by continuous certified weed-free rice wattles located at all locations where runoff from excavated or filled areas can occur, in accordance with the Sempra Energy Utilities "Water Quality Construction Best Management Practices Manual." At a minimum, continuous fiber rolls shall be placed along the toe, top, face, and at grade breaks of exposed and erodible slopes to comply with sheet flow requirements. Any extra clarification required can be brought up in the pre-bid meeting and/or walk-down."

6.2.4 "The Contractor shall follow the Storm Water Pollution Prevention Plan (SWPPP) in accordance with the California Water Resource Control Board General Construction Storm Water Permit and any local Regional Water Quality Control Board (RWQCB) guidance or directives. The contractor is also responsible for implementing all required BMP's per the SWPPP, including, but not limited to, providing the necessary material, equipment, and trained personnel."

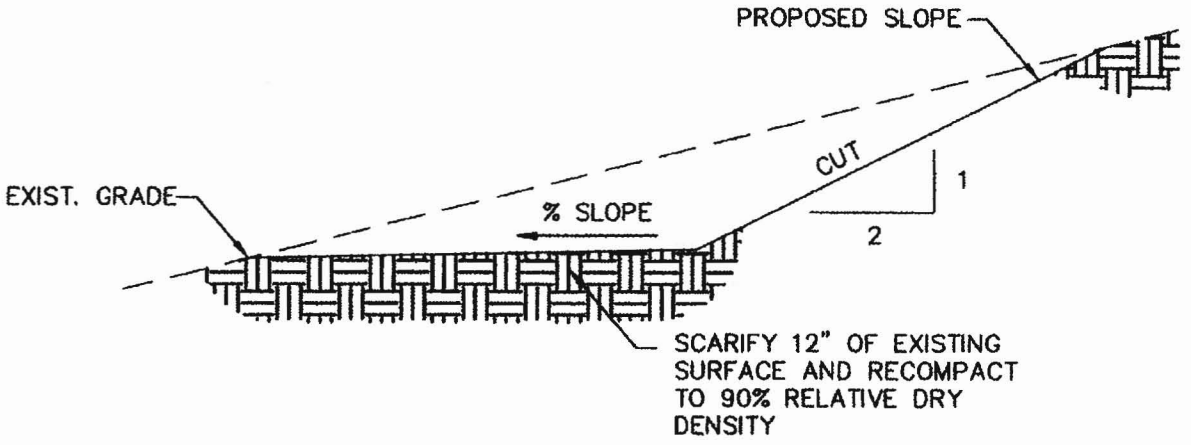
6.2.5 "Hydroseeding slopes shall follow the recommendations of the project biologist as to the selection of species, seed specifications, mixture, time of seeding, seeding method, and irrigation requirements."

6.2.6 "The Contractor shall provide the necessary material, equipment, and trained personnel to provide the required vegetative cover and for the time

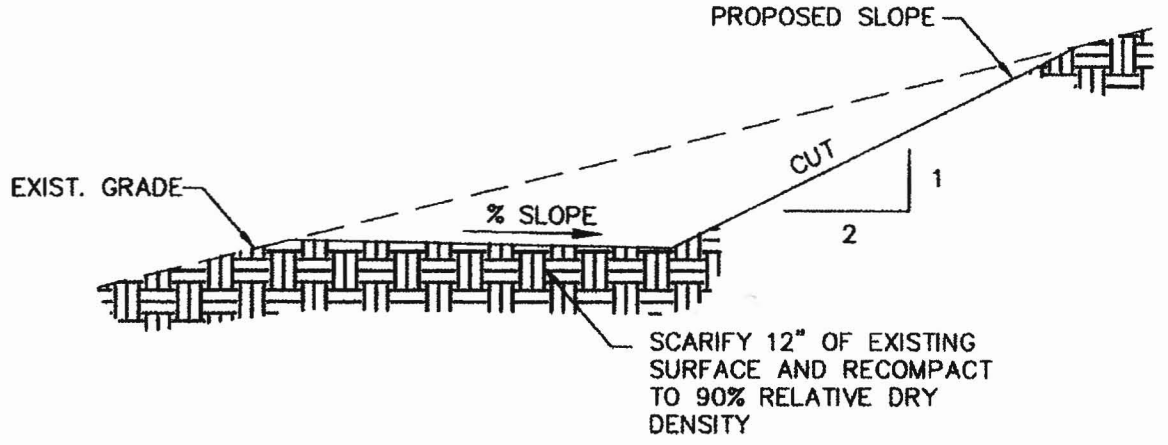
periods as specified by the appropriate California Water Resource Control Board General Construction Storm Water Permit applicable to the project or project section and in effect at the time of construction.

7.0 Detail Drawings

The following drawings are provided as a general guideline.



PREFERRED SECTION – SHEET FLOW



ALTERNATE SECTION

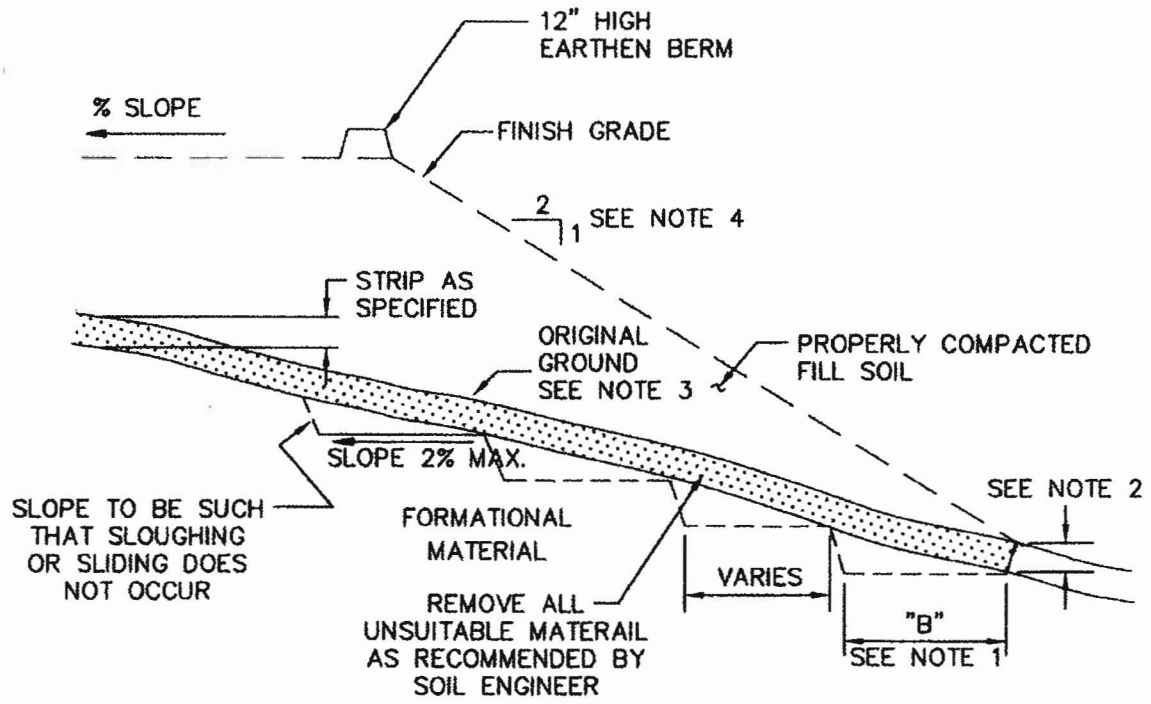
NOTES:

1. CUT SLOPES IN SOIL SHALL BE 2:1 MAXIMUM UNLESS OTHERWISE APPROVED BY SDG&E CIVIL/STRUCTURAL ENGINEERING MANAGER.
2. CUT SLOPES IN SOLID ROCK MAY BE ½:1 MAXIMUM.
3. 4% MAXIMUM CROSS SLOPE FOR ROADS. 2% MAXIMUM CROSS SLOPE FOR STRUCTURE PADS

SDGE

TYPICAL CUT SECTIONS

GD–1



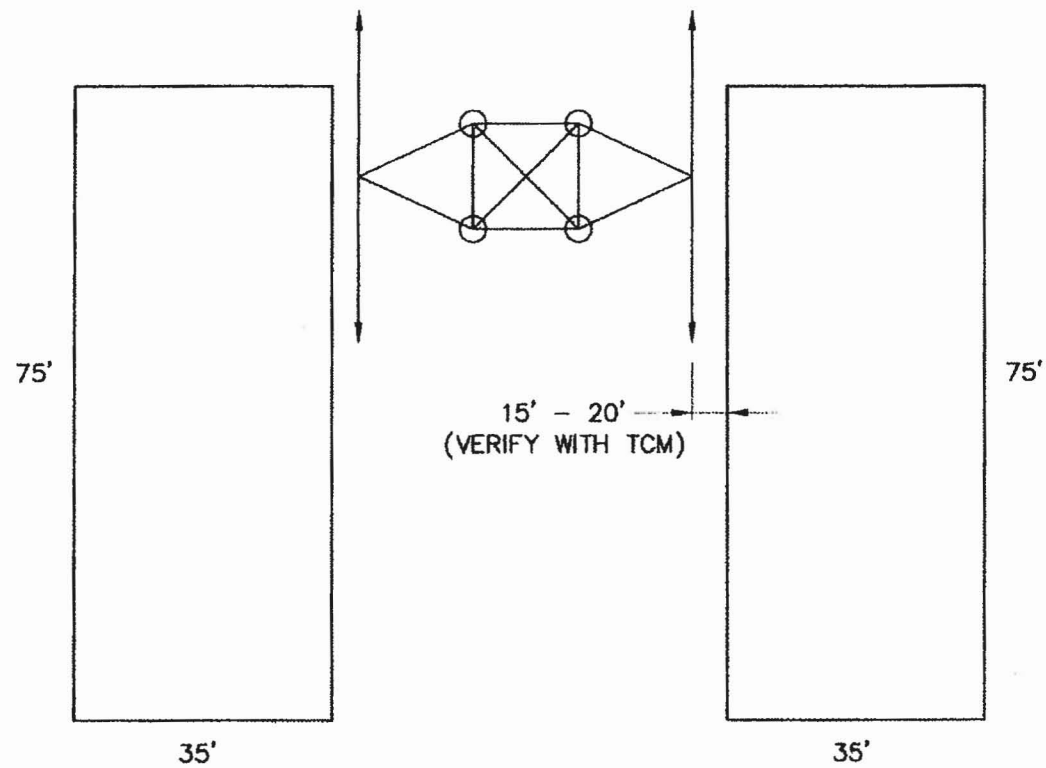
NOTES:

1. THE MINIMUM WIDTH "B" OF KEY SHALL BE 2 FEET WIDER THAN THE COMPACTION EQUIPMENT, AND NOT LESS THAN 10 FEET.
2. THE OUTSIDE EDGE OF THE BOTTOM KEY SHALL BE BELOW TOPSOIL OR LOOSE SURFACE MATERAIL AND AT LEAST 3 FEET INTO DENSE FORMATIONAL MATERIAL.
3. KEYS ARE REQUIRED WHERE THE NATURAL SLOPES ARE STEEPER THAN 6 HORIZONTAL TO 1 VERTICAL, OR WHERE SPECIFIED BY SOIL ENGINEER.
4. FILL SLOPES SHALL BE A 2:1 MINIMUM UNLESS OTHERWISE APPROVED THE THE SDG&E CIVIL/STRUCTURAL ENGINEERING MANAGER.
5. 4% MAXIMUM CROSS SLOPE FOR ROADS. 2% MAXIMUM CROSS SLOPE FOR STRUCTURE PADS.

SDGE

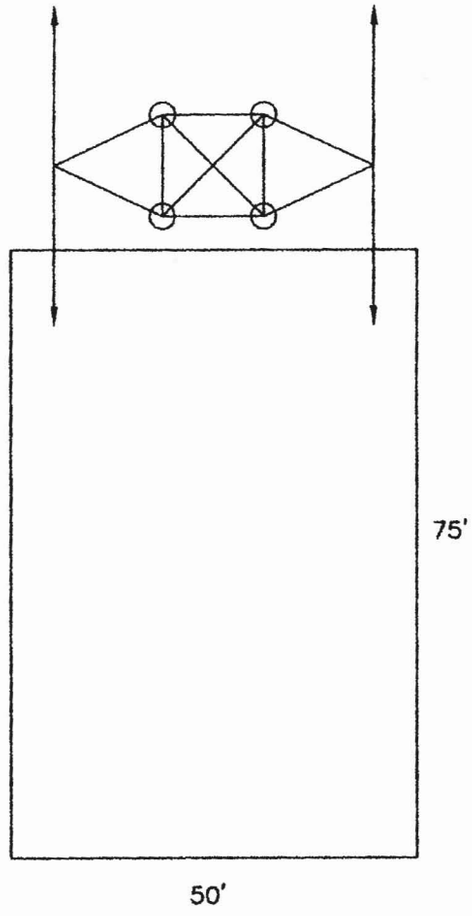
TYPICAL FILL SECTION

GD-2



SDGE

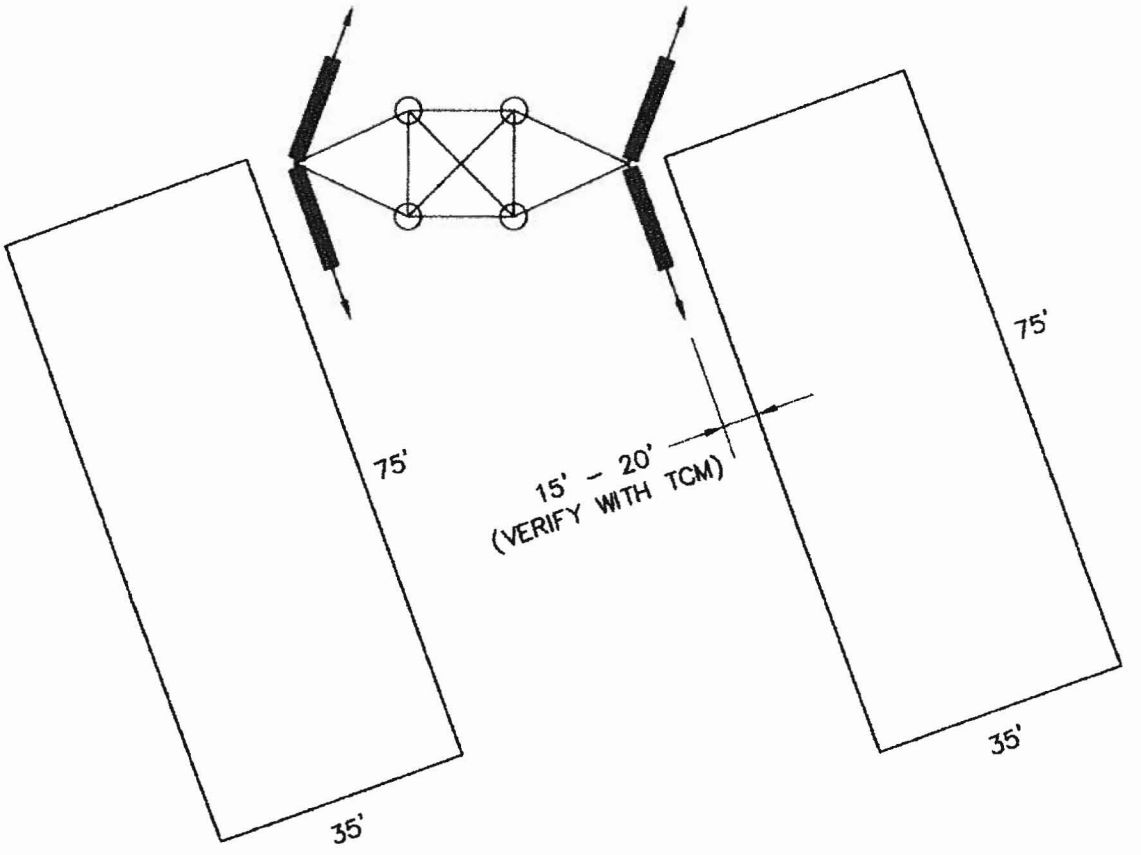
69kV, 138kV, 230kV PREFERRED TANGENT STRUCTURE PADS SIZE AND ORIENTATION	GD–3



NOTE:
FOR PREFERRED PAD SIZE AND ORIENTATION SEE GD-3

SDGE

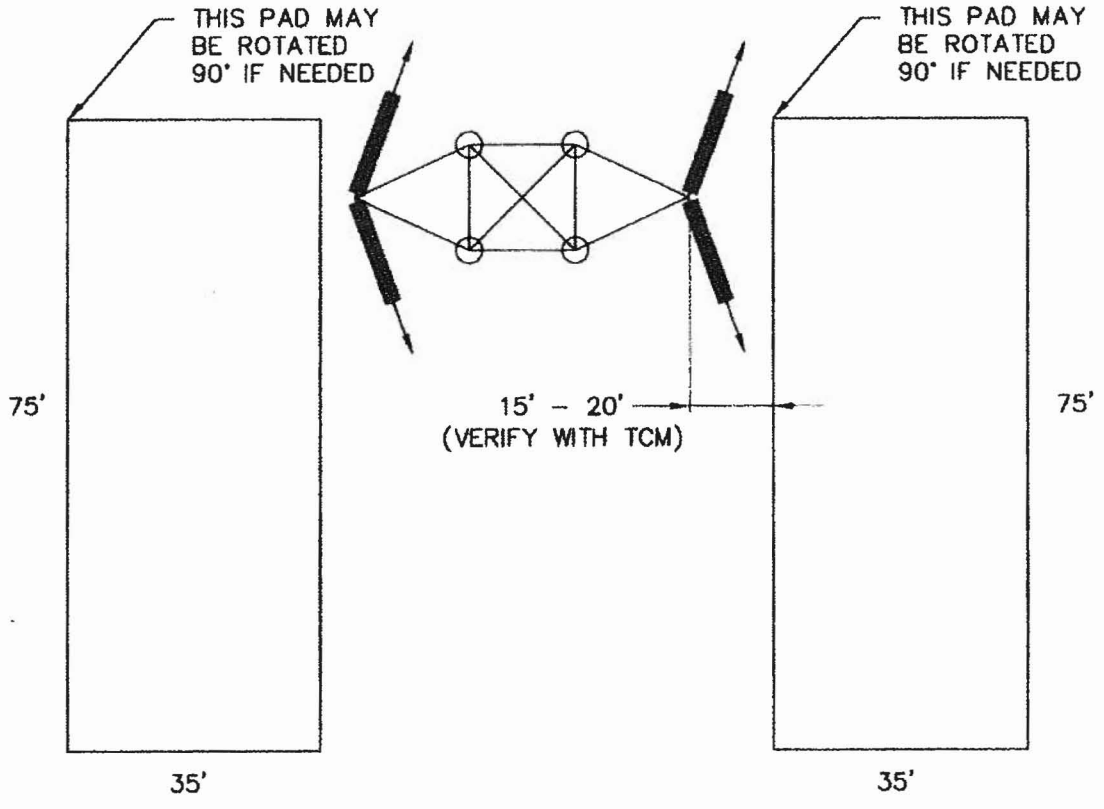
69kV, 138kV, 230kV ALTERNATE TANGENT STRUCTURE PAD SIZE AND ORIENTATION	GD-4



NOTE:
PADS MAY BE ROTATED 90° IF NEEDED

SDGE

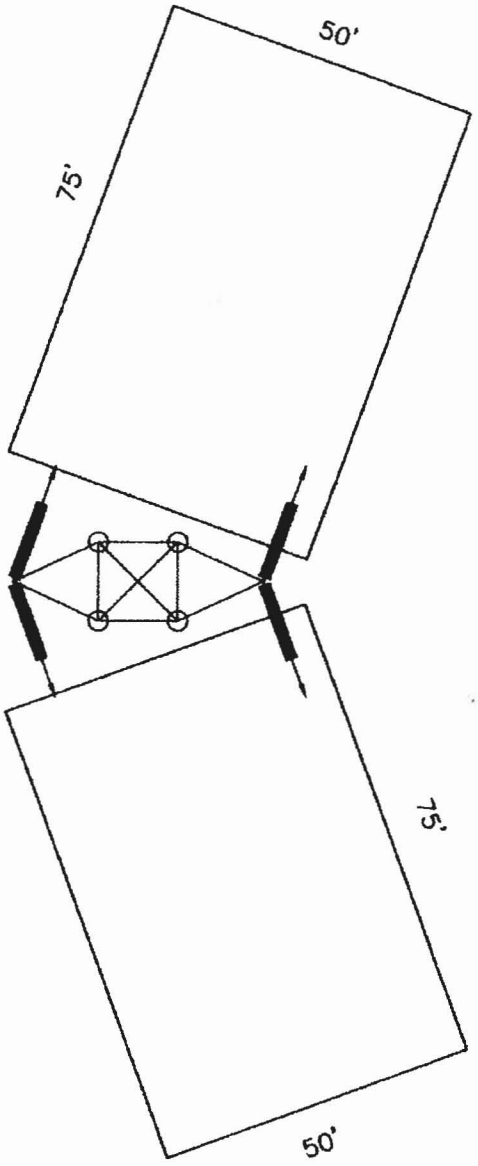
69kV, 138kV, 230kV PREFERRED DEADEND STRUCTURE PADS SIZE AND ORIENTATION	GD-5



NOTES:
1. THIS IS THE PREFERRED OPTION.
2. PADS MAY BE ROTATED 90° IF NEEDED

SDGE

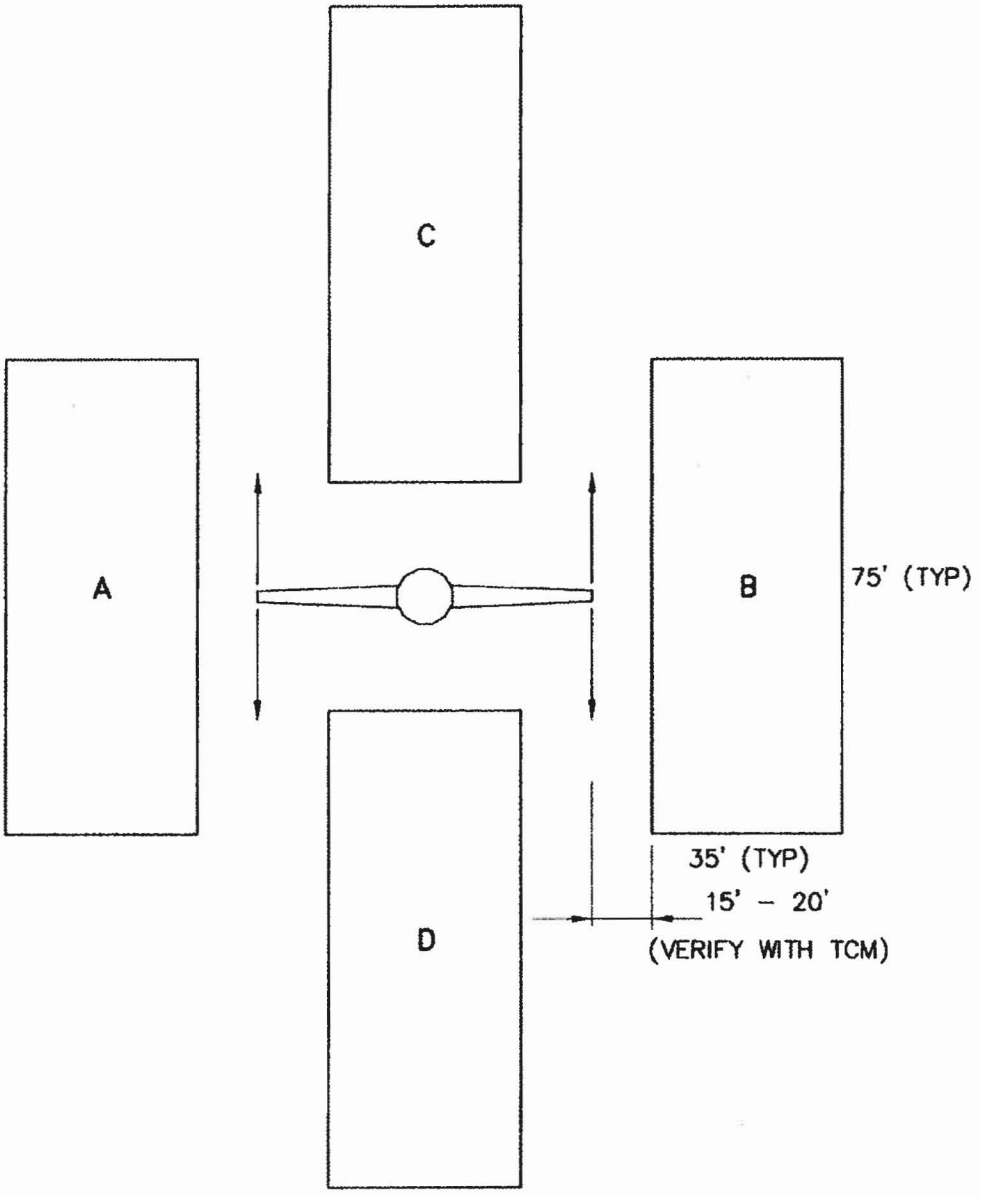
69kV, 138kV, 230kV ALTERNATE 1 DEADEND STRUCTURE PADS SIZE AND ORIENTATION	GD–6



NOTE:
PADS MAY BE ROTATED 90° IF NEEDED

SDGE

69kV, 138kV, 230kV ALTERNATE 2 DEADEND STRUCTURE PADS SIZE AND ORIENTATION	GD–7

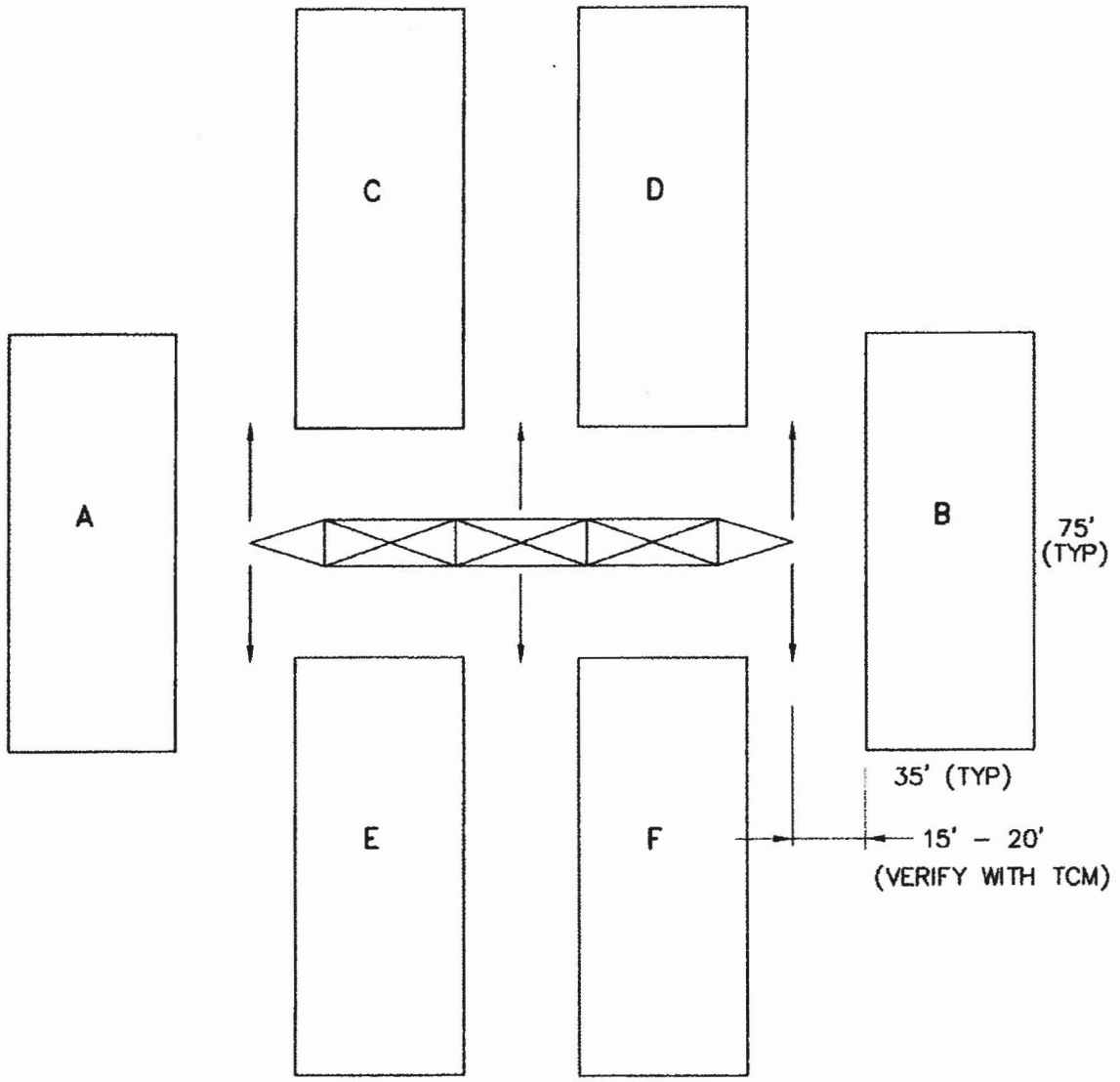


NOTES:
A AND B PADS ARE REQUIRED. IN ADDITION, EITHER C OR D PAD IS REQUIRED, BUT NOT BOTH. THREE (3) TOTAL PADS ARE REQUIRED.

SDGE

500kV
STEEL POLE PAD REQUIREMENTS

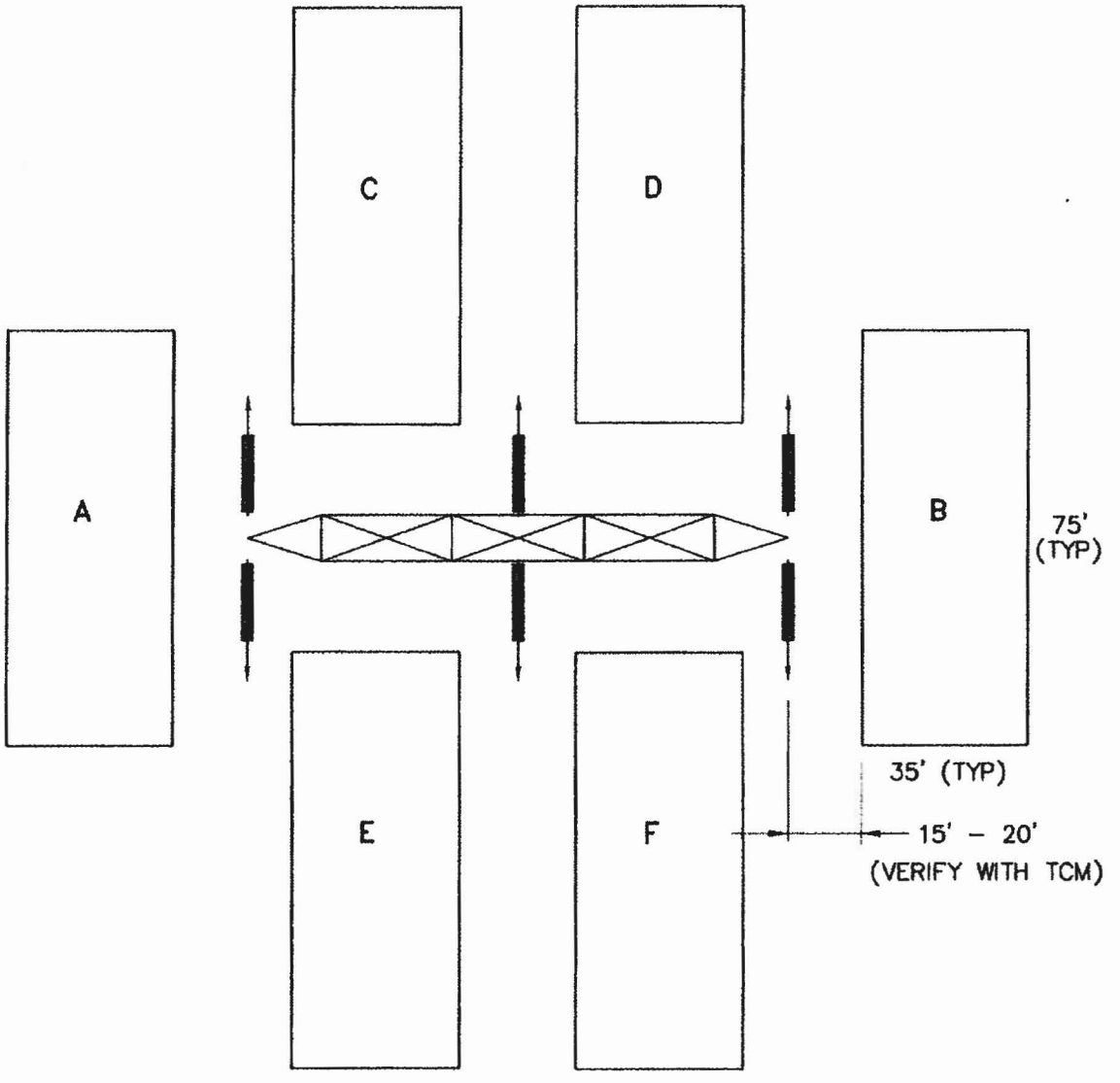
GD–8



NOTE:
A AND B PADS ARE REQUIRED. IN ADDITION, EITHER PAD C OR D OR E OR F IS REQUIRED. THREE (3) TOTAL PADS ARE REQUIRED.

SDGE

500kV TANGENT LATTICE TOWER PAD REQUIREMENTS	GD-9

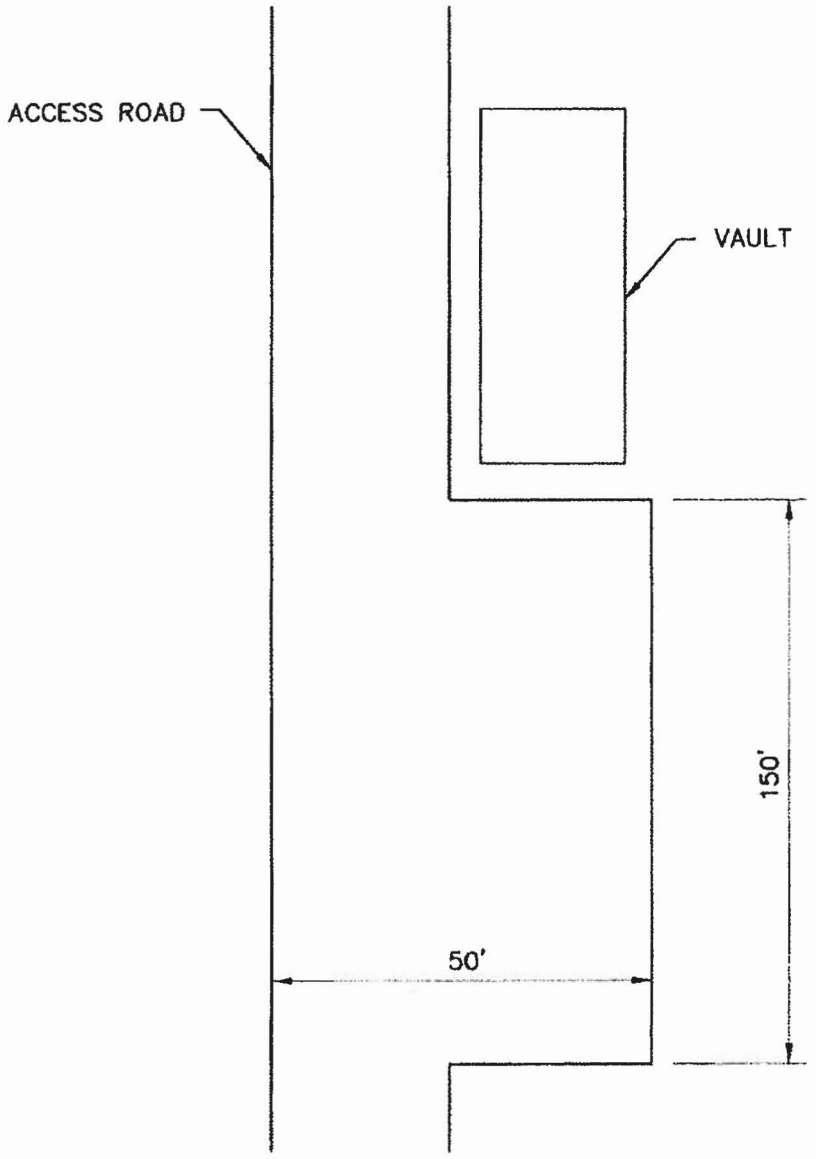


NOTES:
A AND B PADS ARE REQUIRED. IN ADDITION, EITHER PAD C OR D, PLUS PAD E OR F ARE REQUIRED. FOUR (4) TOTAL PADS ARE REQUIRED.

SDGE

500kV DEAD END LATTICE TOWER PAD REQUIREMENTS

GD-10

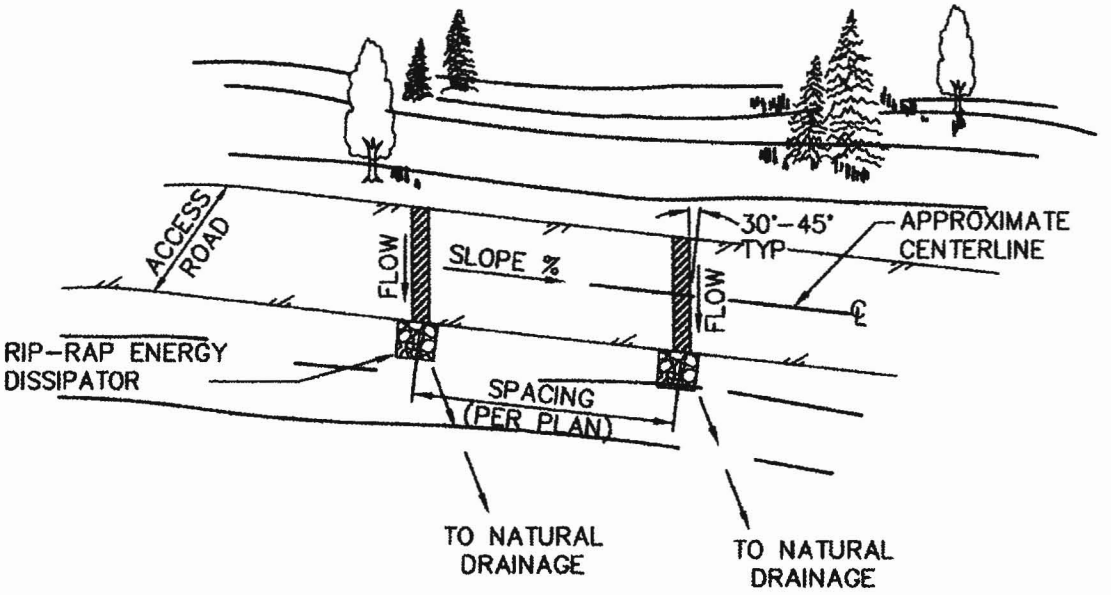


TYPICAL SECTION

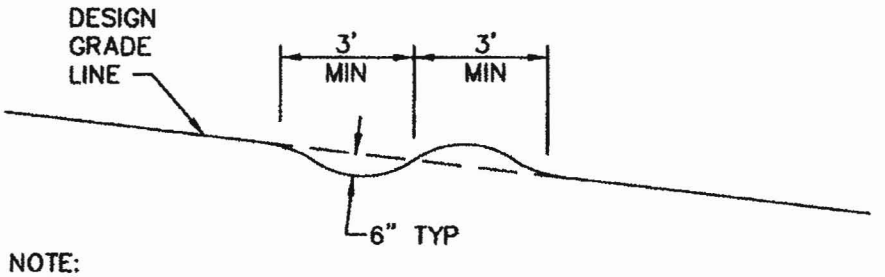
SDGE

TYPICAL VAULT SETTING PAD SIZE AND ORIENTATION

GD–11



PLAN

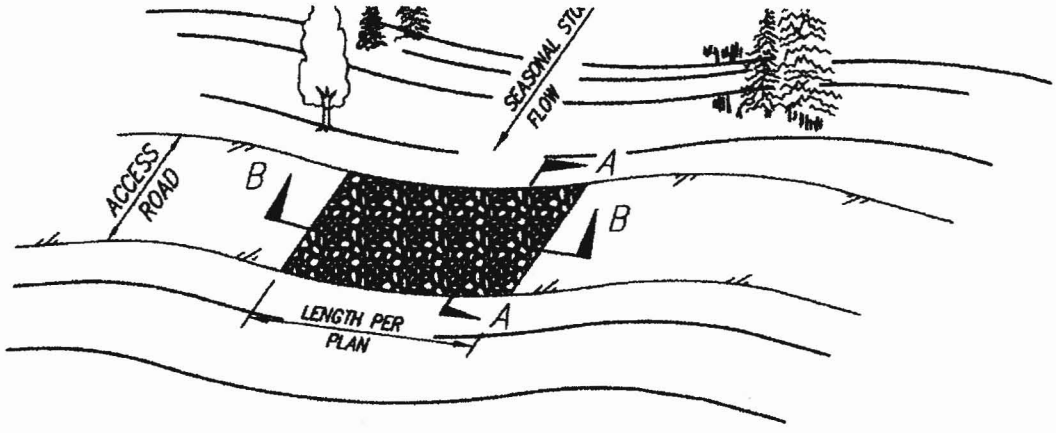


NOTE:
THE RIDGE OF EACH WATERBAR IS TO BE MAINTAINED AT AN ELEVATION AT LEAST 6 INCHES ABOVE THE ADJACENT DEPRESSION

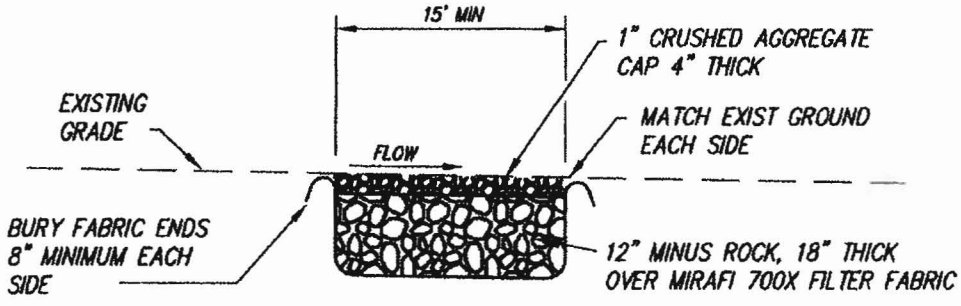
TYPICAL SECTION

SDGE

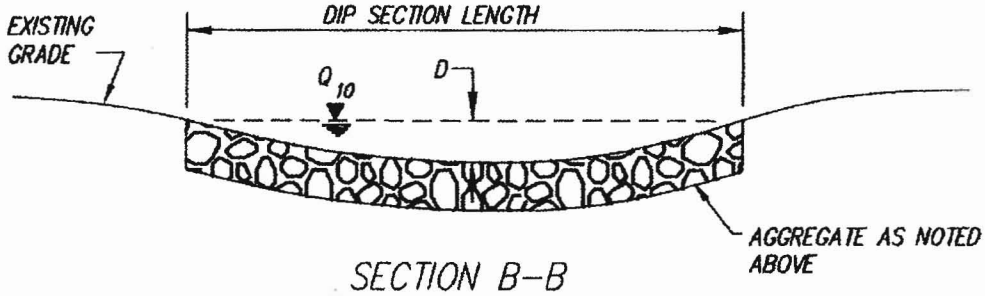
WATER BAR	DR-1



PLAN



SECTION A–A



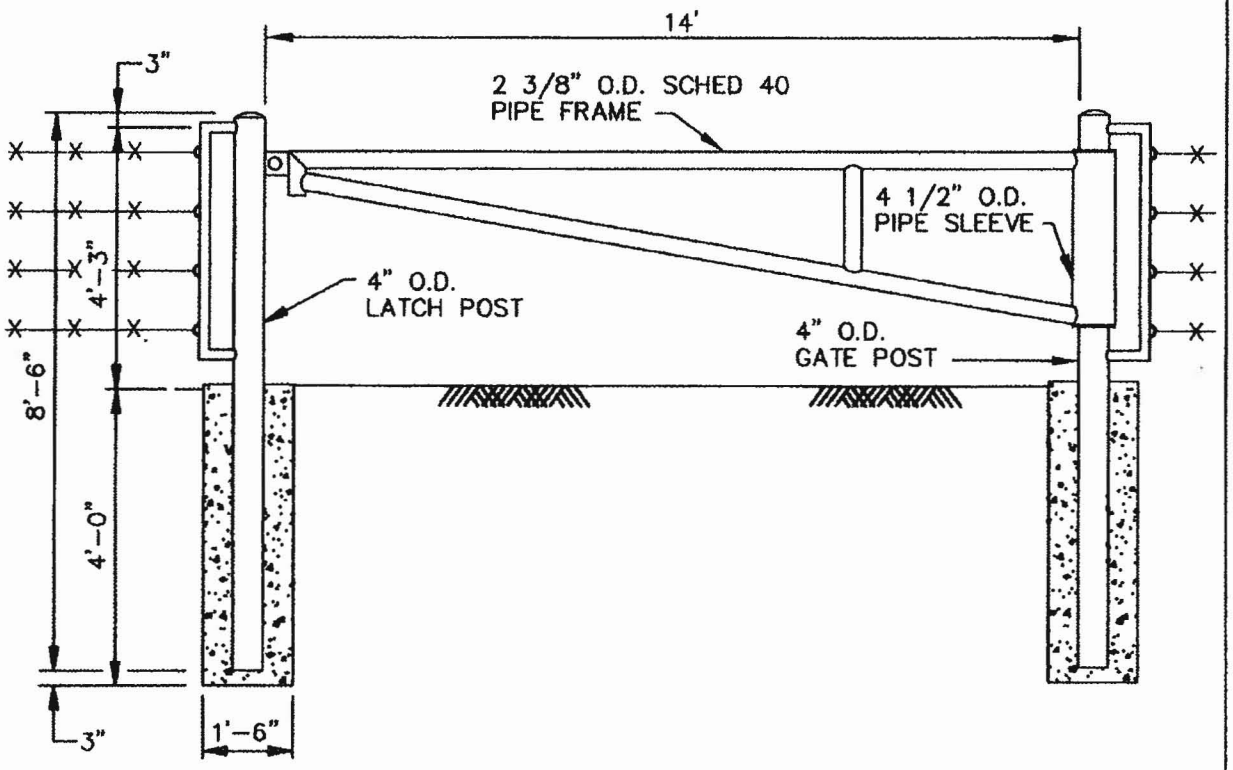
SECTION B–B

NOTE:

THE MAXIMUM WATER DEPTH, BASED ON A 10 YEAR FREQUENCY STORM, SHALL BE 10". THE DEPTH (D) IN FEET MULTIPLIED BY THE VELOCITY (V) IN FEET PER SECOND SHALL BE EQUAL TO SIX OR LESS. (DXV=6)

SDGE

DIP SECTION	DR–2

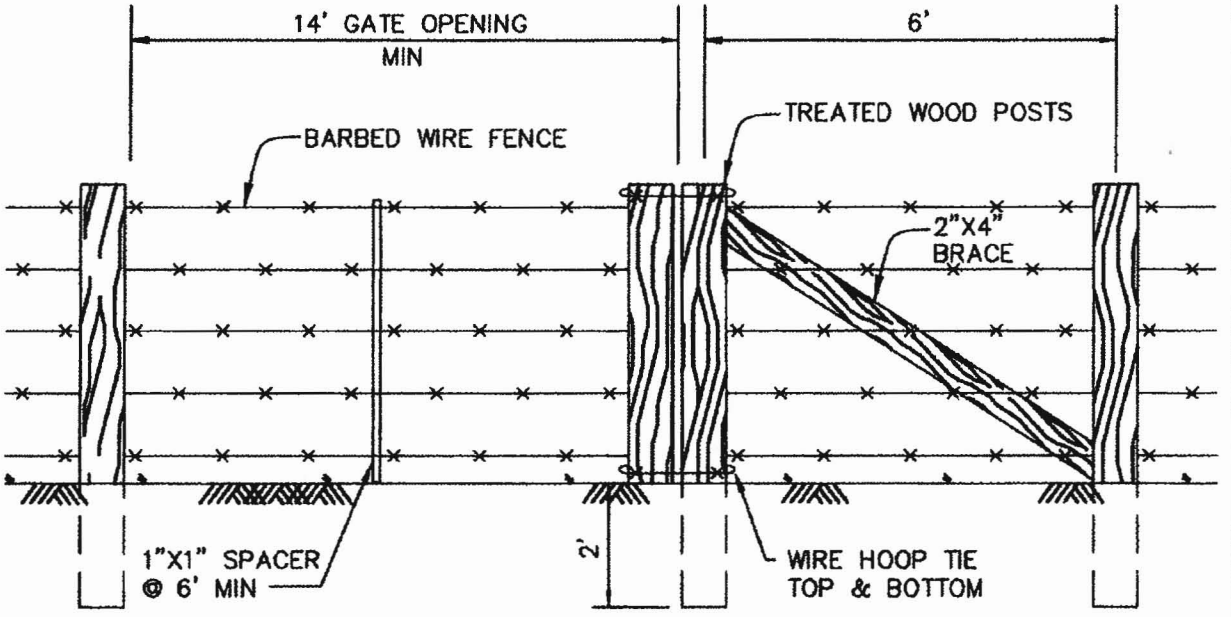


NOTES

1. FOOTINGS SHALL BE MINIMUM 3000 PSI CONCRETE

SDGE

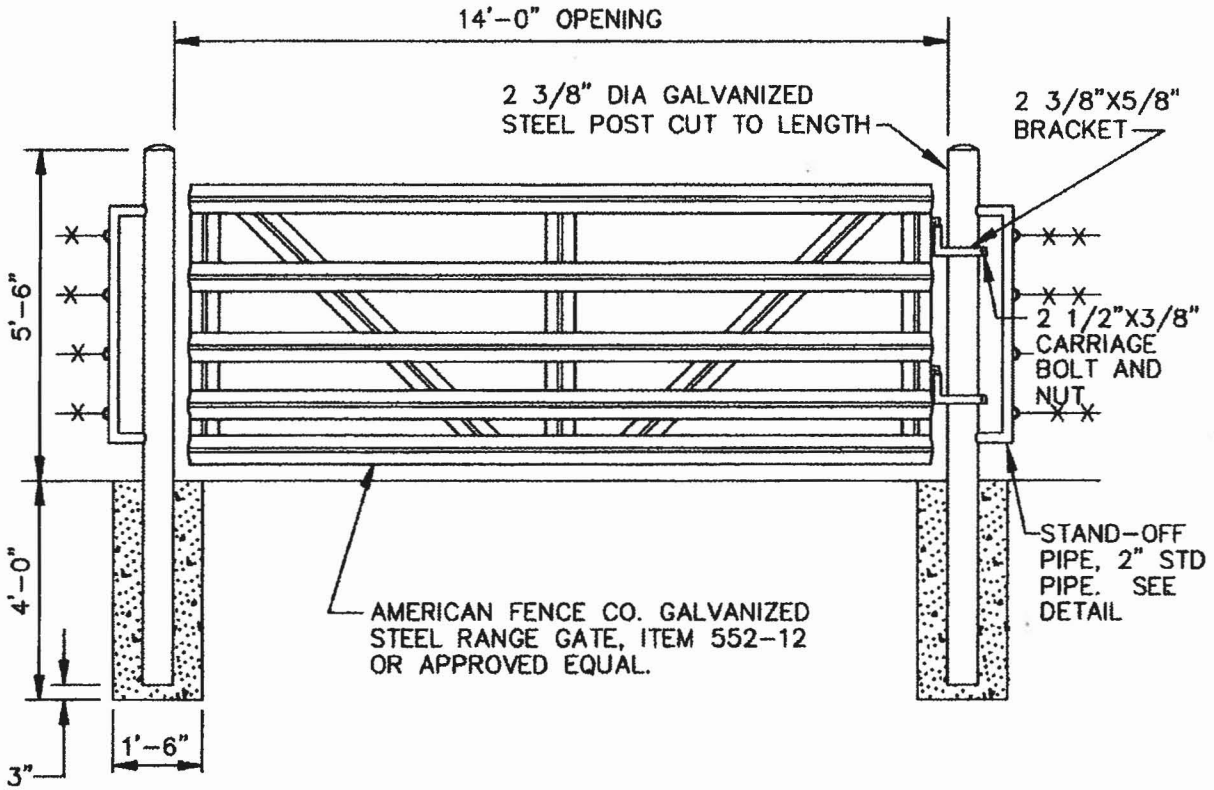
PIPE GATE	MS-1



SDGE

BARBED WIRE GATE

MS-2



SDGE

RANGE GATE

MS-3

APPENDIX D

CONDOR MAINTENANCE VEHICLE

CONDOR

CALAVAR CORPORATION

Turning Diameter Comparison

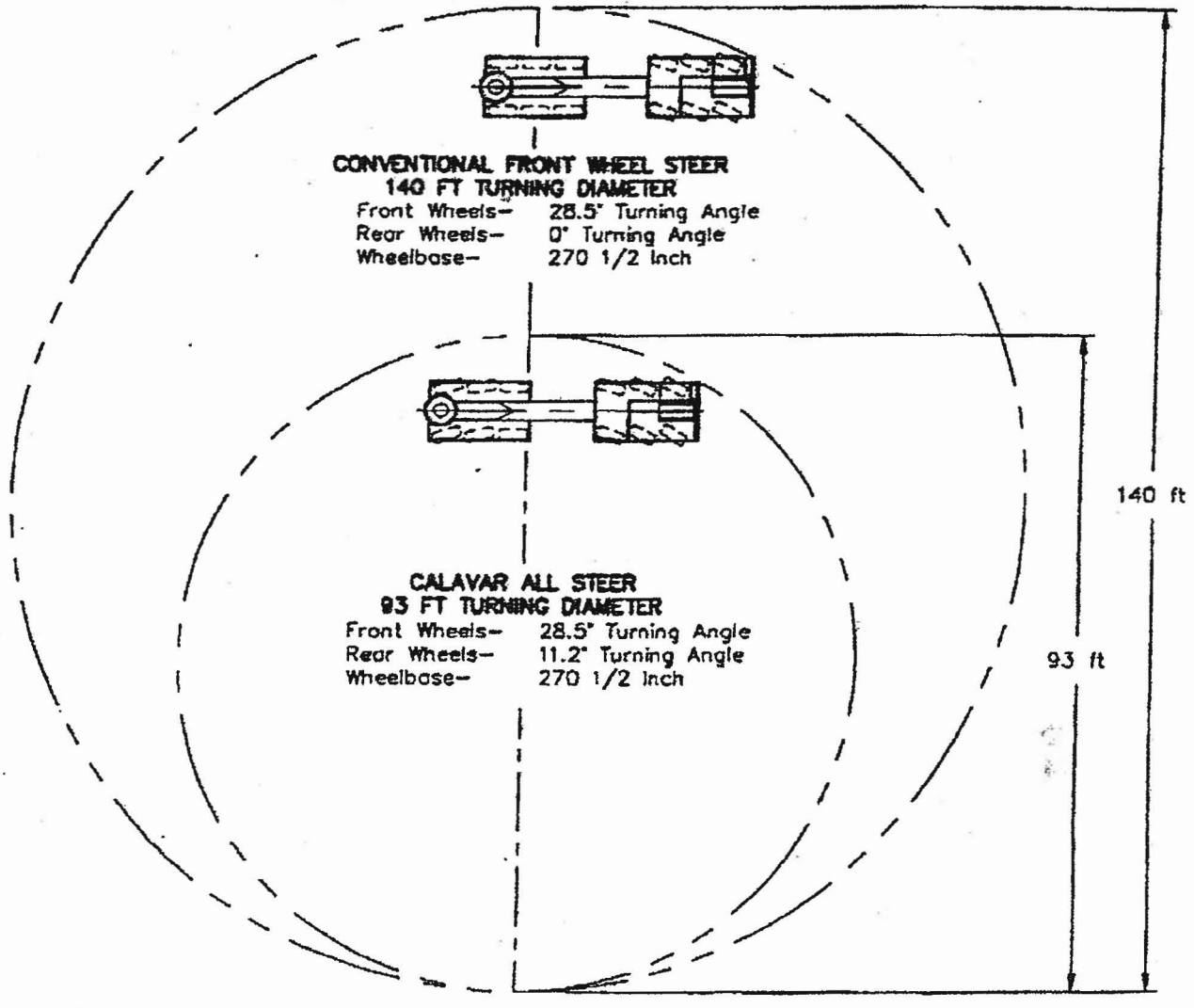
Outrigger requires 30' min front and rear.

Ground Slope can not be greater than 3 degrees

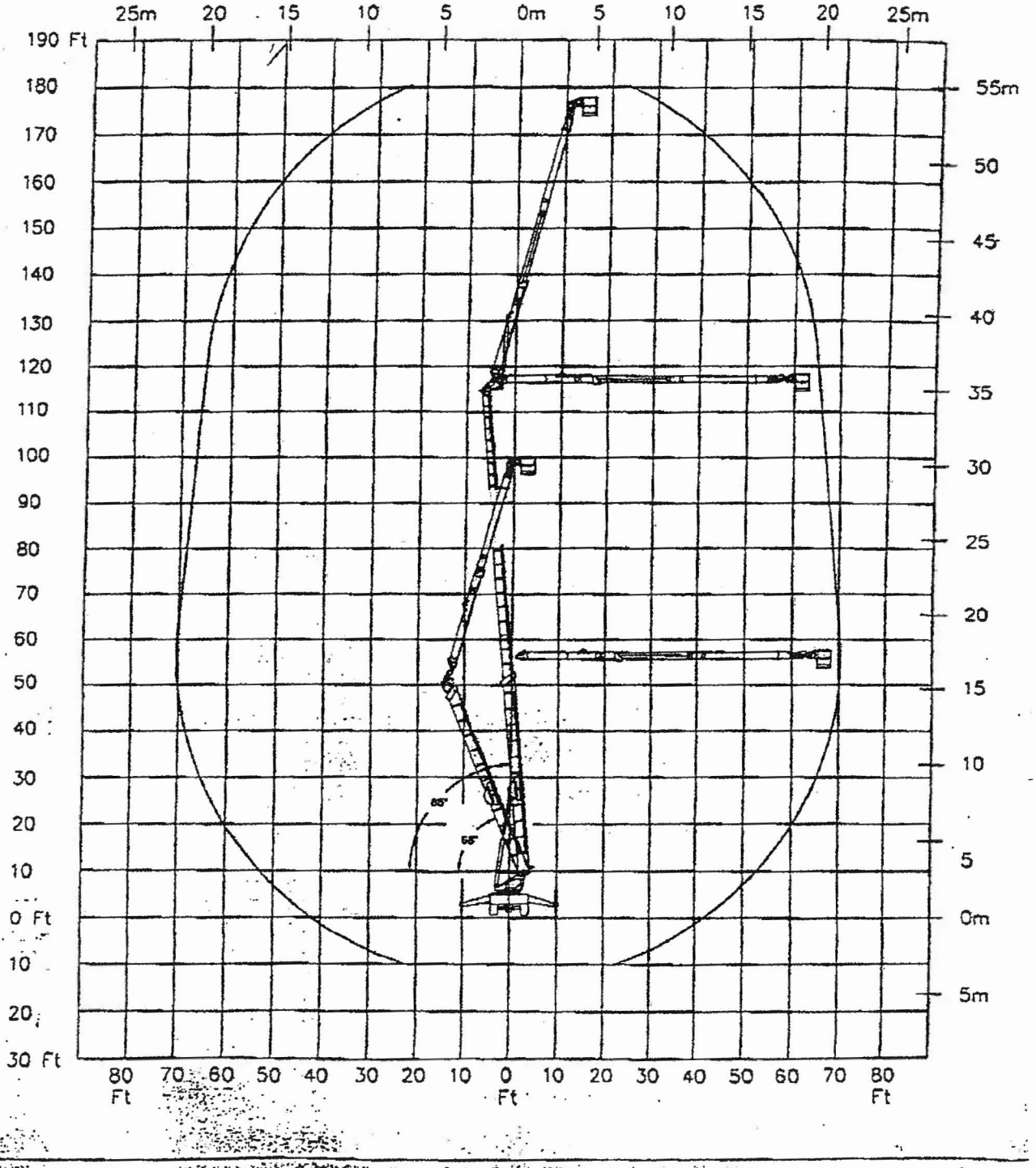
30 x 100'

50' TURNING RADIUS

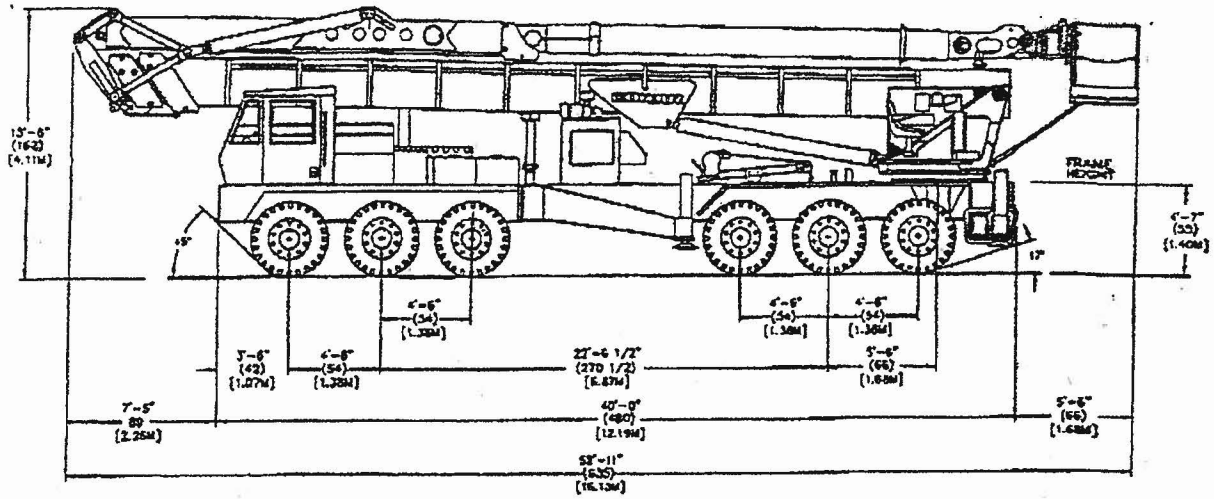
CLEAR SPACE



OPERATING ENVELOPE MDL180-I



REVISION						
REV	ERON NO.	DESCRIPTION	BY	CHKD.	APPR.	DATE



20533

FEATURES/OPTIONS
1. 1500 LBS (680 KG) UNRESTRICTED CAPACITY
2. INTERCHANGEABLE STEEL PLATFORM
3. 180° PLATFORM ROTATION
4. FRONT SWING OUT OUTRIGGERS
5. REAR DOUBLE TELESCOPING OUTRIGGERS
6. 24" (61 CM) OUTRIGGER PENETRATION
7. 360° CONTINUOUS ROTATION.
8. ALUMINUM WHEELS.
9. ALUMINUM FENDERS
10. 36" X 36" OUTRIGGER FLOATS
11. 500KV ELECTRICALLY CERTIFIED (765KV OPTION AVAILABLE)
12. DECK MOUNTED ENGINE OPTION SHOWN.

ESTIMATED WEIGHTS:
FRONT – 45000 LBS (20408 KG)
REAR – 50000 LBS (22678 KG)
TOTAL – 95000 LBS (43086 KG)

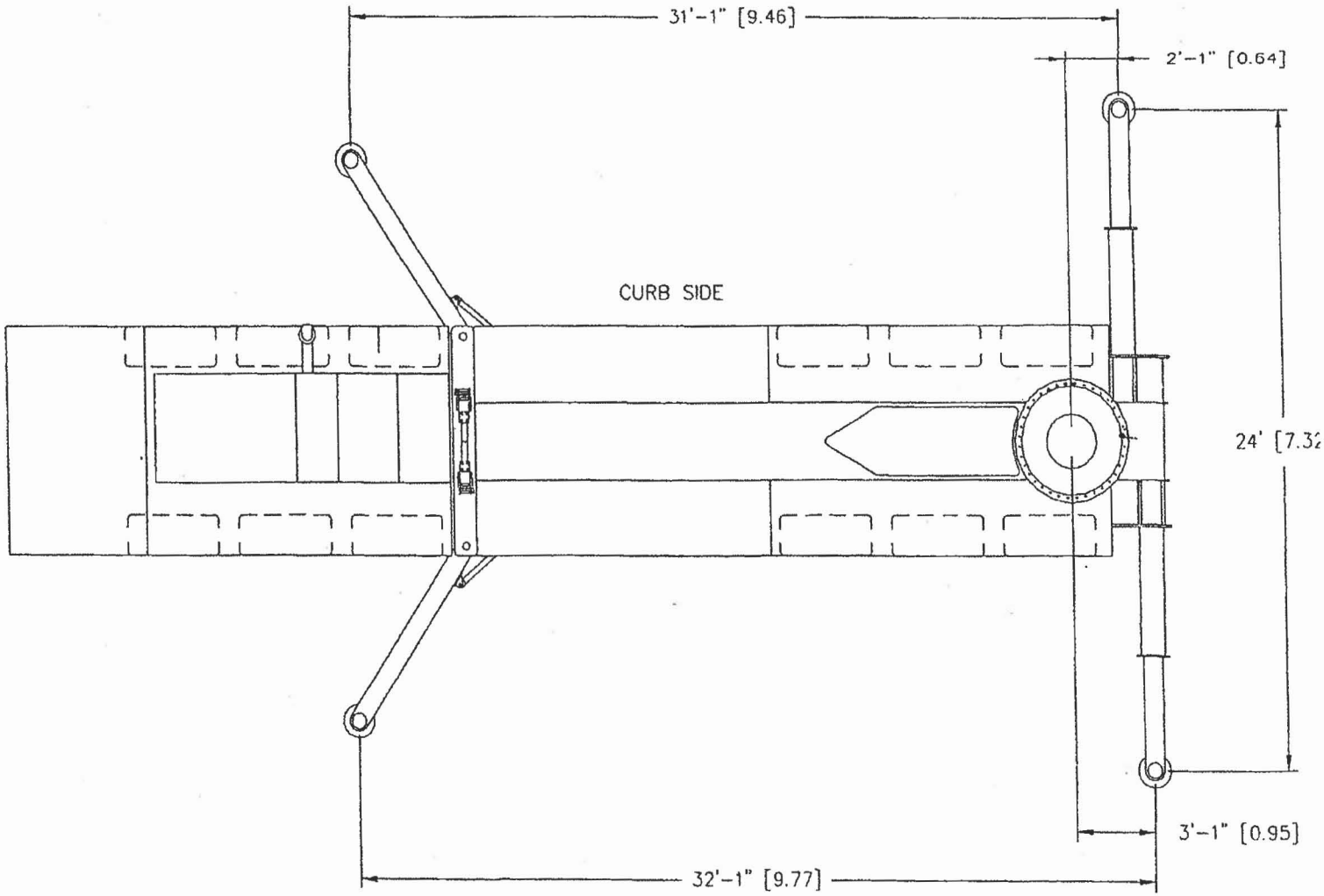
Rob (from Condor)
(626) 335-7281

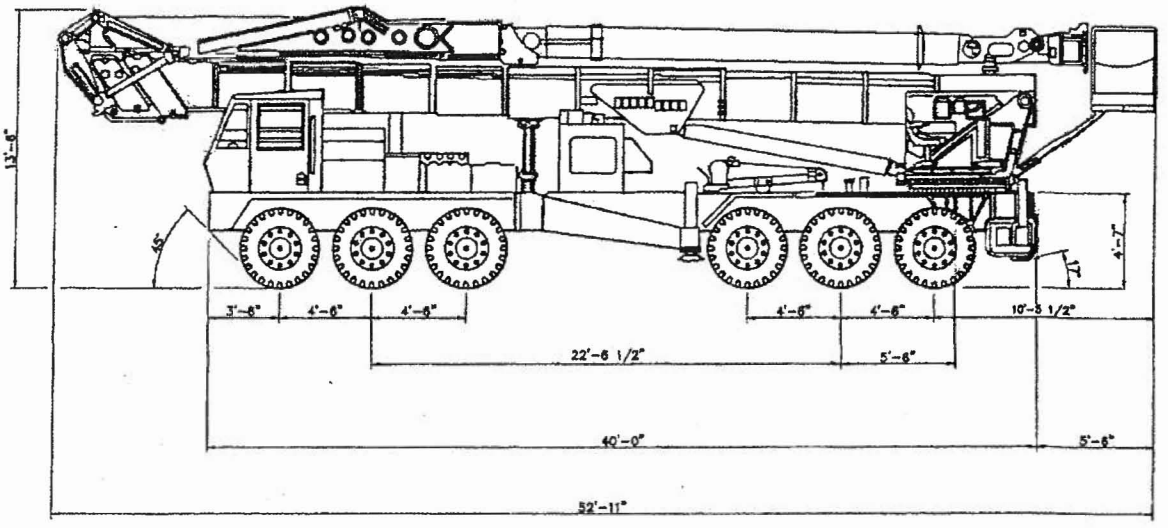
OUTRIGGER REQUIRES 30' MIN FRONT and back
Ground Slope can not be more than 6°

UNLESS OTHERWISE NOTED: TOLERANCES: FRACTIONS ± 1/16, ANGLES ± 1°, DECIMALS .X ± .1, .XX ± .03, .XXX ± .010, SURFACE FINISH 125, PROJECTION OF VIEWS, REMOVE BURRS & SHARP EDGES, ALL DIMENSIONS ARE IN INCHES		CONDOR	THE CONDOR CORPORATION 8300 IMPERIAL DRIVE WACO, TEXAS 76712		
DRAWN CW	11/5/97	TITLE: CONDOR MODEL 180-1 12 X 8 TORQUE BOX CHASSIS			
CHECKED		SIZE B	DRAWING NO. 20533		REV. C
APPROVED		ERON NO. –	SCALE 1/100	SHEET 1 OF 3	

ORIGINAL

CONDOR
175-I





CONDOR

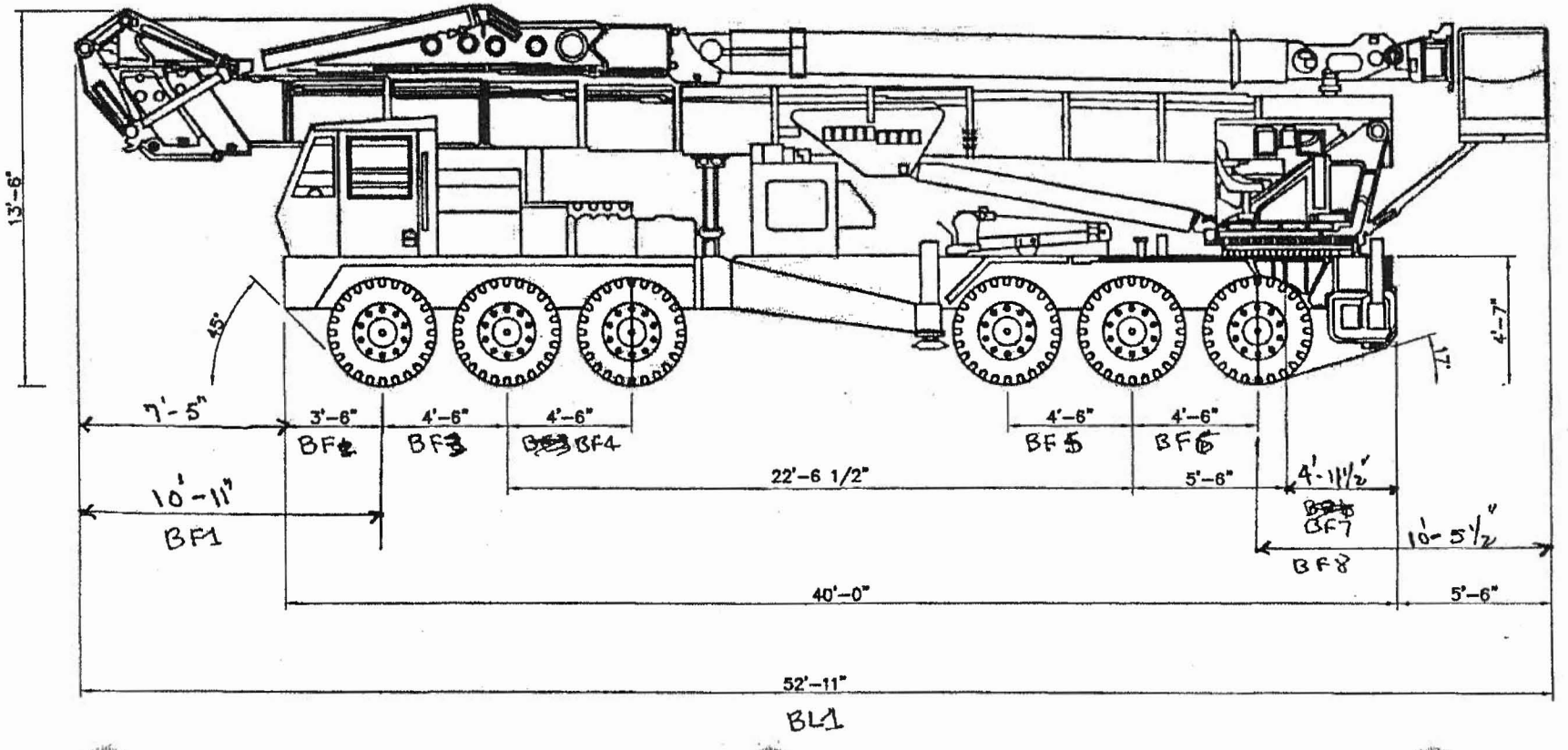
CONDOR MODEL 180–1
12 x 8 TORQUE BOX CHASSIS

FEATURES/OPTIONS

1. 1500 LBS (680 KG) UNRESTRICTED CAPACITY
2. INTERCHANGEABLE STEEL PLATFORM
3. 180° PLATFORM ROTATION
4. FRONT SWING OUT OUTRIGGERS
5. REAR DOUBLE TELESCOPING OUTRIGGERS
6. 24" (61 CM) OUTRIGGER PENETRATION
7. 360° CONTINUOUS ROTATION.
8. ALUMINUM WHEELS.
9. ALUMINUM FENDERS
10. 36" x 36" OUTRIGGER FLOATS
11. 500kV ELECTRICALLY CERTIFIED
    (765KV OPTION AVAILABLE)
12. DECK MOUNTED ENGINE OPTION SHOWN.

ESTIMATED WEIGHTS

FRONT – 45,000 LBS (20,408 KG)
REAR – 50,000 LBS (22,678 KG)
TOTAL – 95,000 LBS (43,086 KG)



APPENDIX E

DRAFT SUNRISE POWERLINK EIR/EIS MITIGATION DESIGN STANDARDS ACCESS ROADS

Draft Sunrise Powerlink
EIR/EIS Mitigation Design Standards
Access Roads

Introduction

The following standards have been derived from the Sunrise Powerlink EIR/EIS keyed on the southern route and focus on measures which will direct the design of temporary and permanent access roads to structures, substations and any other ancillary or related actions (e.g. reconductors) associated with the project. These standards are ***requirements*** and should be adhered to unless explicitly provided for in the measure itself. In certain cases, because of the requirements either specified in the measure or due to subsequent permits or requirements and the delays associated with them, it will always be better to comply with the avoidance standard than to impact a sensitive feature. In this case, even if the standard allows for mitigation, the design standard has been kept as absolute. Impacts to sensitive features should be limited to those areas where site conditions, engineering or operations and maintenance constraints provide no other choice but to impact the sensitive feature. The full text of the mitigation measures from where these standards are derived is included as Attachment Two. It should be noted that some of these measures were written to cover other facilities or activities other than access road design but they are included in their entirety to provide context. Furthermore, in all cases, these mitigation measures as interpreted by the CPUC and BLM during their plan review and approval process always override the standards outlined below. The standards are only a guide to assist in complying with the mitigation measures.

Design Standards for Access Road Construction

SENSITIVE FEATURE - VERNAL POOLS, Location: *Section 1 and 2.*

Mitigation Measure(s) Where Standard is Derived

B-1b Implement appropriate avoidance/minimization/ compensation strategies for vernal pools and fairy shrimp habitat. Direct impacts to vernal pools and water-holding basins (aka road pools) shall be avoided where the absence of fairy shrimp has not been proven by USFWS protocol wet/dry sampling and/or where the absence of vernal pool indicator species has not been proven. Indirect impacts to vernal pool watersheds shall also be avoided. Temporary and permanent access roads shall not enter vernal pools or water holding basin areas unless absolutely necessary.

Design Standard

Vernal Pools and Road Pools should be avoided by new access roads and structure pads. Vernal Pool Watersheds should also be avoided.

SENSITIVE FEATURE - DRAINAGE COURSES, Location: *All Sections*

Mitigation Measures Where Standard is Derived

B-1g Build access roads at right angles to streambeds and washes. To the extent feasible, access roads would be built at right angles to the streambeds and washes. Where it is not feasible for access roads to cross at right angles, SDG&E would limit roads constructed parallel to streambeds or washes to a maximum length of 500 feet at any one transmission line crossing location. Such parallel roads would be constructed in a manner that minimizes potential adverse impacts on "waters of the U.S." or waters of the state. Streambed crossings and roads constructed parallel to streambeds would require review and approval of necessary permits from the ACOE, CDFG, and RWQCB. Culverts would be installed where needed for right angle crossings, but rock crossings would be utilized across most right angle drainage crossings. All construction and maintenance activities would be conducted in a manner that would minimize disturbance to vegetation, drainage channels and stream banks (e.g.,

structures would not be located within a stream channel, construction activities would avoid sensitive features). Prior to construction in streambeds and washes, SDG&E would perform a pre-activity survey, or more as appropriate, to determine the presence or absence of endangered riparian species. However, this survey would not replace the need for SDG&E to perform detailed on-the-ground surveys as otherwise required by the BIO-APM-1. [BIO-APM-5].

B-1i Restrict the construction of access and spur roads. Except when not feasible due to physical or safety constraints, all project vehicle movement would be restricted to existing access roads and access roads constructed as a part of the project and determined and marked by SDG&E in advance for the contractor, contractor-acquired accesses, or public roads. New access road construction for the project would be allowed year-round. However, when feasible, every effort would be made to avoid constructing roads during the nesting season. When it is not feasible to keep vehicles on existing access roads or to avoid constructing new access roads during the nesting, breeding, or flight season, SDG&E would perform a site survey, or more as appropriate, in the area where the work is to occur. This survey would be performed to determine presence or absence of endangered nesting birds, or other endangered species in the work area. SDG&E would submit results of this survey to the USFWS and CDFG and consult on reasonable mitigation measures to avoid or minimize for potential impacts, prior to vehicle use off existing access roads or the construction of new access roads. However, this survey would not replace the need for SDG&E to perform detailed on-the-ground surveys otherwise required by BIOAPM- 1. Parking or driving underneath oak trees is not allowed in order to protect root structures. In addition to regular watering to control fugitive dust created during clearing, grading, earth-moving, excavation, and other construction activities which could interfere with plant photosynthesis, a 15 miles per hour speed limit shall be observed on dirt access roads to reduce dust and allow reptiles and small mammals to disperse. [BIO-APM-3] All new access roads or spur roads constructed as part of the project that are not required as permanent access for future project maintenance and operation would be permanently closed. Where required, roads would be permanently closed using the most effective feasible and least environmentally damaging methods appropriate to that area with the concurrence of the underlying landowner and the governmental agency having jurisdiction (e.g., stockpiling and replacing topsoil or rock replacement). This would limit new or improved accessibility into the area. Mowing of vegetation can be an effective method for protecting the vegetative understory while at the

same time creating access to the work area. Mowing should be used when permanent access is not required since, with time, total re-vegetation is expected. If mowing is in response to a permanent access need, but the alternative of grading is undesirable because of downstream siltation potential, it should be recognized that periodic mowing would be necessary to maintain permanent access. The project biological construction monitor shall conduct checks on mowing procedures to ensure that mowing for temporary or permanent access roads is limited to a 14-foot-wide area on straight portions of the road and a 16- to 20-foot-wide area at turns, and that the mowing height is no less than 4 inches from finished grade. [BIO-APM-17]

H-1d Avoid watercourses to the maximum extent possible. To the extent feasible, structures shall be placed so as to avoid sensitive features such as watercourses, or to allow conductors to clearly span the features, within limits of safety and standard structure design. [WQ-APM-2]

H-1i Construction routes to avoid and minimize disturbance to stream channels. To the extent feasible, where the construction of access roads would disturb sensitive features such as streambeds, the route of the access road would be adjusted to avoid such impacts. Whenever practicable, construction and maintenance traffic would use existing roads or cross-country access routes (including the ROW) which avoid impacts to the sensitive feature. To minimize ground disturbance, construction traffic routes will be clearly marked with temporary markers such as easily visible flagging. Construction routes, or other means of avoidance, should be approved by the appropriate agency or landowner before use. Where it is not feasible for access roads to avoid streambed crossings, such crossings would be built at right angles to the streambeds whenever feasible. Where such crossings cannot be made at right angles, SDG&E would limit roads constructed parallel to streambeds to a maximum length of 500 feet at any one transmission line crossing location. Such parallel roads would be constructed in such a manner that minimizes potential adverse impacts on waters of the U.S. or waters of the state. Streambed crossings or roads constructed parallel to streambeds would require review and approval of necessary permits from the ACOE, CDFG, and SWRCB/RWQCB. [WQ-APM-15]

G-1c Avoid new disturbance, erosion, and degradation. Project construction activities will be designed and implemented to avoid or minimize new disturbance, erosion on manufactured slopes, and off-site degradation from accelerated sedimentation. Maintenance of cut

and fill slopes created by project construction activities would consist primarily of erosion repair. Where revegetation is necessary to improve the success of erosion control, planting or seeding with native seed mix would be done on slopes. [GEO-APM-5]

G-1e Minimize road construction. Any temporary roads developed for the project would be removed, recontoured, and revegetated following construction except where the USFS authorizes continued use of the roads for transmission line maintenance, eliminating long term impacts from temporary roads.

Design Standards

Use existing access roads and spur roads to access structures. Where additional access is required to reach the structure pad, existing access and spur roads should be extended to reach the structure pad as a first priority, as long as no drainage course and/or wetland feature is impacted. If extension of the road off of an existing road will result in an impact to a drainage course or wetland feature, then the priority will be to avoid the drainage course or wetland feature even if a new access or spur road is necessary. If an access road potentially impacts a significant cultural feature to avoid a drainage course, then the design should avoid the significant cultural feature first and minimize impacts to the drainage course to the greatest extent feasible. If an access road impacts a wetland while avoiding a significant cultural feature, then a priority will be established on a case by case basis.

New access roads should be designed to cross drainages at right angles, as perpendicular as possible at the point of crossing to reduce the crossing length to the shortest amount practicable, where avoidance is not possible.

Access roads should not parallel any one drainage course for more than 500 feet for any one transmission line crossing such that for drainage courses the toe of slope would not be located closer than 50 feet from the drainage course centerline and for wetlands the toe of the slope would not be closer than 100 feet from from the wetlands centerline (based on the City of San Diego Environmentally Sensitive Lands Ordinance).

No access road fill slopes shall encroach into any drainage courses.

Temporary access roads shall be removed, recontoured, and revegetated following construction except where the USFS authorizes continued use of the roads for transmission line maintenance.

Access roads that should cross drainage courses should be culverted and designed with appropriate short- and long-term BMP's or should be spanned with a bridge or equivalent structure with headwalls and fill located outside of the drainage course as delineated by the wetlands biologist. The use of culvert or bridge or equivalent bridge-like crossings will be determined on a case by case basis. In general, drainage courses that have perennial water should be crossed with a bridge or equivalent structure. Intermittent drainage courses should be traversed with a culvert crossing if flow duration, flood volumes and velocities and local soil conditions, including scour potential, indicate a long-term maintenance and BMP benefit or comparative costs between culvert and dip crossing approaches reach similar levels. For ephemeral drainage courses and desert washes, rock or dip crossings can be utilized, however, culvert crossings should be considered on a case by case basis with input from the wetland biologist, hydrologic and soil conditions assessment and actual site conditions.

SENSITIVE FEATURE – DESIGNATED ENDANGERED SPECIES CRITICAL HABITAT, *Location: 6, 7, 8B, 8C, 9B, 9C, 10A, and 10B*

Mitigation Measures Where Standard is Derived

B-2c Avoid sensitive features. In areas designated as sensitive by SDG&E or the resource agencies, to the extent feasible structures and access roads would be designed to minimize impacts to sensitive features. These areas of sensitive features include but are not limited to high-value wildlife habitats, sensitive vegetation communities, and high value plant habitats, and/or to allow conductors to clearly span the features, within limits of standard structure design. If the sensitive features cannot be completely avoided, structures and access roads would be placed to minimize the disturbance to the extent feasible.

Design Standard

For structures located in Designated Critical Habitat where there is no existing road to fully access structures, SDG&E may use helicopter construction techniques to avoid or mimimize the construction of new access and spur roads. There are no exceptions in these areas unless there are overriding physical, equipment or safety issues that can be demonstrated to the CPUC and underlying Land Managing Entity requiring full vehicle access for construction or long-term operations, maintenance and repair.

SENSITIVE FEATURE – SENSTIVE PLANT SPECIES, *Location: All Sections*

Mitigation Measures Where Standard is Derived

B-2c Avoid sensitive features. In areas designated as sensitive by SDG&E or the resource agencies, to the extent feasible structures and access roads would be designed to minimize impacts to sensitive features. These areas of sensitive features include but are not limited to high-value wildlife habitats, sensitive vegetation communities, and high value plant habitats, and/or to allow conductors to clearly span the features, within limits of standard structure design. If the sensitive features cannot be completely avoided, structures and access roads would be placed to minimize the disturbance to the extent feasible.

Design Standards

Use existing access roads and spur roads to access structures. Where additional access is required to reach the structure pad, existing access and spur roads should be extended to reach the structure pad as a first priority, as long as no known sensitive plant population is impacted. If extension of the road off of an existing road will result in an impact to a known sensitive plant population, then the priority will be to avoid the known sensitive plant population even if a new access or spur road is necessary. If an access road potentially impacts a significant cultural feature to avoid a known sensitive plant population, then the design should avoid the significant cultural feature first and minimize impacts to the known sensitive plant population to the greatest extent feasible. If an access road impacts a known rare, endangered or threatened plant

population while avoiding a significant cultural feature, then a priority will be established on a case by case basis.

As an alternative to the above, if there remains potential impacts to a known sensitive plant population after all avoidance or minimization, then relocation of the sensitive plant population to be impacted may be pursued on a case by case basis in consultation with the USFWS, CDFG and appropriate agency Land Management Entity.

For all known sensitive plant populations including native trees, a 20-foot buffer around the mapped plant population should also be accounted for in avoidance to the greatest extent feasible unless the creation of the buffer results in an impact to another sensitive feature as outlined above.

SENSITIVE FEATURE – NATIVE TREES, *Location: All Sections*

Mitigation Measures Where Standard is Derived

B-1a Tree Mitigation. Mitigation for loss of native trees or native tree trimming shall be provided by (1) acquiring and preserving habitat within which the trees occur and/or (2)restoring (i.e., planting) trees on land that would not be subject to vegetation clearing (either in the applicant's ROW and/or on land acquired and preserved). Any land to be used for this mitigation shall be approved by the CPUC, BLM, State Parks (for ABDSP restoration), USDA Forest Service (for alternatives with restoration on National Forest lands), and the Wildlife Agencies. For habitat acquisition and preservation, the mitigation ratios shall follow those in Table D.2-7 for the Proposed Project (see Impacts to Vegetation Communities and Required Mitigation tables in alternatives sections for the alternatives). For example, removal of coast live oak trees (that occur in coast live oak woodland) shall require mitigation at a 3:1 ratio based on the permanent impact to the summed acreage of all individual coast live oak trees impacted. Therefore, if the total acreage of all individual coast live oak trees in coast live oak woodland impacted is 10 acres, then 30 acres of coast live oak woodland shall be acquired and preserved. For all trimmed native trees, the ratio shall be 1:1. For restoration (planting trees), these guidelines, based on recommendations from the CDFG, shall be followed. Native trees that are removed shall be replaced in-kind as follows.

Trees less than five inches diameter at breast height (DBH) shall be replaced at 3:1

Trees between five and 12 inches DBH shall be replaced at 5:1

Trees between 12 and 36 inches shall be replaced at 10:1
Trees greater than 36 inches shall be replaced at 20:1
Native trees that are trimmed shall be replaced in-kind as follows.
Trees less than 12 inches DBH shall be replaced at 2:1
Trees greater than 12 inches DBH shall be replaced at 5:1
All restoration shall be maintained and monitored for a minimum of 10 years. The restoration shall be directed according to a Habitat Restoration Plan approved by the CPUC, BLM, State Parks (for ABDSP restoration), USDA Forest Service (for National Forest land restoration), and the Wildlife Agencies.

Design Standards

Existing trees should be protected in place wherever possible to best preserve the health and well-being of the tree. A minimum 20' tree protection buffer should be provided around each tree trunk. The Project Biologist shall determine if additional measures are required to protect trees based on species, size and local conditions. Where construction should occur within the buffer area, or within 50' of existing trees protect the tree to the extent possible by installation of temporary fencing to surround the maximum buffer area available before the start of any construction operations. Vehicle use, parking, stockpiling of materials or soil is not allowed in the tree protection areas.

Where an impact to native trees cannot be avoided, then replanting at the ratios specified under mitigation measure B-1a, Native Trees, shall be located in areas appropriate for their continued health and vigor with final approval by the CPUC and BLM and wildlife agencies with priority given to locations that also provide screening and blending of new access road cut and fill slopes as long as all short- and long-term clearance requirements are met, including clearances for operations, maintenance and repair vehicles and equipment.

Pruning of existing native trees shall be avoided where possible. Where pruning of existing trees to remain is required for access or construction, the following levels of pruning may be required:

1. For removal of small branches more than 50% of the distance from crown to dripline, and less than 10% of the tree canopy volume the tree may be pruned as needed.

2. For all other pruning, the tree shall be pruned by skilled tree workers under the direction of a Certified Arborist. All work shall be done to promote the health, survival and natural appearance of the tree, with the goal of leaving the tree in as natural appearing condition as possible. Selective pruning methods shall be used, severing branches at crotches, and not leaving branch stubs. Topping of trees will not be permitted.

3. Where removal of tree roots is required for grading, trenching or other reasons, all top and root pruning work shall be done prior to the clearing, grubbing, grading or other operations that may damage the roots. Construction work shall be performed to minimize the amount of root removal required. Roots required to be removed shall be severed cleanly prior to ripping or trenching. Tunnel under roots for trenches instead of cutting the roots. After root pruning, prune the tree canopy to compensate for root removals. If 20% of roots are removed, a similar percentage of the canopy shall be removed by thinning.

4. Where more than 50% of the tree canopy volume is required to be removed, one tree of the same species shall be planted for every 5 feet of vertical height of the tree.

SENSITVE FEATURE – FIELD OBSERVATIONS PRIOR TO OR DURING CONSTRUCTION, *Location: All Sections*

Mitigation Measures Where Standard is Derived

B-2c Avoid sensitive features. In areas designated as sensitive by SDG&E or the resource agencies, to the extent feasible structures and access roads would be designed to minimize impacts to sensitive features. These areas of sensitive features include but are not limited to high-value wildlife habitats, sensitive vegetation communities, and high value plant habitats, and/or to allow conductors to clearly span the features, within limits of standard structure design. If the sensitive features cannot be completely avoided, structures and access roads would be placed to minimize the disturbance to the extent feasible.

B-1a Provide restoration/compensation for affected sensitive vegetation communities. Any impacts associated with unauthorized activity (e.g., exceeding approved construction footprints) shall be mitigated at a 5:1 ratio (5.5:1 in FTHL MA). Restoration of the unauthorized impacts shall be credited at a 1:1 ratio (i.e., mitigated by in-place habitat restoration); the remaining 4:1 (or 4.5:1 in FTHL MA) shall be acquired off site.

Design Standard

Sensitive features that may not have been known during design may be found during pre-construction surveys or during actual construction activity. Any field redesign of access roads should be documented and quantified and routed as directed by the SDG&E Compliance Manager, environmental monitors, CPUC and the Agency Land Managing Entity. Prior to actual construction of the rerouted access road, an estimation of impact should be completed and compared to the impact of the previous access road design.

SENSITIVE FEATURE - VISUAL RESOURCES, *Location: Sections 6, 7, 8B, 8C, 9B, 9C,10A, and 10B*

Mitigation Measures Where Standard is Derived

V-2a Reduce in-line views of land scars. Construct access or spur roads at appropriate angles from the originating, primary travel facilities to minimize extended, in-line views of newly graded terrain. Contour grading should be used where possible to better blend graded surfaces with existing terrain. SDG&E shall submit final construction plans demonstrating compliance with this measure to the CPUC and BLM, as well as the Forest Service and Anza-Borrego Desert State Park (as appropriate), for review and approval at least 60 days prior to the start of construction.

V-2b Reduce visual contrast from unnatural vegetation lines. In those areas where views of land scars are unavoidable, the boundaries of disturbed areas shall be aggressively revegetated to create a less distinct and more natural-appearing line to reduce visual contrast. Furthermore, all graded roads and areas not required for on-going operation, maintenance, or access shall be returned to pre-

construction conditions. In those cases where potential public access is opened by construction routes, SDG&E shall create barriers or fences to prevent public access and patrol construction routes to prevent vandalized access and litter clean-up until all vegetation removed returns to its pre-project state. SDG&E shall submit final construction and restoration plans demonstrating compliance with this measure to the BLM and CPUC, as well as Forest Service and Anza-Borrego Desert State Park (as appropriate), for review and approval at least 60 days prior to the start of construction.

V-2c Reduce color contrast of land scars on non-Forest lands. For non-USFS-administered land areas where views of land scars from sensitive public viewing locations are unavoidable, disturbed soils shall be treated with Eonite or similar treatments to reduce the visual contrast created by the lighter-colored disturbed soils with the darker vegetated surroundings (Eonite and Permeon are commercially available chemical treatments that "age" or oxidize rock and are used specifically for coloring concrete or rock surfaces to tone down glare and contrast and simulate naturally occurring desert varnish). SDG&E will consult with the Authorized Officer (as determined by the CPUC and BLM as appropriate) on a site-by-site basis for the use of Eonite. SDG&E shall submit final construction and restoration plans demonstrating compliance with this measure to the BLM and CPUC, as well as Anza-Borrego Desert State Park (as appropriate), for review and approval at least 60 days prior to the start of construction.

V-2d Construction by helicopter. In those areas where long-term land-scarring and vegetation clearance impacts would be visible to sensitive public viewing locations, or where construction would occur on slopes over 15 percent, SDG&E will consult with the Authorized Officer and appropriate land management agency, on a site-by-site basis regarding the use of helicopter construction techniques and the prohibition of access and spur roads. Agency consultations should be conducted and approvals received at least 120 days prior to the start of construction.

V-2e Minimize vegetation removal. Only the minimum amount of vegetation necessary for the construction of structures and facilities will be removed. Topsoil located in areas containing sensitive habitat shall be conserved during excavation and reused as cover on disturbed areas to facilitate re-growth of vegetation. Topsoil located in developed or disturbed areas is excluded from this APM. [BIO-APM-23]

V-2f Reduce land scarring and vegetation clearance impacts on USFS-administered lands. Vegetation within the right of way and ground clearing at the foot of each tower and between towers will be limited to the clearing necessary to comply with electrical safety and fire clearance requirements. Mitigation will be incorporated to reduce the total visual impact of all vegetation clearing performed for the power line (USFS Scenery Conservation Plan)

V-45a Prepare and implement Scenery Conservation Plan. Within one year after license issuance, or prior to any ground disturbing activities, the Licensee shall file with the Commission a Scenery Conservation Plan that is approved by the Forest Service. The purpose of this Scenery Conservation Plan is to identify specific actions that will minimize the project's visible disturbance to the naturally established scenery and to establish final direction to best achieve the spirit and intent of the Scenic Integrity Objectives of the Cleveland National Forest Land and Resource Management Plan. To achieve the greatest consistency with the Scenic Integrity Objectives, the project shall detail and integrate the following design recommendations into the Scenery Conservation Plan:

Roads. No new access or spur roads, or improvements reconstruction/expansion) to existing roads are to be constructed in the following areas: (1) where ground slopes exceed 15%, or (2) on Forest lands subject to a HIGH Scenic Integrity Objective (SIO) where the new access or spur road would be visible from primary travel (paved) roads or the Pacific Crest National Scenic Trail, regardless of ground slope. Existing roads needing reconstruction/expansion on other areas of the forest shall be configured to minimize the creation of cut/fill slopes. Where such slopes are created, they shall be immediately treated to minimize their level of scenery disturbance. These treatments may include construction of structural elements designed to blend with the adjacent natural scenery, or revegetation with native species.

Design Standards

In Sections 10A and 10B and other areas where intervening topography between the existing primary access road and the structure average 15% or less in slope, design of access roads shall not allow an uninterrupted linear view down the access road. This may be accomplished by providing periodic turns to break the directional view. For ease of access, roads may meet the adjoining public road at 90 degrees, with a straight section

for 150 feet before curving away from 90 degrees to prevent a linear view down the road. Exceptions to this are where compliance with this standard creates an impact to a drainage course, significant cultural resource or other sensitive feature that cannot be avoided.

For USFS congressional boundary lands, areas located within 1000 feet of existing recreational trails, areas located within County or City parks, BLM ACEC areas or areas otherwise designated as high value recreation or scenic areas in the Final EIR/EIS, cut and fill slopes for access roads shall not exceed 50 feet in vertical height as measured from the toe of the cut/fill slope to the top of the cut/fill slope (vertical projected distance).

For lands within the congressional boundaries of the Cleveland National Forest, no new access or spur roads, or improvements (reconstruction/ expansion) to existing roads are to be constructed in the following areas: (1) where ground slopes exceed 15%, or (2) on Forest lands subject to a HIGH Scenic Integrity Objective (SIO) where the new access or spur road would be visible from primary travel (paved) roads or the Pacific Crest National Scenic Trail, regardless of ground slope. For structures located in these areas where there is no existing road to fully access structures, SDG&E should use helicopter construction techniques to prohibit the construction of access and spur roads. There are no exceptions in these areas unless there are overriding physical, equipment or safety issues that can be demonstrated to the CPUC and USFS requiring full vehicle access for construction or long-term operations, maintenance and repair.

For all other areas, cut and fill slopes for access roads greater than 50 feet in vertical height shall be avoided to the greatest extent feasible. Where cut and fill slopes exceed 50 feet the slope shall be contour graded with variable slopes ranging from 1:1 to 4:1 depending on geologic and soil condition constraints. Exceptions to the variable slope requirement are where compliance with this standard creates an impact to a drainage course, significant cultural resource or other sensitive feature that cannot be avoided from the creation of a greater area of horizontal disturbance.

In non-USFS congressional boundary lands, if cut and fill slopes greater than 50 feet cannot be avoided in access road design, and creates an impact to a drainage course, cultural resource or other sensitive feature, retaining walls shall be used as an alternative method of avoidance. Construct retaining walls of materials and colors that minimize the visual impact of the wall structure based on the views of the wall. Avoid retaining walls with long, straight runs when exposed to view. Avoid acute angles in walls, in favor of walls that curve to match existing conditions. Consider construction impacts, and select the wall type allowing the least disturbance to existing soils and vegetation. Acceptable options for walls include plantable segmental retaining walls, or sculpted and colored rock concrete surfacing that match the shapes, textures and colors of surrounding rock outcrops. Provide plantable areas in front of walls to permit establishment of vegetation to help obscure the walls and create a transition to the natural landscape.

Use existing access roads and spur roads to access structures. Where additional access is required to reach the structure pad, existing access and spur roads should be extended to reach the structure pad as a first priority, as long as no recreational trails, areas located within County or City parks, BLM ACEC areas or areas otherwise designated as high value recreation or scenic areas in the Final EIR/EIS are impacted by the extension. For structures located in these areas where there is no existing road to fully access structures, SDG&E should use helicopter construction techniques to prohibit the construction of access and spur roads. There are no exceptions in these areas unless there are overriding physical, equipment or safety issues that can be demonstrated to the CPUC and underlying Land Managing Entity requiring full vehicle access for construction or long-term operations, maintenance and repair.

SENSITIVE FEATURE - CULTURAL RESOURCES, Location: *All Sections*

Mitigation Measures Where Standard is Derived

C-1b Avoid and protect potentially significant resources. Where operationally feasible, regardless of cost, potentially register-eligible resources shall be protected from direct project impacts by project redesign; complete avoidance of impacts to such resources shall be the preferred protection strategy. On the basis of preliminary National

Register of Historic Places (NRHP) eligibility assessments (Mitigation Measure C-1a) or previous determinations of resource eligibility, the BLM and CPUC, in consultation with the SHPO, may require the relocation of the line, ancillary facilities, or temporary facilities or work areas, if any, where relocation would avoid or reduce damage to cultural resource values. Where the BLM and CPUC decide that potentially NRHP- and/or CRHR-eligible cultural resources cannot be protected from direct impacts by project redesign, the Applicant shall undertake additional studies to evaluate the resources' NRHP- and/or CRHR-eligibility and to recommend further mitigative treatment. The nature and extent of this evaluation shall be determined by the BLM in consultation with the CPUC and the SHPO and shall be based upon final project engineering specifications. Evaluations will be based on surface remains, subsurface testing, archival and ethnographic resources, and in the framework of the historic context and important research questions of the project area. Results of those evaluation studies and recommendations for mitigation of project effects shall be incorporated into a Historic Properties Treatment Plan consistent with Mitigation Measure C-1c (Develop and implement Historic Properties Treatment Plan).

All potentially NRHP- and/or CRHR-eligible resources (as determined by the BLM and CPUC, in consultation with the SHPO) that will not be affected by direct impacts, but are within 50 feet of direct impact areas, will be designated as Environmentally Sensitive Areas (ESAs) to ensure that construction activities do not encroach on site peripheries. Protective fencing, or other markers (after approval by CPUC/BLM), shall be erected and maintained to protect ESAs from inadvertent trespass for the duration of construction in the vicinity. ESAs shall not be identified specifically as cultural resources. A monitoring program shall be developed as part of a Historic Properties Treatment Plan and implemented by the Applicant to ensure the effectiveness of ESA protection (as detailed in Mitigation Measure C-1e).

Design Standard

Potentially NRHP- and/or CRHR-eligible cultural resources shall be avoided. Avoidance can be achieved in any of the following means, either individually or in combination:

1. **Access road and structure relocation placed outside of the defined boundaries of the cultural resource.**

2. **Capping with gravel, soil or plates, on a case by case basis with input and guidance from CPUC, BLM, SHPO (including the PA and HRTP) and the project archaeologist.**
3. **Surface recovery of artifacts where temporary access roads and spur roads can be placed without grading or soil disturbance.**

Traditional Cultural Properties or current or potential Historic Districts that contain or could contain human remains shall be avoided.

Use existing access roads and spur roads to access structures. Where additional access is required to reach the structure pad, existing access and spur roads should be extended to reach the structure pad as a first priority.

SENSITIVE FEATURE - UNIQUE GEOLOGIC FEATURE, Location: Sections 10A and B

Mitigation Measures Where Standard is Derived

G-2a Protect desert pavement. Grading for new access roads or work areas in areas covered by desert pavement shall be avoided or minimized. If avoidance of these areas is not possible, the desert pavement surface shall be protected from damage or disturbance from construction vehicles by use of temporary mats placed on the ground surface. A plan for identification and avoidance or protection of sensitive desert pavement shall be prepared and submitted to the CPUC and BLM for review and approval at least 60 days prior to start of construction. The plan shall define how protective measures will prevent destruction of desert pavement.

Design Standard

Access road and structure relocation outside of the defined boundaries desert pavement. Exceptions to this are where compliance with this standard creates an impact to a drainage course, cultural resource or other sensitive feature that cannot be avoided.

Design of facilities, construction and operations shall be performed in a manner to protect desert pavement to the fullest extent possible. Since any vehicle use, grading, or pedestrian use will damage desert pavement, desert pavement

shall be protected by restricting all construction activity, vehicle use, pedestrian activity and any other activity that may affect the pavement, to the defined route by use of temporary fencing to protect all desert pavement not directly in the established route.

ATTACHMENT ONE – GLOSSARY

ACEC: Area of Critical Environmental Concern is designated by the BLM due to a significant biological, cultural, historic otherwise sensitive environmental feature. These are afforded high levels of protection by the BLM.

APM: Applicant Proposed Measures are proposed by SDG&E in the Proponent's Environmental Assessment (PEA), part of the project application to the CPUC. The measures are incorporated into the project description by SDG&E to address potential environmental effects of the project. In all cases, the CPUC and BLM, when they prepared the EIR/EIS augmented or otherwise replaced these measures with their own, more stringent mitigation measures.

BLM: Bureau of Land Management. The lead agency granting right of way for the Sunrise Powerlink in BLM administered lands in the desert and portions of eastern San Diego County. They are co-lead agencies with the CPUC for the preparation of the Environmental Impact Report/Environmental Impact Statement.

CPUC: California Public Utilities Commission: Lead state agency granting SDG&E a Certificate of Public Convenience and Necessity, essentially a permit and co lead agency with the BLM for the preparation of the Environmental Impact Report/Environmental Impact Statement.

Contour grading: A grading design technique using varying slope ratios, and undulating slope faces to promote a more natural appearance and continuity with the shapes of adjacent land forms. Techniques include creating smooth transitions between slope faces and adjacent grades, rounding slopes and avoiding or minimizing continuous flat slope faces, angular transitions and grade breaks.

Drainage Course: Any feature that carries or could carry either permanently or temporarily, regardless of duration or the presence of water or the feature's size, location or the presence of vegetation.

Ephemeral Drainage Course: Drainage course containing running water only seasonally and not necessarily every year.

Existing Access Road: A paved, gravel or dirt road that can currently accommodate and be traversed by a four-wheel drive vehicle without improvements.

Historic Districts: A series of cultural features that may be individually distinct but due to location and the nature of the features associated with them are related significantly enough to render them as being considered one site.

HRTP: Historic Resources Treatment Plan. Prepared as part of the Programmatic Agreement which is a document that outlines how the BLM will mitigation for potential impacts to cultural and historic resources as required by Section 106 of the Historic Resources Protection Act.

Intermittent Drainage Course: Drainage course containing water only in certain segments fed by springs or ground water and dry for long distances between.

Land Managing Entity: Underlying owner or manager of a parcel of land, either a private entity or an agency.

Land Scar: A visible disturbance to the soil surface or vegetation which contrasts to existing appearance of the land. This may be a graded cut or fill slope, road, or facility pad, erosion, or damage resulting from construction, vehicular use or other activity.

NRHP- and/or CRHR-eligible cultural resources: Cultural or historic resources that qualify or could qualify as National Register of Historic Places and California Register of Historic Resources based on criteria set forth to determine their designation by state and federal laws.

New Access Road: A road traversing lands with no previous disturbance where vegetation and other natural features appear to have not been disturbed by human activities.

PA: Programmatic Agreement which is a document that outlines how the BLM will take into account the potential impacts to cultural and historic resources as required by Section 106 of the Historic Resources Protection Act.

Perennial Drainage Course: Drainage course that flows year-round.

Sensitive Feature: Any feature that is considered to have significant biological, cultural, historic, aesthetic, visual or recreational value as outlined in the EIR/EIS.

SHPO: The State Historic Preservation Office is the Agency which is responsible for compliance with state and federal historic and cultural resource protection laws.

Significant Cultural Feature: Any feature that has been mapped previously by others, or as part of the Sunrise Powerlink environmental process or that is found in the field by professional cultural resource monitors or archeologists, that they and/or the CPUC, BLM, or SHPO indicates as significant and have a high priority for avoidance of impact or disturbance.

Traditional Cultural Properties: A property or a place that is eligible for inclusion on the National Register of Historic Places because of its association with cultural practices and beliefs that are (1) rooted in the history of a community, and (2) are important to maintaining the continuity of that community's traditional beliefs and practices.

USFS congressional boundary: Boundary of the Cleveland National Forest as set forth by Congress when the forest was established, as subsequently amended, which can include both federally owned and private lands.

Vernal Pool/Road Pool: Shallow depression that holds water seasonally underlain by specific soil types and located in unique topography that sustain sensitive features including rare and endangered plants and animals. For the purposes of these standards, vernal pool/road pool is considered the same feature.

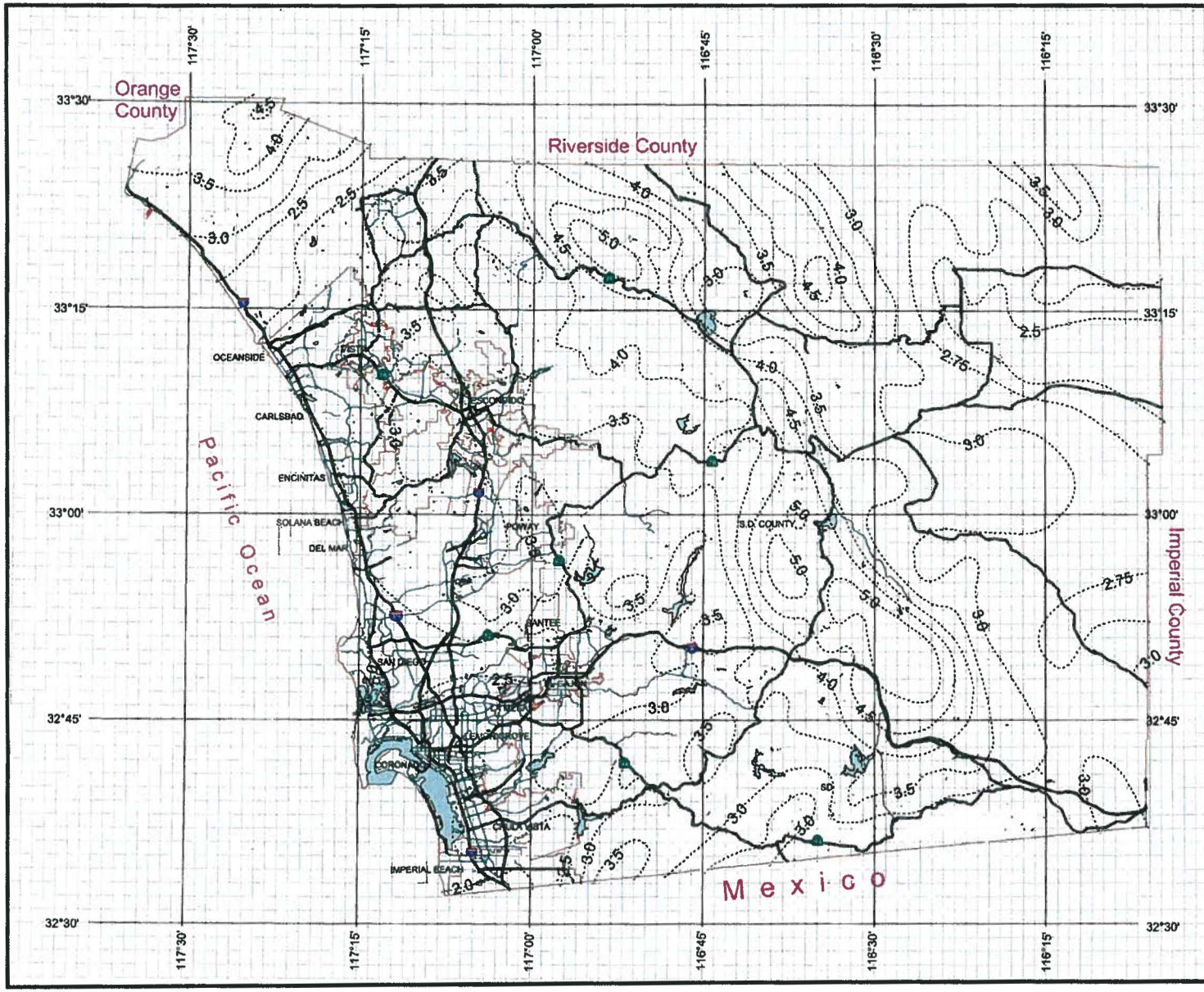
Wetland: Drainage feature that has vegetation, soil and hydrologic characteristics that indicate a long-term presence of surface and subsurface water either permanently or intermittently.

APPENDIX F

COUNTY OF SAN DIEGO HYDROLOGIC REFERENCE MATERIAL

County of San Diego Hydrology Manual

Rainfall Isopluvials



100 Year Rainfall Event - 6 Hours

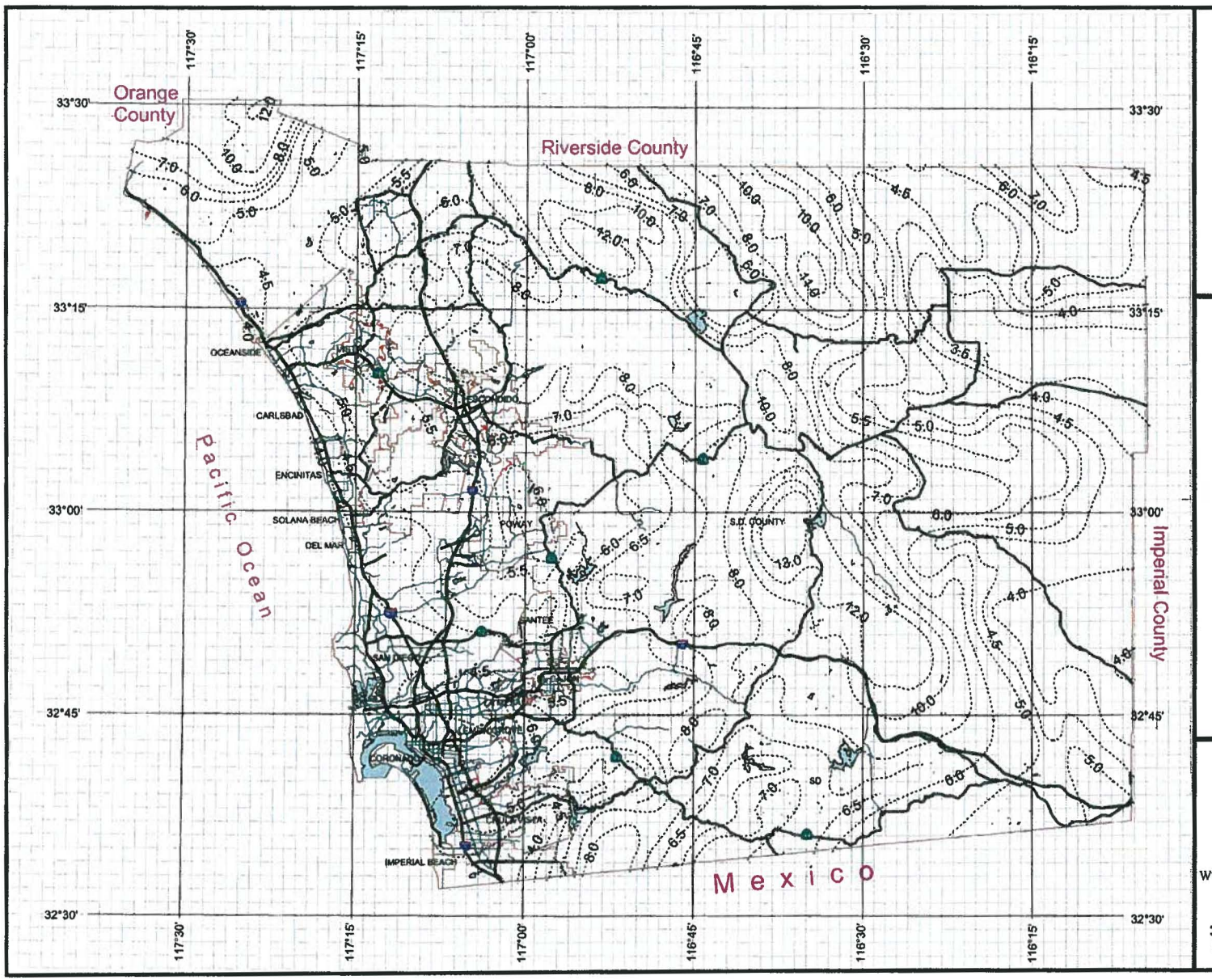
Isopluvial (inches)

DPW GIS — Department of Public Works Geographic Information Services

SanGIS — We Have San Diego Covered!

N W E S

3 0 3 Miles



County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 24 Hours

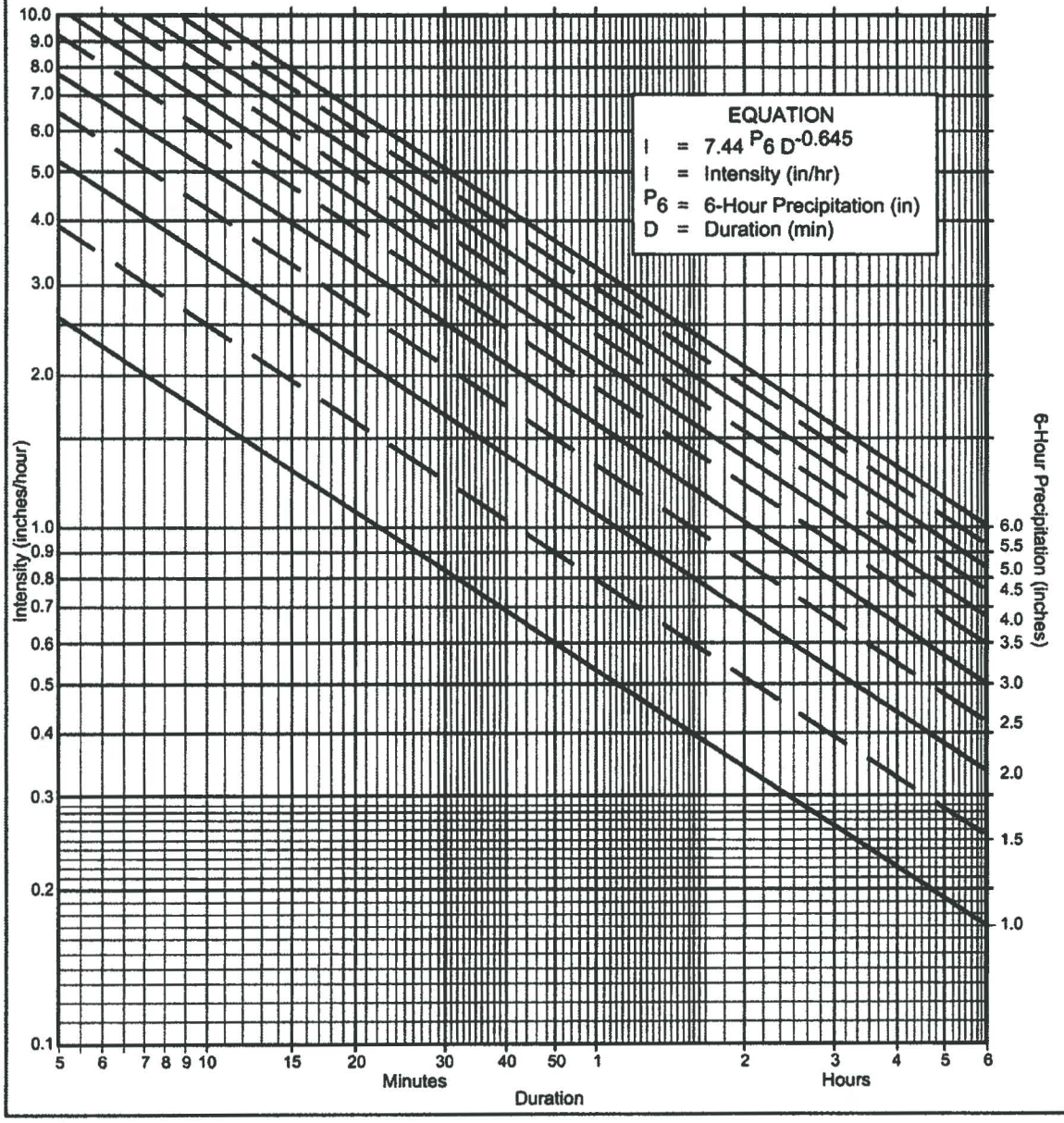
Isopluvial (inches)

DPW GIS
Department of Public Works Geographic Information Services

SanGIS
We Have San Diego Covered!

N
W E
S

3 0 3 Miles



Directions for Application:

(1) From precipitation maps determine 6 hr and 24 hr amounts for the selected frequency. These maps are included in the County Hydrology Manual (10, 50, and 100 yr maps included in the Design and Procedure Manual).

(2) Adjust 6 hr precipitation (if necessary) so that it is within the range of 45% to 65% of the 24 hr precipitation (not applicaple to Desert).

(3) Plot 6 hr precipitation on the right side of the chart.

(4) Draw a line through the point parallel to the plotted lines.

(5) This line is the intensity-duration curve for the location being analyzed.

Application Form:

(a) Selected frequency _____ year

(b) P_6 = _____ in., P_{24} = _____, $\frac{P_6}{P_{24}}$ = _____ %(2)

(c) Adjusted P_6(2) = _____ in.

(d) t_x = _____ min.

(e) I = _____ in./hr.

Note: This chart replaces the Intensity-Duration-Frequency curves used since 1965.

P6	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
Duration	I	I	I	I	I	I	I	I	I	I	I
5	2.63	3.95	5.27	6.59	7.90	9.22	10.54	11.86	13.17	14.49	15.81
7	2.12	3.18	4.24	5.30	6.36	7.42	8.48	9.54	10.60	11.66	12.72
10	1.68	2.53	3.37	4.21	5.05	5.90	6.74	7.58	8.42	9.27	10.11
15	1.30	1.95	2.59	3.24	3.89	4.54	5.19	5.84	6.49	7.13	7.78
20	1.08	1.62	2.15	2.69	3.23	3.77	4.31	4.85	5.39	5.93	6.46
25	0.93	1.40	1.87	2.33	2.80	3.27	3.73	4.20	4.67	5.13	5.60
30	0.83	1.24	1.66	2.07	2.49	2.90	3.32	3.73	4.15	4.56	4.98
40	0.69	1.03	1.38	1.72	2.07	2.41	2.76	3.10	3.45	3.79	4.13
50	0.60	0.90	1.19	1.49	1.79	2.09	2.39	2.69	2.98	3.28	3.58
60	0.53	0.80	1.06	1.33	1.59	1.86	2.12	2.39	2.65	2.92	3.18
90	0.41	0.61	0.82	1.02	1.23	1.43	1.63	1.84	2.04	2.25	2.45
120	0.34	0.51	0.68	0.85	1.02	1.19	1.36	1.53	1.70	1.87	2.04
150	0.29	0.44	0.59	0.73	0.88	1.03	1.18	1.32	1.47	1.62	1.76
180	0.26	0.39	0.52	0.65	0.78	0.91	1.04	1.18	1.31	1.44	1.57
240	0.22	0.33	0.43	0.54	0.65	0.76	0.87	0.98	1.08	1.19	1.30
300	0.19	0.28	0.38	0.47	0.56	0.66	0.75	0.85	0.94	1.03	1.13
360	0.17	0.25	0.33	0.42	0.50	0.58	0.67	0.75	0.84	0.92	1.00

Intensity-Duration Design Chart - Template

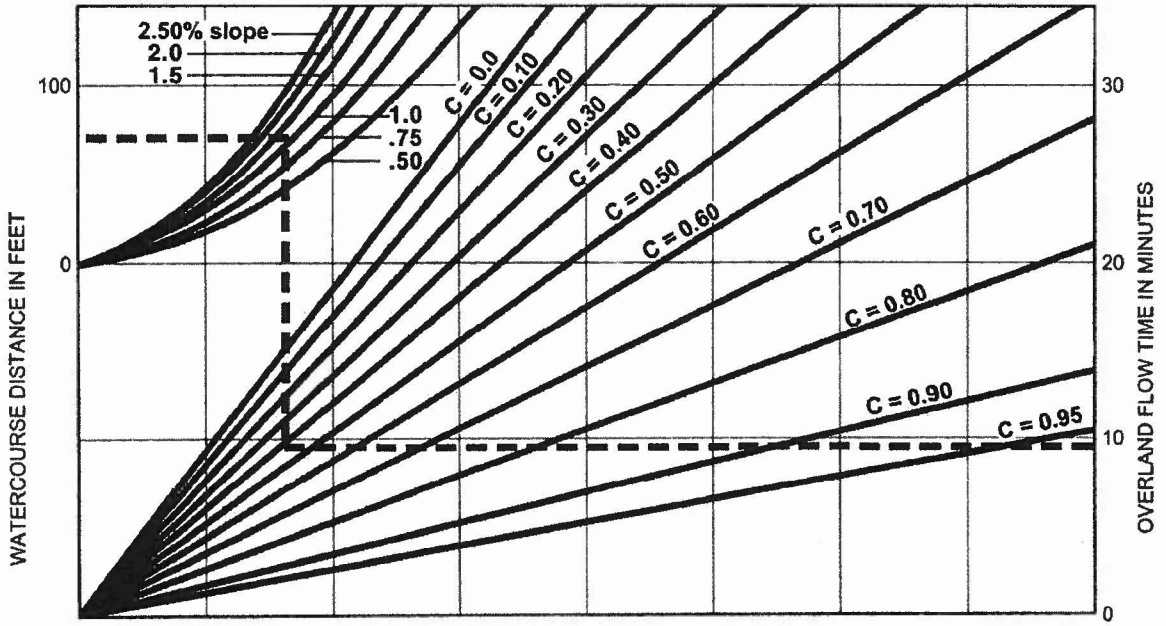
FIGURE

3-1

Table 3-1
RUNOFF COEFFICIENTS FOR URBAN AREAS

Land Use		Runoff Coefficient "C"				
			Soil Type			
NRCS Elements	County Elements	% IMPER.	A	B	C	D
Undisturbed Natural Terrain (Natural)	Permanent Open Space	0*	0.20	0.25	0.30	0.35
Low Density Residential (LDR)	Residential, 1.0 DU/A or less	10	0.27	0.32	0.36	0.41
Low Density Residential (LDR)	Residential, 2.0 DU/A or less	20	0.34	0.38	0.42	0.46
Low Density Residential (LDR)	Residential, 2.9 DU/A or less	25	0.38	0.41	0.45	0.49
Medium Density Residential (MDR)	Residential, 4.3 DU/A or less	30	0.41	0.45	0.48	0.52
Medium Density Residential (MDR)	Residential, 7.3 DU/A or less	40	0.48	0.51	0.54	0.57
Medium Density Residential (MDR)	Residential, 10.9 DU/A or less	45	0.52	0.54	0.57	0.60
Medium Density Residential (MDR)	Residential, 14.5 DU/A or less	50	0.55	0.58	0.60	0.63
High Density Residential (HDR)	Residential, 24.0 DU/A or less	65	0.66	0.67	0.69	0.71
High Density Residential (HDR)	Residential, 43.0 DU/A or less	80	0.76	0.77	0.78	0.79
Commercial/Industrial (N. Com)	Neighborhood Commercial	80	0.76	0.77	0.78	0.79
Commercial/Industrial (G. Com)	General Commercial	85	0.80	0.80	0.81	0.82
Commercial/Industrial (O.P. Com)	Office Professional/Commercial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (Limited I.)	Limited Industrial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (General I.)	General Industrial	95	0.87	0.87	0.87	0.87

*The values associated with 0% impervious may be used for direct calculation of the runoff coefficient as described in Section 3.1.2 (representing the pervious runoff coefficient, Cp, for the soil type), or for areas that will remain undisturbed in perpetuity. Justification must be given that the area will remain natural forever (e.g., the area is located in Cleveland National Forest).
DU/A = dwelling units per acre
NRCS = National Resources Conservation Service



EXAMPLE:

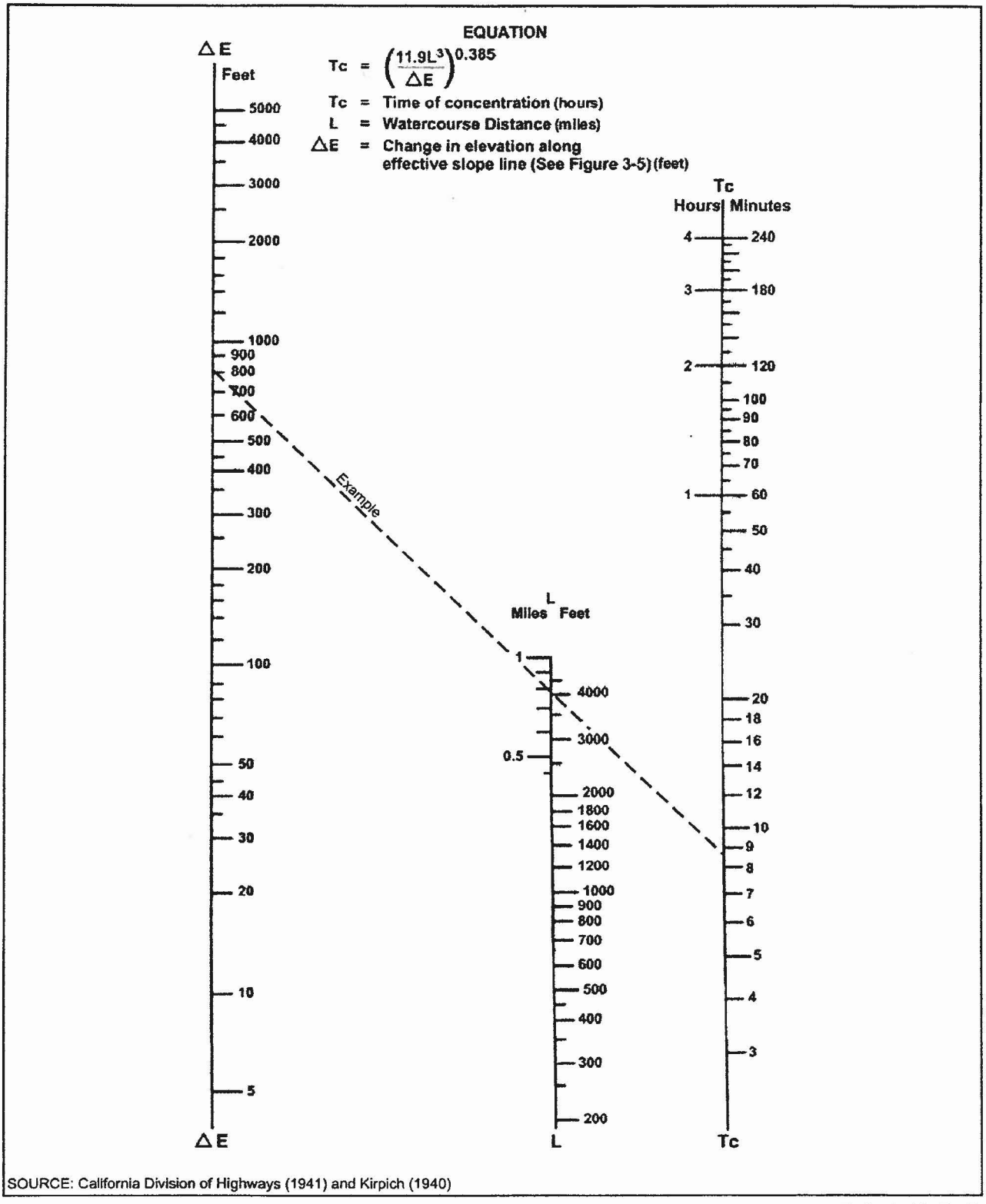
Given: Watercourse Distance (D) = 70 Feet
Slope (s) = 1.3%
Runoff Coefficient (C) = 0.41
Overland Flow Time (T) = 9.5 Minutes

$$T = \frac{1.8\,(1.1-C)\sqrt{D}}{\sqrt[3]{s}}$$

SOURCE: Airport Drainage, Federal Aviation Administration, 1965

Rational Formula - Overland Time of Flow Nomograph

FIGURE 3-3



SOURCE: California Division of Highways (1941) and Kirpich (1940)

FIGURE 3-4

Nomograph for Determination of
Time of Concentration (Tc) or Travel Time (Tt) for Natural Watersheds

Table 4-1
RAINFALL DEPTH-AREA ADJUSTMENT DATA POINTS

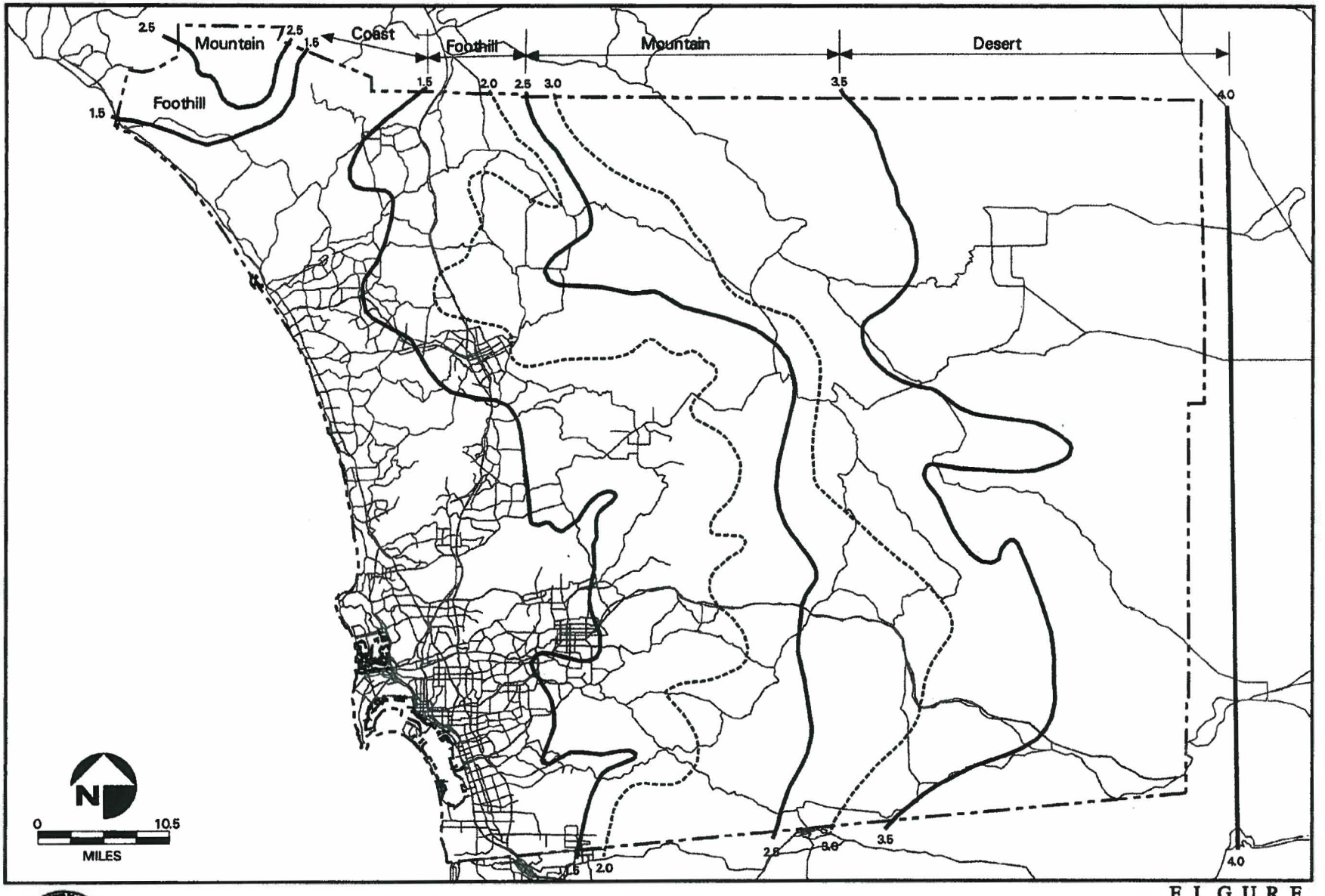
Watershed Area (square miles)	Rainfall Depth-Area Adjustment for Duration				
	30-Minute	1-Hour	3-Hour	6-Hour	24-Hour
0	1.000	1.000	1.000	1.000	1.000
5	0.942	0.970	0.980	0.985	0.990
10	0.900	0.947	0.970	0.980	0.985
20	0.834	0.900	0.952	0.963	0.975
30	0.768	0.858	0.932	0.950	0.964
40	0.730	0.830	0.915	0.940	0.958
50	0.692	0.800	0.900	0.928	0.952
60	0.663	0.778	0.883	0.920	0.948
70	0.645	0.760	0.872	0.912	0.945
80	0.630	0.746	0.862	0.904	0.942
90	0.620	0.735	0.853	0.896	0.938
100	0.610	0.722	0.845	0.890	0.935
125	0.588	0.700	0.830	0.878	0.930
150	0.572	0.685	0.818	0.865	0.925
175	0.572	0.672	0.808	0.858	0.922
200	0.572	0.666	0.798	0.851	0.918
225	0.572	0.660	0.790	0.845	0.915
250	0.572	0.655	0.787	0.842	0.914
300	0.572	0.652	0.782	0.838	0.912
350	0.572	0.652	0.780	0.830	0.910
400	0.572	0.652	0.780	0.828	0.908

Table 4-2
RUNOFF CURVE NUMBERS[1] FOR PZN CONDITION = 2.0

Cover Description	Cover Treatment or Practice[2]	Hydrologic Condition[3]	Average Percent Impervious Area[4]	Curve Numbers for Hydrologic Soil Groups: A	B	C	D
Developing urban areas and newly graded areas (pervious areas only, no vegetation)				77	86	91	94
Impervious areas: Paved parking lots, roofs, and driveways (excluding right-of-way)				98	98	98	98
Residential districts by average lot size:[4]							
1/8 acre or less (town houses)			65%	77	85	90	92
1/4 acre			38%	61	75	83	87
1/3 acre			30%	57	72	81	86
1/2 acre			25%	54	70	80	85
1 acre			20%	51	68	79	84
2 acres			12%	46	65	77	82
Streets and roads	Paved; curbs and storm drains (excluding right-of-way)			98	98	98	98
	Paved; open ditches (including right-of-way)			83	89	92	93
	Gravel (including right-of-way)			76	85	89	91
	Hard surface (including right-of-way)			74	84	90	92
	Dirt (including right-of-way)			72	82	87	89
Urban districts[4]	Commercial and business		85%	89	92	94	95
	Industrial		72%	81	88	91	93
Western desert urban areas:							
Natural desert landscaping (pervious areas only)[5]				63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)				96	96	96	96

Table 4-2 (Continued)
RUNOFF CURVE NUMBERS[1] FOR PZN CONDITION = 2.0

Cover Description	Cover Treatment or Practice[2]	Hydrologic Condition[3]	Average Percent Impervious Area[4]	Curve Numbers for Hydrologic Soil Groups: A	B	C	D
Small grain	Straight row	Poor		65	76	84	88
		Good		63	75	83	87
	Contoured	Poor		63	74	82	85
		Good		61	73	81	84
Vineyards[6]	Disked			76	85	90	92
	Annual grass or legume cover	Poor		65	78	85	89
		Fair		50	69	79	84
		Good		38	61	74	80
Annual grass (Dryland pasture)		Poor		67	78	86	89
		Fair		50	69	79	84
		Good		38	61	74	80
Barren				78	86	91	93
Meadow		Poor		63	77	85	88
		Fair		51	70	80	84
		Good		30	58	72	78
Open space (lawns, parks, golf courses, cemeteries, etc.)[7]	Grass cover <50%	Poor		68	79	86	89
	Grass cover 50% to 75%	Fair		49	69	79	84
	Grass cover >75%	Good		39	61	74	80
Pasture or range land		Poor		68	79	86	89
		Fair		49	69	79	84
		Good		39	61	74	80
Perennial grass		Poor		67	79	86	89
		Fair		50	69	79	84
		Good		38	61	74	80



County of San Diego Hydrology Manual

Precipitation Zone Numbers (PZN)

FIGURE

C-1

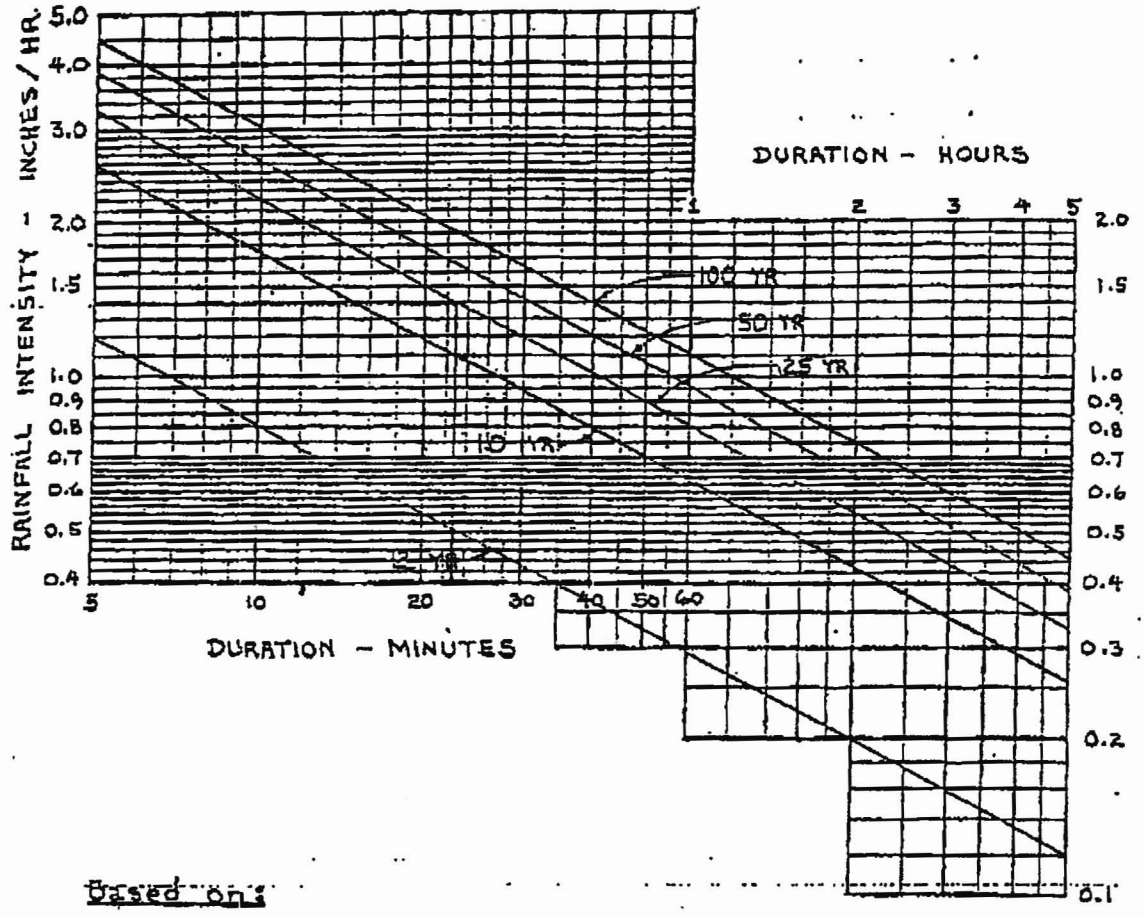
APPENDIX G

COUNTY OF IMPERIAL HYDROLOGIC REFERENCE MATERIAL

INTENSITY-DURATION-FREQUENCY CHART

DISTRICT 11

ZONE VI



Based on:

RAINFALL ANALYSIS FOR DRAINAGE DESIGN
VOLUMES I - II - III
STATE OF CALIFORNIA
DEPT. OF WATER RESOURCES
BULLETIN 195 - OCTOBER 1976

Figure C

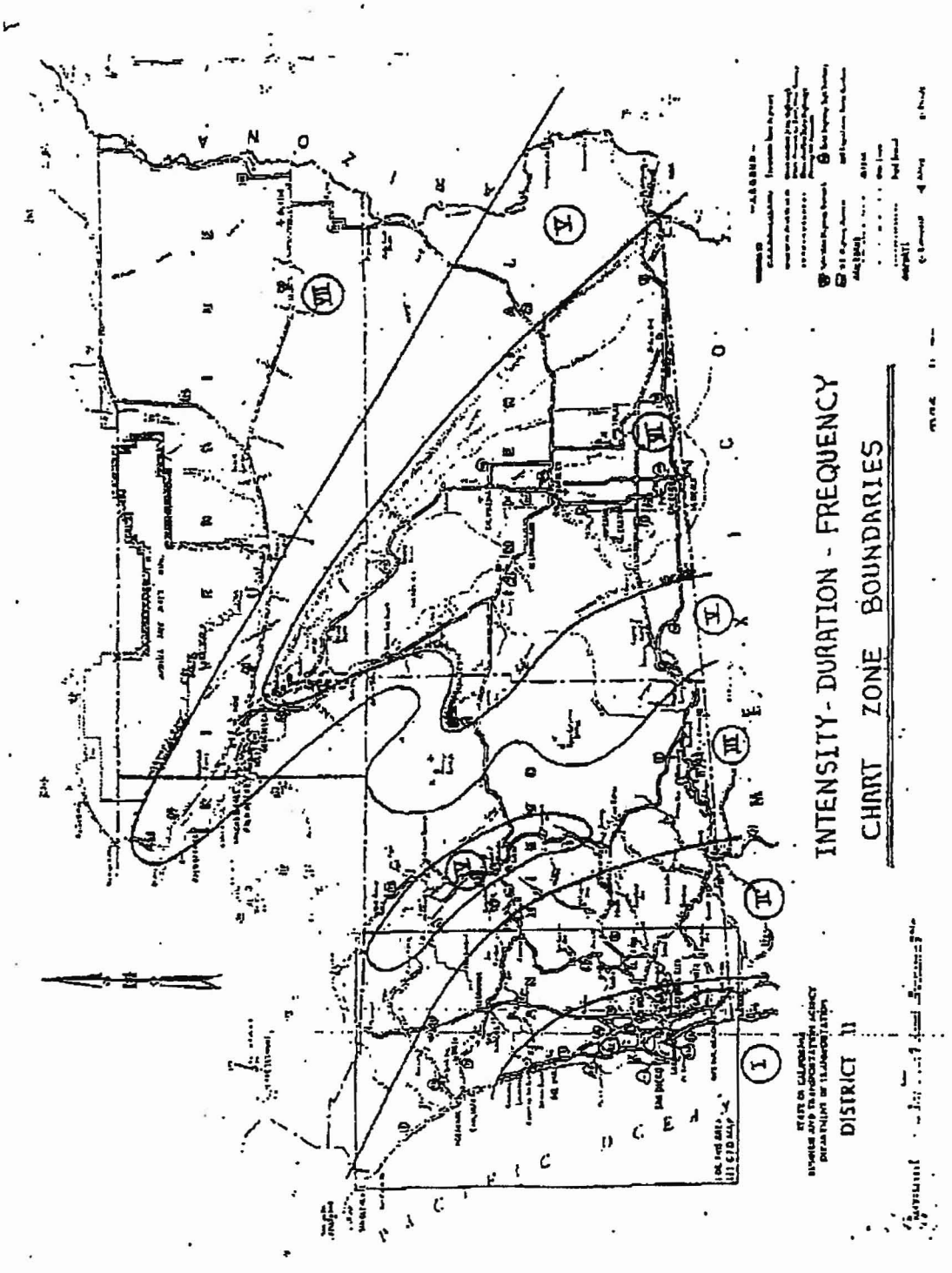

INTENSITY- DURATION - FREQUENCY
CHART ZONE BOUNDARIES
DISTRICT 11

Figure B

816.6 Time of Concentration (Tc) and Travel Time (Tt)

Time of concentration is defined as the time required for storm runoff to travel from the hydraulically most remote point of the drainage basin to the point of interest.

An assumption made in some of the hydrologic methods for estimating peak discharge, such as the Rational and NRCS Methods (Index 819.2), is that maximum flow results when rainfall of uniform intensity falls over the entire watershed area and the duration of that rainfall is equal to the time of concentration. Time of concentration (T_C) is typically the cumulative sum of three travel times, including:

- Sheet flow
- Shallow concentrated flow
- Channel flow

For all-paved watersheds (e.g., parking lots, roadway travel lanes and shoulders, etc.) it is not necessary to calculate a separate shallow concentrated flow travel time segment. Such flows will typically transition directly from sheet flow to channel flow or be intercepted at inlets with either no, or inconsequential lengths of, shallow concentrated flow.

In many cases a minimum time of concentration will have to be assumed as extremely short travel times will lead to calculated rainfall intensities that are overly conservative for design purposes. For all-paved areas it is recommended that a minimum time of concentration of 5 minutes be used. For rural or undeveloped areas, it is recommended that a minimum T_C of 10 minutes be used for most situations. However, for slopes steeper than 1V:10H, or where there is limited opportunity for surface storage, a T_C of 5 minutes should be assumed.

Designers should be aware that maximum runoff estimates are not always obtained using rainfall intensities determined by the time of concentration for the total area. Peak runoff estimates may be obtained by applying higher rainfall intensities from storms of short duration over a portion of the watershed.

(1) Sheet flow travel time. Sheet flow is flow of uniform depth over plane surfaces and usually occurs for some distance after rain falls on the ground. The maximum flow depth is usually less than 0.8 inches - 1.2 inches. For unpaved areas, sheet flow normally exists for a distance less than 80 feet– 100 feet. An upper limit of 300 feet is recommended for paved areas.

A common method to estimate the travel time of sheet flow is based on kinematic wave theory and uses the Kinematic Wave Equation:

$$T_t = \frac{0.93L^{3/5}n^{3/5}}{i^{2/5}S^{3/10}}$$

where

T_t = travel time in minutes.

L = Length of flow path in feet.

S = Slope of flow in feet per feet.

n = Manning's roughness coefficient for sheet flow (see Table 816.6A).

i = Design storm rainfall intensity in inches per hour.

If T_t is used (as part of T_C) to determine the intensity of the design storm from the IDF curves, application of the Kinematic Wave Equation becomes an iterative process: an assumed value of T_t is used to determine i from the IDF curve; then the equation is used to calculate a new value of T_t which in turn yields an updated i. The process is repeated until the calculated Tt is the same in two successive iterations.

To eliminate the iterations, use the following simplified form of the Manning's kinematic solution:

$$T_t = \frac{0.42L^{4/5}n^{4/5}}{P_2^{1/2}s^{2/5}}$$

where P_2 is the 2-year, 24-hour rainfall depth in inches (ref. NOAA Atlas 2, Volume XI or use either of the following web site addresses; http://www.wrcc.dri.edu/pcpnfreq.html or, http://www.nws.noaa.gov/oh/hdsc/noaaatlas2.htm).

The use of flow length alone as a limiting factor for the Kinematic wave equation can lead to circumstances where the underlying assumptions are no longer valid. Over prediction of travel time can occur for conditions with significant amounts of depression storage, where there is high Manning's n-values or for flat slopes. One study suggests that the upper limit of applicability of the Kinematic wave equation is a function of flow length, slope and Manning's roughness coefficient. This study used both field and laboratory data to propose an upper limit of 100 for the composite parameter of $nL/s^{1/2}$. It is recommended that this criteria be used as a check where the designer has uncertainty on the maximum flow length to which the Kinematic wave equation can be applied to project conditions.

Where sheet flow travel distance cannot be determined, a conservative alternative is to assume shallow concentrated flow conditions without an independent sheet flow travel time conditions. See Index 816.6(2).

Table 816.6A Roughness Coefficients For Sheet Flow

Surface Description	*n*
Hot Mix Asphalt	0.011-0.016
Concrete	0.012-0.014
Brick with cement mortar	0.014
Cement rubble	0.024
Fallow (no residue)	0.05
Grass	
Short grass prairie	0.15
Dense grass	0.24
Bermuda Grass	0.41
Woods[1]	
Light underbrush	0.40
Dense underbrush	0.80

(1) Woods cover is considered up to a height of 30 mm, which is the maximum depth obstructing sheet flow.

(2) Shallow concentrated flow travel time. After short distances, sheet flow tends to concentrate in rills and gullies, or the depth exceeds the range where use of the Kinematic wave equation applies. At that point the flow becomes defined as shallow concentrated flow. The Upland Method is commonly used when calculating flow velocity for shallow concentrated flow. This method may also be used to calculate the total travel time for both the sheet flow and the shallow concentrated flow segments under certain conditions (e.g., where use of the Kinematic wave equation to predict sheet flow travel time is questionable, or where the designer cannot reasonably identify the point where sheet flow transitions to shallow concentrated flow).

Average velocities for the Upland Method can be taken directly from Figure 816.6 or may be calculated from the following equation:

$$V = (3.28)\, kS^{1/2}$$

Where S is the slope in percent and k is an intercept coefficient depending on land cover as shown in Table 816.6B.

Table 816.6B Intercept Coefficients for Shallow Concentrated Flow

Land cover/Flow regime	k
Forest with heavy ground litter; hay meadow	0.076
Trash fallow or minimum tillage cultivation; contour or strip cropped; woodland	0.152
Short grass pasture	0.213
Cultivated straight row	0.274
Nearly bare and untilled-alluvial fans	0.305
Grassed waterway	0.457

The travel time can be calculated from:

$$T_t = \frac{L}{60\,V}$$

where T_t is the travel time in minutes, L the length in feet, and V the flow velocity in feet per second.

such as transposing a hydrograph from another hydrologically homogeneous watershed. The stream hydraulic method, and upland method are described in HDS No. 2. These, and other methods, are adequate for use with Rational Methods for estimating peak discharge and will provide results that are acceptable to form the basis for design of highway drainage facilities.

It is clearly evident upon examination of the assumptions and parameters which form the basis of the equation that much care and judgment must be applied with the use of Rational Methods to obtain reasonable results.

- The runoff coefficient "C" in the equation represents the percent of water which will run off the ground surface during the storm. The remaining amount of precipitation is lost to infiltration, transpiration, evaporation and depression storage.

Values of "C" may be determined for undeveloped areas from Figure 819.2A by considering the four characteristics of: relief, soil infiltration, vegetal cover, and surface storage.

Some typical values of "C" for developed areas are given in Table 819.2B. Should the basin contain varying amounts of different cover, a weighted runoff coefficient for the entire basin can be determined as:

$$C = \frac{C_1A_1 + C_2A_2 + \cdots}{A_1 + A_2 + \cdots}$$

- To properly satisfy the assumption that the entire drainage area contributes to the flow; the rainfall intensity, (i) in the equation expressed in inches per hour, requires that the storm duration and the time of concentration (t_c) be equal. Therefore, the first step in estimating (i) is to estimate (t_c). Methods for determining time of concentration are discussed under Index 816.6.
- Once the time of concentration, (t_c), is estimated, the rainfall intensity, (i), corresponding to a storm of equal duration, may be obtained from available sources such as intensity-duration-frequency (IDF) curves. See Index 815.3(3) for further information on IDF curves.

The runoff coefficients given in Figure 819.2A and Table 819.2B are applicable for storms of up to 5 or 10 year frequencies. Less frequent, higher intensity storms usually require modification of the coefficient because infiltration, detention, and other losses have a proportionally smaller effect on the total runoff volume. The adjustment of the rational method for use with major storms can be made by multiplying the coefficient by a frequency factor, C(f). Values of C(f) are given below. Under no circumstances should the product of C(f) times C exceed 1.0.

Frequency (yrs)	C(f)
25	1.1
50	1.2
100	1.25

(2) Regional Analysis Methods. Regional analysis methods utilize records for streams or drainage areas in the vicinity of the stream under consideration which would have similar characteristics to develop peak discharge estimates. These methods provide techniques for estimating annual peak stream discharge at any site, gaged or ungaged, for probability of recurrence from 50 percent (2 years) to 1 percent (100 years). Application of these methods is convenient, but the procedure is subject to some limitations.

Regional Flood - Frequency equations developed by the U.S. Geological Survey for use in California are given in Figures 819.2C and 819.2D. These equations are based on regional regression analysis of data from stream gauging stations. The equations in Figure 819.2C were derived from data gathered and analyzed through the mid-1970's, while the regions covered by Figure 819.2D are reflective of a more recent (1994) study of the Southwestern U.S. Nomographs and complete information on use and development of this method may be found in "Magnitude and Frequency of Floods in California" published in

Figure 819.2A

Runoff Coefficients for Undeveloped Areas

Watershed Types

	Extreme	High	Normal	Low
Relief	.28 -.35 Steep, rugged terrain with average slopes above 30%	.20 -.28 Hilly, with average slopes of 10 to 30%	.14 -.20 Rolling, with average slopes of 5 to 10%	.08 -.14 Relatively flat land, with average slopes of 0 to 5%
Soil Infiltration	.12 -.16 No effective soil cover, either rock or thin soil mantle of negligible infiltration capacity	.08 -.12 Slow to take up water, clay or shallow loam soils of low infiltration capacity, imperfectly or poorly drained	.06 -.08 Normal; well drained light or medium textured soils, sandy loams, silt and silt loams	.04 -.06 High; deep sand or other soil that takes up water readily, very light well drained soils
Vegetal Cover	.12 -.16 No effective plant cover, bare or very sparse cover	.08 -.12 Poor to fair; clean cultivation crops, or poor natural cover, less than 20% of drainage area over good cover	.06 -.08 Fair to good; about 50% of area in good grassland or woodland, not more than 50% of area in cultivated crops	.04 -.06 Good to excellent; about 90% of drainage area in good grassland, woodland or equivalent cover
Surface Storage	.10 -.12 Negligible surface depression few and shallow; drainageways steep and small, no marshes	.08 -.10 Low; well defined system of small drainageways; no ponds or marshes	.06 -.08 Normal; considerable surface depression storage; lakes and pond marshes	.04 -.06 High; surface storage, high; drainage system not sharply defined; large flood plain storage or large number of ponds or marshes

Given An undeveloped watershed consisting of;
1) rolling terrain with average slopes of 5%,
2) clay type soils,
3) good grassland area, and
4) normal surface depressions.

Solution:

Relief	0.14
Soil Infiltration	0.08
Vegetal Cover	0.04
Surface Storage	0.06
C=	0.32

Find The runoff coefficient, C, for the above watershed.

(4) Manning's Equation. Several equations have been empirically derived for computing the average flow velocity within an open channel. One such equation is the Manning Equation. Assuming uniform and turbulent flow conditions, the mean flow velocity in an open channel can be computed as:

$$V = \frac{1.486}{n} R^{2/3} S^{1/2}$$

Where V = Mean velocity, in feet per second

n = Manning coefficient of roughness

S = Channel slope, in foot per feet

R = Hydraulic Radius, in feet = A/WP

Where A = Cross sectional flow area, in square feet

WP = Wetted perimeter, in feet

Commonly accepted values for Manning's roughness coefficient, n, based on materials and workmanship required in the Standard Specifications, are provided in Table 864.3A. The tabulated values take into account deterioration of the channel lining surface, distortion of the grade line due to unequal settlement, construction joints and normal surface irregularities. These average values should be modified to satisfy any foreseeable abnormal conditions.

Direct solutions for Manning's equation for many channels of trapezoidal, rectangular, and circular cross sections can be found in FHWA's Hydraulic Design Series No. 3, "Design Charts for Open Channel Flow".

(5) Conveyance Equation. Often it is convenient to group the properties peculiar to the cross section into one term called the conveyance factor, K. The conveyance factor, as expressed by the Manning's equation, is equal to:

$$K = \frac{1.486}{n} AR^{2/3}$$

For the non-pressure, full flow condition, the geometric properties and conveyance of a channel section can be computed. Then for a given channel slope the discharge capacity can be easily determined.

Table 864.3A

Average Values for Manning's Roughness Coefficient (n)

Type of Channel	n value
Unlined Channels:	
Clay Loam	0.023
Sand	0.020
Gravel	0.030
Rock	0.040
Lined Channels:	
Portland Cement Concrete	0.014
Air Blown Mortar (troweled)	0.012
Air Blown Mortar (untroweled)	0.016
Air Blown Mortar (roughened)	0.025
Asphalt Concrete	0.018
Sacked Concrete	0.025
Pavement and Gutters:	
Portland Cement Concrete	0.015
Asphalt Concrete	0.016
Depressed Medians:	
Earth (without growth)	0.040
Earth (with growth)	0.050
Gravel	0.055

NOTES:

For additional values of n, see "Introduction to Highway Hydraulics", Hydraulic Design Series No. 4, FHWA Table 14.

(6) Critical Flow. A useful concept in hydraulic analysis is that of "specific energy". The specific energy at a given section is defined as the total energy, or total head, of the flowing water with respect to the channel bottom. For a channel of small slope;

APPENDIX H

HYDRAULIC REFERENCE MATERIAL

Figure 4-3

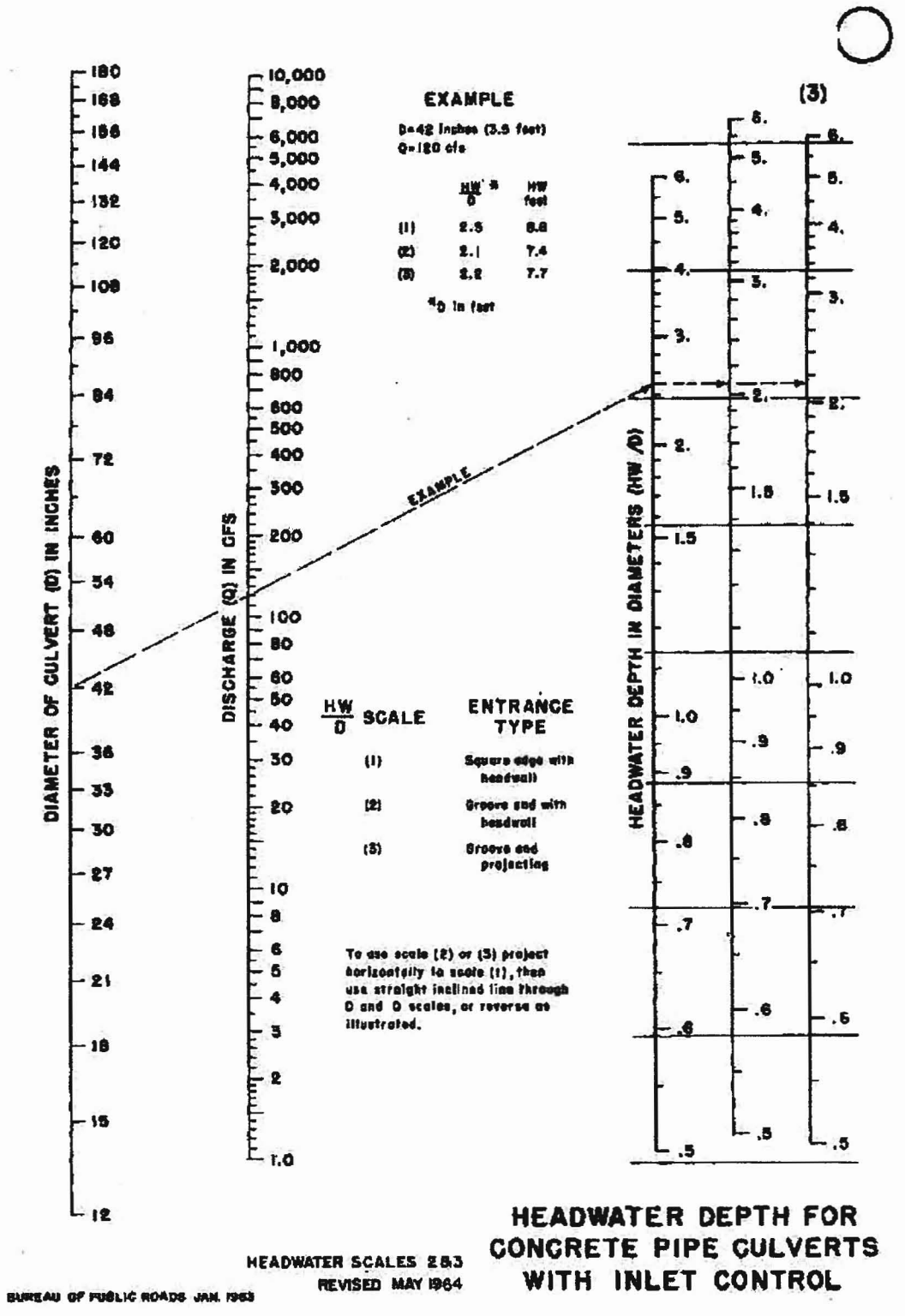


Figure 4-3 Sample Inlet Control Nomograph

Figure 4-4

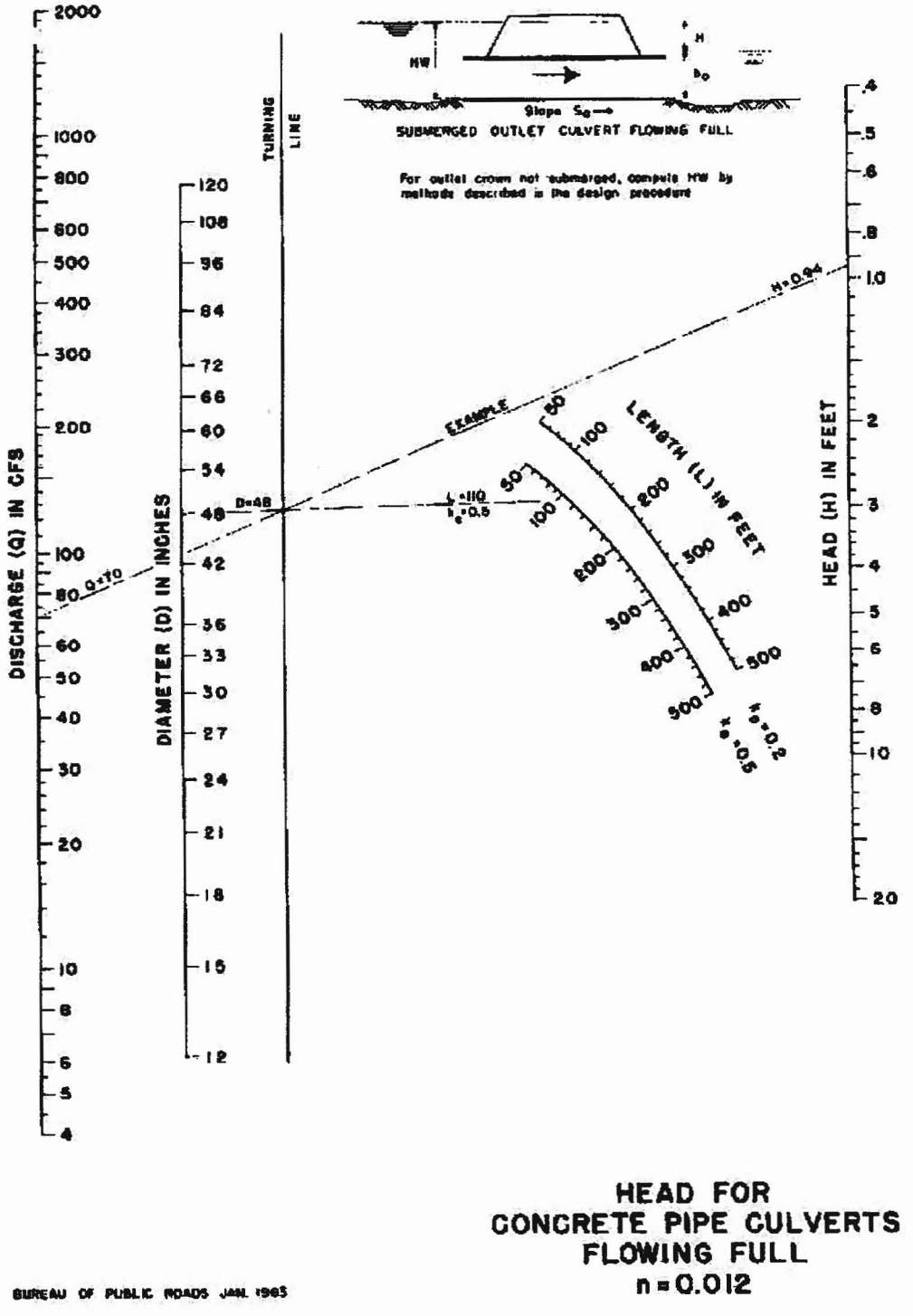
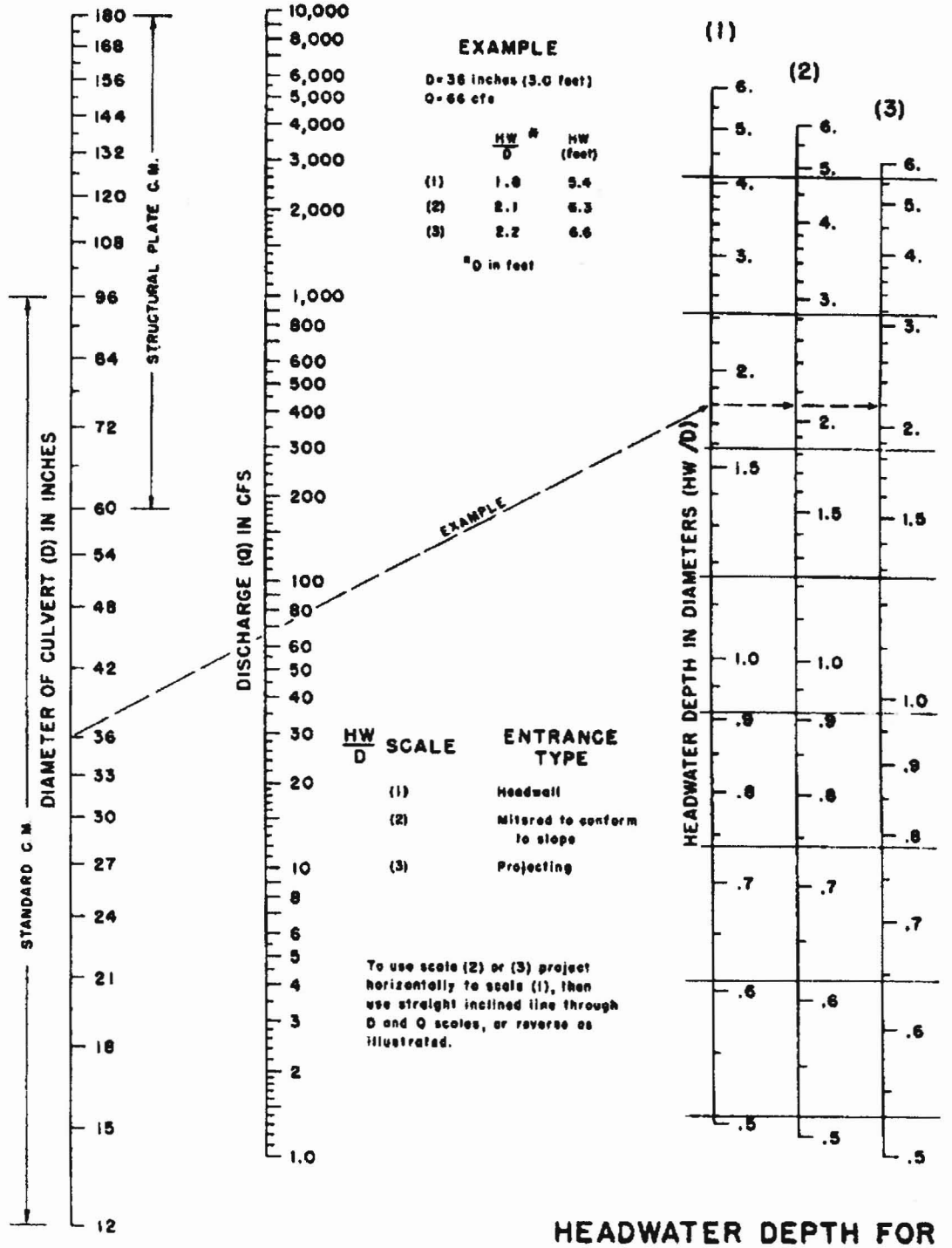


Figure 4-4 Sample Outlet Control Nomograph

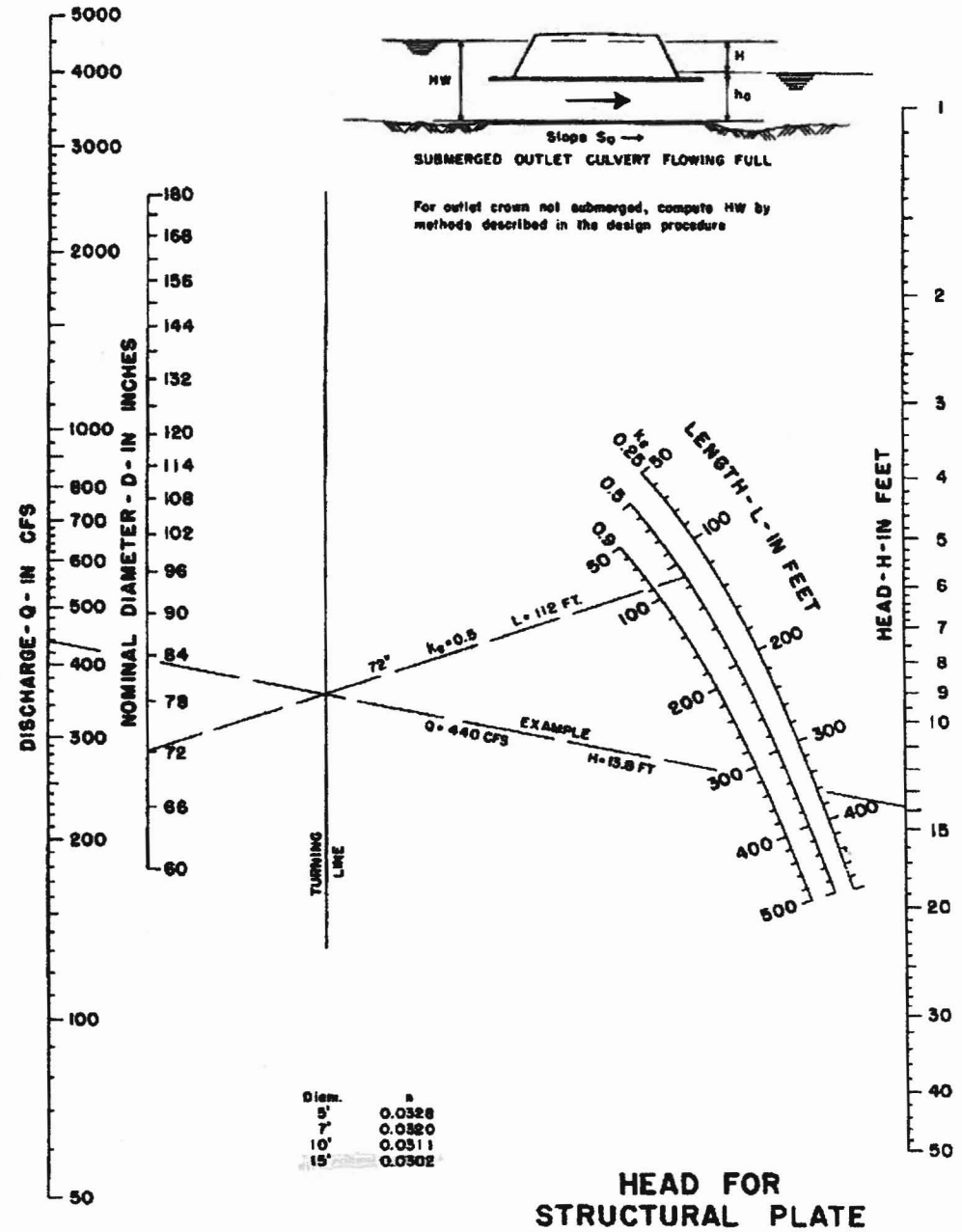
CHART 2B



HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

CHART 7B

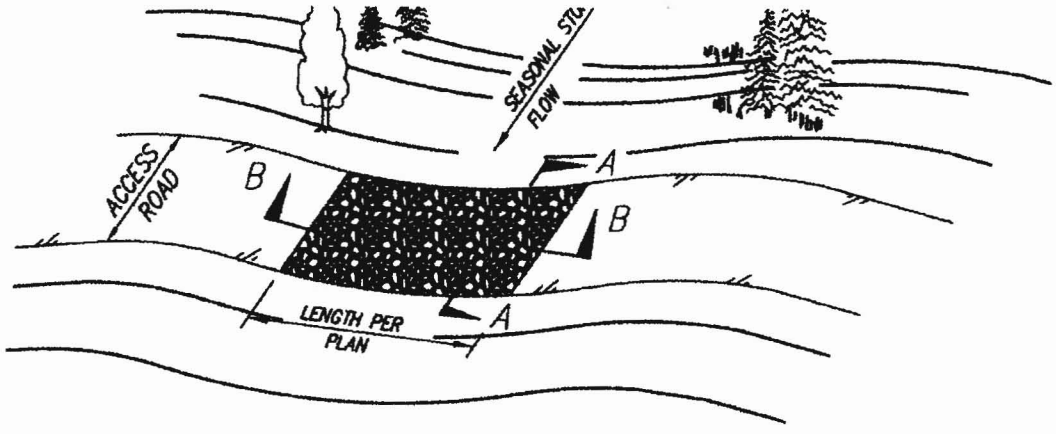


HEAD FOR STRUCTURAL PLATE CORR. METAL PIPE CULVERTS FLOWING FULL n = 0.0328 TO 0.0302

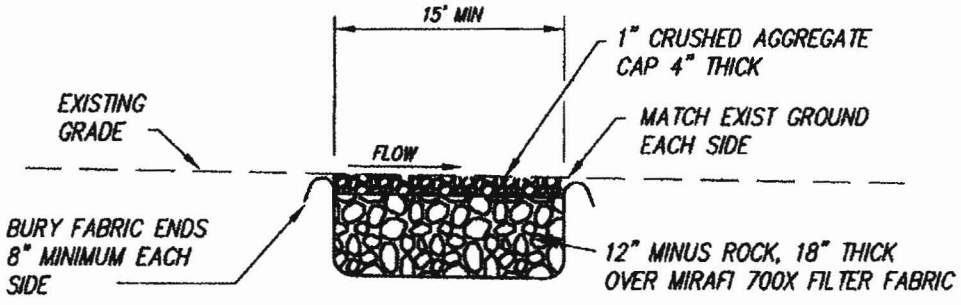
BUREAU OF PUBLIC ROADS JAN. 1963

Table A-5 Average Manning Roughness Coefficients for Natural Channels

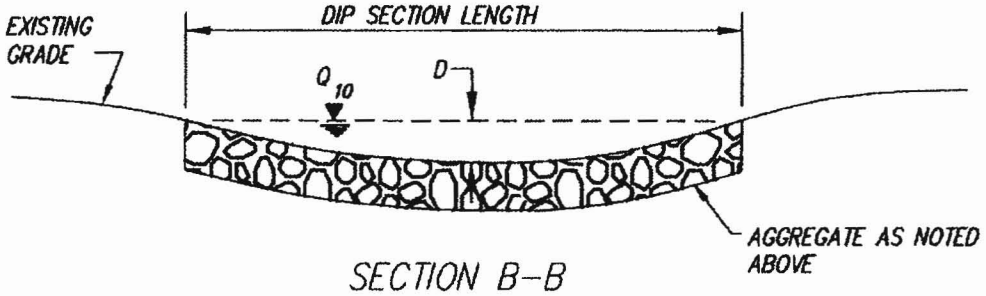
Minor Streams (Surface Width at Flood Stage < 100 ft)	
Fairly Regular Section	
(A) Some Grass and Weeds, Little or No Brush	0.030
(B) Dense Growth of Weeds, Depth of Flow Materially Greater Than Weed Height	0.040
(C) Some Weeds, Light Brush on Banks	0.040
(D) Some Weeds, Heavy Brush on Banks	0.060
(E) For Trees within Channel with Branches Submerged at High Stage, Increase All Above Values By	0.015
Irregular Section, with Pools, Slight Channel Meander	
Channels (A) to (E) Above, Increase All Values By	0.015
Mountain Streams; No Vegetation in Channel, Banks Usually Steep, Trees and Brush along Banks Submerged at High Stage	
(A) Bottom, Gravel, Cobbles and Few Boulders	0.050
(B) Bottom, Cobbles with Large Boulders	0.060
Flood Plains (Adjacent To Natural Streams)	
Pasture, No Brush	
(A) Short Grass	0.030
(B) High Grass	0.040
Cultivated Areas	
(A) No Crop	0.040
(B) Mature Row Crops	0.040
(C) Mature Field Crops	0.050
Heavy Weeds, Scattered Brush	0.050
Light Brush and Trees	0.060
Medium To Dense Brush	0.090
Dense Willows	0.170
Cleared Land with Tree Stumps, 100-150 Per Acre	0.060
Heavy Stand of Timber, Little Undergrowth	
(A) Flood Depth below Branches	0.110
(B) Flood Depth Reaches Branches	0.140



PLAN



SECTION A–A



SECTION B–B

NOTE:

THE MAXIMUM WATER DEPTH, BASED ON A 10 YEAR FREQUENCY STORM, SHALL BE 10". THE DEPTH (D) IN FEET MULTIPLIED BY THE VELOCITY (V) IN FEET PER SECOND SHALL BE EQUAL TO SIX OR LESS. (DXV=6)

SDGE

DIP SECTION

DR–2