APPENDIX A

GEODETIC UNIT PROCEDURAL MANUAL

NOTE: the nmshtd geodetic unit procedural manual is subject to change in order to implement real time kinematic surveying and other new techniques and technologies.
GEODETiC Unit

Procedural Manual

New Mexico State Highway And Transportation Department

Santa Fe, New Mexico, USA
This manual was developed for the internal use and application of the Global Positioning system (GPS) and geodetic surveying by the Surveying and Lands Engineering Section of the New Mexico Department of Transportation. The purpose of this manual is to serve as a guide for day-to-day operational procedures and implementation of the States tasks. The Manual was developed with the assistance of the undersigned as initial guidelines for systematically obtaining survey control data that will reflect a consistency in methodology and quality results:

GEODETIC UNIT SUPERVISOR

William B. Bowers, PS i1765

CONSULTANT SURVEYS, SPECIALTY UNITS SUPERVISOR

Aaron H. Garcia, PS 9979

SURVEYING & LANDS ENGINEERING DIVISION SUPERVISOR

Gregory Clarke, PE 17148
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1 ..... Purpose and goals of the DEPARTMENT'S GEODETIC UNIT
2 ..... Unit Structure, Equipment and Staffing
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PURPOSE AND GOALS OF THE DEPARTMENT'S GEODETIC UNIT

To support and expedite the completion of engineering surveys and property surveys on the Department's projects.

To increase effectiveness, efficiencies and productivity of the preliminary design and R/W design development process.

To ensure spatial compatibility and continuity of the various Department's highway system improvement projects.

To provide coherent state wide network of high accuracy control geodetic monuments, data base and a mechanism for their updating and maintenance.

To furnish control data to survey field crews.

To achieve high accuracy for these control points (at least 1:100,000 relative accuracy) by employing the GPS technology.

To provide data for geodetic control plan sheets as a part of every project file.

To assist the Department's District offices when requested with geodetic control data and consultations.

To obtain and implement new technology components as available for the geodetic and engineering plan development process through attendance and participation in professional conferences, seminars, meetings and workshops.

To modify and periodically evaluate procedures to meet current and future Department programs and goals.

To broaden the acceptance and the utilization of results obtained by this process and to provide data for Geographic Information System when implemented.

To strive to implement GPS controlled aerial photography.

To support and expand the high accuracy New Mexico GPS Control Network initiated in 1989 by the National Geodetic Survey (NGS) and the NMSHTD.
UNIT STRUCTURE, EQUIPMENT AND PERSONNEL

The proposed unit organization structure is as follows:

GEODETIC UNIT MANAGER (PS)

HIGHWAY SURVEYING TECHNICIAN SUPERVISOR
HIGHWAY TECHNICIAN III
HIGHWAY TECHNICIAN II

Field Equipment:
- 4 GPS receivers
- 4 all terrain vehicles
- 1 total station for 1st order work
- 5 tripods
- 2 sets of prism reflectors
- 5 radio communication units
- 2 sets of equipment for setting monuments
- 1 lap top PC computer with software
- 2 hand held calculators

Office Equipment:

- 1 desk top PC computer with software and connections to main frame server
- 1 high speed modem
- 1 hand held calculator
- 1 office with standard furniture and space for 2 to 3 persons with room for equipment storage and maintenance

Software specification:
- GPS post processing
- geodetic network adjustment (Fiiilnet, Geolab, Trimnet Plus or Columbus)
- coordinate transformation (Corpscon)
- geoid heights data base (Geoid96)
- coordinate geometry
- OMNI and GAPP (from NGS)
- communication (Procomm+)
- operating systems (Windows NT)
- word processing (Word Perfect, EC editor or MS Word)
- relational data base (Microsoft Access or Paradox)
FIELD PROCEDURES AND STANDARDS

Monumentation

- number of monuments and their location -

There should be at minimum two (2) intervisible monuments per project of permanent type (see below for acceptable types of permanent monuments). It is recommended that there would be two (2) pairs of these monuments set on each project in excess of five (5) miles in length. These points should be located away from areas to be disturbed by construction, usually along R/W fence in right-of-way.

Existing monuments set by other agency and in place (NGS, USGS, BLM, etc.) can be used as well.

All other project control points required for the project can be of lower stability and precision, set primarily for the time of duration of the project construction. These will be iron pins with aluminum cap. Their number and location is determined by the terrain and techniques and methods of the location survey crew assigned to the project. Typically those would be intervisible points at max. 4,000 feet apart.

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Figure 1

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type and specifications for permanent monuments

A. NGS 3-D Marker
9/16-inch stainless steel rod driven into the ground until the driving rate with a gasoline powered reciprocating hammer slows to 60 seconds per foot or slower. For details see "Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques" published by FGCC on May 11, 1988. See Appendix for cross-section of the 3-D rod.

B. BRASS CAP in bedrock or rock
Create a hole in rock using rock drill bit. Create also an inlay in the surface of the rock so that the top of the cap can be recessed slightly below. Fill the hole with cement and press a standard brass cap in it. Let the cement harden.

C. BRASS CAP in reinforced concrete
Create a hole 30" deep with 5" radius and fill it with concrete. Insert a 5/8" rebar with a standard brass cap tied to it with a wire and let it harden.

D. BRASS CAP in pipe filled with concrete
Drive 2" or 3" diameter steel pipe 30" in length into ground and fill it with concrete. Insert standard brass cap with wire or nail through hole in base of cap and let it harden.
- designation of monument markings -

Place label on new or unmarked highway department monuments only. Orient the top towards North. Provide other monuments with NMSHTD tags that designates GPS survey. Place a survey marker sign in appropriate location.

The standard label shall consist of the following parts:

the letters "NEW MEXICO STATE HIGHWAY AND TRANSPORTATION DEPARTMENT"
or any current official designation of the Department.

CENTER DOT
designating the exact position of the point.

POINT NUMBER
above the center dot, will consist of
- four digits of the project control number
- dash
- two digits of the particular point number (between 11 and 99)
example: 2637-11

the letters "GPS"
below the center dot

the registration number of the Professional Surveyor in charge

the YEAR when the monument was set
at the bottom margin
Observation Standards and Data Acquisition

A. Prerequisites:

1. Reference point, High Accuracy Reference Network (HARN), with NAD 83 coordinates usually NGS monument with know Geoid Height and ellipsoidal height. This point is occupied during main session to establish coordinate base within project. Preferably use tie to two (2) HARN points.

2. Charged external batteries.

3. (Optional) Observation schedule for all observation sessions and time log (form) sheets.

4. Enough receiver memory to collect new data.

B. Site Requirements:

1. Clear view above antenna with no trees or other obstacles (overhead wires may be okay).

2. Park your vehicle no closer than the full extend of antenna-receiver cable (a minimum of 30 feet) to prevent multipath.

3. While receiver is on, do not lean over antenna or measure HI.

C. Procedures for Static GPS Mode:

1. Set up tripod with tribrac and antenna, use standard precision leveling procedures same as for other survey instruments.

2. Measure HI and fill out time log form (use meters).

3. Connect antenna and receiver with the antenna cable. Connect external battery.

4. Turn receiver on and check whether you are getting lock on satellites.

5. Enter site name, check session (A,B,C,...), enter operator’s name (yours) and HI and skip all other fields. Collect at least two (2) hours of data for reference points, one (1) hour of data for project points.

6. When finished with observations, end survey and turn receiver off.
D. Procedures for Kinematic GPS Mode:

Prerequisites

1. Reference point with NAD 83 coordinates usually NGS monument with known Geoid Height and mean sea level elevation or ellipsoidal height. This point is occupied during the whole kinematic session while other unknown points are being determined. This point should be established by static sessions.

2. Charged external batteries and internal battery of the receiver that will become a rover!

3. Enough receiver memory to collect new data.

4. Mount roof rack on top of the vehicle that will be designated for moving the rover receiver.

Fixed point procedure

You must have clear view above the antenna with no trees or other obstacles (overhead wires are okay) along the path. You will have to maintain uninterrupted lock on at least four satellite during the entire survey.

Set up one receiver over the master point (known coordinates in the NAD83 datum) and follow the same procedures as for the static mode. Leave receiver on for the entire time of the kinematic run.

Rover procedure

1. Rover has to start from known baseline - this resolves the unknown integer number. If the baseline does not exist, use OTF initialization.

2. Move rover - plug it to the roof rack and then drive to the next point. All this time, continuous lock on satellites has to be maintained.

3. Occupy unknown point for 3-10 epochs (duration can be set on receiver) and then move to the next one.

4. If you lose lock, return to the last good point and re-initialize or wait for OTF initialization.

5. Close your survey at a known point or at the initial baseline point.
E. **Times of Occupancy and Ties:**

Monuments of permanent type (suitable for the DEPARTMENT'S control point data base) shall be occupied for 3 hours or more and shall be tied to two (2) points of the 1st order (1:100,000 or higher). These points should be preferably points of the NM GPS NETWORK established at the State's airport facilities (HARN points). Only the static mode shall be used.

All other monuments can be established by either the static, fast static or kinematic mode.

F. **Quality Control:**

An EDM distance measurement shall be taken between each of the permanent monuments on the project location. The deviation from GPS calculated distance should stay within 1:100,000 relative accuracy or the EDM specification.
GPS DATA PROCESSING, OUTPUT REQUIREMENTS

Follow Trimble procedural manuals for GPSurvey and TS Office.

FILE NAMING CONVENTIONS

PROJECT NAME: = Department’s project control number
               = “CN1234” or “1234”

1) STATIC OBSERVATIONS

   STA + point name + A = “STA14A”
   B
   C
   
   sessions

2. FAST STATIC OBSERVATIONS

   base ..........FB + point name + A = “FB14A”
   B
   C
   
   rover..........FR + base point number + A = “FR14A”
   B
   C
   

3. **KINEMATIC (RTK + PP ...)**

base ..........B + point name + A = "B14A"
    
    B
    C

rover..........R + base point number + A = "R14A"
    
    B
    C


STORAGE, MANAGEMENT AND ACCESS TO DATA

GEODETC CONTROL DATABASE

All stations and their positions are in reference to the GRS 80 or WGS 84 ellipsoid. State plane coordinates are therefore on NAD 83 datum and are shown in meters. Stations can be converted to feet using the U.S. foot for conversion or 3.2808333333 factor. To obtain ground local coordinates, compute the average project elevation and use it for the average ground-grid scale factor derivation at the midpoint of the project.

1. STATION NAME

A number consisting of Department's project control number (CN####) and local pint number in the range 11-99. Format: ####-##. All points set by other government agencies like the USGS or NGS if observed would be entered with their proper names.

example of format: 1234-99

2. NORTH GEODETC LATITUDE

example format: 32° 47' 56.12345"

3. WEST GEODETC LONGITUDE

example format: 106° 34' 12.45663"

4. ELLIPSOIDAL ELEVATION IN METERS

5. CODE FOR ELLIPSOIDAL ELEVATION

code 1 = value derived directly by GPS measurements from point with known precise ellipsoidal elevation (NMGPSNET).

code 2 = value derived from point with known mean sea level elevation and interpolated geoid height using Geoid90 model. N=h-H, where h...ell.el., H...ortho.el. these would be typically NGS triangulation stations on which precise mean sea level elevation was established.

code 3 = value uncertain.

6. MEAN SEA LEVEL ELEVATION (ORTHOMETRIC HEIGHT) IN METERS

7. CODE FOR MEAN SEA LEVEL ELEVATION
code 1 = value derived directly by differential leveling from NGS points on the NAVD 88 datum or point is the NGS vertical datum point. Accuracy is of at least 3rd order, e.i. error must not exceed 12mm $\sqrt{K}$, 0.05"$\sqrt{M}$, where K is the length of the level loop in km, M is the length of the level loop in miles.

code 3 = value derived from precise ellipsoidal elevation (like from GPS survey) and interpolated geoid height (N) using Geoid90 model (H=h-N) and a local fit on project BM of min. 3rd order was performed (local shift or local interpolation).

code 4 = value derived from precise ellipsoidal elevation (like from GPS survey) and interpolated geoid height.

code 5 = elevation unreliable; was established probably from ellipsoidal elevation with code 2 or code 3.

8. NORTHING (Y) IN METERS

State plane coordinate value converted from geodetic latitude and longitude of this station.

9. EASTING (X) IN METERS

State Plane coordinate value converted from geodetic latitude and longitude of this station.

10. ZONE OF THE STATE PLANE COORDINATE SYSTEM

11. REFERENCE NAD83 MASTER STATION

Name of station(s) used for tie(s), date of survey, estimated accuracy from least squares adjustment.

12. DESCRIPTION AND LOCATION

Use county name, road designation, mike post and brief description of how to access the station. Describe the type of monument used.
APPENDIX

3D MONUMENT SPECIFICATION AND X-SECTION

NGS ACCURACY STANDARDS

NGS SUPPORT FOR THE ABOVE PROCEDURES
Schematic of the NGS 3-D marker
Table 1. -- Geometric relative positioning accuracy standards for three-dimensional surveys using space system techniques.

<table>
<thead>
<tr>
<th>Survey categories</th>
<th>Order</th>
<th>(95 percent confidence level)</th>
<th>Minimum geometric Accuracy standard</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Base error</td>
<td>Line-length Dependent error</td>
</tr>
<tr>
<td></td>
<td></td>
<td>e (cm)</td>
<td>p (ppm)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a (1:1)</td>
<td></td>
</tr>
<tr>
<td>Global-regional geodynamics; deformation measurements ..........</td>
<td>AA</td>
<td>0.3</td>
<td>0.01</td>
</tr>
<tr>
<td>National Geodetic Reference System, &quot;primary&quot; networks; regional-local geodynamics; deformation measurements ..........</td>
<td>A</td>
<td>0.5</td>
<td>0.1</td>
</tr>
<tr>
<td>National Geodetic Reference System, &quot;secondary&quot; networks; connections to the &quot;primary&quot; NGRS network; local geodynamics; deformation measurements; high-precision engineering surveys ..........</td>
<td>B</td>
<td>0.8</td>
<td>1</td>
</tr>
<tr>
<td>National Geodetic Reference System (Terrestrial based); dependent control surveys to meet mapping, land information, property, and engineering requirements ..........</td>
<td>(C)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>1.0</td>
<td>10</td>
</tr>
<tr>
<td>2-I</td>
<td></td>
<td>2.0</td>
<td>20</td>
</tr>
<tr>
<td>2-II</td>
<td></td>
<td>3.0</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>5.0</td>
<td>100</td>
</tr>
</tbody>
</table>

Note: For ease of computation and understanding, it is assumed that the accuracy for each component of a vector base line measurement is equal to the linear accuracy standard for a single-dimensional measurement at the 95 percent confidence level. Thus, the linear one-standard deviation (s) is computed by:

\[ s = \pm \sqrt{e^2 + (0.1d \cdot p)^2}/1.96. \]  
(See appendix B.)

Where, d is the length of the baseline in kilometers.

In defining the accuracy standards, it was assumed that each component of the baseline determined by GPS relative positioning techniques are much alike, i.e. error sources that are highly correlated. Thus, no particular component has characteristics making it desirable to treat it differently from the other two components. It was also a premise that optimum accuracies achievable with GPS satellite surveying techniques are routinely and economically possible if the survey is carried out carefully and with adequate control of error sources.
TO: Rick Fencil, Geodetic Unit - Aerial and Lands Survey
Section, New Mexico State Highway and Transportation
Department, Santa Fe, NM

FROM: William A. Stone, New Mexico State Geodetic Advisor,
National Geodetic Survey, Albuquerque, NM

SUBJECT: Support of proposed geodetic control system and database

I want to express my support for the proposed establishment of
a mechanism within the New Mexico State Highway and Transportation
Department (NMSHTD) that will provide a network of monumented
points to serve as the coordinate basis for all of the Department's
projects. As proposed, the monumented points should be placed in
areas with public access and the database housing the information
pertaining to the points should be accessible to the public.

The National Geodetic Survey (NGS) has historically maintained
a database of geodetic control for the entire nation. While NGS
will continue to do so, I feel it is important and appropriate for
individual states to play a more active role in the development of
systems to establish and house geodetic control information generated
at the state level. With the availability of the Global Positioning
System (GPS) technology that we enjoy today, it is possible
to generate large quantities of high quality positional information
much more easily than previously possible. We are extremely fortunate here in New Mexico to have the New Mexico GPS Reference Network, which will soon be complete. This will serve as the ideal framework on which to base subsequent GPS surveys of all types.

NGS has determined that it must improve its capability to
maintain and distribute the large quantities of geodetic control
information that exist around the nation and that are continuously
being generated. NGS has proposed a nationwide network, the Coastal
and Geographic Information Network (CAGIN), to satisfy this
need. CAGIN encompasses the human resources, computers, telecommu-
nications, and methods organized to distribute geodetic data. The
approach of CAGIN would be to establish a partnership with states
that includes, among other things, shared geodetic data bases.

By starting soon to work towards a statewide control system
and database, the NMSHTD will be in a good position, if it chooses,
to participate in the proposed CAGIN project which may start taking
shape in fiscal year 1992. The project will likely include funding
incentives for states' participation. In any case, I think people
at all levels of the surveying and related professions in New Mexico
will benefit greatly from the geodetic control plan and database
proposed by the NMSHTD.
APPENDIX B

SAMPLE SURVEY NOTES
<table>
<thead>
<tr>
<th>Station</th>
<th>Bearing</th>
<th>Elevation</th>
<th>Description</th>
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<tbody>
<tr>
<td>14G3-1</td>
<td></td>
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<tr>
<td>14G3-12</td>
<td></td>
<td>1811.9857</td>
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<tr>
<td>14G3-13</td>
<td>280.28</td>
<td>69.85</td>
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<tr>
<td>14G3-18</td>
<td>340.45</td>
<td>0.081</td>
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<tr>
<td>14G3-19</td>
<td>34.7493</td>
<td>5.494</td>
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</table>

See page 9, Book #1
See plan, Plans, 1, 015, 8, 016, Book #2
See pg. 2 of 2

P-3636, NGS BC, 1980
NMSHD B.C.
APPENDIX C

POINT CODE TABULATION
**New Mexico State Highway & Transportation Department**  
*Point Code Tabulation*

The following point code tabulation is taken from the New Mexico State Highway and Transportation Department’s Computer Aided Design and Drafting (CADD) Standards Manual.

<table>
<thead>
<tr>
<th>Code</th>
<th>Descriptor</th>
<th>Description</th>
<th>Level/Layer</th>
<th>DTM</th>
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<td>1</td>
<td>ST</td>
<td>START</td>
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<td></td>
</tr>
<tr>
<td>2</td>
<td>CL</td>
<td>CLOSE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>PC</td>
<td>POINT OF CURVATURE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>PT</td>
<td>POINT OF TANGENCY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>DNC</td>
<td>DO NOT CONTOUR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>RECT</td>
<td>RECTANGLE</td>
<td></td>
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<tr>
<td>7</td>
<td>CLRECT</td>
<td>CLOSE RECTANGLE</td>
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<td>JOIN POINT</td>
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<td>JNC</td>
<td>JOIN NEAREST CODE</td>
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<td>NT</td>
<td>NON TANGENT CURVE</td>
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<td>11</td>
<td>DIST</td>
<td>DISTANCE</td>
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<td>12</td>
<td>TMPL</td>
<td>TEMPLATE</td>
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<tr>
<td>100</td>
<td>CP</td>
<td>Control Point</td>
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<td>CPGPS</td>
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<td>102</td>
<td>MU</td>
<td>Move Up</td>
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<td>RWR</td>
<td>R/W Rail</td>
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<td>RWBC</td>
<td>R/W Brass Cap</td>
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<tr>
<td>105</td>
<td>CALC</td>
<td>Calculated Point</td>
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<tr>
<td>106</td>
<td>BRC</td>
<td>Brass cap</td>
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<tr>
<td>107</td>
<td>AC</td>
<td>Aluminum cap</td>
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<td>BCM</td>
<td>Brass cap monument</td>
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<td>P/C</td>
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<td>RBR3</td>
<td>No. 3 rebar (3/8&quot;&quot;)</td>
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<td>RBR4</td>
<td>No. 4 rebar (1/2&quot;)</td>
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<td>RBR5</td>
<td>No. 5 rebar (5/8&quot;)</td>
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<td>RBR6</td>
<td>No. 6 rebar (3/4&quot;)</td>
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<td>117</td>
<td>RBR8</td>
<td>No. 8 rebar (1&quot;)</td>
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<td>118</td>
<td>P4</td>
<td>½&quot; pipe</td>
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<td>119</td>
<td>P6</td>
<td>¾&quot; pipe</td>
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<td></td>
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<td>120</td>
<td>P8</td>
<td>1&quot; pipe</td>
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<td>121</td>
<td>X</td>
<td>chiseled &quot;X&quot;</td>
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<td>RP</td>
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<td>WC</td>
<td>Witness corner</td>
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<td>STONE</td>
<td>Stone</td>
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<td>125</td>
<td>NAIL</td>
<td>Nail</td>
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<tr>
<td>126</td>
<td>PK</td>
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<td>127</td>
<td>AX</td>
<td>Axle</td>
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<td>Code</td>
<td>Descriptor</td>
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<td>Level/Layer</td>
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<td>------------</td>
<td>------------------------------------</td>
<td>-------------</td>
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<tr>
<td>128</td>
<td>COTS</td>
<td>Cotton spindle</td>
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APPENDIX D

RAILROAD AND UTILITY SECTION MANUAL
NEW MEXICO STATE
HIGHWAY & TRANSPORTATION
DEPARTMENT

1996

UTILITIES

RAILROADS and

MANUAL

CALL BEFORE YOU DIG!
IT'S FREE - AND
IT'S THE LAW!

Statenido
1-800-321-ALERT
Albuquerque
260-1990
NEW MEXICO ONE CALL
SYSTEM, INC.

PUBLISHED BY THE RAILROADS & UTILITIES SECTION
ENGINEERING DIVISION & RIGHT OF WAY BUREAU
NMAC TRANSMITTAL FORM

1. NMAC 3.1.22 [7-1-94, 7-1-95]
   [Sequence No.]
2. Agency Name & Mailing Address
   New Mexico State Highway and Transportation
   Department
   P.O. Box 1149
   Santa Fe, New Mexico 87504-1149
3. Type of Rule Action
   New
   Amending X
   Repealing

4. NMAC Title Name
   Public Utilities & Utility Services
   NMAC Title Number
   17
5. NMAC Chapter Name
   Utility Rights of Way and Easements
   NMAC Chapter Number
   4
6. NMAC Part Name
   Requirements for Occupancy of State Highway System
   Rights-of-Way by Public Utility Facilities
   NMAC Part Number
   2
7. Modified NMAC Name
   Regulations, Policy and Procedure Governing Occupancy
   of State Highway System Right of Way by Public
   Utility Facilities
   Modified NMAC Number
   SHC 71-1
   Filing Date (if applicable)
   3 / 10 / 71

Are there any materials incorporated by reference?

No X

Yes ___ Please list attachments: 1.

2.

3.

9. If materials are attached, have copyright permissions been received?

No __

Yes ___ Public domain

10. Total Number of Pages: 72

11. Hearing Date of Rule:

12. Effective Date of Rule: 11 / 15 / 96

13. Contact Person: Lester Cisneros
   Phone Number: 827 , 5357

14. Signature & Title of Issuing Authority
   Name: Pete K. Rahn
   Title: Secretary
   Signature
   Date Signed
   10-31-96
# REQUIREMENTS FOR OCCUPANCY OF STATE HIGHWAY SYSTEM RIGHT-OF-WAY BY PUBLIC UTILITY FACILITIES

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ISSUING AGENCY: New Mexico State Highway and Transportation Department
P.O. Box 1149
Santa Fe, New Mexico 87504-1149
(505) 827-5357 [11/15/96]

SCOPE: This utility accommodation policy shall apply to all publicly, privately, cooperatively, municipally or governmentally owned facilities used for the carriage, transmission or distribution of electric power, telephone, telecommunications, telegraph, water, gas, oil, petroleum products, steam, chemicals, sewage, drainage, irrigation and similar lines, that are to be accommodated, adjusted or relocated within the right-of-way of highways, roads or streets under the jurisdiction of the New Mexico State Highway and Transportation Department.

2.1 This utility accommodation policy is provided for the regulation of the location, design and methods for installing, adjusting or relocating, accommodating and maintaining physical utility facilities on highway rights-of-way.

2.2 Where laws or orders of public authority or industry codes prescribe a higher degree of protection or construction than provided by this utility accommodation policy, such laws, orders or codes shall prevail.

[3/10/71, 11/15/96]


DURATION: Permanent. [3/10/71, 11/15/96]

EFFECTIVE DATE: November 15, 1996, unless a later date is cited at the end of a Section or Paragraph. [11/15/96]

OBJECTIVE: To prescribe conditions under which utility facilities may be accommodated on all public highway right-of-way under the jurisdiction of the New Mexico State Highway and Transportation Department improved by State or Federal funds and to set forth the regulations covering the relocation of utility facilities in conflict with the construction of highways. The principle objectives of these regulations are to achieve maximum public use of such right-of-way, consistent with the laws of New Mexico and to insure that utility
relocations on highway construction projects are accomplished in accordance with New Mexico Statutes, Regulations and Federal Codes. These regulations shall also provide for maximum public safety, maintenance of the roadways, and should minimize future conflicts between the public highway systems of New Mexico and utilities serving the general public in this State. [3/10/71, 11/15/96]

7. **DEFINITIONS:**

7.1 **AASHTO** - American Association of State Highway and Transportation Officials.

7.2 **Access Control** - The condition where access rights of owners or occupants of abutting land adjacent to highways are fully or partially controlled or limited by public authority, with no right to obtain a driveway permit.

7.3 **Aerial Facilities** - Pole mounted utility lines or other above ground structures for the transmission or distribution of electric power, communications, traffic control lights and street lighting.

7.4 **Agreement** - Pertains to the New Mexico State Highway and Transportation Department standard form Utility Relocation Agreement or other specifically written agreements pertaining to the relocation of utilities in conflict with highway construction, but not limited only for these purposes.

7.5 **Archaeological Clearance** - Legally required documented finding and/or field investigation procedure to insure the protection of known and unknown cultural/historic sites. It must be performed prior to any construction excavation, subsurface clearing or ground surface disturbance in connection with highway construction projects, or the accommodation of utilities or other facilities within public highway right-of-way.

7.6 **Average Daily Traffic** - The average 24 hour vehicular traffic volume, derived from the total volume divided by the number of days in a one year (usually) period. Commonly abbreviated as ADT.

7.7 **Backfill** - Placement and compaction of material around and/or over a structure such as a pipe, conduit, casing or gallery.

7.8 **Barrier** - A device which provides a physical limitation through which a vehicle could not normally pass. It is intended to contain or redirect the movement of an errant vehicle away from roadside or median obstacles, ravines, ditches, etc.

7.9 **Bored or Boring** - A construction procedure for pushing or jacking a pipe or conduit under the highway, without disturbance to the highway structure or prism.
7.10 **Breakaway** - A design feature which allows a device such as a utility pole, sign post, luminaire, or traffic signal support to yield or separate upon impact. The release mechanism may be slip plains, planes hinges, fracture elements, or a combination thereof.

7.11 **Cap** - Rigid structural element surmounting a pipe, conduit, casing or gallery.

7.12 **Carrier** - Pipe that directly contains a transmitted fluid (liquid or gas).

7.13 **Casing** - A larger pipe enclosing a smaller pipe.

7.14 **Catch Point** - The point on the undisturbed ground surface where highway backslopes and foreslopes terminate after being cut or filled by construction equipment; usually established by a slope stake.

7.15 **CBC** - Concrete Box Culvert.

7.16 **Clear Roadside Area or Clear Zone** - That roadside border area, starting at the edge of the traveled way, available for use by errant vehicles, wherein no fixed obstruction or above ground utility facility may be placed unless protected by a barrier, or by incorporating a Department approved breakaway feature.

7.17 **CMC** - Corrugated Metal Culvert.

7.18 **CME** - Construction and Maintenance Easement; document providing for use of non-Department owned land on which to construct and maintain permanent facilities.

7.19 **Coating** - Protective material applied to, or wrapped around a pipe.

7.20 **Communication Facilities** - Includes, but not limited to, telephone, telegraph, TV cable, microwave and fiberoptics.

7.21 **Compaction** - A measure of the density of soil, achieved by mechanical means on highway surfaces and on backfill in trenches to harden the material to a predetermined density. Density is the soil weight maximum, in a measured (Modified Proctor Method “C” T-99) volume, with a pre-determined water content, plus a uniform compaction effort.

7.22 **Condemnation** - The process by which private property is acquired for public purposes through legal proceedings, under the power of eminent domain.

7.23 **Conductor** - Various types of electrical wire used for the transmission and distribution of electricity.
7.24 Conduit or Duct - An enclosed tubular runway for protecting wires or cables.

7.25 Control Number or CN - Four digit number assigned to specific highway projects and used for identification and tracking purposes.

7.26 Cost of Relocation - The entire amount properly attributable to relocation of a utility facility after deducting therefrom the value of any betterment of the new facility and any salvage value derived from the old facility.

7.27 Cover - Depth to the top of a pipe, conduit, casing or gallery below the ground surface.

7.28 Cradle - Supporting structural element below a pipe.

7.29 Cultural Resource Study and Clearance - To determine the impact of construction to any known or unknown cultural/historic sites; see Archaeological Clearance.

7.30 Density - Compaction of soil by mechanical means on highway surfaces and for backfill in trenches to harden the fill material to a predetermined density. Density is the soil weight maximum, in a measured volume, with a pre-determined water content, plus a uniform compaction effort.

7.31 Department - The New Mexico State Highway and Transportation Department, sometimes identified herein as NMSHTD, State Highway Department, State, and Highway Agency.

7.32 Direct Burial - Installing a utility facility underground without trenching separately, i.e., plowing. A method usually used for installing flexible cable.

7.33 Distribution Lines - Intermediate utility lines or arterials that supply natural gas, steam, electricity, telephone communications, water and TV cable services to local customers. These systems do not include the service connections.

7.34 District Engineer - The engineer in charge of one of the Department’s six construction and maintenance districts.

7.35 Drain - Appurtenance to discharge liquid contaminants from casings.

7.36 Drop Inlet (D.I.) - An underground storm water collector with surface grating at curbside, in medians or at other locations in and around highways and streets. It connects to storm water trunk lines usually running parallel to the highway.

7.37 Easement - The document that grants the right to use land (usually in corridors or
strips) owned by others, and that defines the conditions of such use.

7.38 **Eminent Domain** - The right of government, utilities and other public entities to take land for public use (upon the payment of just compensation) from land owners unwilling to sell the land after a negotiation for purchase has failed.

7.39 **Encasement** - A structural element surrounding a pipe. See Casing.

7.40 **Encroachment** - Unauthorized and illegal use of highway right-of-way or other lands owned or administered by the Department, State or other Public Agencies.

7.41 **Engineer** - Secretary of New Mexico State Highway and Transportation Department. Identified in the past as State Highway Engineer and Chief Highway Administrator, acting directly or through his/her designee.

7.42 **Entrance Ramp** - A one-direction vehicular traffic lane for entering freeways, access controlled highways, and other highways at interchanges and at other authorized locations.

7.43 **Environmental Impact Statement (EIS)** - A study that determines the total impact of any proposed construction on the environmental system, and the proposed action to mitigate the anticipated impacts.

7.44 **Exit Ramp** - A one-direction vehicular traffic lane for exiting a freeway or controlled access highway, and other highways at interchanges and at other authorized locations.

7.45 **Expressway** - A divided arterial highway for through traffic with full or partial control of access, generally with grade separations (bridges) at major intersections.

7.46 **Field Design Inspection** - The Department's initial highway project inspection to insure agreement on design items and to furnish any additional design criteria.

7.47 **Federal-Aid Highways** - All roads constructed in whole or in part with federal aid.

7.48 **FHWA** - Federal Highway Administration.

7.49 **Flexible Pipe** - A plastic, fiberglass, or metallic pipe having a large ratio of diameter to wall thickness that can be deformed without undue stress.

7.50 **Frangible** - A structure readily or easily broken upon impact.

7.51 **Freeway** - An expressway with full control of access.
7.52 **Frontage Road** - A local street or road auxiliary to, and located on the side of, an arterial highway for service to abutting property, adjacent areas, and to aid in maintaining access control of the adjoining arterial highway.

7.53 **Force Account** - A daily record of expenditures. Records construction labor, materials, equipment usage, transportation costs and other costs such as commercial travel, per diem and other legitimate administrative costs incidental to utility relocation construction work performed by a utility with their own personnel, at actual costs incurred, without profit.

7.54 **Gallery** - An underpass (Concrete Box Culvert, or the like) for numerous utility lines, cables or pipes crossing beneath or running parallel under a street, highway or road.

7.55 **Grade & Drain Inspection** - The Department’s highway project inspection to establish the final grade line, drainage design and review of the overall project design.

7.56 **Grade Separation Structure** - A highway, railroad or other type bridge, underpass or large culvert.

7.57 **Grounded** - Connected to earth or to some extended conducting body which serves as a conductor instead of the earth, whether the ground connection is intentional or accidental. Usually pertains to an electrical ground.

7.58 **Grout** - A cement mortar or a slurry of fine sand or clay.

7.59 **HA** - Highway Agency or State Highway Agency (SHA) or other named State Highway Organizations.

7.60 **Highway, Street or Road** - A general term denoting a public way for the purpose of vehicular and other modes of travel. The names usually apply to the entire area within the right-of-way limits.

7.61 **Hot Work** - Work by field electricians on an electrical system that is energized and dangerous.

7.62 **I-Project** - Interstate Highway Project.

7.63 **Inlet** - The graded and contoured approach to a storm water drainage system or culvert. The entrance through a drop inlet to a buried storm water pipeline drainage system.

7.64 **Insert** - A steel or cast iron cylinder with a female threaded hole in one end. These
cylinders are installed in the concrete deck bottom of a bridge to suspend a threaded rod and suspension saddle to support pipelines and other conduits permitted on the bridge crossing.

7.65 **Jacket** - Encasement by concrete poured around a pipe.

7.66 **Joint Use Agreement** - An Agreement between the Department and a utility owner that provides for one future utility relocation and replacement right-of-way payment when a utility facility that occupies a private easement (corridor or strip of land) is taken for new highway right-of-way but no utility relocation is immediately necessary. The utility remains in place since there is no conflict with the highway features.

7.67 **Longitudinal Barrier** - A barrier primarily to prevent penetration and safely redirect errant vehicles away from a roadside or median hazards, such as above ground utility structures.

7.68 **Longitudinal Installation** - A utility facility or system located within or out of the right-of-way limits of a highway, where the facility runs parallel to the highway.

7.69 **MUTCD** - Manual on Uniform Traffic Control Devices. The standard highway, street or road traffic marking and signing directive implemented by the U.S. Department of Transportation, for standard use throughout the United States.

7.70 **Manhole** - An opening to an underground utility that allows workmen to enter, repair and inspect the system.

7.71 **Median** - The portion of a divided highway separating the opposing traffic lanes.

7.72 **Natural Ground** - Undisturbed ground not affected by construction or other disturbing factors.

7.73 **Normal** - Crossing at a right angle (90 degrees).

7.74 **Oblique** - Crossing at an acute angle.

7.75 **Outlet** - Downstream channel beyond the end of a drainage pipe or the end of the pipe itself.

7.76 **P & P Sheets** - Construction plan and profile sheets.

7.77 **PS & E Review** - Final plans, specifications and estimate reviews by the Department, just before letting a highway project to contract.
7.78 **Partial Control of Access** - The condition where access rights of owners or occupants of abutting land adjacent to highways are partially controlled or limited by the public authorities.

7.79 **Pavement Structure** - The combination of subbase, base course and surface course placed on a highway, street or road subgrade to support the traffic load.

7.80 **Permit** - Department document that provides for the occupancy of public right-of-way by utilities, entitled New Mexico Public Highway Utility Accommodation Permit, also called a use and occupancy agreement, in the references.

7.81 **Pipe** - A tubular steel, cast iron, concrete, plastic or other material product designed for the transmission of liquid or gaseous substances.

7.82 **Plan In Hand Inspection** - The Department's final field inspection to review the completed highway project plans.

7.83 **Plowing** - See, Direct Burial.

7.84 **Police Power** - The right of government to legislate, regulate and limit the rights of individuals, corporations, companies and others when prompt and prudent action is necessary for the public good, health, safety or welfare. Its application to utility/highway relations is that certain New Mexico statutes provide the Department with specifically defined enforcement powers for utility relocation performance so that highway construction work can be completed without delay and with minimum legal conflict.

7.85 **Private Utility** - A system owned by an individual, corporation, company or others not devoted to public service but for private use to deliver, transmit electricity, communications, natural gas, water or sewage disposal in a closed, private or confined area, such as an industrial site, mine, ranch, mobile home park or other remote location. The utility product(s) can be generated by the private owner or purchased from others (for example, a public utility) for delivery within the private entity.

7.86 **Public Highway** - Any federal, state, county or city highway, street, road or other public way devoted to vehicular and other modes of travel including the entire area within the right-of-way.

7.87 **Questionnaire** - Utility Relocation Questionnaire. A Department standard form a utility owner uses to provide pertinent information concerning their eligibility to be reimbursed, construction method to be used, right-of-way ownership, and other information needed by the Department.
7.88 **Reimbursement** - For the purposes of this regulation, shall mean payment by the Department for eligible costs properly attributable to the highway construction, pursuant to State and Federal regulations.

7.89 **Relocation** - Means and includes any horizontal or vertical movement of utility facilities intact and any protective measures taken or, where found by the Department to be necessary, the construction of new or additional facilities (with or without contemporaneous removal and salvage of old facilities) in this state, including, in any case, adjustment or protection of connecting off-highway utility lines to the extent necessary.

7.90 **Right-of-Way, R/W or R.O.W.** - A general term or abbreviations for right-of-way, denoting land, property or interest therein; usually referring to a strip or corridor acquired for transportation or utility purposes.

7.91 **Roadside** - A general term denoting the area adjoining the outer edge of the roadway but within the right-of-way. Extensive areas between lanes of a divided highway may also be considered roadside.

7.92 **Roadway Prism** - A road bed section from toe of slope to toe of slope, or borrow ditch bottom, that includes the compacted subgrade, subbase and the paved surface of the highway.

7.93 **Scenic Overlook** - A roadside area provided for motorists to stop their vehicles beyond the shoulder, usually with parking areas, primarily for viewing spectacular scenes.

7.94 **Secondary Highway** - Minor roads, rural and/or urban, farm to market roads and the like that are designated secondary state highways, and are either paved or unpaved.

7.95 **Secretary** - Secretary of the New Mexico State Highway and Transportation Department.

7.96 **Semi-Rigid Pipe or Rigid Pipe** - Pipe designed to tolerate from 1% to 3% (semi-rigid) diametric deflection or less than 1% (rigid).

7.97 **Service Drop or Service Connection** - A utility service connection from a distribution line to a house, business or other entity.

7.98 **Skew or Skewed** - Usually refers to a highway drainage structure set at oblique angles (not at 90 degrees) to the centerline of a highway. Could also be used to describe utility crossings.
7.99 **Slab, Floating** - A concrete slab set between the ground surface and the top of a pipeline to protect the pipeline segment from static and dynamic load damage.

7.100 **Sleeve** - See Casing.

7.101 **Specifications or "Specs"** - Refers to technical design parameters written to define construction methods, materials quality and durability requirements, inspection and certification procedures, test procedures, and other mandatory procedures incidental to construction quality in general.

7.102 **Special District** - Any single or multipurpose district organized as a local public body of the state for the purpose of constructing and furnishing any urban-oriented service which another political subdivision of the state is authorized to perform, including but not limited to the services of water, sewage, garbage, refuse collection and recreation, but excluding the functions or services of drainage, irrigation, recreation, reclamation, soil and water conservation or flood control.

7.103 **Storm Sewer Trunk Line** - Usually a large diameter storm water pipeline underground and parallel to the centerline or adjacent to the roadway or street, and fed by curb or median drop inlets.

7.104 **Structure** - A bridge, drainage culvert or irrigation facility in highway usage, and a power or telephone pole in utility usage. Many other items are identified as structures in other industries.

7.105 **Structure Profile Sheets** - Construction plan sheets showing the size, depth and flow line gradient of proposed highway drainage culverts plus the inlet and outlet profiles.

7.106 **Subsurface Utility Engineering or SUE** - An engineering discipline, whereby records research, geophysical techniques and soft digging methods are used to accurately locate subsurface utilities. The process is intended to collect utility data very early in the design (FDI) process so as to mitigate conflicts between highway construction features and utilities.

7.107 **Temporary Construction Permit (T.C.P.)** - A land use agreement that terminates when the construction work within the permitted area is completed.

7.108 **Termini** - The written description of the location of a highway project.

7.109 **Traffic Control Plan (T.C.P.)** - A plan designed to guide drivers safely through a construction area; such plan must meet MUTCD minimum requirements.

7.110 **Transmission System** - Refers to a utility system which transmits a substantial
volume of electric current, telephone calls, fluid or gaseous products from a
generation location, source point, major storage point, well or the like to a location
where actual distribution to the consumer will begin.

7.111 **Traveled Way** - The portion of the roadway for the movement of vehicles, exclusive
of the shoulders and auxiliary lanes.

7.112 **Trenched** - Installed in a narrow and open excavation.

7.113 **Turn-Out** - A delineated roadway exit from a street or highway to allow access to
private or other property; usually paved or improved with gravel.

7.114 **Use and Occupancy Agreement** - See Permit.

7.115 **Utility** - All publicly, privately and cooperatively owned utilities, without distinction,
for the rendition of water, electric power, sanitary sewer, storm sewer, steam, fuel
gas, telephone or telegraph service through a system of pipes or wires devoted to
public utility service. The systems can include natural gas; sanitary sewage
collection systems; electricity; communication systems, including telephone,
telegraph, TV cable, microwave, fiberoptics and others. The term "utility" does not
apply to utility systems devoted solely to private use, or when the product of the
private utility system is not for sale or for use by the general public as a whole.

7.116 **Vent** - Appurtenance to discharge gaseous contaminants from a pipe casing.

7.117 **Vertical Clearance** - The difference in elevation, without obstruction, from the lowest
point of the superstructure (bridge or box culvert, usually bottom of roof or deck
bottom) or a wire conductor to the highest point of the traveled-way, river or railroad
track, or below the bottom of a corrugated metal culvert or concrete box culvert or
other utility underground facility to the top of another utility pipeline, conduit or
cable built beneath the drainage structure or other utility facility.

7.118 **Walled** - Partially encased by concrete poured alongside the pipe.

7.119 **Wet-Bore** - Illegal method of boring a hole beneath a highway using a water jet
or sluicing method.

7.120 **Work Order System** - A procedure for accumulating and recording all costs related
to relocations into separate accounts.

7.121 **X-ing** - Abbreviation for crossing. Refers to a railroad and/or utility crossing.

[3/10/71, 11/15/96]
8. **ORGANIZATION:**

8.1 The Railroads and Utilities Section of the New Mexico State Highway and Transportation Department is managed by the Railroads and Utilities Section Manager who is directly responsible to the Right-of-Way Bureau Chief, and is a part of the Engineering Design Division, headed by the Division Director. The Section Manager is responsible for the direction of all work undertaken by the Railroads and Utilities Section, and for the supervision of the various Railroad and Utility Relocation Agents and other personnel who may be assigned to perform designated functions of the Section. [3/10/71, 11/15/96]

9. **FUNCTION:**

9.1 The Railroads and Utilities Section is responsible for the coordination and functional control pertaining to all aspects of public utility and railroad related construction considerations, accommodations and installations affecting the New Mexico State Highway and Transportation Department. These functions include, but are not limited to: [3/10/71, 11/15/96]

9.1.1 The relocation of utilities and railroad facilities in conflict with the construction of highway projects. [3/10/71, 11/15/96]

9.1.2 The control of utility occupation of public highway right-of-way, including utility permits, coordination, regulation and central administration. [3/10/71, 11/15/96]

9.1.3 General liaison with public and private utilities and railroad companies. [3/10/96, 11/15/96]

9.1.4 Assist other New Mexico State Highway and Transportation Department functionaries concerning matters pertaining to the administration of utility company occupation of public right-of-way, utility and railroad relocations on construction projects, and other matters relative to railroad safety. [3/10/71, 11/15/96]

9.1.5 Coordinate, develop and administer the Railroad Safety Program. [3/10/71, 11/15/96]

10. **GENERAL POLICY:**

10.1 It is the general policy of the Department to accord utilities certain legal rights pertaining to the occupation of public right-of-way as outlined below:
It is in the public interest for utilities to be accommodated within the public right-of-way of highways and, under limited conditions, within access controlled freeways, including interstates under the jurisdiction of the New Mexico State Highway and Transportation Department when such use does not adversely affect the highway features, aesthetic quality, public use, or safety of the traveling public. NMSA 1978, Section 67-8-15.

Public utilities have the power of eminent domain, which gives them a quasi-public status. In addition, a public utility operating in New Mexico has a legal right to install its facilities within highway right-of-way, subject to the regulations of this Department. Public utility facilities are not right-of-way encroachments, nor may they be treated as such. Therefore, the administrative intent of the Railroads and Utilities Section is to provide reasonable, efficient and economic solutions to conflicts between the requirements of highway design, construction operations and safety and the location of public utility facilities. Railroads and Utilities Section Agents, Technicians and other assigned personnel should engage in constant liaison with utilities and railroads, to ensure that the communication and interrelations with them are an on-going function of their work performance.

The location or the relocation of public utility facilities within existing New Mexico public highway right-of-way, or right-of-way to be acquired for highway construction purposes, shall be governed by all applicable State laws, rules and regulations, Federal Codes and the Department policy set forth herein. [3/10/71, 11/15/96]

11. **UTILITY ACCOMMODATION POLICY:**

11.1 Application: This utility accommodation policy shall apply to all publicly, privately, cooperatively, municipally, or governmentally owned facilities used for the carriage, transmission or distribution of electric power, communication facilities, water, gas, oil, petroleum products, steam, chemicals, sewage, drainage, irrigation and similar items, that are to be accommodated or relocated within the rights of way of highways, roads or streets under the jurisdiction of the New Mexico State Highway and Transportation Department.

This utility accommodation policy is provided to regulate the location, design and methods for installing, accommodating and maintaining physical utility facilities within public highway rights-of-way. This section provides for the continuation of past regulations, State law and modifies and adds new regulations where necessary to comply with new State Laws and/or Federal Codes pertaining to the accommodation and relocation of utilities on State and Federal Aid Projects. The accommodation policy does not address the financial responsibility for replacing right-of-way or relocating the facilities of utilities in conflict with planned highway construction. The reimbursement policy of this Department is set forth in Section 19
of this manual.

When laws or orders of public authority or industry codes prescribe a higher degree of protection for utility facility construction than provided for in the accommodation procedures set forth in this regulation, such laws, orders, or codes shall prevail.

[3/10/71, 11/15/96]

11.2 General Utility Design Requirements: Except when a higher degree of protection is required by industry or governmental codes, laws, or by regulations of this Department, or orders of the public authority having jurisdiction over the utility, all utility facility installations on, over, along or under the surface of the rights-of-way of State highways, including attachments to highway structures shall, as a minimum, meet the following utility industry and governmental requirements: [3/10/71, 11/15/96]

11.2.1 Electric power and communication facilities installations shall conform with the current applicable National Electric Safety Code. [3/10/71, 11/15/96]

11.2.2 Water, sewage and other effluent lines shall conform with the requirements of the American Public Works Association or the American Water Works Association. [3/10/71, 11/15/96]

11.2.3 Pressure pipelines shall conform with the current applicable sections of the standard code of pressure piping of the American National Standards Institute, 49 CFR 192, 193 and 195, and/or applicable industry codes. [11/15/96]

11.2.4 Liquid petroleum pipelines shall conform with the current applicable recommended practice of the American Petroleum Institute for pipeline crossings under railroads and highways. [11/15/96]

11.2.5 Any pipeline carrying hazardous commodities shall conform to the rules and regulations of the U.S. Department of Transportation governing the transmission of such materials. [11/15/96]

11.3 Pipelines located in casings, galleries, utility tunnels or highway structures shall be designed to withstand expected internal pressures, and to resist internal and external corrosion; casings or uncased pipelines shall be designed to withstand external pressures as well. [3/10/71, 11/15/96]

11.4 Joints in carrier pipe lines operating under pressure shall be of a mechanical or
11.5 Ground-mounted utility facilities shall be of a design compatible with the scenic quality of the specific highway segment being traversed. [3/10/71, 11/15/96]

11.6 All utility installations, on, over, along or under highway rights-of-way, and attachments to highway structures, shall be of durable materials, designed for a long service-life and relatively free from routine maintenance. [3/10/71, 11/15/96]

11.7 On new installations or relocation of existing facilities, provisions shall be made for expansion of the facilities, particularly those underground or attached to highway structures. These provisions shall be planned so as to avoid interference with highway traffic when additional facilities are installed in the future. [3/10/71, 11/15/96]

11.8 Utility installations that are required for highway purposes, such as highway lighting, traffic signals, pump stations, telecommunications services for rest areas, etc. shall be handled as highway project construction items on proposed highway projects. As such, coordination by the appropriate Department design unit and the affected utility is required so as to ensure that proper bid items are included in the highway construction plans/documents, and that appropriate agreements are developed for addressing service, maintenance and other costs.

Where no highway project is proposed, but utility services for highway purposes are required, coordination between the Department unit requesting the service, the utility and the affected highway district shall be required, and appropriate documentation developed so as to outline the responsibilities of each party. In all cases, the location of such facilities within highway right of way shall be properly established and included in the District’s utility data base. [11/15/96]

11.9 The utility owner shall be responsible for compliance with industry code, the conditions and/or special provisions specified in the permit, applicable statutes and regulations of the State of New Mexico, and the U.S. Department of Transportation Code of Federal Regulations. [11/15/96]

11.10 The utility shall be responsible for the design, construction, and maintenance of all facilities to be installed within highway rights-of-way. All elements of these facilities are subject to review and approval by the Department, particularly the materials, location and method of installation. The utility is responsible for, and will provide all measures as required to preserve the safe and free flow of traffic, structural integrity of the roadway or highway structure, ease of highway maintenance and appearance of the highway, resulting from their installation. Traffic Control Plans and signing shall be approved by the Department prior to any utility work.
12. **GENERAL UTILITY CONSTRUCTION REQUIREMENTS:** Disturbance of areas within highway rights of way by utility operations shall be kept to a minimum and restored to the satisfaction of this Department. All utility construction methods used within the highway right-of-way shall be performed in accordance with current Standard Specifications for Highway and Bridge Construction, the provisions of this regulation, and utility accommodation permit requirements. All unsatisfactory installation or construction work performed by the utility on highway right-of-way will be corrected or reconstructed upon written notification by the Department that identifies the deficiencies. The Utility shall promptly initiate the restoration work and shall work continuously until the installation complies with the regulations and specifications. If the restoration is not performed within a reasonable specified time, the Department may perform the restoration work and the utility shall be responsible for all costs incurred. [3/10/71, 11/15/96]

12.1 The utility shall avoid disturbing or damaging existing highway drainage facilities and shall be responsible for repairs and restoration of any damage, including restoration of ditch flow lines, as determined by the Department. Wherever necessary, the utility shall provide drainage away from its own facilities to avoid damage to the highway. Construction or compaction by means of jetting, puddling, or water flooding is prohibited within all highway rights-of-way. [3/10/71, 11/15/96]

12.2 The utility is prohibited from spraying, cutting or trimming of trees or other landscaping elements, unless specific written permission is given by this Department. The approval of a utility accommodation permit does not include approval of such work, unless the cutting, spraying and trimming is clearly indicated on the permit application. In general, when permission is given, only light trimming will be permitted. When tree removal is approved, the stump shall be removed and the hole properly backfilled to natural ground density, and/or other Department approved landscape elements provided. The work site shall be left in a clean and trash free condition and all debris shall be removed. Reseeding shall be performed as per schedule outlined in Paragraph 12.5. [3/10/71, 11/15/96]

12.3 **Traffic Control** for utility construction and maintenance operations shall conform with the Manual on Uniform Traffic Control Devices (MUTCD). All utility construction and maintenance operations shall be planned to keep interference with traffic to an absolute minimum. On heavily traveled highways, utility operations interfering with traffic shall not be conducted during periods of peak traffic flow. All such work shall be planned so that closure of intersecting streets, road approaches or other access points is held to a minimum. Traffic Control Plans for each installation are mandatory and must be attached to each utility accommodation permit application. No utility installation work shall commence until the permit and Traffic Control Plans are approved by the District Engineer or his/her representative.
12.4 All utility facilities located on public rights-of-way shall be kept in an adequate state of repair. Minor maintenance of existing facilities may be performed without notification. However, any physical revisions, relocations, additions, excavations, impedance of traffic or other disturbances within the right-of-way shall require the submittal of a new utility accommodation permit application. No remedial work may commence until the new utility accommodation permit is approved. Repairs of an emergency nature, necessary for the safety of the traveling public, may be immediately performed without prior approval, to be followed by formal written notification to the appropriate District Engineer or his/her representative. When such emergency repairs may constitute a traffic hazard, the proper District Highway Office and the New Mexico State Police shall be officially notified to coordinate any safety measures required. [3/10/71, 11/15/96]

12.5 Restoration of the highway right-of-way disturbed by excavations or grading work performed by the utility shall include reseeding. This work shall consist of seeding all areas which are denuded of vegetation during the utility's construction operations. The reseeding work by the utility will be subject to inspection and acceptance by a representative from the Department. All affected areas shall be treated with Class "A" seeding of standard Department specifications. Fertilizer shall be used on all areas at the rate of 200 pounds per acre, Department Specification 16-20-0. The various species, origin and seed required for each Highway District area are shown on the following schedule: [3/10/71, 11/15/96]
SANDY SOILS

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<th>Species</th>
<th>Origin</th>
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HEAVY CLAY SOILS

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12.5.3 DISTRICTS 4 AND 5

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HEAVY CLAYS

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<td>2.0</td>
</tr>
<tr>
<td>Fourwing Saltbrush</td>
<td>New Mexico</td>
<td>4.0</td>
</tr>
</tbody>
</table>

HIGHER RAINFALL

<table>
<thead>
<tr>
<th>Species</th>
<th>Origin</th>
<th>Pounds Pure Live Seed Per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Wheatgrass</td>
<td>Arriba</td>
<td>6.0</td>
</tr>
<tr>
<td>Blue Grama</td>
<td>Pastura</td>
<td>3.0</td>
</tr>
<tr>
<td>Sideoats Grama</td>
<td>Vaughn</td>
<td>4.0</td>
</tr>
</tbody>
</table>

FERTILIZER REQUIRED: ALL DISTRICTS
200 pounds per acre, Specification 16-20-0.

[3/10/71, 11/15/96]

12.6 Scenic Enhancement: The following provisions for scenic enhancement shall apply for utility facility installation in cited areas:

12.6.1 The type and size of the utility facilities and the manner and extent to which they are permitted within areas of scenic enhancement and natural beauty may materially alter the scenic quality, appearance and view of highway roadsides and adjacent areas. Such areas include
scenic strips, overlooks, rest areas, recreation areas and the rights-of-ways and adjacent highways. Also included are sections of highways which pass through public parks, recreation areas, wildlife and waterfowl refuges and historic sites. Whenever possible, new utility installations within all such strips overlooks and areas shall be avoided. [3/10/71, 11/15/96]

12.6.2 New underground utility installations may be permitted within such strips, overlooks, scenic areas or in the adjacent rights-of-way when they do not require extensive removal or alteration of trees and other shrubbery visible to the highway user, or do not impair the scenic appearance of the area. [3/10/71, 11/15/96]

12.6.3 New overhead (aerial) installations of communication and electric power lines are to be avoided at such locations unless there is no feasible and reasonable alternative. Any such installation shall be fully justified to the Department by demonstrating that:

12.6.3.1 Other utility locations are not available or present unusually difficult construction constraints or are unreasonably costly or are less desirable from the standpoint of visual quality.

12.6.3.2 The placing of underground utility facilities is not technically feasible or economical, or is more detrimental to the scenic appearance of the area.

12.6.3.3 The proposed installation can be made at a location and in a manner that will not detract from the scenic quality of the area being traversed, utilizes suitable design, and uses materials aesthetically compatible to the scenic area. [3/10/71, 11/15/96]

12.6.4 It is within the Department's sole discretion as to whether adequate justification has been demonstrated to it by the utility, which decision shall be final and accepted by the utility. [11/15/96]

12.6.5 When a utility desires to construct a facility through or within scenic enhancement areas, the request for a utility accommodation permit shall be submitted to the appropriate District Traffic Engineer, providing substantial leadtime, because the permit must be carefully
evaluated to determine the impact upon the scenic area involved. [11/15/96]

12.6.6 Utility accommodation permit applications for installations in scenic enhancement areas must be accompanied by comprehensive and detailed supporting documentation. The design and materials should be aesthetically pleasing to the eye and the installation should not intrude in such a manner as to detract from the Scenic quality presented for viewing by the traveling public. Permits not adequately supported will be rejected by the Department. [11/15/96]

12.6.7 Utility installations through scenic enhancement areas that are required for highway purposes, such as highway lighting, service to weigh stations, rest and recreation areas, and other official sites shall be located and designed to conform with these scenic enhancement provisions. Such installations shall be coordinated with the utility, the appropriate Department design unit, and included as bid items in the highway construction plans if they involve a new highway project. [11/15/96]

12.6.8 Archaeological or Cultural Resources Clearances: To comply with the New Mexico State Law, The Cultural Properties Act, NMSA 1978, Sections 18-6-1 through 18-6-17 and specific Federal Law Historic Preservation Act of 1966, relating to the protection and preservation of historic and cultural resources, it shall be mandatory for utility facility owners to obtain an archaeological survey prior to any installation within highway right-of-way or property or new right-of-way to be acquired for highway construction. This survey shall be required for utility installations or relocations which include any utility structure, overhead or underground utility systems, either pipeline or ditch and/or any clearing operations, and any or all other ground surface disturbing construction activities across or through any obvious or suspected archaeological site. The survey report shall be submitted to the Department for its review and approval. No utility permit shall be issued without archeological clearance from the Department.

No survey will be necessary if the utility has determined by inquiry and written substantiation from the Department that an acceptable archaeological survey was previously done by the Department or others approved by the Department. [3/10/71, 11/15/96]

12.6.9 Environmental Clearances: It shall be the utility’s responsibility to comply with all Federal, State, and local laws and regulations
controlling pollution of the environment. Prior to the start of utility construction, the utility shall contact the Department's Environmental Section to establish if any action is necessary by the utility for adhering to air, noise, and water quality control regulations.

It shall also be the responsibility of the utility owner to insure compliance with National Pollutant Discharge Elimination System (NPEDS) Regulations on all utility work within highway right-of-way, where any ground disturbance activities involve areas exceeding five (5) acres. A Notice of Intent (NOI) must be filed with the Environmental Protection Agency (EPA) before the utility work can begin, and approval of the sediment control and reclamation plan from the NMSHTD Landscape Architect must be secured. The Landscape Architect shall also be responsible for final acceptance of permanently established vegetation as required by NPDES and as provided for by the utility owner. Information on these environmental regulations is available from the Roadside Environment Design Unit of the NMSHTD. [11/15/96]

12.7 New Mexico Public Highway Utility Accommodation Permit:

12.7.1 General Requirements: A utility owner who desires to install segments of their utility systems, or needs to relocate an existing facility already installed within the rights-of-way of public highways under the jurisdiction of the NMSHTD, must apply for a New Mexico Public Highway Utility Accommodation Permit. No utility construction shall commence on public highways right-of-way until the utility owner has obtained the approved permits, approval of their insurance, with coverages and face amounts shown in Paragraph 12.11, and added the NMSHTD as an additional insured. After receiving approval, the utility owner shall notify the Department in writing, five days in advance of the date their installation or relocation construction will commence. [3/10/71, 11/15/96]

12.7.2 The utility owner seeking a utility permit must provide as-built plans, within thirty (30) days of completion of the installation pertaining to the location of the facility installed. The location must be tied by a survey, performed and certified by a registered New Mexico Land Surveyor, to the Department's monuments and referenced to Department's mileposts and/or to the highway construction project stationing. The Utility shall provide a map to the Department detailing location and elevation of each break point along the facility. Where
utility owners fail to establish documentation and provide survey maps to the Department, and Department maintenance crews damage utilities, the utility shall be responsible for all costs associated with repair, but only if Department requested a utility locate prior to beginning maintenance activities. [11/15/96]

12.7.3

Information on the horizontal and vertical survey ties may be obtained from the Department’s Aerial and Lands Survey Section, Monumentation Unit, located in the Department’s General Office (G.O.); mailing address: NMSHTD, Aerial and Lands Survey Section, Monumentation Unit, P.O. Box 1149, Santa Fe, NM 87504-1149. [11/15/96]

12.7.4

Survey monumentation and project stationing survey information may also be obtained from the appropriate District Engineer, along with the New Mexico Public Highway Utility Accommodation Permit Forms. The Railroad and Utility Section of the G.O., in Santa Fe also can provide permit forms (see G.O. address in above Paragraph). The addresses and phone numbers of the Department’s six District Offices are:

NMSHTD
District One Office
P.O. Box 231
Deming, NM 88031-0231
(505) 546-2603

NMSHTD
District Two Office
P.O. Box 1457
Roswell, NM 88202-1457
(505) 624-3300

NMSHTD
District Three Office
P.O. Box 91750
Albuquerque, NM 87119-1750
(505) 841-2700

NMSHTD
District Four Office
Box 30
Las Vegas, NM 87701-0030
(505) 425-7527

NMSHTD
District Five Office
Box 4127, Coronado Sta.
Santa Fe, NM 87502-4127
(505) 827-9500

NMSHTD
District Six Office
P.O. Box 2159
Milan, NM 87021
(505) 285-6623

[11/15/96]

12.7.5

The utility owner applying to place utilities within the right-of-way of public highways must determine in which Highway District the
installation will be constructed. Completed utility accommodation permit forms should be submitted to the appropriate District Engineer, to the attention of the District Permit Agent, at the address previously listed. The boundaries of each District may be obtained from the appropriate District Permit Agent. [11/15/96]

12.7.6 The utility seeking a utility accommodation permit from the Department will provide the Department with comprehensive plans that depict the utility installation by plan view and profiles. Details that clarify complicated features of the installation shall be added as appropriate. In addition to the detailed plans, the utility owner shall provide all the information required on the permit form. Utility Permit Instructions are available to assist in preparation of all required documents. [11/15/96]

12.7.7 The utility who has received authorization to proceed with their installation/relocation shall strictly adhere to performing the work in accordance to the approved plans. No deviation from the plans, without prior written approval from the Department, shall be allowed. [11/15/96]

12.7.8 It shall be the responsibility of the utility owner to renew each permit prior to its expiration. The utility shall submit a renewal permit, along with plans that reflect the current location of the utility relative to existing roadway features. If the plans are as-built and reflect the actual current condition, a certification stating that this is the case shall accompany the as-built plans. Any costs to repair damage to utility facilities by highway maintenance crews due to inconsistencies between the as-built plans and the actual utility location shall be borne by the utility. [11/15/96]

12.7.9 All changes in ownership of a utility facility shall require the new owner to submit fully executed and approved assignment documents between the utility owners involved to the Department, along with new State utility permit applications and plans of the assigned facility located within Department’s highway right-of-way. If the plans are as-built and reflect the actual current location of the facility, a certification stating that this is the case shall be required; otherwise new plans that reflect the actual location relative to existing roadway features shall be provided. Any requirements stipulated by the underlying fee owner in cases where a change of ownership occurs shall be the sole responsibility of the new facility owner and may require the new owner to obtain appropriate approvals from the fee owner. Any costs to repair
damage to utility facilities by highway maintenance crews due to inconsistencies in the as-built plans and the actual utility location shall be borne by the utility. [11/15/96]

12.7.10 Utility work shall commence within six (6) months of the date of issuance of the utility permit, otherwise the permit shall become null and void. Any work not started within this six month period shall require new permit applications and associated documentation, as well as Department approval of the new submittal before the utility work can commence. [11/15/96]

12.8 Other Required Permits: In areas where highways pass through land controlled by the U.S. Forest Service, Bureau of Land Management, U.S. Military Bases, Indian Lands and other designated Federally controlled lands, and certain New Mexico state lands under the jurisdiction of the New Mexico State Land Office, and/or other state agencies, the utility owner must also obtain a permit, written permission, or other documented authorization from these agencies for utility installations. This written authorization is required in addition to the Department's Utility Accommodation Permit, and shall accompany the Department's permit request for new installations, or as determined by the Department. [3/10/71, 11/15/96]

12.9 Traffic Control Plans: Utility owners shall provide Traffic Control Plans in accordance with the Manual on Uniform Traffic Control Devices, and shall comply with the approved Traffic Control Plan during the utility installation, relocation or maintenance work within the highway right-of-way. The Traffic Control Plan must be accompanied by an approved utility accommodation permit and utility construction authorization. [3/10/71, 11/15/96]

12.10 Indemnification: The utility owner must indemnify and hold harmless the Department from loss due to any negligent act of the utility, the utility's employees, any agent acting on the utility's behalf, and anyone else engaged by the utility to work on the utility installations, maintenance or relocations of their facilities. Any contractor or subcontractor engaged by the utility to perform utility installations or relocations in conjunction with or prior to highway construction must also indemnify and hold harmless the Department from loss due to any negligent act of the utility's contractor or subcontractor. [11/15/96]

12.11 Insurance Requirements: Utility owners shall carry insurance in amounts not less than those below specified and as outlined in Section 107.25 of the Standard Specifications for Highway and Bridge Construction, 1994 Edition, (hereinafter, "Specifications"), as may be updated from time to time. In the event of conflict between the specification, and this regulation, owner shall carry the larger amount of insurance. If a utility is self-insured, the utility shall provide an Owner's Protective Liability
Insurance Policy, in favor of the Department, in the amounts below specified. [11/15/96]

12.11.1 General Liability: Bodily injury liability and property damage liability insurance applicable to the utility installation or relocation work shall be provided as follows, which amounts may be changed, by the Department, from time to time:

12.11.1.1 Insurance coverage in the amount of $1,000,000.00 for each occurrence; $1,000,000.00 aggregate for Bodily Injury Liability and $500,000.00 each occurrence; $1,000,000.00 aggregate for Property Damage Liability, written on a comprehensive General Liability Form or Commercial General Liability Form which must include the following:

12.11.1.1.1 Coverage for liability arising out of the operation of independent contractors;

12.11.1.2 Completed operations Coverage;

12.11.1.3 Attachment of the Broad Form Comprehensive General Liability Endorsement.

[11/15/96]

12.11.2 In the event that any use of explosives is required during the installation or relocation, the insurance shall include coverage for injury to or destruction of property arising out of:

12.11.2.1 The collapse of, or structural injury to any building or structure due to excavation, including borrowing, filling or backfilling in connection therewith, or to tunneling cofferdam work or caisson work, or to moving or shoring, underpinning, raising or demolition of any building or structural support thereof.

[11/15/96]

12.11.3 Coverage must be included for injury to or destruction of any property arising from injury to or destruction of wires, conduits, pipes, mains, sewers or other similar property or any other apparatus in connection
therewith below the ground. If such injury or destruction is caused by or during the use of mechanical equipment for the purpose of excavating, digging or injury to or destruction of property at any time resulting therefrom.

[11/15/96]

12.11.4 **Automobile Liability Insurance:** Coverage for the utility, its contractor or subcontractor (whether included in the policy providing General Liability insurance or in a separate policy) must provide liability for the ownership, operation and maintenance of owned, non-owned, and hired cars. The limits of liability for Automobile Liability insurance shall be provided in the following amounts, which amounts may be changed from time to time:

12.11.4.1 Bodily Injury Liability $500,000 each person; $1,000,000 each occurrence.

12.11.4.2 Property Damage Liability $1,000,000 each occurrence.

[3/10/71, 11/15/96]

12.11.5 **Department as Additional Named Insured:** The utility, its contractor or subcontractor shall have the New Mexico State Highway and Transportation Department added as an additional named insured on the Comprehensive General Liability Form or Commercial General Liability Form furnished by the Utility. [11/15/96]

12.11.6 **Proof of Insurance:** The utility shall provide to the appropriate Department District Engineer a certified copy of the utility owner's insurance policy and certificate of insurance, or in the event the utility is self-insured, a copy of the Owner's Protective Liability Insurance Policy or a Certificate of Insurance at the time the original utility accommodation permit application is submitted for approval. The utility owner shall also be responsible for and require that any contractor or subcontractor engaged by them shall provide the Department with a certified copy of their insurance policy or certificate of insurance in the amounts and with the provisions as herein provided. If a bond is required, the utility shall provide a proof of that bond to the appropriate Department District Engineer. [11/15/96]

12.11.7 **Worker's Compensation Insurance:** The utility, its contractor or subcontractor shall also carry Worker's Compensation Insurance or
otherwise comply with the provisions of the New Mexico Workmen's Compensation Act and Occupational Disease Disablement Law. [11/15/96]

12.11.8 Liability Insurance, Automobile Liability Insurance and Worker's Compensation Insurance: For the utility, its contractor or subcontractor shall be kept in force for the duration of the utility facility installation, relocation, remedial or clean up work required due to Department authorized utility relocation or utility installation. [11/15/96]

12.11.9 Insurance required during utility relocations: The insurance listed herein shall be provided by the utility, its contractor or subcontractor on all utility relocation work authorized by the Department. If the utility owner is otherwise eligible for utility relocation reimbursement, the premium cost can be added to the utility's cost estimate; if not eligible for reimbursement, the premium(s) shall be paid by the utility owner. A certified copy of the utility owner's insurance policy(s), or a certificate of insurance for and covering the utility relocation work, shall be provided to the Section Head, Railroad and Utilities Section, NMSHTD, P.O. Box 1149, Santa Fe, NM 87504-1149. [11/15/96]

12.12 Compliance with Regulations: Any utility owner that installs its utility facilities within the Department rights-of-way shall comply with the provisions of these regulations.

Violation of any regulation pertaining to the installation and maintenance of utility facilities placed within the Department rights-of-way may result, at the discretion of the Department, in:

(1) An order requiring the utility owner to make prompt corrections or take the appropriate remedial action as directed in writing by the Department;

(2) A written order declaring utility's New Mexico Public Highway Utility Accommodation Permit, applicable to the violation, as null and void. In such case, the utility owner may be required to vacate the public highway right-of-way if prompt remedial action is not completed by the utility owner. If the utility fails to correct the problem, all costs as a consequence of a vacation order, including the total cost of removal of the permitted facility, plus all administrative costs, shall be at the expense of the utility owner. Failure of the utility or its agent to comply with such order can result in the utility owner being denied further utility permits until they are able to satisfy the Department District Engineer or appropriate Department representative that they are
in compliance or are making a good faith effort to comply;

(3) Violations may also preclude the issuance of additional utility permits until such time as the utility is in compliance.

[11/15/96]

13. **Physical Location of Facilities**: The following requirements apply to the physical location of utility facilities on non access-controlled highways; additional requirements for access-controlled highway facilities are set-out in Paragraph 17, "The Accommodation of Utility Facilities Within Freeway or Interstate Right-of-Way." [3/10/71, 11/15/96]

13.1 **Aerial Facilities, Parallel**: The proposed installation of aerial utility facilities parallel to a state highway shall be located no more than .3048 m (1 foot) within the right-of-way line on a uniform alignment, wherever practical. Down guys and anchors shall not project into the cut or fill slopes. Minor variations will be considered on an individual basis upon substantiation submitted by the utility. [3/10/71, 11/15/96]

13.2 **Aerial Facilities Crossing**: Proposed installations of aerial facilities crossing a highway shall cross the highway at an angle near ninety (90°) degrees whenever practical. Poles, anchors and other appurtenances shall be located at, near, or outside the highway rights-of-way. No crossing components shall obstruct upon the roadway prism unless approved by the Department, and all vertical clearances shall conform to the National Electric Safety Code as a minimum, but shall not be less than twenty feet (20'). Minor variations will be considered on an individual basis, or upon substantiation submitted by the utility. [3/10/71, 11/15/96]

13.3 **Buried Facilities, Parallel**: The proposed installation of buried utility facilities parallel to a highway shall be located no more than 1.52 m (5 feet) within the right-of-way line, whenever practical. Surface components of buried facilities, i.e., valves, manholes, vents, etc., shall be located as close as possible to the right-of-way line. The high point of structural elements such as manholes, vaults and anchor blocks shall be at or below the grade of the right-of-way surface. Minor variations will be considered on an individual basis, on substantiation submitted by the utility. All buried facilities shall be installed at a minimum depth of .91 m (36 inches) from natural ground elevation to the top of the buried facility. All trenches and ditches will be backfilled and compacted to the satisfaction of the Engineer. All excavations outside the roadway foreslopes shall be compacted to a density equal to the surrounding undisturbed soil. All excavations within the toes of the foreslopes shall be compacted to 95% maximum dry density (modified Proctor method "C" T-99 or equivalent) as determined by an approved standard compaction test. Parallel trenches shall be backfilled and compacted during the same work period in which they are excavated. Excavations on or near the traveled way shall not remain open overnight. [3/10/71, 11/15/96]

17 NMAC 4.2 30
13.4 **Buried Facilities, Crossing:** The proposed installation of buried utility facilities crossing a highway shall cross the highway at an angle of ninety \(90^\circ\) degrees, wherever practical. All Surface components or proposed buried facility crossings shall be located within 1.52 m (5 feet) of the right-of-way line. All buried facility crossings shall be installed at a minimum depth of .91 m (36 inches) or more from the lowest point of the right-of-way surface to the top of the facility. Minor variations will be considered on an individual basis, on substantiation submitted by the utility.

Unless otherwise permitted, installation of buried facilities crossing a state highway shall be performed by boring or jacking under the roadway. Installations by open cut of the pavement structure may be permitted only where boring or jacking is not feasible due to soil conditions, or where the pavement structure is aged, deteriorated or in generally poor condition. Open cut installations will be considered on an individual basis, on substantiation submitted by the utility.

In cases where the utility owner is allowed an open cut installation, the utility shall be responsible for the restoration and maintenance of the pavement structure, until such time that the section of roadway is improved by resurfacing, as approved by the Department.

All proposed buried carrier pipes crossing a state highway shall be constructed of steel, cast iron, or reinforced concrete and/or shall be cased (or encased), and shall be of such materials and design as may be approved by the Engineer. Each question of carrier pipe material and/or casing pipe requirements shall be considered on an individual basis, on design data submitted by the utility. As a minimum, the casing shall extend at least from just outside the toe of foreslope to just outside the toe of the opposite foreslope.

The utility shall be responsible for the backfill, compaction and surface restoration of utility trenches outside the roadway prism, and for the restoration and protection of the pavement structure if open cut trenching across the existing roadway is approved by the Engineer, District Engineer or his/her representative. The utility is also responsible for the safety and progress of the traveling public. All backfill, compaction, materials, and pavement structure restoration shall be performed to the satisfaction of Engineer. Backfill in trenches excavated outside the roadway prism shall be compacted to a density equal to the surrounding undisturbed soil. All excavations within the roadway prism shall be compacted to 95% of maximum dry density (Modified Proctor, method "C", T-99 or equivalent) as determined by a standard compaction test. Any portion of the pavement structure which is broken, disturbed, cut or otherwise damaged in any way, shall be removed and replaced to a design equal to or better than the condition that existed prior to the damage to the pavement structure, as determined by the Department.
Where the party making the installation either is not equipped or fails to properly repair any damage to the pavement structure, the Department will repair the damage and shall bill the utility the actual cost of restorations, plus administrative costs incurred.

All buried utility facilities crossing Department maintained highways shall be identified by the installation of weather proof signs that provide the type of facility, the facility owner and a phone number where maintenance personnel may be contacted. The signs shall be set over the facility at both right-of-way lines.

[3/10/71, 11/15/96]

14. **DEFINITIVE DESIGN REQUIREMENTS:**

14.1 **Pipeline Installations; Location and Alignment:** From the highway viewpoint, there are sound reasons for requiring pipeline crossings at right angles to the roadway alignment. Oblique angle highway crossing pipeline installations have many detrimental characteristics as they increase the interference with traffic during construction, are more liable to conflict with highway drainage and structures, upset distribution of live loads to the subgrade and across pavement joints, are considerably harder to control as to line and grade when boring or jacking the pipeline beneath the highway, and they usually create more damage to the pavement structure and subgrade on open cut installations. Diagonal crossings usually require more maintenance and repairs; therefore, all pipeline crossings shall be at or near ninety (90°) degrees. Minor variations will only be considered on a case by case basis, upon justification submitted to the Department by the utility.

Conditions which are generally unsuitable for pipeline crossings should be avoided, such as locations in deep cuts, across cuts and fills on steep slopes, near the footings of bridge piers, abutments, retaining walls and other structures, across intersections at grade or entrance and exit ramp terminals, at cross drains (transverse drop inlets) where flow may be obstructed, or in locations requiring extensive rock excavations to provide the minimum bury. [3/10/71, 11/15/96]

14.2 **Pipeline Casings; Encasement:** A carrier pipe is said to be cased (or encased) if it is installed freely inside in a larger diameter pipe. Encasement may also be complete or partial, designed to protect the carrier pipe, lighten its burden, facilitate its insertion and withdrawal and guarantee the integrity of the roadway structure or prism. Common types of casements are those carriers cased or sleeved inside a larger pipe, cradled by a continuous concrete seat fitting the pipe (cradling), walled by a continuous concrete sidefill (walling), boxed or jacketed by concrete completely surrounding the pipe (boxing), capped by a continuous concrete topping or slab (capping)), coated or wrapped by a substantial girdling cover (wrapping), grouted by mortar filling borehole
annulus and overbreak (grouting), or tunneled by installation in a utility subway.

Of these methods, only the casing, tunnel, utility subway or gallery provide the complete independence of the carrier pipe from the surrounding roadway structure, and adequate protection to the roadway from leakage of the pipeline. These methods also provide means for insertion and replacement of carriers without access or disturbance to through-traffic roadways.

The following encasement methods do not provide all of the above benefits, but may be utilized subject to individual approvals, on substantiation submitted by the utility: Concrete cradling enhances the load supporting capability of rigid pipes, but accomplishes little else. Walling does the same for semi-rigid and flexible pipes. Capping strengthens both rigid and flexible pipes, and somewhat protects from highway operations penetrating the overfill. When applied to weak or brittle pipes, concrete boxing or jacketing provides protection to the pipe from earth loads, leakage, corrosion or abrasion to some degree. Adequate coating or wrapping prevents contact with corrosive water, soil or vapors. Grouting aids in restoring the continuity and integrity of the earth supporting the pavement structure. [3/10/71, 11/15/96]

14.3 Uncased carriers: An uncased carrier crossing a highway becomes an integral part of the embankment supporting the pavement structure. Just as for a culvert, the Department must be assured of adequate structural design. All uncased carriers shall be designed to withstand all combinations of earth and live load, internal pressure, earth and live load plus internal pressure, and earth and live load plus alterations to full and zero internal pressure. Rigid carriers will generally be satisfactory, if they meet culvert design criteria and withstand the internal pressure. Semi-rigid and flexible carrier pipes shall be cased within a rigid pipe encasement. [3/10/71, 11/15/96]

14.4 Hazardous Transmittants: Transmittants which are flammable, corrosive, expansive, unstable, at high pressure, and/or possibly hazardous to the traveling public or the roadway itself, shall be encased on all highway crossings of carrier pipes over 2 inches in diameter. Uncased crossings of welded steel pipelines may be permitted, provided additional protective measures are taken in lieu of encasement. Such measures may include higher safety factors in design, materials and construction, coating, and wrapping of carriers in accordance with industry standards, and cathodic protection, subject to the approval of the Engineer, District Engineer or his/her representative.

14.4.1 Requirements for Uncased Carriers: Uncased hazardous or corrosive product pipeline crossings on state highways will be allowed provided they are:

welded steel pipelines;
cathodically protected;
coated in accordance with industry standards;
meet requirements of the pipeline safety regulations - 49 Code of Federal Regulations, Parts 191 and 192, or Parts 191 and 195 with respect to wall thickness;
designed for operating stress levels in accordance with federal pipeline safety regulations;
appropriately marked with permanent signs at each right-of-way line indicating ownership, type of facility, and an emergency telephone number; and
owner provides an official signed written statement certifying that the facility complies with the conditions and provisions required in this section, Paragraph 14.4.1.

It should be noted that each request for waiver of casing will be considered on an individual bases. The ultimate decision to approve or reject a waiver will not be subject to pipeline owner criteria, but will be based on the following casing considerations:

(1) as an expediency in the insertion, removal, replacement, or maintenance of carrier pipe crossings of freeways, expressways, and other controlled access highways and at other locations where it is necessary to avoid trenched construction;

(2) as protection for carrier pipe from external loads or shock, either during or after construction of the highway;

(3) as a means of conveying leaking fluids or gases away from the area directly beneath the traveled way to a point of drainage in the highway ditch or a natural drainage way; and

(4) traffic safety considerations and maintaining the structural integrity of the roadway.

[11/15/96]

14.5 **Restriction Against Varied Use:** Subject to the safety requirements of the various regulatory bodies, the following precautionary measures are required for pipeline
crossings:

(1) Pipeline crossing utility accommodation permit applications shall specify the class of transmittants, the maximum working or test pressure, and the design standards for the carrier pipe.

(2) Prior approval shall be obtained from the Department before the utility is allowed to change the type of transmittant or raise the working or potential pressures beyond those provided for in the design and the utility accommodation permit.

Non-compliance by the utility with any of the provisions of this regulation shall be grounds for rejection of the utility accommodation permit or the revocation of an existing permit.

[3/10/71, 11/15/96]

14.6 **Trenched Construction and Backfill:** In trenched construction, bedding is the subgrade soil and its surface, as prepared to support a pipe. Backfill is the material that refills the rest of the trench, consisting of sidefill up to the level of top of facility, and of overfill above that level. The latter specifically includes restoration of the pavement structure and the road surface. From the Department's viewpoint, the pavement structure which is broken, disturbed, cut or otherwise damaged in any way, shall be removed and replaced to a design equal to or greater than the surrounding undisturbed pavement structure, as determined by the Department. Open cut trenched construction on State roads shall be limited to areas where the pavement structure is deteriorated and in generally poor condition and only when justified in writing by the utility and subsequently approved by the District Traffic Engineer or his/her representative.

In cases where the utility owner is allowed an open cut installation, the utility shall be responsible for the restoration and maintenance of the pavement structure, until such time that the section of roadway is improved by resurfacing as approved by the Department.

Where the utility or other party making the installation is not equipped to or fails to properly repair the damage to the pavement structure, the Department shall repair the damage and will bill the utility owner the actual costs incurred, including any administrative costs. [3/10/71, 11/15/96]

14.6.1 **Open Trench Installations Crossing the Highway:** From the Department's viewpoint, the essential features of open trench construction are detailed as follows: [3/10/71, 11/15/96]
14.6.1.1 Restoration of the structural integrity of the roadbed. [3/10/71, 11/15/96]

14.6.1.2 Security of the pipe against deformation and leakage. [3/10/71, 11/15/96]

14.6.1.3 Assurance that the trench does not become a drainage channel, and that the backfill does not block road drainage. [3/10/71, 11/15/96]

14.6.1.4 Open-cut trenched installations shall not be permitted unless it is not feasible to bore, push or jack under the roadway. All trenched or other utility installations shall conform to the applicable provisions of the current construction requirements of the Department, i.e., The New Mexico State Highway and Transportation Department Standard Specifications for Road and Bridge Construction, and any supplemental provisions thereto. [3/10/71, 11/15/96]

14.6.1.5 Trenches shall be cut to have vertical faces with a maximum width of .61 m (2 feet), or the outside diameter of the pipe plus .46 m (1.5 feet) on each side, or as approved by the Engineer or his representative. The trench shall be shored where necessary to prevent cave-ins or sloughing, and shall meet OSHA requirements. [3/10/71, 11/15/96]

14.6.1.6 Bedding should be provided to a depth of half the diameter of the pipe. Bedding shall consist of granular material, free from rocks, lumps, clods, cobbles, or frozen materials and shall be graded to a firm surface without abrupt change in bearing value. Unstable soils and rock ledges shall be sub-excavated from beneath the bedding zone and replaced with suitable granular material. [3/10/71, 11/15/96]

14.6.1.7 Backfill shall be placed in 150.6 mm (6 inch) layers of granular materials, and each layer shall be consolidated (compacted) by mechanical tamping equipment and with a controlled addition of moisture, to a density of 95% maximum dry density (modified proctor method "C," T-99 or equivalent) determined by a standard compaction test. Consolidation by supersaturation, ponding or flooding will not be permitted in any circumstance. Materials and methods of compaction shall be adapted to achieve rapid restoration of traffic service. There
shall be additional cutback of base and surfacing courses to minimize later development of sag in the replaced pavement over the trench. [3/10/71, 11/15/96]

14.6.1.8 Pavement replacement may be performed by either the utility, or a contractor engaged by the utility, (constructed to a specification approved by the state) or by Department forces at the expense of the utility. The utility shall be liable from the date of completion of the pavement replacement, for the cost of repairs if the backfill subsides or the patched pavement fails, until such time that the roadway cut is resurfaced as approved by the Department. [3/10/71, 11/15/96].

14.7 Untrenched Construction and Grout: Methods for installing a utility under a highway or roadway without disturbing the pavement surface are as follows: [3/10/71, 11/15/96]

14.7.1 Driving - A pipe with a pilot shoe may be driven through compressible soil by steady thrust, hammering or vibration. Driven pipe must be smooth and uncoated, thus a casing or corrosion resistant carrier pipe should be used. Line and grade are difficult to control on long drives. [3/10/71, 11/15/96]

14.7.2 Coring - A casing without a pilot shoe can be drilled into more difficult soil, which enters the casing as it advances. The core is removed during and after the drilling. Control of line and grade is fairly easy. [3/10/71, 11/15/96]

14.7.3 Boring - A pipe can be jacked through a slightly oversized bore carved progressively ahead of the leading edge of the advancing pipe as the spoil is mucked back through the pipe. Line and grade control is excellent, but annular voids and overbreaks may be large and must be backfilled. [3/10/71, 11/15/96]

14.7.4 Wet Boring - A hole is sluiced by a jet of slurry and kept full of pressurized slurry to avoid collapse. The pipe is pushed through the slurry evacuating the excess. Soils may soften, expand or disintegrate from saturation by slurry moisture. This method is absolutely forbidden on all highways and roads under the jurisdiction of the Department. [3/10/71, 11/15/96]

14.7.5 Untrenched installations (boring, coring or driving) will be required for all pipeline crossings of access controlled and other major highways.
Open trench installations on other highways and roads will be permitted only where bad soil conditions or extremely difficult rocky conditions preclude untrenched construction, or where older pavement is severely deteriorated. All untrenched pipeline installations should extend under and across the entire roadway prism to a point 1.22 m (4 feet) beyond the toes of the foreslopes or borrow ditch bottom or across the access control lines, or as otherwise required by the Engineer or his/her representative. [3/10/71, 11/15/96]

14.7.6 The oversize of boring operations is restricted to the minimum size necessary for the pipeline installation. The boring hole shall not exceed the pipe installation diameter by more than five percent (5%) oversize. The oversize excavation shall be backfilled to the satisfaction of the Engineer or his/her representative. [3/10/71, 11/15/96]

14.7.7 All overbreaks, unused holes or larger diameter abandoned casings or pipes shall be backfilled with grout. The composition of the grout shall be cement mortar, a slurry of fine sand, or other fine granular materials, as local conditions dictate, and subject to the approval of the Engineer or his/her representative. [3/10/71, 11/15/96]

14.8 Relocation of Existing Pipelines: Highway design and construction requirements generally preclude compromise of proposed highway alignment or grade for new construction projects in order to avoid conflict with the line and grade of an existing pipeline. The feasibility of minor adjustments in the highway design to avoid extensive conflicts with existing utility facilities will be investigated, but in most instances a utility relocation or added pipeline protection will be required. Specific case factors are so varying as to make each such crossing unique. Therefore, standardized solutions are not uniformly applicable, but the following items will be considered: [3/10/71, 11/15/96]

14.8.1 An existing pipeline should be relocated in alignment and/or grade, where the angle of the crossing is too acute, the top of the pipe is too close to the designed highway gradient, or its bedding will be depressed by static and dynamic highway loadings. [3/10/71, 11/15/96]

14.8.2 An existing or relocated pipeline shall be encased or otherwise protected as would normally be required for a future pipeline installation, built under the same conditions. [3/10/71, 11/15/96]

14.8.3 An existing pipeline, inadequate to support highway loadings, shall be sheltered by an adequately designed casing or reinforced by a jacket, cap, or replaced with heavier weight pipe. [3/10/71, 11/15/96]
14.8.4 An existing pipeline which would lack adequate cover for protection from vehicular loads or highway construction operations, may be protected by a floating slab in lieu of encasement. [3/10/71, 11/15/96]

14.8.5 Notwithstanding utility facility protection, the highway construction contractor shall be warned of, and made responsible for the security of utility facilities located within the construction limits of a project. Where there are unusual utility hazards, or where heavy construction equipment will cross a facility, the highway contractor shall provide a temporary earth cover, or other such protection as may be required. [3/10/71, 11/15/96]

14.8.6 Further clarification of the responsibility of highway contractors to protect utilities and for the relocation of utilities concurrently with highway construction and other utility/highway contractor relationships, are defined as to the joint responsibilities required, in the New Mexico State Highway and Transportation Department Standard Specification for Highway and Bridge Construction, and any modifying provisions or rule changes applicable thereto. [11/15/96]

14.9 Other Design Requirements:

14.9.1 Overhead Power and Communication Lines: The type of utility construction, vertical clearances, the lateral location of poles and down guys and related ground mounted utility facilities along the roadside are factors of major importance in preserving a safe traffic environment, the appearance of the highway, and the efficiency and economy of highway construction and maintenance. As such, the physical location of aerial utility facilities shall be as close to the right-of-way line as possible, normally .3048 m (1 foot) inside the right-of-way line. [11/15/96]

14.9.2 Aerial utility lines to be installed longitudinally on highway rights of way will usually be limited to single pole construction. Joint-use single pole construction is encouraged at locations where more than one utility or type of facility are involved. Except in very unusual circumstances and for short distances only, duplication of utility facility aerial pole-line installations on the same side of the highway will not be permitted. [11/15/96]

14.9.3 The vertical clearance for overhead power and communication lines above the highway, and the lateral and vertical clearances from structures shall conform to the National Electrical Safety Code as a
minimum, except where greater clearances are required by the utility, or where required by other industry or governmental codes or regulations. [3/10/71, 11/15/96]

14.9.4 On and along conventional highways in rural areas, poles and related facilities shall be located at or as near to the right-of-way line as possible, normally within .3048 m (1 foot) thereof. Down guys, anchors or other components shall not project into cut and fill slopes, nor shall such surface mounted obstacles intrude into the clear roadside area for the segment of the highway involved. [3/10/71, 11/15/96]

14.9.5 In keeping with the nature and extent of roadside development along conventional highways in urban areas, aerial or buried utility facilities shall be located at, or as near as possible to the right-of-way line. On curbed sections, the utilities shall be located as far as possible behind the face of the outer curbs, and preferably behind the sidewalks. Utilities located within sidewalks shall not be permitted unless no other viable alternative can be identified; however, under no circumstances shall their location compromise ADA requirements. Utilities must be protected in accordance with the AASHTO guide insofar as possible. Variations must be fully justified to the Engineer or his/her representative. The Department may require certain details of the method and manner of relocation in order to accommodate aesthetic, environmental, ecological and historical considerations (i.e. commitments contained in EIS or other documents) or in order to obtain consistency with local zoning, codes or ordinances. [11/15/96]

14.9.6 Locations of aerial utility facilities on highways with exceptionally narrow rights-of-way, or on urban streets with abutting improvements are special cases that must be resolved in a manner consistent with prevailing limitations and conditions. Locations behind sidewalks are required where feasible. Before a utility requests Department approval of a location other than near the right-of-way line, consideration shall be given to designs utilizing self-supporting armless single pole construction, with vertical alignment of wires and cables, or other techniques permitted by the utility, industry or governmental standards or codes that are also conducive to a safe traffic environment. Exceptions to these clearances may be made where poles and guys may be placed behind existing barriers, guardrails, beyond deep drainage ditches, the toe or top of steep slopes, retaining walls and other similar protected locations, or when poles are of a breakaway type manufacture. [11/15/96]
14.9.7 Where irregularly shaped portions of the right-of-way lines extend beyond the normal right-of-way limits, individual consideration will be given to requests for variations to maintain a reasonably uniform alignment for longitudinal, aerial or underground utility facility installations. [11/15/96]

14.9.8 Longitudinal installations of utility facilities shall not be permitted in the highway median. In rare instances, aerial components of utility crossings may be permitted in a highway median in excess of 24.38 m (80 feet) in width, if the highway is not access controlled. [3/10/71, 11/15/96]

15. INSTALLATIONS ON HIGHWAY STRUCTURES: Attachment of utility lines to a highway structure can materially affect the capacity of the structure, the safe operation of traffic, the efficiency of maintenance and reducing the aesthetic appeal of the structure. [3/10/71, 11/15/96]

15.1 Where it is feasible to locate utility lines elsewhere, attachments to highway structures should be avoided. However, when installation of the utility at an alternate location proves to be extremely difficult or unreasonably costly, consideration will be given for an attachment of utility lines to a highway structure. The attachment shall be made by a method acceptable to the Bridge Engineer of this Department. [3/10/71, 11/15/96]

15.2 All proposed attachment methods shall conform to adequate engineering considerations for preserving the highway structure's integrity, safety, ease of maintenance, and its appearance. In this respect, the following considerations shall govern: [3/10/71, 11/15/96]

15.3 Due to variations in highway structure designs and site specific considerations, it is not feasible to completely standardize the method by which utilities are attached to structures. Therefore each proposed attachment shall be considered on its individual merits, and shall be individually designed for the specific structure. [3/10/71, 11/15/96]

15.4 Utility line attachments to a highway structure shall not be considered unless the structure in question is of a design, age, and physical condition that is adequate to support the additional load and accommodate the utility without any compromise of the highway features, including reasonable ease of maintenance. [3/10/71, 11/15/96]

15.5 Attachment of a pipeline carrying a hazardous transmittant to a highway structure shall be avoided whenever possible. When such an attachment is permitted, the facility design shall be at a level to provide maximum safety. [3/10/71, 11/15/96]
15.6 Utility positioning on a highway structure which will inhibit access to any structure part for maintenance shall not be allowed. Utility access manholes shall not be allowed in a structure deck or load carrying member. [3/10/71, 11/15/96]

15.7 The entire utility installation on a highway structure shall be so located as to not reduce the vertical clearance otherwise available above river, stream, roadway surface or rails. In general, acceptable utility installations are those designed to occupy a position beneath the deck and in an interior bay of an I Girder Beam, or within a cell of a Box Girder Bridge. Installations shall always be above the bottom of girders on a Girder Bridge or above the bottom of the bottom cord on a Truss Bridge. [3/10/71, 11/15/96]

15.8 Utility line attachments to the visible outer portions of structures are unsightly, susceptible to damage, and shall not be permitted unless there is no reasonable alternative. [3/10/71, 11/15/96]

15.9 Utility line mountings shall be of sufficient strength to carry the weight of the utility and shall be of a type which will not rattle or loosen through vibrations caused by vehicular traffic. This is a matter of particular concern on steel structures. Utility attachments shall be designed to accommodate differences in thermal movements between the highway structure and the utility. [3/10/71, 11/15/96]

15.10 Where a utility facility is to pass through an abutment wingwall or other wall of a highway structure, the utility is required to neatly restore the disturbed construction by approved methods which shall preclude any leakage of water or backfill through the substructure elements. Where such construction is approved, any hole created in the highway structure shall be of a minimum size necessary for the installation. The annular space between the structure and pipe shall be completely filled with grout so as to seal the opening and effectively preclude the leakage of any moisture or backfill material through the substructure. Where a pipe or conduit is to be sleeved (cased) through the structure, the sleeve shall be tight sealed into the opening, and the annular space between the pipe conduit and the sleeve shall be sealed with a Department approved material. [3/10/71, 11/15/96]

15.11 Acceptable utility attachment methods are hangers or roller assemblies suspended from the underside of the bridge deck, or from hanger rods clamped to the flange of some superstructure member. Bolting through the bridge floor or deck shall not be permitted. Where there are transverse floor beams sufficiently removed from the underside of the deck to allow adequate clearances for the utility, the Bridge Engineer may consider a proposal to support the utility line on top of the floor beams. [3/10/71, 11/15/96]

15.12 Clearances of utility facilities from bridge members shall conform to all governing codes, and shall be such as not to render any portion of the structure inaccessible for
any maintenance or other highway function. [3/10/71, 11/15/96]

15.13 The utility shall be required to make satisfactory provisions for lineal expansion and contraction of its facility as a result of temperature and pressure differentials. Line bends or expansion couplings are generally used for this purpose. [3/10/71, 11/15/96]

15.14 The utility shall restore or repair any portion of the structure or highway disturbed or damaged by utility installation or use. [3/10/71, 11/15/96]

15.15 If weatherall steel is utilized in the highway structure, utility attachments shall be of similar material. [3/10/71, 11/15/96]

15.16 A pipeline carrying volatile fluids, pressurized gas, water or sewage poses an element of risk when mounted on a highway structure. When such a carrier is placed in a casing pipe of leakproof construction, the hazard to the utility, the highway facility, and the traveling public can be minimized. It is good practice to case all such pipeline attachments through the highway structure. The casing pipe should be carried beyond the back of the structure abutment and be effectively vented at each end to detect leakage and prevent possible build-up of pressure. In addition, all welds shall be tested by non-destructive means. [3/10/71, 11/15/96]

15.17 Where a casing is not provided for a pipeline attachment to a bridge, additional protective measures shall be taken. Such measures shall include, but are not limited to, higher safety factors in design and pressure testing. The safety design factor shall be twice that normally used. [3/10/71, 11/15/96]

15.18 Communication and electric power line attachments shall be suitably insulated, grounded and carried in a protective steel conduit or pipe from below the point of ground exit, to below the point of ground re-entry. Carrier pipe and casing pipe shall be suitably insulated from electric power lines. [3/10/71, 11/15/96]

15.19 All pipeline attachments carrying gas or liquid under pressure, which by nature of the transmittant might cause damage or injury if the transmittant escapes on or in the vicinity of the highway structure, shall be provided with emergency shutoff valves of automatic design. Such valves shall be placed within an effective distance on each side of the structure. Exceptions to this rule may be considered by the Engineer, upon written justification submitted by the utility. [3/10/71, 11/15/96]

15.20 The responsibility of the utility owner requesting a bridge or highway structure attachment cannot be overstressed. The utility shall ascertain the extent of the Department's design requirements prior to initiating the design for attachment. A Registered Professional Engineer experienced in structural design shall be responsible for the design effort. Complete plans showing all details of the proposed work,
together with pertinent design documents shall be prepared and submitted, along with the New Mexico Public Highway Utility Accommodation Permit Application. Traffic control plans must also accompany the permit. The plans must be complete and adequate enough to show in detail the full extent of the proposed work. [3/10/71, 11/15/96]

15.21 All materials integrated into the design must be certifiable for quality and strength, and full specifications must be provided in support of the design. [3/10/71, 11/15/96]

15.22 A complete written justification must support the need for attachment and demonstrate that there is no viable cost effective alternative. [3/10/71, 11/15/96]

15.23 All components of the utility attachment shall be protected from corrosion. Steel components shall be galvanized or painted in accordance with current Standard Specifications For Highway And Bridge Construction. [3/10/71, 11/15/96]

16. CLEAR ROADSIDE POLICY: The Department discourages the installation or relocation of any utility facilities within the designated clear zones of highways in this state. However, if severe space limitation precludes any other viable option, consideration will be given when the public need for utility services and access to properties adjacent to highways or streets is evaluated. [11/15/96]

16.1 Specific Installation Guidelines: Utilities may be permitted to install facilities within the clear zones of highways in this state if the installation design: [11/15/96]

16.1.1 Is approved by the Engineer, District Engineer, District Traffic Engineer, or the Traffic Design Engineer of this Department. [11/15/96]

16.1.2 Provides for the installation of the utility facilities, including all supporting appurtenances, below the ground surface of the clear zone area involved. [11/15/96]

16.1.3 Provides for the protection of the above ground utility facility by the installation of an intervening barrier or barriers, crash cushions, impact attenuators or longitudinal barriers approved for the use as per the current Roadside Design Guide. [11/15/96]

16.1.4 Protects errant vehicles from collision with utility poles, luminaire standards or masts, or any other above ground structures supported by poles, by the incorporation of break-away features in the structure design. Break-away features may include a hinge design, slip plate design, slotted fuse plate design, frangible coupling design and other
accepted designs. The utility owner must comply with the design standards set forth in the AASHTO designs and specifications when accepted by the Traffic Design Engineer, or District Traffic Engineer. [11/15/96]

16.2 **General Requirements:** In evaluating whether to allow utilities in the clear zone, utility owners must provide the Department with a complete justification in support of a request to install utilities within the clear zone. This justification must include: [11/15/96]

16.2.1 Comprehensive information to support the utilities contention that no other viable location is available. [11/15/96]

16.2.2 That an installation on nearby adjacent right-of-way would be prohibitively expensive. [11/15/96]

16.2.3 That a right-of-way corridor nearby would adversely affect wetland or agricultural lands or areas of scenic enhancement. [11/15/96]

16.2.4 The utility must provide the Department with completed and comprehensive plans and specifications, including: [11/15/96]

16.2.4.1 Grades and elevations tied by survey to the design grade of the highway segment involved. [11/15/96]

16.2.4.2 A clearly defined clear zone, shown on the utility's plans, along with details and elevation views. [11/15/96]

16.2.4.3 Plan, profile and details of underground utility installations. [11/15/96]

16.2.4.4 Any additional information in support of the design. [11/15/96]

17. **THE ACCOMMODATION OF UTILITY FACILITIES WITHIN FREEWAY OR INTERSTATE RIGHT-OF-WAY:** Pursuant to Federal Highway Administration (FHWA) regulations regarding the accommodation of longitudinal utility facilities within the access control limits of Freeways and Interstate Highway rights-of-way, the Department will allow under controlled circumstances, the placement of longitudinal utility facilities within the access control limits of the Interstate System or other fully access controlled Freeways. These regulations do not apply to utility lines for servicing facilities required for the operation of the Freeway. [11/15/96]

17 NMAC 4.2
17.1 Term and Cost of Permit: Permits for longitudinal utility facilities within the access controlled Freeways shall have a term as set by the Engineer, but in no event shall the term exceed twenty-five (25) years. The Engineer may impose charges, fees or other compensation or consideration as may be reasonable for the occupancy of the right-of-way by the utility. The permit shall be subject to any other reasonable conditions deemed appropriate by the Department under the circumstances.

Even though payment may be made by the utility to the Department, no permit shall be exclusive, meaning the Department may issue additional permits to other utilities within the same Freeway right-of-way. [6/15/96; 17 NMAC 4.2.8.1, 17 NMAC 4.2.8.3, 17 NMAC 4.2.8.5, 11/15/96]

17.2 Physical Location of New Longitudinal Utility Facilities along Interstate Highways and Freeways: New utilities to be installed longitudinally within the control of access lines of any freeway shall be subject to controlled conditions, and the utility requesting permits must meet the following requirements:

17.2.1 The accommodation will not adversely affect the safety, design, construction, maintenance or stability (integrity) of the Freeway.

17.2.2 The accommodation will not interfere with or impair the present or future use, or future expansion of the Freeway.

17.2.3 Any alternative location would be contrary to the public interest. This determination must include an evaluation of the direct and indirect environmental and economic impacts resulting from disapproval of the use of such right-of-way for the accommodation of the facility.

17.2.4 If by reason of any change in the location, construction, grade or by any other matter affecting the highway upon which any facility is located because of changing traffic conditions or otherwise, it shall become advisable in the opinion of the Engineer that said facility be removed, relocated or otherwise modified, the utility, upon written notice from the Engineer, shall remove, relocate or modify such facility without undue delay in such manner as the Engineer may direct or approve, at the utility's expense and at no cost to the Engineer. All facilities located on public right-of-way under the dual jurisdiction of the State and a subordinate governmental entity shall comply with all applicable rules and regulations of such entity properly and lawfully in force and including but not limited to provisions of local franchises not in conflict with the rules and regulations of the Engineer. The Engineer makes no warranty, either express or implied, as to the continued existence of any highway in any particular location and expressly
assumes no obligation with regard to the facility upon change, vacation or abandonment of any highway or portions thereof.

17.2.5 If approval for installation is granted, any and all utility installations and components associated thereto shall be buried parallel to the Freeway, and shall be located within 1.52 m (5 feet) of the access control line, wherever practicable. Surface components of buried facilities, i.e., valves, manholes, vents, etc., shall be located as close as possible to the access control line. The high point of structural elements such as manholes, vaults, and anchor blocks, shall be at or below the natural ground line of the right-of-way surface. All buried facilities will be installed at a minimum depth of 0.91 m (36 inches) or more from the right-of-way surface to the top of the facility. All trenches and ditches will be backfilled and compacted by the facility installer to the satisfaction of the Engineer. All excavations outside the roadway foreslopes shall be compacted to a density equal to the surrounding soil. All excavations within the toes of the foreslopes shall be compacted to ninety-five percent (95%) of maximum dry density as determined by a Standard Compaction Test, Modified Proctor Method T-99 or equivalent. Parallel ditches in excess of 106.68 m (350 feet) in length shall not remain open over 24 hours. Any excavations on or near the traveled way shall not remain open overnight. All future relocations or adjustments shall be the responsibility of the utility and shall be at the sole expense of the utility.

17.2.6 No service connections shall be allowed from within access controlled facilities.

[6/15/96; 17 NMAC 4.2.8.2, 17 NMAC 4.2.8.4, 17 NMAC 4.2.8.6, 17 NMAC 4.2.8.7, 11/15/96]

17.3 Existing Utility Facilities Along Proposed Interstate Highways or Freeways: Where a utility facility already exists within the proposed right-of-way of an Interstate Highway or Freeway and it can be serviced, maintained and operated without access from the through-traffic roadways or ramps, it may remain as long as it does not adversely affect the safety, design, construction, operation, maintenance or stability of the Interstate Highway or Freeway; otherwise it must be relocated. [11/15/96]

17.4 Major Valley Crossings, Grade Separation Structures: Where an Interstate Highway or Freeway crosses a major valley or river on an existing structure, any utility facility carried by said structure at the time the highway route is improved may continue to be so carried when a relocation of the facility would not be cost effective, and provided
that the utility facility could be serviced without interference with road users. All such approvals must be first cleared by the Department's Bridge Engineer.

The expansion of a utility facility carried by an existing structure may be permitted provided the utility installed on the existing structure fulfills the methods of installation required by the Department's Bridge Engineer, and that any such installation can be serviced without interference with the road users.

A new utility facility will not be permitted to be installed on a structure at or after the time the highway route is improved, except for special cases as covered in Paragraph 15, supra. [11/15/96]

17.5 **Utility Facilities Crossing Interstate Highways**: New utility facility installations or the relocations of existing facilities may be permitted to cross Interstate Highways or Freeways. To the extent feasible and practical, they should cross on a line generally normal (crossing at 90 degrees) to the highway alignment and preferably under the Interstate Highway or Freeways. [3/10/71, 11/15/96]

17.6 **Utilities Along Roads or Streets Crossing Freeways**: Where a utility follows a crossroad or street which is carried over or under a Freeway, provision shall be made for the utility to cross the Freeway at the location of the crossroad or street in such a manner that the utility can be serviced without access from the through-traffic roadways or ramps. Generally, the utilities are to be located within the right-of-way of the crossroad or street (existing or relocated) and may cross over or under the Freeway or be carried on or through the highway grade separation structure, provided the installation and servicing thereof can be accomplished without access from the through-traffic roadways or ramps.

Where distinct advantage and appreciable cost saving are effected by locating the utilities outside the right-of-way of the crossroad or street, they may be so located, with written approval of the Department, in which case they shall be located and treated in the same manner as utility lines crossing the Freeway at points removed from grade separation structures, as in Paragraphs 17.7 and 17.8. [11/15/96]

17.7 **Overhead Utility Crossings**: Overhead utility lines crossing a Freeway at points removed from grade separation structure, or those crossings near a grade separation but not within the right-of-way of a crossroad or street, in general, shall be adjusted so that the supporting utility pole and structure are located outside the outer edges of the through-traffic roadway side slopes and preferable outside the access control lines. In any case, supporting poles shall not be placed within the appropriate clear zone as designated in the current AASHTO publication "Roadside Design Guide, 1989," and as may be updated from time to time.
Supporting poles may be placed in medians of sufficient width to provide for the previous mentioned clear zones from the edges of both roadways. If additional lanes are planned, the clear zone shall be determined from the ultimate edges of the roadway to be built. Where control of access and right-of-way lines are not one and the same, and where frontage roads are provided, supporting poles may be located in the areas between them. In extraordinary cases where such spanning of the roadway is not feasible, consideration may be given to conversion to underground facilities to cross the highways.

At interchange areas, in general, support for overhead utility facilities will be permitted only where all of the following conditions are met:

1. A clear zone is provided with respect to the freeway through-traffic lanes;
2. The appropriate clear zone from the edge of the ramp is provided as designated for the specific condition in the AASHTO publication, "Roadside Design Guide, 1989," which may be updated from time to time;
3. Essential sight distance is not impaired;
4. The conditions of Paragraph Section 17.12 "Access for Servicing Utilities" are satisfied; and
5. The vertical clearance to overhead utility lines crossing freeways shall be determined by the Department, but in no case shall they be less than the vertical clearances required by the current National Electrical Safety Code.

[11/15/96]

17.8 Buried Utility Crossings: Buried utilities shall be of durable materials and so installed as to virtually preclude any necessity for disturbing the roadways to perform maintenance or expansion operations. The design and type of materials shall conform to standards and installations outlined in Paragraphs 13 and 14 of this regulation, or to the appropriate governmental or industry codes, rules and specifications, whichever is more restrictive.

Manholes and other points of access to underground utilities may be permitted within the right-of-way of a freeway if (1) they are located beyond the shoulder of the through-traffic roadways or ramps, and (2) can be serviced or maintained without access from the through-traffic roadways or ramps. [11/15/96]

17.9 Irrigation Ditches and Water Canals: Except for necessary crossings, irrigation ditches and water canals shall be excluded from the right-of-way of Freeways, except for
special cases as covered in Paragraph 17.2. Crossings may be made by underground siphon or through culverts or on bridges as appropriate to the size of the canal, topographic condition and highway safety aspects. In general, locations and structure are to be selected and designed in the same manner as are facilities for natural transverse drainage.

All ingress and egress for servicing or patrolling such irrigation facilities shall be from outside the control of access lines. The procurement of necessary ingress and egress is the responsibility of the irrigation ditch and water canal owners. Ditch-walkers or ditch-riders shall not be permitted to indiscriminately cross the Freeway at grade. Under appropriate traffic control arrangements, special ditch cleaning equipment may be permitted to cross in those cases where considerable travel distance would otherwise be required to utilized grade separation structures. [11/15/96]

17.10 Provisions for Expansion of Utilities: When existing utilities are relocated in conjunction with the construction of a Freeway, provision shall be made for known and planned expansion of the utility facilities, particularly those underground. They shall be planned to avoid interference with traffic at some future date when additional or new overhead or underground lines are installed. [11/15/96]

17.11 Utilities in Vehicular Tunnels: As a general rule, utilities shall not be permitted to occupy vehicular tunnels on freeways at new locations, except in special cases as covered in Paragraph 17.2.

Utilities which transmit a hazardous commodity shall not be allowed in a vehicular tunnel under any circumstances.

When a utility is located in an existing vehicular tunnel that is converted to a freeway, relocation of the utility may not be required, at the Department’s discretion. Utilities not occupying an existing vehicular tunnel that is incorporated into a freeway shall not be permitted therein, except in special cases as covered in Paragraph 17.2. [11/15/96]

17.12 Access for Servicing Utilities: Access for servicing a utility along or across a freeway shall be limited to access via frontage roads where provided; nearby or adjacent public roads or streets; or trails near the highway right-of-way lines, connecting only to an intersecting road, from any one of which entry may be made to the outer portion of the freeway right-of-way.

In those special cases where utility supports, manholes or other appurtenances are located in medians or interchange areas, access to them from through-traffic roadways or ramps may be permitted, but only by utility accommodation permits issued by the Department to the utility owner setting forth the conditions for policing and other controls to protect the traveling public.

17 NMAC 4.2
Utilities requiring maintenance from within the Freeway right-of-way must obtain an approved utility accommodation permit from the Department before accessing the utility from within the Freeway.

Advance arrangements, when practicable, shall be made between the utility and the Department for emergency repair and maintenance work within the rights-of-way of Freeways. [11/15/96]

17.13 Construction and Location Details: The Department shall review and approve the location and the design of all utility installations and relocations affecting highways under the jurisdiction of this Department and issue New Mexico Public Highway Utility Accommodation Permits for any contemplated work on these highways. [11/15/96]

17.14 Manner of Making Utility Installations and Relocation: In general, utility installations and relocations are to be made with consideration for highway and utility costs; maximum safety to the traveling public; the least possible interference with the highway facility and its operation; not increasing the difficulty or cost of highway maintenance to the Department; and all installations and/or relocations must have prior review, appropriate approvals and the associated documentation required by Departmental Authority. [11/15/96]

18. SAFETY MARKERS FOR IDENTIFICATION OF ABOVE GROUND UTILITY APPURTEANCES, WITHIN PUBLIC HIGHWAY RIGHT-OF-WAY: Buried utility facilities with supporting above ground appurtenances shall be marked as follows: [11/15/96]

18.1 All existing buried utilities, including pipeline carriers, delivering natural gas or other gaseous products, water, sewage, steam, buried electric lines, telephone and other communication systems, petroleum products, and any other buried facilities with above ground appurtenances thereto located within the rights-of-way of highways under the jurisdiction of the Department shall have such above ground appurtenances clearly marked with the appropriate warning markers as described herein. [11/15/96]

18.2 Above ground appurtenances to all buried utility systems such as pipeline valves, regulators and the like, pad mounted transformers, telephone pedestals, junction boxes and the like, shall be identified with a yellow, red, orange or other appropriate industry colored flexible fiberglass restorable blade, four feet six inches (1.65 m) minimum height above the ground surface. It shall be color coded a minimum of six inches (150 mm) in height and three inches (75 mm) width at the top of the blade. The blade shall be visible in all directions. The color coded portion of the marker shall be at least two feet (.61 m) above the surrounding high grass, weed or shrubbery line. [11/15/96]

18.3 The utility owner shall maintain the markers in good condition; color faded markers
shall be replaced as necessary so that their visibility to maintenance crews and others is not impaired. The markers shall not be placed within the Access Control Lines of Interstate Highways or Freeways in a manner that would create a safety hazard, or by methods contrary to this regulation. [11/15/96]

18.4 The utilities shall commence the placement of these markers on new facility installations within public highway rights-of-way thirty (30) days after the date this new statutory regulation is approved and becomes effective (the approval and effective date is that date inscribed on page one (1) of this rule). The utilities are also directed to make these marker installations on existing utility facilities on a continuing basis whenever their maintenance crews are repairing or maintaining their existing facilities located within the public highway right-of-way of this State in rural areas and/or on certain designated public highways within municipalities. [11/15/96]

18.5 Variances not involving significant changes to the marker specifications detailed herein or the rules governing the installation of utilities within the access control lines, set forth in Paragraph 17 herein, may be approved by the Engineer or their representatives, upon the submittal by the utility owner of a written detailed justification supporting the variance requested. [11/15/96]

18.6 During this marker installation process, the utility shall observe all appropriate regulations stipulated herein pertaining to the installation of utility facilities within the public highway right-of-way under control of this Department. [11/15/96]

19. **UTILITY RELOCATIONS AND REIMBURSEMENT**: The Department develops their annual highway construction schedule based upon engineering studies conducted on an ongoing basis, that determines when and where highway construction projects will be let to contract. In the early stages of development, the Railroad & Utility Section of the Department or its approved representative will begin discussions with utility owners who are thought to have portions of their facilities in conflict with the proposed highway construction features. This section sets forth the regulations pertaining to eligibility for utility relocation reimbursement, methods and scheduling of the utility relocation work required, and the documentation and record keeping required when the expenditure of public funds is involved. [11/15/96]

19.1 **Public and Private Utilities**: Statutory reimbursement regulation pertains only to utilities. Utilities that have to be relocated or removed from the right-of-way will be handled in accordance with the terms of the New Mexico Public Highway Utility Accommodation Permit and these regulations. The relocation of a private utility, situated on private land and not dedicated to public use, is to be handled as a right-of-way taking consideration. A private utility on public right-of-way will be handled in accordance with terms of the permit and these regulations. [3/10/71, 11/15/96]

17 NMAC 4.2 52
19.2 **Interstate Highway Projects**: On Interstate highway projects only, the required relocation of public utility facilities within existing public right-of-way is generally eligible for reimbursement by the Department, unless the facilities were installed with knowledge of future conflict, or as documented in an approved New Mexico Public Highway Utility Accommodation Permit which defines the future obligation of the utility owner. Facilities owned by a public utility that are situated on lands, easements or other properties, in which the owners have a documented compensable property right thereto, and which utilities shall be relocated because of conflict with highway features are also reimbursable to the utility owner. [3/10/71, 11/15/96]

19.3 **Other State Highway Projects**: On any type of state highway project (other than Interstate Highways) where the utilities are located on private right-of-way, and the owner holds a documented compensable property interest therein, the relocation required of the owner is compensable to the owner under the Department's regulations providing for reimbursement. On any Non-Interstate Projects where public utility facilities are located within existing public rights-of-way, the relocation cost is not eligible for reimbursement, unless the utility facility occupies the right-of-way under a Joint Use Agreement, issued and approved by the Department, which authorizes reimbursement issued and approved by the Department. [3/10/71, 11/15/96]

19.4 **Other Highway Projects Involving Public Funds**: On any highway project where public utility facilities have once been relocated to the satisfaction of the Department for a specific highway project, but due to a revision or change in plan on the same highway project an additional complete or partial relocation is required, and the Department directs the utility to relocate all or some of their facilities by written instruction, then the additional complete or partial relocation costs are reimbursable to the utility owner by the Department.

If additional relocations are required due to errors, omissions or faulty workmanship performed by the utility owner, their personnel and/or those engaged by the utility, or if any of these parties fail to complete the relocation in accordance with the Utility Adjustment Agreement, the utility relocation plans, specifications, and/or contract documents, the utility shall make any correction required as directed in writing by this Department. This remedial work will be at the sole expense of the utility owner, including administrative costs incurred by the Department pertaining to the remedial work, regardless of the cost responsibility for the previous relocation.

On projects where overhead utilities that occupy public right of way have to be buried because of safety, environmental, archeological, aesthetic, or highway construction considerations, such relocation from overhead to underground shall be performed at the expense of the utility owner.

Should any highway construction delay claims be paid by the Department because of
unreasonable actions or inaction by the utility owner, all costs associated therewith shall be reimbursed to the Department by the utility within ninety (90) days of receipt of a reimbursement request. [11/15/96]

19.5 Special Districts, Municipalities and Counties: Pursuant to NMSA 1978, Section 67-8-21, financial assistance will be provided by the Department to special districts, municipalities and counties to relocate utilities if they can demonstrate they are unable to pay for the relocation costs themselves.

To qualify for relocation costs, the special districts, municipalities and counties must officially notify the Department in writing that they have made a determination that utility relocation will be necessary as a result of a highway project. The notification must be explicit in terms of the need to relocate specific utilities and the need for financial assistance. It must also be specific as to whether the need is for engineering and design services, relocation construction or both.

All reimbursement requests shall be considered on their individual merits and shall be forwarded to the Department for handling. All requests shall include the following as a minimum:

1. A written request for reimbursement by an authorized representative of the utility.

2. Letter of Transmittal, along with the following items:

   (a) Copies of Utility Permits or other instruments authorizing the placement of utilities in their present location.

   (b) Resolution by the appropriate governing body regarding the need to relocate utilities and the need for financial assistance, pursuant to relevant State statutes.

   (c) Financial Statement that is current and sufficiently detailed for the State Department of Finance and Administration to perform an analysis and make an informed decision regarding the entity's financial condition.

   (d) Current fiscal year budget as required by the local Government Division of the Department of Finance and Administration.

Reimbursement for the cost of relocation shall be made only after the provisions of this regulation have been fulfilled and after the State Department of Finance and Administration, Local Government Division issues an official finding.
In the event the Department of Finance and Administration is unable to make a determination as to financial condition or the determination is not made in a timely manner, the Department shall then make such a determination.

[11/15/96]

19.6 Documentation Required to Determine Eligibility for Reimbursement: It is mandatory that a utility facility owner provide the Department with copies of their land use documentation to substantiate their right to occupy the public and private land affected by the proposed highway construction. If a utility owner is seeking reimbursement under New Mexico State Law, the right to compensation must be justified and substantiated by documented proof of the utilities existing compensable property rights. The Department will not reimburse a utility owner for any utility relocation occasioned by the construction of highway project unless the utility can prove their right to be paid. The documentation shall include copies of any land use conveyances, including Deeds, Easements, Permits, Land Use Agreements and any other documentation acceptable under the Laws of the State of New Mexico providing for transfer, sale and use of land, including a claim for prescriptive rights or adverse possession. [3/10/71, 11/15/96]

20. UTILITY RELOCATION PROCEDURES: The following procedures shall be followed to assure the proper completion of utility relocation necessitated by the State Highway Program. To provide uniformity and avoid duplication, these procedures shall be followed on all State Highway Projects whether or not Federal Aid participation is involved. The FHWA's reimbursement to the New Mexico State Highway and Transportation Department will be governed by State Law and State Regulations, as well as the Code of Federal Regulations, Title 23, Part 645, Subpart A and Subpart B. When State Law or Regulation differs from the aforementioned Code, (Part 645, Utilities), a determination shall be made by the Department, subject to concurrence by FHWA, as to which standards shall govern, and the record will be documented accordingly for each relocation in which the differing procedural action is undertaken.

The Department shall develop a Utility Cooperative Agreement for handling the relocation of utilities. The Agreement shall clearly stipulate the responsibilities of each party for financing and accomplishing the relocation work, shall incorporate the appropriate regulation(s) by reference and designate the method to be used for performing the work. The method for developing all relocation costs, including engineering and relocation construction, shall be acceptable to the Department and to the Federal Highway Administration on Federal Aid projects.

When applicable, the Agreement shall specify the terms and amounts of any contributions or repayments made or to be made by the utility to the Department under eligibility provisions of State Laws and Federal Regulations. When the relocation involves both work to be done
at the Department's expense and work to be done at the expense of the utility, the Agreement shall state the share to be borne by each party.

Except as otherwise provided by this Agreement, authorization by the Department to the utility to proceed with the relocation work may be given after it has been included in an approved program and fulfills State and Federal requirements.

If the utility does not have the necessary resources to perform the relocation, such work may be done as follows:

1. A contract awarded by the utility to the lowest qualified bidder based on appropriate procurement procedures;

2. Inclusion as part of the Department's highway construction contract let by the Department as agreed to by the utility; or

3. An existing continuing contract, provided the costs to the Department are reasonable.

All contract work performed for the utility under a contract let by the Department shall be reported separately from the other contract items on the highway project.

All utility relocation costs shall be recorded by means of work orders in accordance with a work order system approved by the Department, except when another method of developing and recording costs, such as a lump-sum agreement, has been approved by the Department, and the Federal Highway Administration when applicable. The utility shall keep its work order system or other accounting procedure approved by the Department in such a manner as to show the nature and cost of each item. The current Federal Aid Policy Guide shall be used as a guide for all cost development and reimbursement matters. All reimbursed costs shall be subject to state audit for a period of three years following the date of final payment.

[3/10/71, 11/15/96]

20.1 Locating Utilities: On all proposed highway construction and/or maintenance projects, utilities shall be located horizontally, vertically, shall be identified as to type and ownership, and their locations tied to the project center line. The locating process should meet, as a minimum, survey requirements outlined in the Department's Survey Manual, unless otherwise specified. Railroad facilities must also be treated as a utility, the facilities located and tied to the center line of track or other railroad structure, and referenced to existing railroad mile posts.

The location should be conducted early enough in the project development process so as to allow for inclusion of the utility and railroad information in the highway construction Field Design Inspection plans. [11/15/96]
20.2 **Location Stage:** The Railroad and Utility Section of the Department shall become involved at the inception of each State Highway Project. The earliest conceptual design information available shall be reviewed to determine whether possible serious utility conflict can be avoided by minor highway alignment revisions without undue added cost. The assigned Agent should discuss the possibility of alignment changes with the assigned Project Development and Design Engineers as appropriate, and any other observations that have been made that might improve cost benefits to the project concerning the utility facilities. Liaison with the utility owners involved shall begin at this stage to avoid the installation of new utilities by the utility owners that could conflict to an even greater extent.

If preliminary right-of-way maps are available, a preliminary review could disclose the extent of the utility involvement and give the Agent a workable idea as to the eligibility each owner may have for utility relocation reimbursement. Preliminary coordination meetings with all of the affected utilities in attendance should serve to avoid future problems concerning where each utility owner must place their relocated utilities to avoid conflict with the other utilities involved. [3/10/71, 11/15/96]

20.3 **Project Programming Procedures:** Utility adjustments eligible for reimbursement on Federal-Aid Highway Projects shall be programmed in accordance with the requirements set forth in Title 23 of the Code of Federal Regulations, Part 630(A). Generally, utility relocations and utility relocation engineering will be programmed when the initial state highway project programming is accomplished. Preliminary Engineering for the use of Consultant Engineers engaged by the utility owner will be programmed each time these services are required and authorized by the Department and the FHWA.

The utility lead time cannot commence until the Utility Section has access to plans sufficiently completed to permit the utilities to design their relocations. Therefore, the plans should be in the post Grade & Drain or pre-Plan-in-Hand stage, with definite line grades, right-of-way, access control and other major features shown before they may be sent to the utilities with the formal authorization to proceed with their preliminary engineering. Prior to this stage, any plans provided to utilities must clearly be marked as "preliminary" with a statement that they are not yet authorized to proceed on any basis. [3/10/71, 11/15/96]

20.4 **Preliminary Engineering:** Before preliminary engineering is authorized on a project, the basic eligibility for reimbursement of utility adjustment cost must be determined from a plan review. This eligibility is to be in conformity with the reimbursement policy set forth in Paragraph 19 herein. Plan review will, in most cases, resolve questions of such eligibility. [3/10/71, 11/15/96]

20.5 **Engineering by Utility's Staff, or a Consultant Engineer:** Preliminary engineering for
utility relocation design can be accomplished by any of the following methods:

(1) By utilization of the utility owner's engineering staff;

(2) By utilization of a consultant engineer selected by the Department after consultation with the utility owner; contract shall be administered by the Department with the consent of the utility; or

(3) By the utilization of a consultant engineer selected by the utility owner under a contract approved by the Department and FHWA; the contract shall be administered by the utility owner.

When the utility is not adequately staffed to perform the necessary preliminary engineering work related to the utility relocation on a State Highway Construction Project, Department and Federal funds may be used to reimburse the utility owner for amounts paid to engineers, architects, and others for allied services, provided such amounts are not based on a percentage of the relocation costs. The Department, utility owner and the engineering consultant shall agree in writing as to the services to be performed and the fee amount to be paid for the work in advance of the commencement of the engineering services agreed upon. The approval of these arrangements by the FHWA shall be obtained on all Federal Aid Projects.

State and Federal funds may participate in the cost of consultant engineering services performed on existing continuing contracts between the utility and the consultant when it can be demonstrated that such work is performed regularly for the utility at a reasonable cost.

The basic eligibility for reimbursement for the utility relocation costs must be determined from near final highway construction Plan and Profile Sheets developed after the Department's Grade and Drain Inspection. A utility owner must be otherwise entitled to utility relocation reimbursement costs to be eligible for payment for utility relocation preliminary engineering (PE). The PE written authorization is a commitment by the Department to reimburse the utility for PE, subject to compliance with these regulations.

If the utility relocation preliminary engineering is determined to be ineligible for reimbursement after the plan review, a non-reimbursable PE notice will be sent to the utility owner requesting that they commence their relocation design effort at their own expense, and on a schedule which would insure that the utility relocation construction would be completed in a timely manner.

If the project should be abandoned, postponed, or delayed by the Department, the utility is entitled to be paid for their design effort from the date of the PE authorization
to the date of abandonment, but only if the utility was eligible initially for utility relocation PE.

If a highway project is delayed, substantially revised or even abandoned and the utility has incurred engineering costs at the request of the Department, such costs are not eligible for reimbursement if the relocation is not reimbursable.

It should be noted by the utility owner that any costs incurred by the utility owner in the initial negotiation phase, including early engineering reviews and relocation planning, will not be reimbursed. The Department shall not be liable for reimbursing any utility PE costs prior to notification and proof by the utility of its compensable property rights and after the Department has provided the utility written authorization of its intent to reimburse the utility for its costs of relocation.

[3/10/71, 11/15/96]

21. **UTILITY RELOCATION ESTIMATES:**

21.1 **Developing and recording costs:** It shall be necessary to develop a cost estimate for the utility relocation engineering and construction. All reimbursable utility relocations shall be in sufficient detail to permit analysis and evaluation of all anticipated costs and all such costs shall be recorded by means of work orders in accordance with an approved work order system except when another method of developing and recording costs, such as a lump-sum agreement, has been approved by the Department and the FHWA.

Each utility shall keep its work order system or other approved accounting procedure in such a manner as to show the nature of each additions to or retirement from the facility, the total costs thereof, and the source of cost. As a minimum, each utility shall conform to the requirements of the Federal Aid Policy Guide on federal aid projects and/or to the Department's Estimate/Billing Guide.

In the event there are changes in the scope of the reimbursable utility work covered by the approved Agreement, plans and estimate, state and/or federal reimbursement shall be limited to costs covered by a modification of the Agreement, a written change order or extra work order approved by the Department, FHWA or both. [3/10/71, 11/15/96]

21.2 **Salvage, Accrued Depreciation, Betterments:** [3/10/71, 11/15/96]

21.2.1 Credit to the highway project shall be required for the cost of any betterments to the facility being replaced or relocated and for the salvage of the materials removed. [3/10/71, 11/15/96]
21.2.2 Credit to the highway project will be required for the accrued depreciation of utility facility being replaced such as a building, pumping station, filtration plant, power plant, substation, or other similar operational unit. Such accrued appreciation is that amount based on the ratio between the period of actual length of service and total life expectancy applied to the original cost. Credit for accrued depreciation shall not be required for a segment of the utility's service, distribution, or transmission lines.

When the facilities, including equipment and operating facilities, described in Paragraphs 21.2.1 and 21.2.2 are not being replaced but rehabilitated and/or moved, as necessitated by the highway project, no credit for accrued depreciation is needed. [3/10/71, 11/15/96]

21.2.3 Betterment credit shall not be required for additions or improvements which are:

21.2.3.1 Required by the highway project;

21.2.3.2 Replacement devices or materials that are of equivalent standards although not identical;

21.2.3.3 Replacement of devices or materials no longer manufactured with next highest grade or size;

21.2.3.4 Required by law under governmental and appropriate regulatory commissions code; or

21.2.3.5 Required by current design practices regularly followed by the company in its own work, and there is a direct benefit to the highway project.

[11/15/96]

21.2.4 In no event shall the total of all credits required under the provisions of this regulation exceed the total costs of relocation exclusive of the costs of additions or improvements necessitated by the highway project. [3/10/71, 11/15/96]

22. **RIGHT-OF-WAY DISPOSITION:** [11/15/96]

22.1 Replacement Right-of-Way: The Department and/or the FHWA may approve the acquisition of replacement right-of-way if the utility has the right of occupancy in its
existing location because it holds the fee, an easement or other real property interest, and the damaging or taking is compensable in eminent domain, and is necessary to meet the requirements of the highway project. Such replacement right-of-way shall only be allowed where no change to the project for the utility's existing right-of-way, being transferred to the Department for highway purposes, is made.

Any replacement right-of-way being paid for with state and/or federal funds shall be evaluated as to fair market value by a qualified and licensed New Mexico Real Estate Appraiser. A written evaluation/appraisal shall be accomplished and approved by the Department prior to acquisition.

Acquisition of replacement right-of-way by the Department on behalf of the utility may be accomplished when it can be demonstrated by the utility that it is not staffed to accomplish the acquisition or consultant services are prohibitively expensive or unavailable. Acquisition by the Department should coincide with other Department acquisition functions, if at all possible, and shall be approved by the Right-of-Way Bureau Chief. [3/10/71, 11/15/96]

22.2 **Joint Use of Right-of-Way:** When a utility occupies a utility corridor by virtue of an easement or other property interest, that is compensable under eminent domain laws, and the Department's highway project will envelop the utility corridor, the following regulation shall apply:

If the utility's facilities are in physical conflict with proposed highway construction features, the utility may opt to vacate the Department's newly acquired right-of-way, obtain replacement right-of-way and relocate its facilities to the newly acquired utility corridor/easement. All eligible costs incurred by the utility in this situation are reimbursable when properly documented and supported.

If the utility facilities do not conflict with proposed highway construction features and no relocation is necessary, they shall remain in place. When it becomes necessary to relocate the utility facilities, the Department shall reimburse the utility owner for all eligible expenses incurred for replacement right-of-way and relocation construction, if allowed under the terms of the permit. This one time future reimbursement obligation shall be documented by the issuance of a Joint Use Agreement, which defines future obligations of the Department to the utility. The Joint Use Agreement shall have no other purposes than those detailed herein, and shall not otherwise be issued by this Department.

In the event a utility relocation is necessary and vacation of the existing utility corridor/right-of-way to replacement right-of-way is not a viable option, the utility may opt to relocate to another location within the newly acquired highway right-of-way if no conflict between the utility facilities and highway features exists. The costs for this
utility relocation from utility right-of-way to highway right-of-way are reimbursable. Since this option has been granted for the benefit of the utility, at the utility's request, the Department will issue a New Mexico Highway Utility Accommodation Permit, after which time the utility owner shall be subject to the Permit provisions. This option does not deprive the utility owner of any land rights previously held, as the terms of the Permit grant the use of public right-of-way for a specific renewable time period. In the alternative, the utility may elect the option of locating completely outside highway right-of-way and under that option the utility would be eligible for relocation costs and replacement right-of-way costs. [3/10/71, 11/15/96]

23. **UTILITY RELOCATION/CONSTRUCTION DOCUMENTATION:** A complete review of all utility relocation documents shall be performed upon submittal to the Railroads and Utility Section by the utility. The review should demonstrate that the Agreement, Estimate and associated documents comply with State regulations and/or the Federal Aid Policy Guide. [11/15/96]

23.1 **Force Account:** When work will be performed by utility forces, the documentation shall include, 1) three (3) executed copies of the Utility Relocation Agreement, NMSHTD Form A-366; 2) three (3) completed copies of the completed Utility Relocation Questionnaire, NMSHTD Form A-365; 3) four (4) fully executed copies of the New Mexico Highway Utility Accommodation Permit Application, NMSHTD Form M-202 for each crossing and each longitudinal run, five (5) each if on the Interstate System; 4) four (4) executed copies of the Joint Use Agreement (if applicable), NMSHTD Form A-421; and 5) three (3) copies of the cost estimate; (6) three (3) copies of land use documents. [11/15/96]

23.2 **Continuing Contract Work:** In addition to items in Paragraph 23.1, a copy of a fully executed Continuing Contract that is in force and effect, along with appropriate cost estimates associated thereto, shall be provided if work is to be performed by an outside contractor under contract with the utility. [11/15/96]

23.3 **Contract Let Out to Bid:** If a contract is to be let out to bid to the lowest qualified bidder by the utility, the utility shall provide to the Department three (3) copies of each utility's relocation cost estimate, construction plans and contract documents. Such documents may be prepared by the utility owner or a consultant engineer engaged by the utility.

When the relocation will be let to contract with an ultimate award to the lowest qualified bidder, the utility's engineering staff or a consultant engineer engaged by the utility must prepare a construction plan assembly that provides adequate location plans and profiles, structure installation details, technical specifications, and other plans and details appropriate to the type of facility being relocated. One set of reproducible transparencies of these plans and/or acceptable electronic files shall be provided to the
Department.

The consultant or utility shall also prepare a written contract which includes the administrative terms of the contract, definition of the scope of the work, clauses for liquidated damages, clauses for labor relations, materials and construction performance specifications, bidding documents with bid unit tabulation sheets, materials quality certifications, special provisions, if any, and other contractual arrangements, usually assembled in the form of a bound book.

Prior to the advertisement and solicitation of bids, the utility owner shall supply the documents specified above and a list of prospective and qualified contractors to whom the utility has provided information concerning the utility relocation project that will be opened for bids. This documentation will be reviewed and approved by the Department. Prior to the actual solicitation of bids, the Utility must receive the Department's Authority to solicit bids, and an additional written authorization to award the contract after the bid opening. The Department's authorization to award the contract will be based upon the utility owner's written recommendation, stating that the contract is in order, and the amount bid is not excessive for the work to be performed. [11/15/96]

23.4 Utility Relocation As Part of the Highway Construction Project shall be documented as follows:

If the utility relocation is to be performed as part of the NMSHTD Highway Construction Project by the highway contractor, the utility must provide the Department with complete utility relocation construction plans in acceptable electronic and/or hard copy format, adequate enough to include/merge in the highway construction plan assembly. The utility must also provide complete installation specifications, which must be numbered to adhere to the specification numbering system used by the Department, and unit bid tabulations, for insertion in the highway bid units.

Each unit of the bid proposal must be estimated and an overall total obtained so the Department can review the unit cost of each construction item and program the overall utility relocation costs. A contract with a single lump sum bid item, for the total project, is not acceptable to this Department.

Close coordination with the Department's Contracts Specifications Section, and/or the Road, Bridge and Traffic Design Sections will be necessary to integrate the utility relocations into the highway construction project. Two (2) copies of all contract and bid documentation and one (1) set of the utility relocation plans in the form of reproducible transparencies and/or electronic file are required. [11/15/96]
24. **UTILITY CONSTRUCTION AUTHORIZATION**: After review and approval of the utility relocation documents, authorization to proceed with construction shall be provided by the utility owner. The authorization letter, over the signature of the Department's Railroads and Utilities Section Manager, shall detail the specific authorization being provided, i.e., by Force Account, by lowest qualified bidder, by a contractor under a continuing contract, or authorizing the utility to commence utility relocation in accordance with an approved Lump Sum Agreement between the Department and the utility; a Lump Sum Agreement shall not exceed $100,000.00, unless authorized by the Department or FHWA.

On non-reimbursable utility relocations, the Department shall authorize the utility owner to proceed with the relocation by written notice. The coordination between the Department and the utility should be no less than that required for reimbursable utility relocations. All authorizations to relocate shall include an advisory for the utility to coordinate their work with the appropriate District Construction Engineer and other utilities as appropriate.

The notice of authorization to proceed with relocation construction to the utility shall also include authorization for the District Construction Engineer to assign an inspector to ensure compatibility of highway features and utility locations. The Department's Railroad and Utility Section Agent shall send a copy of the notice to the District Construction Engineer. (See Paragraph 24.2 on Inspection.) [3/10/71, 11/15/96]

24.1 **Verbal Authorizations**: In urgent or emergency situations, verbal authorizations for the utility construction to commence may be made by the Department. On federal aid projects, concurrence from the FHWA shall be secured and documented by a memo to file prior to authorization. The utility should notify the Railroads and Utilities Section Manager by phone or in writing if the confirmation is not received within ten (10) working days, as undocumented authorizations may preclude reimbursement. [3/10/71, 11/15/96]

24.2 **Inspection of Utility Relocations**: Utility relocation inspection by the Department and/or the FHWA and the utility owner shall be performed during construction as necessary.

A trained technician from the appropriate District shall be assigned to inspect and verify the labor, materials and equipment used by the utility owner or utility contractor performing the utility relocation construction. The Department's assigned inspector shall assist the utility owner or its contractor in determining the planned location of the utility facilities, as taken from the utility relocation plans. However, it is the sole responsibility of the utility owners for the accuracy of utility relocation work, including, but not limited to, surveying and staking performed by its employees or the utility contractor's employees. It is also the sole responsibility of the utility owner to do all necessary inspections to ensure the integrity of utility construction, quality of materials being installed, construction methods, testing, and insure that the work is...
performed in a good and workmanlike manner.

Periodic inspection of utility relocation work shall be made, as necessary, by the Department's assigned Railroads and Utilities Relocation Agent. The Agent shall also assist the utility owner, as necessary, in defining the highway features shown on highway construction and/or right-of-way plans and in resolving problems the utility may encounter during construction. The Agent shall also assist highway project personnel, as necessary, to interpret utility relocation plans, estimates, agreements and any other utility relocation contract documents. [11/15/96]

24.3 Notification of Beginning and Completed Utility Relocation Construction: Once the utility has received authorization from the Department to construct, it shall notify the Department, a minimum of three (3) weeks in advance, of the date it will commence utility relocation construction. Such notification by the utility shall be provided on the Department's Form No. A-369, "Acknowledgment of Authority for Utility Construction." Upon completion of the relocation work, the utility owner shall so notify the Department in writing, of the completion. [3/10/71, 11/15/96]

24.4 Highway-Utility Preconstruction Conferences: When utility relocation is to be performed concurrent with highway construction, or if the relocation is not completed when the Department's contractor is scheduled to begin highway construction operations, a Utility Preconstruction Conference, either concurrent with the Department's or immediately following, should be held. The conference shall be called by the Department's Highway Project Manager and all affected utilities shall be invited to attend. The scheduling of the utility's relocation work shall be discussed and a sequence of construction developed to assure completion of utility relocation work as expeditiously as possible, without delay or conflict to the Department's Contractor.

Any highway contractor delay claims paid by the Department due to unreasonable utility owner or utility contractor actions or inactions shall be reimbursed to the Department by the utility owner. Any such actions or inactions shall be fully documented by Department personnel so as to substantiate reimbursement claims. [11/15/96]

25. BILLING AND AUDIT REQUIREMENTS: Payment to utilities shall be made only when the billings conform to State and Federal requirements, and are in sufficient detail so that each element is clear and its cost understood. Billings received prior to the appropriate authorization letter or that are inadequate or inaccurate shall be returned with appropriate correspondence to the utility.

Billings may be submitted on a progressive basis, but shall only include actual costs incurred; billings shall be identified as "first partial," "second partial," "final," etc. In all cases, billings shall be certified by the utility's auditor or person directly responsible for its accuracy.
It shall be the responsibility of the utility to ensure that final billings are submitted for payment within ninety (90) days of completion of the utility relocation work. Failure to submit billings within the ninety (90) day period may result in a penalty being assessed against the utility for five hundred dollars ($500.00) for amounts due the utility of twenty-five thousand dollars ($25,000.00) or less, and two and one-half percent (2.5%) for amounts due the utility that exceed twenty-five thousand ($25,000.00).

Any reimbursable amounts for utility work that remains outstanding (unpaid) for a period of one year from the date of completion of utility relocation work shall be forfeited by the utility. In such a situation, the Department will disencumber the funds previously authorized for reimbursement and such funds may revert to the state road fund.

When the utility performs reimbursable utility work, all utility records and accounts relating to the specific highway project are subject to audit by representatives of the State of New Mexico and the Federal Government for a period of three (3) years from the date of final payment. It shall also be the Department's prerogative to audit billings prior to reimbursement. [3/10/71, 11/15/96]

26. **RESOLUTION OF DISPUTES:** Disputes between the Department and utility owners regarding reimbursement eligibility, replacement right-of-way, utility/highway construction operations and other issues may develop. Most disputes are generally resolved at administrative levels, by staff more directly involved in the day to day operations of highway/railroads/utilities functions. Therefore, dispute resolutions shall begin with official notification to the Railroads and Utilities Section Manager. If a dispute is not resolved at the Railroad and Utility Section Manager level, the utility shall submit a request for hearing within thirty (30) days of the Manager's decision. Within a reasonable time, taking into consideration the nature of the dispute, a hearing shall be scheduled by the Department and a hearing officer appointed to conduct the hearing. The hearing officer's decision shall be final and the findings and orders shall be documented and made available to the appropriate parties. Any party aggrieved by any order may appeal to the District Court of Santa Fe County for a review pursuant to NMSA 1978, Section 67-8-19, as amended. A dispute involving eligibility for reimbursement or the amount of such reimbursement shall not be grounds for a delay in making an ordered relocation. The utility must suffer the relocation as ordered, pending the resolution of the dispute. [11/15/96]

27. **WAIVERS FOR THE PUBLIC GOOD:** The Secretary of the Department, at his/her discretion, may waive any regulation herein, if such waiver will not violate any State Statute or Federal Regulation, and it has been determined to be for the public good. The Secretary shall appoint a three member committee, one member which must be from the Department's Office of General Counsel, to consider the waiver and prepare an appropriate justification. [11/15/96]
RAILROAD COST AND MAINTENANCE RESPONSIBILITY ON HIGHWAY/RAILWAY PROJECTS: During the development or maintenance of some highway projects, it shall be necessary to coordinate with and secure approval from railroad companies to resolve conflicts between highway construction features or maintenance activities and railroad property and/or facilities. This section sets forth railroad eligibility for reimbursement by the Department for costs incurred in resolving such conflicts where construction of a highway project necessitates the use of railroad property or affects railroad facilities. There shall be a written agreement between the State and the railroad company, and such agreements shall meet the requirements of the Federal Aid Policy Guide, Part 646. [3/10/71, 11/15/96]

28.1 Preliminary Negotiation: Preliminary negotiation should be initiated by the Department with the railroad at the location stage, if possible. Upon approval of the location, the railroad shall be provided with information showing a tie to the railroad center line, railroad mile post or bridge. A proposed highway typical section shall be supplied, along with a request that the railroad's horizontal and vertical clearances, maintenance road, drainage and other requirements be forwarded to the Department as soon as possible. This information shall then be forwarded to the appropriate Engineering/Design Division Unit, preferably before design of the highway project begins. As soon as preliminary plans showing the railroad requirements are available, they shall be sent to the railroad, along with a letter requesting a field meeting with railroad officials. The negotiations and understandings reached at such meeting shall be documented and reviewed prior to beginning negotiations for a State/Railroad Agreement. [3/10/71, 11/15/96]

28.2 Right-of-Way: Acquisition of right-of-way, other than railroad operating right-of-way, required for highway construction shall be handled as any other acquisition by the Department's Right-of-Way Bureau.

When railroad operating right-of-way is required for highway construction purposes, including, but not limited to soil exploration, a right of entry shall be secured by the Department prior to entering railroad property. Such right of entry may be in letter or agreement form and shall be fully executed by the State and railroad. Where soil exploration within railroad property is necessary, it is preferable that Department crews perform such exploration, because of strict insurance and agreement provisions. Because the State is self-insured, it is less cumbersome and time consuming to have State forces perform exploration activities within railroad property. [3/10/71, 11/15/96]

28.3 Negotiations for Agreements/Authorizations: Negotiations for a final agreement can be started after the following plans are available for review by the railroad company: (1) the layout structure over or under the tracks if a grade separation is involved, showing a tie to the railroad centerline, minimum clearances, both horizontal and
vertical, and provisions for extra tracks, and off track maintenance equipment, if such provisions are required; (2) right-of-way plans showing the crossing area or easements required from the railroad company, together with a description thereof; and (3) highway plans showing grade, drainage and other features that may affect the railroad. The plans shall be developed to a stage where changes by the Department will not require re-engineering by the railroad.

If authorization has been received from the FHWA for preliminary engineering, the plans that are applicable shall be sent to the railroad company in quadruplicate, with an explanation of any items that may be obscure to the railroad company. The transmittal letter to the railroad shall include information regarding the letting date for the project, a request for review of the plans transmitted, and comments or approval, and a request for the railroad to prepare their force account estimate. This submittal is the authorization from the Department to the railroad to proceed with their engineering and design. [3/10/71, 11/15/96]

28.4 Processing Agreements: Four (4) copies of the Agreement (two original signatures and 2 stamped originals) shall be submitted for processing, accompanied by a letter to the FHWA requesting an authorization to proceed with construction (include method of construction, i.e., force account, contract, etc.) if provisions for railroad work are part of the Agreement. When the authorization from FHWA is received, the Department shall authorize the railroad to proceed with the railroad work required, in accordance with the approved agreement, plans, and estimate. [3/10/71, 11/15/96]

28.5 Railroad Liability for Cost of Project:

28.5.1 Federal Aid Projects: The classification of projects and the requisite railroad share the cost on federal aid projects shall conform to the Federal Aid Policy Guide, Part 646. [3/10/71, 11/15/96]

28.5.2 State Funded Projects: The NMSHTD has determined that railway liability with respect to specific project types shall be as follows:

(1) Grade Crossing Elimination: When a project eliminates an existing rail/highway at-grade-crossing, either by grade separation or relocation of the highway or the railway, whether or not railway active warning devices are in place, the project shall be deemed a benefit to the railroad. The assigned railroad liability shall be five percent (5%) of the cost of the project, which costs shall be based on the cost for preliminary engineering, right-of-way and construction costs, including utilities and railroad force account. Where the project does not result in closing an existing at-grade-crossing, railroad
participation shall not be required.

Railroad participation is limited to the grade separation structure and approaches required to transition to a theoretical highway profile, which would have been constructed if there were no railroad present, for the number of lanes on the existing highway and in accordance with the current design standards of the Department. Responsibility for maintenance of a newly constructed grade separation shall be as follows:

(a) Where a separation facility overpasses a railroad, maintenance responsibility for the entire structure and approaches shall be assumed by the Department.

(b) Where a grade separation structure underpasses a railroad, maintenance of the approaches and of the entire structure below, including the deck plate, hand rails and parapets, shall be the responsibility of the Department. Maintenance of the waterproofing, ballast, ties, rails and any portion of the supporting structure above the top of the ballast deck plate between parapets shall be the responsibility of the railroad company owning the tracks.

(c) The cost of repairing damage to a structure, occasioned by collision, equipment failure or derailment of railroad equipment shall be borne by the railroad.

(2) Grade Crossing Protection: This type includes all projects for protection of highways and railways by automatic signal devices. Authorizations for installation of automatic signal devices are described in the Federal Aid Highway Policy Guide, Part 646; the U.S. Department of Transportation on Railroad-Highway Grade Crossing Handbook, or as otherwise determined by the Department.

Flashing light signals shall be installed at all highway projects crossing a railroad, when the highway traffic count exceeds 100 A.D.T. and there are more than two (2) trains per day at the crossing. When the highway facility consists of more than two (2) lanes, cantilever type signals shall be installed. Automatic flashing light signals with short-arm gates shall be installed if one or more of the following conditions prevail:
(a) Multiple mainline railroad tracks.

(b) Multiple tracks at or in the vicinity of the crossing which may be occupied by a train or locomotive so as to obscure the movement of another train approaching the crossing.

(c) High speed train operation combined with limited sight distance at either single or multiple track crossing.

(d) A combination of high speeds and moderately high volumes of highway and railroad traffic.

(e) A high volume of vehicular traffic crossing the tracks; a high number of train movements; a substantial numbers of school buses or trucks carrying hazardous materials; unusually restricted sight distance; continuing accident occurrences; or any combination of these conditions.

(f) A diagnostic team recommends them. Motion sensors and predictors shall be installed at locations where they may expedite highway traffic.

The New Mexico State Highway Department has determined that at-grade crossing protection falls into four (4) general classifications and conditions, as follows:

A. Where a highway or railway project requires installation of automatic signal devices at a location which is presently only protected by advance warning signs and standard cross-bucks, the project is deemed to be of no benefit to the railroad company involved. The railroad rehabilitation work which will be required at such crossings, consisting of raising or lowering of track, pavement materials between tracks, including any widened roadway section, shall be deemed to be of no benefit to the railroad and railroad participation in that portion of the project shall not be required.

B. Where an existing highway crosses a railroad at-grade and there are presently automatic signal devices in place, and if on account of highway widening, the signals must be relocated and the crossing improved but no new signals required, the project shall be considered to be of no benefit to the railroad and railroad participation shall not be
C. Where an existing highway crosses a railroad at-grade and there are presently automatic signal devices in place, and due to highway widening the signals must be replaced with cantilever type signals or signals with gates, the project shall be considered to be of no benefit to the railroad; the railroad rehabilitation work required at such crossings; consisting of raising or lowering of track, pavement materials between tracks, including any widened roadway section, shall be considered of no benefit to the railroad and railroad participation in that part of the project shall not be required.

D. Where an existing highway crosses a railroad at-grade and there are presently automatic signal devices in place, and if on account of highway widening and improvement of the crossing the signal system must be modernized to include cantilever type or signals with gates, and the existing signals are to be relocated to the roadway median, the project shall be considered to be of no benefit to the railroad and railroad participation shall not be required. The railroad rehabilitation work which will be required at such crossing, consisting of raising or lowering of track pavement materials between tracks, including any widened roadway section, shall be considered to be of no benefit to the railroad, and railroad participation in that part of the project shall not be required.

Maintenance of automatic signal devices at the crossing surface and two (2) feet beyond each outside rail including space between multiple tracks under any of the above described conditions, shall become the responsibility of the railroad company involved.

(3) Reconstruction of Existing Railroad/Highway Grade Separation: A project to reconstruct an existing overpass or underpass shall include the entire structure and railroad and the highway approaches thereto. Since there is no railway liability for such projects, there shall be no benefit to the railroad and railroad participation shall not be required. Responsibility for maintenance shall be the same as described under I.A. and I.B., above.

(4) Existing Railroad Crossed by New Highway: Where a new highway is constructed which is not a relocation of an existing highway and it intersects an existing railroad, the construction of a separation structure or the installation of a signal device at
such crossing will not be considered a benefit to the railroad and railroad participation shall not be required. Responsibility for maintenance shall be the same as described under I.A., I.B., and II.D (fourth classification) aforementioned.

(5) **Existing Highway Crossed by a New Railroad**: Where a new railroad crosses an existing highway, the required separation or signal devices and any pavement work at the crossing shall not be considered to be of benefit to the road user and 100% railroad participation shall be required. The determination as to separation or type of protection shall be according to the policy existing on the classification and traffic volume of the highway crossed and the relative traffic hazard.

In the event exceptional situations arise and expansion of these regulations are necessary to cover the situation, the provisions of Federal Aid Policy Guide, Part 646, the U.S. Department of Transportation Grade Crossing Handbook, and other relevant data and/or conditions shall be considered; however, the decision of the Department shall be final.

[3/10/71, 11/15/96]

28.6 **Railroad Section 130 Safety Funds**: On highway projects where railroad facilities are being impacted by highway construction, Section 130 funds shall not be used as a funding source unless the specific location of the rail/high facilities has been identified and included in an approved safety program by the State and FHWA. Exceptions may be projects where federal regulations that allow transfer of such funds have been considered and appropriate steps taken by the State and FHWA to allow their use.

In all cases where railroad facilities are involved, early coordination between the Preliminary Engineering Bureau and the Railroads & Utilities Section shall be pursued so as to identify potential options for addressing conflicts and circumventing project delays. [11/15/96]
NEW MEXICO STATE HIGHWAY AND TRANSPORTATION DEPARTMENT
SPECIAL PROVISIONS
FOR
UTILITY SURVEY
SECTION 663-B

All provisions of SECTION 663 - UTILITY ITEMS of the New Mexico State Highway Department’s Standard Specifications for Highway and Bridge Construction shall apply except as modified herein.

1.0 DESCRIPTION

1.1 This work shall consist of, but not necessarily be limited to, utility survey plans, field utility survey of new, relocation, existing, and utilities scheduled for new construction and/or replacement on New Mexico State Highway and Transportation Department (NMSH&TD) projects. The Contractor shall comply with the requirements set forth in the NMSH&TD’s Survey Manual, Railroad and Utilities Manual, and the Manual for Highway Construction.

1.11 Field Utility Survey. Field Utility Survey shall be interpreted as field identification and location of all new, relocation, existing, and utilities scheduled for new construction and/or replacement on a project.

1.12 Utility Survey Plan. The Utility Survey Plan shall indicate the location of utilities identified or located from the Field Utility Survey. Utility Survey Plans shall include as-built horizontal and vertical location information in hard copy and electronic file (AutoCAD DWG. (3D) or Microstation DGN. (3D) format. Utility Survey Plans may be used interchangeably with the words "as-bults" throughout the body of this specification.

1.13 Contractor Supplied Personnel. The Contractor or the Contractor’s Surveyor shall provide qualified personnel to perform the work. The individual supervisor(s) and crew members shall be capable of performing the work in a professional, timely and accurate manner. The individual(s) performing the direct supervision of the Utility Survey Work shall be experienced in utility surveying work and shall be at the Project site while the utility survey work is being performed.

The Contractor shall furnish all materials, labor, tools, equipment and any other appurtenances necessary to complete the work.

1.2 Utility. Utility shall mean, all publicly, privately, and cooperatively owned utilities, without distinction, for the rendition of water, electric power, storm sewer, steam, fuel, gas, telephone or telegraph service through a system of pipes or wires devoted to public utility service. The systems can include natural gas; sanitary sewage collection systems; electricity; communication systems including telephone, telegraph, TV cable, microwave, fiberoptics, and other systems. The term "utility" does not apply to utility systems devoted solely to private use, or when the product of the private utility system is not for sale or use by the general public as a whole.
2.0 MATERIALS

2.1 Data Submittal. The preferred media in which the utility survey data is to be submitted is CD ROM; diskette (3.5") may also be utilized for the data submittal.

2.2 As-built Submittal. The Contractor shall provide as-built horizontal and vertical location information in hard copy and electronic file (AutoCAD DWG. (3D) or Microstation DGN (3D) format).

Location information shall be provided for all utility service piping, valves, and appurtenances in the project or affecting the project.

2.3 Metadata. Metadata shall be interpreted as meaning "data about the data". The metadata shall be submitted with each utility's as-builts and the electronic file, preferably as a separate text file on the electronic submittal media. The data shall include:

1. District Utility Permit Number,
2. Name, address and phone number of the responsible Land Surveyor,
3. Date of completion of the survey,
4. Equipment used to conduct the survey (e.g. total station, GPS, spirit level, etc.),
5. Horizontal and vertical control reference mark(s) used to tie the survey to the NM State Plane Coordinate System 1983 and to the North American Vertical Datum 1988,
6. Ground-to-Grid combined scale factor used,
7. Elevations shall be provided every 500 feet and at all survey break points, including all high and low points.

3.0 CONSTRUCTION

3.1 Staking and Field Notes. The utility surveying and field notes shall be accomplished in accordance with the following Department Manuals (most current editions):

1. Survey Manual;

Field notes shall be kept in standard field notebooks furnished by the Department. Field notes shall be kept in a clear, orderly and neat manner consistent with standard surveying practices.
The field notebooks shall be considered as part of the hard copy submittal for the project as-builts. The field notebooks shall become the property of the Department upon completion of the work. The standard field notebooks for Utility Survey shall be made available to the Project Manager upon request at any time during the prosecution of the work.

3.2 Horizontal and Vertical Control. The standard horizontal datum shall be the North American Datum 1983 (NAD83) and the standard projections shall be the New Mexico State Plane Coordinate System 1983 (NMSPCS83). The standard vertical datum shall be the North American Vertical Datum 1988 (NAVD1988).

3.3 Utility Location Information. The utility location information shall be tied to Department monuments and referenced to highway mileposts and/or to highway project construction stationing and certified by a New Mexico Registered Land Surveyor.

Necessary movement or re-establishment of bench marks, control points, or monuments belonging to agencies of the United States of America, the State or local governments shall be performed in accordance with the procedures accepted and determined by the governmental agencies, and will be performed by the Department, or the Contractor, as determined by the Project Manager.

3.4 Utility Location Accuracy. Accuracy shall mean the location of utilities in compliance with Federal, State, Municipal, and Local statutes for accuracy for surveying work performed by a Registered Professional Land Surveyor, unless a more precise tolerance is specified for the utility location. If a more precise tolerance is required for location, the tolerance for accuracy shall be as indicated by the Utility Owner, the Project Manager, or as indicated in the contract documents.

3.5 Utility Owner Contact. The Contractor or Contractor's representative shall coordinate all Utility Survey work with the appropriate utility owner. The Utility Survey shall be done in conjunction with the on-going project.

4.0 METHOD OF MEASUREMENT

4.1 Utility Survey Plans shall include complete as-builts for the utilities on the project. Utility Survey Plans shall include electronic file submittal. This work shall also include certification by a New Mexico Registered Land Surveyor. Utility Survey Plans shall be measured as a lump sum unit.
Utility Survey shall include survey party, surveying work, and labor required for the utility survey. This work shall also include certification by a New Mexico Registered Land Surveyor. Utility Survey shall be measured as a work day.

The Contractor shall furnish all materials, tools, equipment and any other appurtenances necessary to complete the work.

5.0 METHOD OF PAYMENT

5.1 Utility Survey Plan shall include complete as-builts (hard copy submittal) and electronic file submittal for the utilities surveyed for the project. Certification of "as-builts" by a Registered New Mexico Land Surveyor shall be considered as part of the Utility Survey Plan. Utility Survey Plan shall be paid as a lump sum unit.

Utility Survey shall include all field surveying work and labor required to do the utility survey. The Contractor shall furnish all personnel, materials, tools, equipment and any other appurtenances necessary to complete the work. Utility Survey shall be paid as a work day unit.

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<th>PAY ITEM</th>
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<tr>
<td>Utility Survey Plan</td>
<td>Lump Sum</td>
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<tr>
<td>Utility Survey</td>
<td>Work Day</td>
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Additional costs incurred by the Contractor in having to perform activities more than once as a result of the Contractor's error(s) will be borne by the Contractor and no additional payment will be made by the Department. If a monument is damaged by the contractor, the contractor shall replace the monument in accordance with the applicable Federal or State regulations and no additional measurement or payment will be made for this work.
EXHIBIT "A"

UTILITY SURVEY DATA REQUIREMENTS

The following "metadata" ("data about the data") shall be submitted with each utility's as-builts and the electronic file, preferably as a separate text file on the submittal media. This information is critical to the Department so as to properly archive the data, as well as to provide follow-up capability in the event problems arise with the data:

1. District Utility Permit Number

2. Name, address and phone number of the responsible Land Surveyor

3. Date of completion of the survey

4. Equipment used to conduct the survey (e.g. total station, GPS, spirit level)

5. Reference mark(s) used to tie the survey to NM State Plane Coordinate System 1983 and to North American Vertical Datum 1988.

6. Ground-to-Grid combined scale factor used

* NOTE THAT ELEVATIONS SHALL BE PROVIDED EVERY 500' AND AT ALL BREAK POINTS, INCLUDING ALL HIGH AND LOW POINTS.
APPENDIX E

SURVEYING PERMISSION FORM (SAMPLE)
NEW MEXICO STATE HIGHWAY & TRANSPORTATION DEPARTMENT
SURVEYING AND LANDS ENGINEERING SECTION
P. O. BOX 1149, M.S.127, SANTA FE, NM 87504-1149

SURVEY PERMISSION FORM

Date: ____________________________

Project Number: ____________________ Control Number ____________________

PROJECT SCOPE

________________________________________________________________________

________________________________________________________________________

SCOPE OF SURVEY

________________________________________________________________________

________________________________________________________________________

General Property Description: __________________________________________

Owner(s)/Occupant(s) ________________________________________________

Address: ____________________________________________________________

Telephone Number: ____________________________

CONDITIONS UNDER WHICH PERMISSION IS GRANTED

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

I HEREBY GRANT PERMISSION TO THE SURVEYORS REPRESENTING THE NEW MEXICO STATE HIGHWAY & TRANSPORTATION DEPARTMENT TO ENTER UPON THE LAND UNDER MY OWNERSHIP OR CONTROL TO PERFORM SURVEYS IN CONNECTION WITH THE ABOVE REFERENCED PROJECT. IT IS AGREED THAT THE STATE WILL PAY FAIR MARKET VALUE FOR ANY DAMAGE DONE TO THE LAND.

Owner/Occupant __________________________ Date __________

CONTACT INFORMATION:

NMSHTD Project Development Engineer (PDE): _______________________ Telephone Number __________________

NMSHTD Project Land Surveyor: ________________________________ Telephone Number __________________

NMSHTD Consultant: _____________________________________________ Telephone Number _____________

Consultant Land Surveyor: ________________________________________ Telephone Number _____________
APPENDIX F

RIGHT-OF-WAY MAPPING DEVELOPMENT PROCEDURES
RIGHT-OF-WAY MAPPING DEVELOPMENT PROCEDURES

NEW MEXICO STATE HIGHWAY & TRANSPORTATION DEPARTMENT
ENGINEERING/DESIGN DIVISION

DECEMBER 30, 1996

APPROVED:  
Charlie V. Trujillo
Engineering/Design Division Director
INTRODUCTION

The acquisition of Rights-of-Way (R/W) required for construction projects is one of the most critical activities that needs to be accomplished so that the project development process can be finalized and the project can be let to contract. It is therefore extremely important that final R/W requirements be determined early in the project development process in order for Final R/W Mapping to be completed in a timely manner. Early completion of R/W Maps will allow sufficient time to carry out all R/W Appraisal and Acquisition activities.

It is also very important that once the R/W Maps are finalized, that revisions be eliminated to be able to meet and maintain the project schedules. Due to a number of factors, the completion of the Final R/W Maps has historically been delayed. These factors include 1) lack of communication between Project Development, Design, Surveying, Lands Engineering, and R/W personnel, and 2) revisions associated with Environmental and Archaeological issues, adjacent Property owner issues, Utility concerns, and Scope changes. Delays in finalizing the R/W Mapping affects the time allowed for carrying out R/W Appraisal and Acquisition activities, and often results in projects being delayed.

During the last few years, a number of internal process reviews have been undertaken to improve the communication process and to find ways to avoid major revisions due to the aforementioned factors. A recently completed process review, Right-of-Way Process Improvement Review of the NMSH&TD - The Development of Right-of-Way Maps dated 12/21/95, made a number of recommendations which will improve the R/W Mapping process. One of the recommendations made in the final report was that the Department develop written procedures covering all Project Development Engineer (PDE) and Design Team activities which impact the development of R/W maps.

The following procedures have been developed to provide the Design Team guidance in the development of R/W Mapping. These procedures stress the importance of addressing required changes as early as possible in the process and include:

- Provisions for coordination with, and feedback to project designers.

- All actions required in order to submit requests for R/W surveying and mapping to the Surveying and Lands Engineering Section.

- Coordination, during map preparation, with Lands Engineering Unit and all those elements which will utilize the maps when available (Customers).

- Addition of a formal milestone activity immediately after the Grade & Drain Inspection to finalize R/W requirements.
- Provision requiring a sheet by sheet analysis and determination by the Design Team addressing the constructability of the project (Can the project as designed be built and maintained within the rights-of-way proposed?). Who has the authority to make the final decision on R/W requirements?

- Provision that whenever changes calling for additional R/W are proposed after the Surveying and Lands Engineering Section has transmitted Final R/W Maps, those requests for changes be processed through the Lands Engineering Unit with concurrence by the Lands Engineering Section Supervisor, and approval by the Preliminary Design Bureau Chief.

- Identification of those positions responsible for key elements (accountability).

- Criteria pertinent to determining when to call for and determining limits of R/W parcels, CMEs, TCPs, and Work Permits.

- Clarification of requirements on Consultant Design Projects.

**Preliminary Engineering Stage**

**Scoping Stage**

The need for R/W on a project shall be addressed by the Design Team and shall be reflected in the Final Scoping Report. The Scoping Report shall identify approximate locations (Station to Station) and approximate widths of R/W requirements. Since Survey information is not available at this stage, this determination will be based on the Field Reviews, the use of available Aerial Photos and As-Built Plans, Design Criteria, etc., as well as on input from the Design Team. A determination of types of property ownership (i.e. Private, State, Federal, Indian, etc.) shall also be made; this information will be requested by the PDE from Department staff, including Surveying and Lands Engineering Section, Design Squads, Conceptual & Quality Assurance Unit (Consultant projects), and the Lands Abstracting Unit (if Title searches are required).

The PDE shall determine who needs to attend the Preliminary Field Reviews. The R/W personnel assigned to the project (including the R/W Agent in charge of Government Lands) should participate in the Preliminary Field Reviews as required.

R/W Feasibility studies shall be part of the Final Scoping Report. The R/W Bureau's R/W Feasibility function should be headed by an experienced and qualified individual with extensive Appraisal and R/W experience. The availability of a R/W Feasibility Report at this stage will provide the Design Team with valuable information...
which will allow them to make better decisions and should reduce the frequency and severity of revisions later in the process.

**Conceptual Stage**

After the project is scoped, and the Location Survey has been completed, the Design Squad or Conceptual & Quality Assurance Unit (Consultant projects) will prepare alternative alignment studies (horizontal and vertical) as required. The Plan & Profile Sheets received from the Surveying Section shall delineate the approximate existing R/W limits. The Design Squad will determine preliminary R/W requirements (roadway slope limits, drainage easements, etc.) for the preferred alignment, based on the the direction provided by the PDE. On areas requiring R/W acquisition, the R/W lines shall extend at least 10 feet beyond the slope limits or pertinent construction feature unless there are circumstances that will not make this feasible; this may be the case in highly developed areas. The Design Squad will work closely with the PDE and will provide the Plan & Profile (P&P) sheets with the proposed Preliminary R/W requirements for review.

The PDE will review R/W requirements developed by the Design Squad. The PDE will obtain Design Team input as required in assessing needs. A Field Review may be required to discuss the impacts of the project; those attending the Field Review should include the PDE, Highway Designer, District Construction Engineer or representative, R/W personnel, and Environmental and/or Archaeological personnel. Environmental/Archaeological input will include location of any Wetlands and Cultural resource areas that may need to be avoided. After the Field review (if required), the PDE will finalize the preliminary R/W requirements. The Design Squad will revise the P&P sheets if necessary. The PDE, Highway Designer, and R/W Agents (including R/W agent in charge of Government Lands if required), will review the conceptual plans and agree upon the Preliminary R/W requirements.

The PDE will then set up a meeting with the Surveying and Lands Engineering Field Unit Supervisor and Surveyor and R/W agent(s) to present the R/W requirements. The PDE will request a Right-of-Way Survey and Mapping for the impacted land areas needed on the project. A copy of the Field Design Inspection package P&P sheets highlighted or redlined with areas denoting the preliminary R/W requirements and slope limits should accompany the Request for R/W Survey. A copy of the Final Scoping Report shall also be submitted with the Request for R/W Survey. Right-of-Way Surveying will not be performed for the entire project limits, unless the project is on a new alignment or will require R/W acquisition along the entire project limits. The Request for R/W Surveying will be made prior to the Field Design Inspection (FDI).

On **District lead** projects requiring R/W, the District Technical Services Engineer (TSE) shall provide written correspondence to the Surveying and Lands Engineering Section Supervisor of the needs for R/W Surveying/Mapping. Close and early coordination is necessary in order to avoid project development delays or
rescheduling. The information forwarded shall be as detailed as possible and will conform to the SAME REQUIREMENTS as projects being developed at the General Office. The TSE shall coordinate these projects with the P.S.&E. Section as required.

Field Design Inspection
During the FDI, the preliminary R/W requirements for the project will be discussed and verified. A sheet by sheet review/analysis of the proposed R/W requirements shall be done by the Design Team. A constructability review of the project shall also be done, taking into account R/W requirements. Turnouts and driveway grades will be discussed to assure that sufficient R/W is being provided for and to assure that there are no adverse impacts with respect to accessibility. Drainage structure requirements will be assessed. Appropriate representatives from the R/W Bureau shall be in attendance to provide input. If it is determined that R/W is required (or major changes are made) at the FDI, the process will be backed up to the reanalysis of alternatives stage for further analysis and the project schedule will be adjusted as required. If there is disagreement on the R/W requirements, the PDE as the Design Team Leader, will have the authority to make the final decisions on R/W requirements. If there is disagreement on a major R/W issue, the PDE shall document his decision and reasons for that decision in the FDI Report.

FINAL DESIGN STAGE
Post Field Design Inspection
The PDE will request Title Reports from the Lands Abstracting Unit of the R/W Bureau for all new R/W impacted areas. The Lands Abstracting Unit will forward completed Title Reports to the Lands Engineering Unit as soon as available.

The Surveying and Lands Engineering Section will proceed with:

- Documentation of Existing R/W,
- Preparing preliminary property ownership map/layout of impacted lands based on current ownership deeds/records,
- Performing R/W Field Survey
- Preparing R/W Survey Mapping
- Will transmit R/W Survey/Mapping to Lands Engineering Unit and PDE

The PDE, accompanied by the R/W Acquisition Agent shall conduct Property Owner Interviews to explain preliminary R/W requirements and address concerns. The R/W agents will explain R/W acquisition procedures if required. Any proposed changes in access will be discussed with the property owners. The PDE will be responsible for documenting the interviews including any commitments made to the property owners. The Property Owner Interviews will be the first opportunity for obtaining Work Permits. During the Property Owner interviews, the PDE will attempt to obtain any Work Permits identified up to this stage. The R/W Agents will be responsible for obtaining Work Permits identified after the Property Owner
interviews.

The PDE shall also invite the District TSE (or appropriate representative as determined by the District) to the Property Owner interviews. Notice of upcoming interviews shall be made at least two weeks in advance. The PDE shall make every effort to involve the R/W Agent and the District TSE in the Property Owner Interviews, however it may not always be possible to coordinate times with the Property Owners, R/W Agents, and the District TSE.

The PDE will delineate the refined R/W requirements/limits on the design plans that are furnished by the Highway Design Squad. The PDE and the Highway Designer will meet with R/W personnel as required to discuss any refinements that may be required. The most current Highway Design plans will be transmitted to the Lands Engineering Unit with the delineated preliminary R/W parcels, CMEs, and TCPs. R/W requirements will be designated as follows:

**Permanent R/W** - To accommodate all permanent features, including slopes, drainage structures, R/W fencing, etc. R/W shall extend a minimum of 10 feet beyond slope limits and pertinent construction features, unless circumstances do not make this possible.

**Construction Maintenance Easements (CMEs)** - To be used in all cases where there is a need for construction and/or ongoing maintenance, i.e., drainage channels, certain drainage structure fences, etc. The property owner receives compensation for use.

**Temporary Construction Permits (TCPs)** - To be used in cases where there is a benefit accrued to the NMSH&TD and there is a temporary need to enter and use a property for construction or maintenance purposes, but not an ongoing need for maintenance, i.e. detours, significant changes to driveway turnouts, etc. The property owner receives compensation for its use. If a project requires no R/W other than TCPs, a R/W Map is not prepared and the TCPs are to be shown in the construction plans referenced to centerline of construction stationing, with offset distances. TCPs are not to be used for Cut and Fill slopes.

**Work Permits** - To be used in cases where there is a temporary need to enter and use a property for construction purposes which benefits the property owner, but there is not a continued need for maintenance, i.e. minor changes to driveway turnouts, etc. The Work permit does not provide for payment to the property owner. Work Permits are to be shown in the construction plans referenced to centerline of construction stationing, with offset distances.

It should be noted that there are minimum time requirements involved for the acquisition of Permanent R/W, CMEs, and TCPs. Often times, the time required to obtain a TCP can take the same amount of time as a Permanent take.

The Lands Engineering Unit will add R/W Parcels, CMEs and TCPs (Parcel Numbers and Ownership) to the R/W maps. Lands Engineering
prepares the Preliminary R/W Maps for review and use at the Grade and Drain (G&D) Inspection.

Lands Engineering will print the Preliminary R/W Maps and transmit them to the PDE for presentation at the Grade & Drain Inspection and Design Public Hearing (if required).

**Grade & Drain Inspection**
During the Grade & Drain (G&D) Inspection, the R/W requirements for the project will be discussed and verified, utilizing the Construction Plans and the Preliminary R/W Maps. A sheet by sheet analysis of R/W requirements shall be done. Turnout and driveway grades will be assessed to verify R/W requirements and accessibility. The R/W Acquisition Agent shall be in attendance to provide input. If it is determined by the Design Team that a major scope change is required that will significantly affect the R/W Requirements/Maps, the process will be backed up to the reevaluation of alternatives stage for further analysis and the project schedule will be adjusted as required.

**Post Grade & Drain Inspection**
Prior to finalizing the G&D Inspection Report, the PDE will coordinate a formal meeting in the office to finalize all R/W requirements (including locations of CMEs, TCPs, etc.). The meeting will include personnel from the R/W Bureau (Appraiser and Acquisition Agent), Lands Engineering Unit Supervisor, Highway or District Designer and P.S.&E. Section (if required). In addition, the team will identify Non-Right of Way Remnants (NRWs) and Access Control Parcels. Any significant changes in access will be communicated and clarified to the R/W agents.

After the G&D inspection report is finalized (within 10 working days of G&D inspection), the PDE will submit prints of the updated design/construction plans furnished by the Highway Designer showing all the Final Right-of-Way limits and requirements to the Lands Engineering Unit Supervisor. Transmittal will be done by IDC with accompanying design plans clearly denoting all Final R/W requirements.

On a new facility, which will be Access Controlled or one with Limited Access Control, the PDE will meet with the Lands Engineering Unit Supervisor to initiate the development the Draft Access Control Administrative Determination for the facility. The preparation of the Draft Access Control Administrative Determination will be the responsibility of the Lands Engineering Unit Supervisor. The PDE will be responsible for presenting the Draft Access Control Administrative Determination to the Department’s Access Control Committee.

The Lands Engineering Unit will compute the areas of take for R/W parcels (Fee acquisitions, CMEs, and TCPs) and will write Legal Land Descriptions for R/W and CME parcels, and will identify and list TCPs. They will assure that all information required by the Appraisal Unit has been included (Remainders, Larger Parcels,
Access Control lines, Access Control parcel numbers, etc.) and will finalize the R/W Maps and Documents.

The Lands Engineering R/W Verifications Unit will review and verify all Final R/W Maps and Documents.

The Lands Engineering Unit will transmit FINAL R/W MAPS AND DOCUMENTS (LEGAL LAND DESCRIPTIONS AND TITLE REPORTS) to the Right of Way Bureau for the initiation of R/W activities (Appraisals, Review Appraisals, Title Review, Acquisition, etc.). Copies of the Final R/W Maps will be forwarded to the appropriate District Office, PDE, Monumentation Unit, and the Environmental Section. The Final Design Bureau’s PDE and Highway Designer shall assure that the R/W requirements shown on the Final R/W Maps correspond to the requirements shown on the Construction plans.

See Attachment 1 for flow chart of the R/W Mapping Development Procedures process.

NOTE: Whenever changes occur that require revisions or new/additional R/W parcels, CNES or TCPs after the final R/W maps have been transmitted to the R/W Bureau, those changes must be processed through the Lands Engineering Unit with concurrence from the Lands Engineering Section Supervisor and approval from the Preliminary Design Bureau Chief. The PDE shall document the required changes in an IDC to the Surveying and Lands Engineering Section Supervisor with copies to the District Office, Monumentation Unit, Environmental Section, Highway Designer, R/W Bureau, and Preliminary Design Bureau Chief.

CONSULTANT PROJECTS:

It is the responsibility of the Design Consultant Engineer to carry out all CONTRACT delegated tasks (Location Survey, Design, Alternative Studies, R/W Surveying, Title Searches, R/W Mapping, Property Owner, Interviews, Coordination, Correspondence, Documentation, etc.) required to produce an acceptable set of Final R/W Maps and Documents. The PDE, along with the rest of the Design Team, will work closely with the Consultant Engineer to establish R/W requirements for the specific projects. Participation in the Field Reviews and Design Team meetings will be the same for Consultant projects as it is for in-house projects, with the exception of the Highway Designer. The Conceptual and Quality Assurance Unit will work with the PDE in the Scoping and early Conceptual stages on Consultant projects.

Before initiating any R/W Surveying/Mapping, the Consultant shall schedule a meeting with the Surveying and Lands Engineering Supervisor. All the limits of surveying/mapping, Department policies and procedures for R/W Surveying/Mapping/Monumentation will be discussed and established. The Lands Engineering Unit has prepared a R/W Plans Verifications Checklist (See Attachment 2) to define requirements and to assist the Consultants in the preparation of the R/W Plans and Documents.
R/W Mapping prepared by Consultants currently requires that it go through a Verifications process in-house. Currently projects go through two formal "checks" based on the provisions of the Contract, and if additional "checks" are required, they are charged to the Consultant in the form of Liquidated Damages. It is the intent of the Department to eventually phase out the Verifications of R/W Mapping; the Consultant Engineer/Surveyor responsible for the individual projects is responsible for the accuracy of the R/W Survey and Mapping.

Preliminary Engineering stage and Final Design stage R/W Mapping requirements and deadlines are the same for Consultant projects as for in-house design projects, with the exception that Consultant projects currently have to go through the Verifications process; therefore, additional time needs to be included in the project schedule to allow for this activity. The Consultant will be required to meet the submittal dates established in the CONTRACT. Submittal dates shall be monitored closely by the PDE and Consultant Project Manager and penalties for late submittals shall be strictly enforced.

The Consultant's Project Manager will be responsible for coordinating all submittals, setting up all meetings and field reviews, and providing all associated documentation, as well as assuring that all appropriate Sections within the Department are provided copies of all appropriate submittals as required and by the established deadlines in the Project Schedule and Consultant Contract.
ATTACHMENT 1 – RIGHT-OF-WAY MAPPING DEVELOPMENT PROCEDURES FLOW CHART
RIGHT OF WAY MAPPING
PROCEDURES - FINAL DESIGN
STAGE

POST F.D.I.

P. D. E. REQUEST
TITLE REPORTS

DOCUMENTATION
OF EXIST. R/W

PREPARE PREL. PROP.
OWNERSHIP MAP/
LAYOUT OF IMPACTED LANDS

PERFORM R/W
FIELD SURVEY

PREPARE R/W
SURVEY MAPPING

TRANSMIT PREL. R/W
SURVEY/MAPPING TO
LANDS ENG. & PDE

PDE, R/W AGENT, DISTRICT
CONDUCTS PROPERTY OWNER
INTERVIEWS

PDE Delineates refined
R/W to accommodate all
perm. & temp. features

LANDS ENGR. ADDS R/W
PARCELS, CME'S AND
TCP'S TO R/W MAPS

LANDS ENGR. TRANSMITS
PREL. R/W MAPS TO
PDE FOR G&D & PUBLIC HEARING
RIGHT OF WAY MAPPING
PROCEDURES - FINAL DESIGN STAGE

GRADE & DRAIN INSPECTION

DESIGN TEAM VERIFIES R/W REQUIREMENTS
W/ CONSTR. PLANS & PRELIMINARY R/W MAPS

MAJOR CHANGE

YES

NO

RE-EVALUATE ALTERNATES ADJUST SCHEDULE

PROCEED TO NEXT STEP

POST GRADE & DRAIN INSPECTION

PDE COORD. FORMAL MTG.
TO VERIFY R/W REQUIREMENTS

PDE SUBMITS FINAL R/W LIMITS
& REQUIREMENTS TO LANDS ENGINEERING UNIT

DEVELOP DRAFT ACCESS CONTROL ADMIN.
DETERMINATION IF REQUIRED

LANDS ENGINEERING UNIT FINALIZE R/W MAPS & DOCUMENTS

LANDS ENGINEER TRANSMITS FINAL R/W MAPS & DOCUMENTS TO R/W BUREAU AND APPR. DEPT. STAFF
ATTACHMENT 2 - CONSULTANT R/W PLANS VERIFICATIONS CHECKLIST
NEW MEXICO STATE HIGHWAY & TRANSPORTATION DEPARTMENT
SURVEYING & LANDS ENGINEERING SECTION
1120 CERRILLOS RD. - P.O. BOX 1149
SANTA FE, NEW MEXICO 87504-1149

GENERAL OFFICE ROOM 222
PHONE (505) 827-5435-5419-5420

REVISED: January 1997

THE CONSULTANT SHOULD CONTACT THE LANDS ENGINEERING UNIT SUPERVISOR OF
THE SURVEYING AND LANDS ENGINEERING SECTION AS TO THE APPROPRIATE
SCALE, LATEST POLICY AND PROCEDURES, ETC. AND OBTAIN THE LATEST
SAMPLE OF R/W DESIGN PLANS, LAND DESCRIPTIONS, AND GOVERNMENT PLATS
BEFORE COMMENCING PREPARATION OF PLANS, METRIC CONVERSION GUIDELINES,
ETC.

CHECKLIST FOR FINAL R/W MAPPING PROJECTS

(FIRST REVIEW SUBMITTAL)

AN APPROPRIATE LETTER OF TRANSMITTAL CONTAINING NMSH&TD PROJECT
NUMBER, PROJECT CONTROL NUMBER, AND A LIST OF ALL ITEMS SUBMITTED, AND
WHAT ACTION IS REQUESTED.

SUBMITTAL SHALL INCLUDE TWO SETS OF PRE-FINAL R/W DESIGN PLANS (100%
COMPLETE), A LIST OR LETTER WITH TOTAL NUMBER OF PARCELS, CME’S, TCP’S
AND TITLE REPORTS SUBMITTED, A CHECKLIST COPY WITH EACH ITEM AS NOTED
BELOW INITIATED BY PROFESSIONAL SURVEYOR; LEGAL DESCRIPTIONS FOR
AFFECTED PARCELS, ONE SET OF LATEST PROJECT DESIGN PLAN AND PROFILE
SHEETS, A HARD COPY OF THE COORDINATE SYSTEM LISTING FOR ALL POINTS
PERTINENT TO THE R/W MAP WITH POINT NUMBER, DESCRIPTOR, X, Y, Z, AND
STATION OFFSET; A HARD COPY OF TRAVERSE CLOSURE FOR EACH PARCEL
(SHOWING PARCEL NUMBER TOGETHER WITH POINT NUMBERS, DISTANCES AND
BEARINGS, AND WITH AREA IN BOTH HECTARES/ACRES AND SQUARE
METERS/SQUARE FEET); SUBMIT ALL CERTIFIED TITLE REPORTS FOR EACH
AFFECTED PARCEL. INCOMPLETE SUBMITTALS WILL BE RETURNED.

BLANK SPACES PROVIDED BELOW FOLLOWING EACH NUMERICAL DESIGNATION ARE
TO BE INITIATED BY THE PROFESSIONAL SURVEYOR IN RESPONSIBLE CHARGE
WHEN THE PARTICULAR ITEM HAS BEEN COMPLETED.

(SECOND REVIEW SUBMITTAL)

AN APPROPRIATE LETTER OF TRANSMITTAL CONTAINING PROJECT NUMBER,
PROJECT CONTROL NUMBER, AND A LIST OF ALL ITEMS SUBMITTED AND WHAT
ACTION IS BEING REQUESTED. SUBMITTAL SHALL INCLUDE ALL FIRST REVIEW
RED-LINED R/W MAP PRINTS AND RED-LINED LEGAL LAND DESCRIPTIONS, 2
PRINT SETS OF CORRECTED MAPS, 1 SET LEGAL LAND DESCRIPTIONS, NEW P &
P’S IF CHANGES HAVE BEEN MADE, AND ANY NEW REVISIONS TO COMPUTATIONS
BEFORE THE SECOND REVIEW CAN BEGIN. INCOMPLETE SUBMITTALS WILL BE
RETURNED.

IF ANY PORTION OF THE ALIGNMENT HAS CHANGED OR IF SUBSTANTIAL CHANGES
HAVE OCCURRED AFTER FIRST REVIEW, THESE CHANGES, REVISIONS, ETC.
SHOULD BE BROUGHT TO THE ATTENTION OF THE SUPERVISOR.
TITLE SHEET

1. ___ VICINITY MAP (SEE SAMPLE)
   USE COUNTY OR STATE MAP; PROJECT NUMBER WITH ARROWS.

2. ___ LOCATION MAP
   USE QUAD MAP, QUADRANGLE MAP, OR CITY MAP IF APPROPRIATE

3. ___ BEGINNING OF PROJECT STATIONS WITH ARROWS (ON LOCATION MAP)

4. ___ END OF PROJECT STATIONS WITH ARROWS (ON LOCATION MAP)

5. ___ LANDS ENGINEER SIGNATURE BLOCK (SEE EXAMPLE).

6. ___ LENGTH OF PROJECT (MILES/KILOMETERS TO THREE DECIMALS)

7. ___ NORTH ARROW ON TOP CENTER OF SHEET.

8. ___ CERTIFICATION OF SURVEYOR NOT REQUIRED ON TITLE SHEET

9. ___ FINAL MAP AND DATE FORMAT (BOLD AND NEAR LOWER RIGHT HAND CORNER)

10. ___ TITLE BLOCK IN LOWER RIGHT HAND CORNER WITH PROJECT NO. IN LARGE BOLD HEAVY LETTERS AND PROJECT CONTROL NO. ABOVE TITLE BLOCK.

11. ___ RIGHT OF WAY MAPS PREPARED BY (PRIME CONSULTANT AND SUBCONTRACTOR, IF APPLICABLE, NAME AND ADDRESS) OR COMPANY LOGO WITH NAME AND ADDRESS.

12. ___ INDEX OF SHEETS IN UPPER RIGHT HAND CORNER.
   (STATIONS SHOULD BE TO THE NEAREST FULL STATION)

13. ___ REVISION BOX IN LOWER LEFT OR RIGHT CORNER

14. ___ STICK-ONS OR PENCIL DRAFTING ARE NOT ACCEPTABLE ON ORIGINAL FINAL MAPS. STICK-ON COMPANY LOGOS CAN BE USED.

15. ___ "ACCESS CONTROLLED" IN BOLD LETTERS ON LOWER RIGHT CORNER, IF APPLICABLE.
PARCEL BLOCK SHEETS

1. ____ PARCEL NUMBERS
   List each one in order
   Skip 1 space between parcel numbers.
   CME’S kept together in separate block.
   TCP’S kept together in separate block.

2. ____ OWNER’S NAME
   Use full name as shown on title report (map sheets and
   description shall match parcel block name).

3. ____ AREA OF TAKE
   Show square feet to nearest square foot and meters to the
   nearest square meter.
   Area in acre’s or hectare’s shall be shown to four decimal
   places. Remainder areas should be shown for all parcels,
   CME’s. For remainder areas greater than 100 acres insert
   as "> 100 acres."
   A note should be placed at the bottom of the sheet noting
   that larger parcel area was obtained from record information
   or other conveyance documents. A +/- symbol is to be placed
   after larger parcel area. Additional calculations for
   separate area remainders may be requested by verifications
   unit when a tract of land is split by roadway corridor.

4. ____ RIGHT OF WAY MAPS PREPARED BY (CONSULTANT NAME AND ADDRESS)
   OR COMPANY LOGO WITH NAME AND ADDRESS

5. ____ TITLE BLOCK IN LOWER RIGHT HAND CORNER (NO EXCEPTIONS)
   PROJECT NO. IN LARGE BOLD HEAVY LETTERS AND PROJECT CONTROL
   NO. ABOVE TITLE BLOCK

6. ____ THE PARCEL BLOCK SHEETS ARE NUMBERED 1-A, 1-B, ETC.

7. ____ FINAL MAP AND DATE FORMAT (NEAR LOWER RIGHT HAND CORNER) (DO
   NOT SET DATE UNTIL DIRECTED BY RIGHT OF WAY VERIFICATION
   UNIT SUPERVISOR.

8. ____ REVISION BOX IN LOWER LEFT OR RIGHT CORNER
23. ONLY NEW R/W LINES SHALL BE TIED TO CONSTRUCTION CENTERLINE.

24. ALL CENTERLINES (RAMPS, SURVEY, LOCATION ETC.) SHALL BE TIED AND A MATHEMATICAL CLOSURE MUST BE MADE.

25. ALL CENTERLINES AND R/W LINES MUST CLOSE MATHEMATICALLY.

26. DIMENSIONS FROM CONSTRUCTION CENTERLINE TO EXISTING R/W AND NEW R/W SHOULD BE SHOWN AT LEAST TWICE ON EACH SHEET IF R/W IS PARALLEL TO CENTERLINE.

27. SHOW STATION AND OFFSET FROM CONSTRUCTION CENTERLINE TO R/W AT EVERY CHANGE IN DIRECTION OF R/W.

28. ALL CONSTRUCTION FEATURES MUST BE SECURED BY R/W. (CHECK THAT ALL SLOPE LIMITS ETC. ARE SECURED BY PERMANENT R/W).

29. TIES TO CONTROL STATIONS (FIRST OR SECOND ORDER - IF USED FOR BASIS OF BEARINGS FOR INSTANCE) SHOULD BE SHOWN ON MAP USING THIN DASHED LINES. USE BROKEN LINES IF NECESSARY TO COMPENSATE FOR DISTANCES INVOLVED.

30. ALL INTERSECTING PROPERTY LINES SHALL BE SOLID LINES AND LABELED AS PROPERTY LINES.

31. WHEN PROPERTY LINES INTERSECT CENTERLINE, SHOW CENTERLINE STATION AT INTERSECTION.

32. IDENTIFY MONUMENTS AND POINTS AS TO WHETHER BRASS CAP, REBAR, SECTION CORNER, 1/4 CORNER, ETC. AND GIVE A THOROUGH AND COMPLETE INFORMATION AND DESCRIPTION.

33. LABEL CORNERS AS FOUND (ACCEPTED/REJECTED/USED, ETC.), SET, NOT FOUND, ETC., AND USE A LEGEND ON EACH SHEET.

34. AT BOTTOM OF SHEET SHOW IN BOLD LETTERS SECTION, TOWNSHIP AND RANGE, CITY, GRANT, NATIONAL FOREST, ETC., WHICHEVER IS APPLICABLE.

35. RIGHT OF WAY PARCELS SHOULD BE NUMBERED ACCORDING TO THE SHEET NUMBERS ON WHICH THEY ARE LOCATED.

36. FOR EACH R/W PARCELS/CME SHOW OWNER'S COMPLETE NAME, PARCEL/CME NUMBER AND AREA OF TAKE. THE AREA OF REMAINDER SHALL BE SHOWN ON THE PARCEL BLOCK SHEET.
APPENDIX G

NMSHTD METRIC CONVERSION GUIDELINES
FOR
GEOMETRICS, ROADWAY DESIGN
AND
SURVEYING

SURVEY HANDBOOK MAY 2000
CONVERSION GUIDELINES
for
Geometrics, Roadway Design,
and
Surveying
Revised 22-August-1996
New Mexico State Highway & Transportation Department
METRICATION POSITION STATEMENT

The New Mexico State Highway & Transportation Department (NMSH&TD) hereby certifies that it will comply with the Omnibus Trade and Competitiveness Act of 1988 and the Federal Highway Administration’s Metric Conversion Policy.

Employee assistance and cooperation with this conversion will ensure a smooth and successful transition.

Charlie V.P. Trujillo
Engineering/Design Division Director
New Mexico State Highway & Transportation Department

Prepared by: Ruben Chavez Garcia
PREFACE

Congress has mandated through the Omnibus Trade and Competitiveness Act of 1988 that the United States convert to the metric system. As a result of this Act, Executive Order 12770, Metric Usage in Federal Government Programs was signed on July 25, 1991 by President Bush. The Executive Order mandates that the Department of Commerce direct and coordinate the metric conversion. The policy guidelines set by the Department of Commerce have defined rules and regulations guiding other Agencies, including Federal Highway Administration, AASHTO and the U.S. Department of Transportation. These Federal agencies have in turn defined the time schedule and the general guidelines for the metric conversion process. The Federal Government purchasing authority has been tied to metric conversion. This has resulted in funding for the U.S. infrastructure to be tied to Metric Conversion.

Our participation in the Federal Highway Program is predicated upon our conversion to the metric system within the time schedules established by the Federal Highway Administration. The National Highway System Designation Act (PL 104-59) signed by President Clinton on November 28, 1995 extended the mandatory conversion date to September 30, 2000.

PURPOSE

The conversion from the traditional English system to the international metric system - SI (Le Systeme International d’Units, or International System of Units) - in the design process is, at best, very cumbersome. This is due primarily to two reasons: 1) the large amount of technical information and the many sources of information that must be conveyed, and 2) the design process is very task oriented requiring a constant effort and continued thought process throughout the transition. These guidelines are intended to aid in the conversion process and to provide helpful information in developing plans based on metric measures. The current system of measurement is sometimes referred to as the English system or the Imperial system. For our purposes these two are synonymous. There are many aspects of metric conversion which are not presented here. Related information can be found in other manuals.
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<tr>
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<td>RULES FOR LINEAR MEASUREMENT (LENGTH)</td>
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<td>MASS</td>
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<td>AREA</td>
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<td>25</td>
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</tbody>
</table>
INTRODUCTION

Once the plan for metric conversion is finalized, it is important that drawings and specifications be made exclusively metric. It is of secondary importance if measurements are hard or soft metric as defined below. It would follow that when documents contain SI measurements only, the reader will learn metric in order to execute or understand the work.

The natural tendency is for people to use dual dimensioning (both English and Metric) units during the conversion process. This should not be done, except on documents such as Right-of-Way or Environmental where there is a direct public involvement and FHWA approval has been obtained. This policy will help prevent errors and will reduce the potential for confusion.

During the metric conversion process, the reader will encounter the use of the terms “Soft Conversion” and “Hard Conversion.” Soft Conversion or Soft Metric means that the product or dimension requires no physical change. One would merely compute (or measure) the dimension and state its metric equivalent. Hard Conversion or Hard Metric means that the product or dimension requires physical change, i.e. adjust the lane width to agree with a user accepted rounded number.

Several organizational areas have been identified which will be impacted by the conversion to metric. Also it is obvious that there are many areas of the design process which will be impacted. The information presented herein hopefully will aid in the day-to-day development process with regard to metric conversion.

Some of these areas are as follows:

STATIONING

- 1 Station = 1000 meters (m) = 1 kilometer (km)

   Example: Sta. 5+123.500

   (This will provide a visible difference between the English and metric stations, i.e. three versus two digits after the plus sign and will avoid confusion in the future or when reviewing or using plans designed in imperial units.)

- Stations should increase from West to East and from South to North.

- Alignment stakes and cross-sections will normally be taken at 20 meter intervals.

- Label all elevations in meters and decimals of a meter.

   Example: Elev. = 182.880 m
SURVEYING

- Use 1 mm accuracy for all measurements except:
  a. natural ground elevations - use nearest 10 mm
  b. elevations on existing pavement surfaces - use nearest 5 mm

- Angles will continue to be measured in degrees/minutes/seconds.

- All recorded deed measurements shall be shown in parenthesis in the units recorded, such as feet, rods, or chains.

- Distance and area measurements on Right-of-Way documents should be shown in dual units with the metric units shown first, followed by the English equivalent in parenthesis. This practice will be essential for property owner to understand the value of appraisals and other negotiations related to the acquisition of Right-of-Way.

  Example: 63.17 m (207.25 ft.)

- Dual units are only permitted on Right-of-Way maps and other documents that may be used in negotiations with property owners. Plans in general shall not use dual dimensioning.

ANGLES AND HORIZONTAL CURVES

Angular measurement will continue to be expressed in Degrees (°), Minutes (′), and Seconds (″).

Radius definition of curves, with the radius expressed in meters, will be used rather than Degree of Curve as we previously used.

For example: A 3 degree horizontal curve on new alignment (Radius = 1909.86 ft. or 582.126 m) should be referred to as a 580.000 m radius curve. Metric radius on office location horizontal curves should always be expressed in multiples of 5 m increments.

On the other hand, alignments which incorporate a previously defined horizontal curve should continue to express the radius to the closest 0.001 m. If the 3 degree curve noted above is a recreation of a previously established curve, it should be assigned a 582.126 m radius.
ANGLES AND HORIZONTAL CURVES (CONTINUATION)

Listed below are three cases defining horizontal curves. In all three cases the curve starts at P.C. Station 300+59.41 (English), equivalent to P.C. Station 9+162.126 (metric).

Case A: Normal English curve definition.

Case B: Metric definition assuming that Case A curve data defined the roadway centerline from a previous survey and is to be retained. All curve data is a direct conversion from English to metric.

Case C: Metric definition of an office location starting at P.C. Station 9+162.126 having approximately the same curvature as the Case A curve. Note that the radius is given in a 5 m increment.

<table>
<thead>
<tr>
<th>Case A</th>
<th>Case B</th>
<th>Case C</th>
</tr>
</thead>
<tbody>
<tr>
<td>P.I. Sta. = 302+68.57</td>
<td>P.I. Sta. = 9+225.879</td>
<td>P.I. Sta. = 9+225.646</td>
</tr>
<tr>
<td>$\Delta = 12^\circ 30'$</td>
<td>$\Delta = 12^\circ 30'$</td>
<td>$\Delta = 12^\circ 30'$</td>
</tr>
<tr>
<td>$D = 3^\circ 00'$</td>
<td>$R = 582.126 \text{ m}$</td>
<td>$R = 580.000 \text{ m}$</td>
</tr>
<tr>
<td>$T = 209.16'$</td>
<td>$T = 63.753 \text{ m}$</td>
<td>$T = 63.520 \text{ m}$</td>
</tr>
<tr>
<td>$L = 416.67'$</td>
<td>$L = 127.000 \text{ m}$</td>
<td>$L = 126.536 \text{ m}$</td>
</tr>
</tbody>
</table>

This information is based on the Arc definition for Degree of Curve (D) and uses the following formulas for Degree, Length and Tangent of Curve:

$$D = \frac{1746.379}{R}; \text{ (R in meters)}$$

$$L = (30.48006) \frac{\Delta}{D}$$

and  $$T = R \tan\left(\frac{\Delta}{2}\right); \text{ (R, L and T in meters)}$$

SURVEY PLOTTING ACCURACY

As a frame of reference, distances expressed in metric units will have the following accuracy in English units:

- Closest 0.1 meters will be within 2" if the true distance.

- Closest 0.01 meters will be within 3/16" of the true distance.
SURVEY PLOTTING ACCURACY (CONTINUATION)

With this in mind, survey distances and elevations transferred to plan sheets should be shown as follows:

- Horizontal alignment data (curve information, equations, reference point tie-ins, etc.) and Benchmark elevations should be shown to the closest 0.001 m.

- Roadway elevations, used for pavement tie-ins and vertical clearance computations, should be shown to the closest 0.01 m.

- All horizontal pluses, offsets, physical feature dimensions and locations, etc. should be shown to the closest 0.01 m.

PROPOSED FEATURES ON ROADWAY PLANS

The location of all proposed features should be given in meters or decimals of a meters to the following accuracy:

- All proposed horizontal alignment data should be given to an accuracy of 0.001 meters.

- Metric curve radii should be in 5 meter increments for new alignments.

- Vertical profile alignment data should be shown with V.P.I. Stations at even 10 m stations, V.C. Lengths in 20 m increments, and V.P.I. Elevations given to 0.001 m accuracy, where practical.

- All other vertical elevations (breaks in ditch grades, pipe invert elevations, etc.) should be shown to the closest 0.01 meters.

- The location of all proposed features should be shown to the closest one meter, where practical, and never closer than 0.1 meter. The following increments are recommended:

  | Driveway Locations | Closest 1.0 meters |
  | Culvert locations  | Closest 1.0 meters |
  | Horizontal ditch grade breaks | Closest 1.0 meters |
  | Guardrail limits   | Closest 0.1 meters |
PHOTOGRAMMETRY

Contour Intervals:

<table>
<thead>
<tr>
<th>Index Contours</th>
<th>Intermediate Contours</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 mm</td>
<td>100 mm</td>
</tr>
<tr>
<td>1 meter</td>
<td>250 mm</td>
</tr>
<tr>
<td>2 meters</td>
<td>500 mm</td>
</tr>
<tr>
<td>5 meters</td>
<td>1 m</td>
</tr>
</tbody>
</table>

DRAFTING STANDARDS

Use recommended dimensionless metric scales as follows:

Metric Ratio Scales
(Related to Imperial Scales)

<table>
<thead>
<tr>
<th>Imperial Scales</th>
<th>Metric Equivalent</th>
<th>Recommended Dimensionless</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot;=2'</td>
<td>1:24 (1 cm = 0.2400 m)</td>
<td>1:20 (1 cm = 0.2 m)</td>
</tr>
<tr>
<td>1&quot;=4'</td>
<td>1:48 (1 cm = 0.4800 m)</td>
<td>1:50 (1 cm = 0.5 m)</td>
</tr>
<tr>
<td>1&quot;=10'</td>
<td>1:120 (1 cm = 1.2 m)</td>
<td>1:100 (1 cm = 1 m)</td>
</tr>
<tr>
<td>1&quot;=20'</td>
<td>1:240 (1 cm = 2.4 m)</td>
<td>1:200 (1 cm = 2 m)</td>
</tr>
<tr>
<td>1&quot;=50'</td>
<td>1:600 (1 cm = 6 m)</td>
<td>1:500 (1 cm = 5 m)</td>
</tr>
<tr>
<td>1&quot;=100'</td>
<td>1:1200 (1 cm = 12 m)</td>
<td>1:1000 (1 cm = 10 m)</td>
</tr>
<tr>
<td>1&quot;=200'</td>
<td>1:2400 (1 cm = 24 m)</td>
<td>1:2000 (1 cm = 20 m)</td>
</tr>
<tr>
<td>1&quot;=300'</td>
<td>1:3600 (1 cm = 36 m)</td>
<td></td>
</tr>
<tr>
<td>1&quot;=400'</td>
<td>1:4800 (1 cm = 48 m)</td>
<td>1:5000 (1 cm = 50 m)</td>
</tr>
<tr>
<td>1&quot;=600'</td>
<td>1:7200 (1 cm = 72 m)</td>
<td></td>
</tr>
<tr>
<td>1&quot;=800'</td>
<td>1:9600 (1 cm = 96 m)</td>
<td>1:10000 (1 cm = 100 m)</td>
</tr>
<tr>
<td>1&quot;=2000'</td>
<td>1:24000 (1 cm = 240 m)</td>
<td>1:24000 (1 cm = 240 m)*</td>
</tr>
</tbody>
</table>

* Soft conversion until USGS maps are converted to metric

<table>
<thead>
<tr>
<th>Architectural Scales</th>
<th>Recommended Dimensionless Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&quot; = 1'</td>
<td>1:5</td>
</tr>
<tr>
<td>1 1/2&quot; = 1' ; 1&quot; = 1'</td>
<td>1:10</td>
</tr>
<tr>
<td>3/4&quot; = 1' ; 1/2&quot; = 1'</td>
<td>1:20</td>
</tr>
<tr>
<td>1/4&quot; = 1'</td>
<td>1:50</td>
</tr>
<tr>
<td>1/8&quot; = 1'</td>
<td>1:100</td>
</tr>
<tr>
<td>1/16&quot; = 1'</td>
<td>1:200</td>
</tr>
<tr>
<td>1/32&quot; = 1'</td>
<td>1:500</td>
</tr>
</tbody>
</table>
GEOMETRIC DESIGN

- Curve radius, R, shall be measured in meters for horizontal curvature.

- Express pavement cross-slopes (normal and superelevated) as a ratio or a percent.

  Example: 0.020 m/m or 2.0%

- Continue to express side slopes as a dimensionless ratio of V:H.

  Example: 1:4

  \[ V = 1 \quad \text{and} \quad H = 4 \]

- Continue to express vertical gradients as percent (rise/run) where (1/1=100%). For slopes less than 45°, the vertical component should be unitary (i.e. 1:3). For slopes over 45°, the horizontal component should be unitary (i.e. 5:1).

  Slope < 45°  \quad \text{Slope = 45°}  \quad \text{Slope > 45°}

  \[ V = 1 \quad \text{and} \quad H = 3 \quad V = 1 \quad \text{and} \quad H = 1 \quad 5:1 \quad V = 5 \]

The following selected metric values have been extracted from AASHTO's A Policy on Geometric Design of Highways and Streets, 1994. This are presented here for quick reference. For a more complete list, refer to appropriate AASHTO publications.

Many of the values used in design do not convert to a nice round number in the metric system. Consequently these values are hard converted to an easy to use number, i.e. a design speed of 75 mph is equal to 121 km/h. A value of 120 km/h should be used.

SPEED

<table>
<thead>
<tr>
<th>Design Speed</th>
<th>Running Speed km/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>(18.64 mph)</td>
</tr>
<tr>
<td>40</td>
<td>(24.85 mph)</td>
</tr>
<tr>
<td>50</td>
<td>(31.07 mph)</td>
</tr>
<tr>
<td>60</td>
<td>(37.28 mph)</td>
</tr>
<tr>
<td>70</td>
<td>(43.50 mph)</td>
</tr>
<tr>
<td>80</td>
<td>(49.71 mph)</td>
</tr>
<tr>
<td>90</td>
<td>(55.92 mph)</td>
</tr>
<tr>
<td>100</td>
<td>(62.14 mph)</td>
</tr>
<tr>
<td>110</td>
<td>(68.35 mph)</td>
</tr>
<tr>
<td>120</td>
<td>(74.56 mph)</td>
</tr>
</tbody>
</table>
WIDTH

<table>
<thead>
<tr>
<th>Driving Lanes</th>
<th>equivalent</th>
<th>Shoulders</th>
<th>equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.7 m</td>
<td>(8.86 ft)</td>
<td>0.6 m</td>
<td>(1.97 ft)</td>
</tr>
<tr>
<td>3.0 m</td>
<td>(9.84 ft)</td>
<td>1.2 m</td>
<td>(3.94 ft)</td>
</tr>
<tr>
<td>3.3 m</td>
<td>(10.83 ft)</td>
<td>1.8 m</td>
<td>(5.91 ft)</td>
</tr>
<tr>
<td>3.6 m</td>
<td>(11.81 ft)</td>
<td>2.4 m</td>
<td>(7.87 ft)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.0 m</td>
<td>(9.84 ft)</td>
</tr>
</tbody>
</table>

CLEAR ZONE


SIGHT DISTANCE

<table>
<thead>
<tr>
<th>Stopping Sight Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye Height</td>
</tr>
<tr>
<td>Object Height</td>
</tr>
<tr>
<td>Headlight Height</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Passing Sight Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye Height</td>
</tr>
<tr>
<td>Object Height</td>
</tr>
</tbody>
</table>

HORIZONTAL CURVATURE

- Radius definition should be used in lieu of degree of curve. Radius should be expressed in multiples of 5 m increments. Also see ANGLES AND HORIZONTAL CURVES, pages 3 and 4.
PLAN & PROFILE SHEETS

- Recommended Scales:

<table>
<thead>
<tr>
<th>Scale</th>
<th>Horizontal Plan Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:200</td>
<td>(1 cm = 2 m) 120 m</td>
</tr>
<tr>
<td>1:500</td>
<td>(1 cm = 5 m) 300 m</td>
</tr>
<tr>
<td>1:1000</td>
<td>(1 cm = 10 m) 600 m</td>
</tr>
</tbody>
</table>

- Grid lines for profiles will normally be at 20 mm intervals.

- Use same ratio between horizontal and vertical scales as we used in the English system.

  Example: A scale of 1" = 100' horizontal and 1" = 10' vertical. Thus H:V ratio is 100:10 or 10:1. Then, for metric scale, use 1:1000 horizontally and 1:100 vertically.

- Show bar scale on the Plan and Profile sheets as well as a written scale.

  Example: | | | | | |
            0 5 10 15 20 m

SELECTED MATERIAL DESIGNATIONS

Materials which are specified by size will be designated in metric units. Metric designations for several common materials are included here:

STEEL REINFORCING (REBARS)


When the Department started the conversion of standard serial drawings from the English System to the Metric System, the intent was to use fabricated reinforcing bars in the Metric System. Reinforcing bars for almost all of the Standard Serials had been “hard” converted using bar designations and dimensions shown in AASHTO M-31M-94. These designations and sizes are:
STEEL REINFORCING (REBARS) (CONTINUATION)

TABLE 1 - Deformed Bar Designation Number, Nominal Masses, and Nominal Dimensions
(Hard Converted Metric Rebars)

<table>
<thead>
<tr>
<th>Bar Designation No.</th>
<th>Nominal Mass kg/m</th>
<th>Nominal Diameter mm</th>
<th>Nominal Cross-sectional Area mm²</th>
<th>Perimeter mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>10M</td>
<td>0.785</td>
<td>11.3</td>
<td>100</td>
<td>35.5</td>
</tr>
<tr>
<td>15M</td>
<td>1.570</td>
<td>16.0</td>
<td>200</td>
<td>50.3</td>
</tr>
<tr>
<td>20M</td>
<td>2.355</td>
<td>19.5</td>
<td>300</td>
<td>61.3</td>
</tr>
<tr>
<td>25M</td>
<td>3.925</td>
<td>25.2</td>
<td>500</td>
<td>79.2</td>
</tr>
<tr>
<td>30M</td>
<td>5.495</td>
<td>29.9</td>
<td>700</td>
<td>93.9</td>
</tr>
<tr>
<td>35M</td>
<td>7.850</td>
<td>35.7</td>
<td>1000</td>
<td>112.2</td>
</tr>
<tr>
<td>45M</td>
<td>11.775</td>
<td>43.7</td>
<td>1500</td>
<td>137.3</td>
</tr>
<tr>
<td>55M</td>
<td>19.625</td>
<td>56.4</td>
<td>2500</td>
<td>177.2</td>
</tr>
</tbody>
</table>

In May, 1996, AASHTO allowed reinforcing steel fabricators to continue to fabricate bars in the present American standard sizes. In response to this declaration, the Concrete Reinforcing Steel Institute (CRSI) issued Engineering Report Number 41, in which they specified soft-converted Metric bars to conform to AASHTO M-31M. TABLE 1 (shown above) was then revised to soft-convert American standard sizes to Metric. TABLE 2 (shown below) is also given in the Metric version of the Standard Specifications. The Department will use the soft-converted bars (TABLE 2) in all new designs.

TABLE 2 - (Revision of TABLE 1) Deformed Bar Designation Numbers, Nominal Masses, and Nominal Dimensions

<table>
<thead>
<tr>
<th>Bar Designation No.</th>
<th>Nominal Mass kg/m</th>
<th>Nominal Diameter mm</th>
<th>Nominal Cross-sectional Area mm²</th>
<th>Perimeter mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>#10M</td>
<td>0.560</td>
<td>9.5</td>
<td>71</td>
<td>29.9</td>
</tr>
<tr>
<td>#13M</td>
<td>0.994</td>
<td>12.7</td>
<td>129</td>
<td>39.9</td>
</tr>
<tr>
<td>#16M</td>
<td>1.552</td>
<td>15.9</td>
<td>199</td>
<td>49.9</td>
</tr>
<tr>
<td>#19M</td>
<td>2.235</td>
<td>19.1</td>
<td>284</td>
<td>59.8</td>
</tr>
<tr>
<td>#22M</td>
<td>3.042</td>
<td>22.2</td>
<td>387</td>
<td>69.8</td>
</tr>
<tr>
<td>#25M</td>
<td>3.973</td>
<td>25.4</td>
<td>510</td>
<td>79.8</td>
</tr>
<tr>
<td>#29M</td>
<td>5.060</td>
<td>28.7</td>
<td>645</td>
<td>90.0</td>
</tr>
<tr>
<td>#32M</td>
<td>6.404</td>
<td>32.3</td>
<td>819</td>
<td>101.3</td>
</tr>
<tr>
<td>#36M</td>
<td>7.907</td>
<td>35.8</td>
<td>1006</td>
<td>112.5</td>
</tr>
<tr>
<td>#43M</td>
<td>11.380</td>
<td>43.0</td>
<td>1452</td>
<td>135.1</td>
</tr>
<tr>
<td>#57M</td>
<td>20.240</td>
<td>57.3</td>
<td>2581</td>
<td>180.1</td>
</tr>
</tbody>
</table>
STEEL REINFORCING (REBARS) (CONTINUATION)

As a result of the change from hard conversion to soft conversion, we now have Standard Serial Drawings for CBC's, drop inlets, concrete barrier railings and similar miscellaneous structures specifying reinforcing bars in hard-converted metric, and detailed drawings of bridge components using the soft-converted bar sizes specified in TABLE 2.

To clarify reinforcing bar sizes used on the Standard Serial Drawings, the following note will be added to each metric standard drawing which uses the hard-converted conversion:

NOTE TO ADD TO STANDARD DRAWINGS

Bar designations shown correspond to the hard-converted metric reinforcing bar sizes specified in AASHTO M-31M-94. Substitution of soft-converted metric reinforcing bars as provided for in the Standard Specifications will be permitted.

Contractors may therefore substitute, at no change in cost, soft-converted bars for the hard-converted bar as shown in Subsection 540.21(b) and Table 540-A of the Metric version of the Standard Specifications, and Table 3 below:

TABLE 3 - Substitution of Soft-Converted Reinforcing Bars for Hard-Converted Reinforcing Bars

<table>
<thead>
<tr>
<th>Metric Bar Size Hard Conv.</th>
<th>Metric Bar Area A1 mm²</th>
<th>Replacement Bar Size Metric (English)</th>
<th>Replacement Bar Area A2 mm²</th>
<th>A2/A1</th>
</tr>
</thead>
<tbody>
<tr>
<td>10M</td>
<td>100</td>
<td>#13M (#4)</td>
<td>126.7</td>
<td>1.267</td>
</tr>
<tr>
<td>15M</td>
<td>200</td>
<td>#16M (#5)</td>
<td>197.9</td>
<td>0.990</td>
</tr>
<tr>
<td>20M</td>
<td>300</td>
<td>#19M (#6)</td>
<td>285.0</td>
<td>0.950</td>
</tr>
<tr>
<td>25M</td>
<td>500</td>
<td>#25M (#8)</td>
<td>506.7</td>
<td>1.013</td>
</tr>
<tr>
<td>30M</td>
<td>700</td>
<td>#32M (#10)</td>
<td>817.3</td>
<td>1.168</td>
</tr>
<tr>
<td>35M</td>
<td>1000</td>
<td>#36M (#11)</td>
<td>1007.4</td>
<td>1.007</td>
</tr>
<tr>
<td>45M</td>
<td>1500</td>
<td>#43M (#14)</td>
<td>1452.3</td>
<td>0.968</td>
</tr>
<tr>
<td>55M</td>
<td>2500</td>
<td>#57M (#18)</td>
<td>2581.2</td>
<td>1.032</td>
</tr>
</tbody>
</table>

The replacement reinforcing bar areas given in Table 3 above are exactly calculated from the diameters of American standard reinforcing bars shown in AASHTO M 31, and differ slightly from the CRSI converted bars.

If the contractor substitutes soft-converted reinforcing bars for hard-converted reinforcing bars as shown in Table 3 above, measurement will be based on the computed weights of the hard-converted bars as shown on the contract documents.
**STRUCTURAL STEEL**


Reference for Section Properties (conversion of size and weight called out from English units to Metric units, dimensions and section properties) - Use **METRIC PROPERTIES OF STRUCTURAL SHAPES, WITH DIMENSIONS ACCORDING TO ASTM A6M**, published by the American Institute of Steel Construction, Inc., Copyright 1992. This is an orange-colored paper back with 97 pages (Dimensions 5 5/8" x 9").
PIPE CULVERTS


Basic Details:

<table>
<thead>
<tr>
<th>Corrugation Sizes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Corrugation Sizes</strong></td>
<td><strong>Metric (mm)</strong></td>
</tr>
<tr>
<td><strong>2 2/3 x 1 1/2</strong></td>
<td>68 x 12</td>
</tr>
<tr>
<td><strong>3 x 1</strong></td>
<td>75 x 25</td>
</tr>
<tr>
<td><strong>5 x 1</strong></td>
<td>125 x 25</td>
</tr>
</tbody>
</table>

Pipe Wall Thickness

<table>
<thead>
<tr>
<th>Gage</th>
<th>Current (inches)</th>
<th>Metric (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>0.040</td>
<td>1.02</td>
</tr>
<tr>
<td>18</td>
<td>0.052</td>
<td>1.32</td>
</tr>
<tr>
<td>16</td>
<td>0.064</td>
<td>1.63</td>
</tr>
<tr>
<td>14</td>
<td>0.079</td>
<td>2.01</td>
</tr>
<tr>
<td>12</td>
<td>0.109</td>
<td>2.77</td>
</tr>
</tbody>
</table>

Reinforced Concrete Pipe (12" and above) - Specification reference - AASHTO M-170M

The actual inside diameter of the pipes is soft-converted from the English equivalent and rounded to the nearest millimeter.

**EXAMPLE:** 4" x 25.4 mm/in. = 101.6 mm, Use 102 mm

Size Designations

<table>
<thead>
<tr>
<th>Nominal inside Diameter in.</th>
<th>Actual Diameter mm</th>
<th>Nominal inside Diameter in.</th>
<th>Actual Diameter mm</th>
<th>Nominal inside Diameter in.</th>
<th>Actual Diameter mm</th>
<th>Nominal inside Diameter in.</th>
<th>Actual Diameter mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>100</td>
<td>30</td>
<td>750</td>
<td>84</td>
<td>2100</td>
<td>2134</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>150</td>
<td>33*</td>
<td>825</td>
<td>90</td>
<td>2250</td>
<td>2286</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>200</td>
<td>36</td>
<td>900</td>
<td>96</td>
<td>2400</td>
<td>2438</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>250</td>
<td>42</td>
<td>1050</td>
<td>102</td>
<td>2550</td>
<td>2591</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>300</td>
<td>48</td>
<td>1200</td>
<td>108</td>
<td>2700</td>
<td>2743</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>375</td>
<td>54</td>
<td>1350</td>
<td>114</td>
<td>2850</td>
<td>2896</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>450</td>
<td>60</td>
<td>1500</td>
<td>120</td>
<td>3000</td>
<td>3048</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>525</td>
<td>66</td>
<td>1650</td>
<td>126**</td>
<td>3150</td>
<td>3200</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>600</td>
<td>72</td>
<td>1800</td>
<td>132</td>
<td>3300</td>
<td>3353</td>
<td></td>
</tr>
<tr>
<td>27*</td>
<td>675</td>
<td>78</td>
<td>1950</td>
<td>138</td>
<td>3450</td>
<td>3505</td>
<td></td>
</tr>
</tbody>
</table>

* - Not listed on Standard Serials for Corrugated Metal Pipe.
** - Not listed on Standard Serials for Reinforced Concrete Pipe.
WIRE CLOTH SIZE DESIGNATIONS

The table below is from information contained in AASHTO M92 and ASTM E11 “Wire Cloth Sieves for Testing Purposes”, and shows Standard (Metric) and Alternative (U.S. Customary) sieve size designations. As shown, metric size designations are given in mm or µm. (1000 µm = 1 mm)

<table>
<thead>
<tr>
<th>Standard</th>
<th>Alternate</th>
<th>Standard</th>
<th>Alternate</th>
</tr>
</thead>
<tbody>
<tr>
<td>125 mm</td>
<td>5 in.</td>
<td>2.36 mm</td>
<td>No. 8</td>
</tr>
<tr>
<td>106 mm</td>
<td>4.24 in.</td>
<td>2.00 mm</td>
<td>No. 10</td>
</tr>
<tr>
<td>100 mm</td>
<td>4 in.</td>
<td>1.70 mm</td>
<td>No. 12</td>
</tr>
<tr>
<td>90 mm</td>
<td>3-1/2 in.</td>
<td>1.40 mm</td>
<td>No. 14</td>
</tr>
<tr>
<td>75 mm</td>
<td>3 in.</td>
<td>1.18 mm</td>
<td>No. 16</td>
</tr>
<tr>
<td>63 mm</td>
<td>2-1/2 in.</td>
<td>1.00 mm</td>
<td>No. 18</td>
</tr>
<tr>
<td>53 mm</td>
<td>2.12 in.</td>
<td>850 µm</td>
<td>No. 20</td>
</tr>
<tr>
<td>50 mm</td>
<td>2 in.</td>
<td>710 µm</td>
<td>No. 25</td>
</tr>
<tr>
<td>45 mm</td>
<td>1-3/4 in.</td>
<td>600 µm</td>
<td>No. 30</td>
</tr>
<tr>
<td>37.5 mm</td>
<td>1-1/2 in.</td>
<td>500 µm</td>
<td>No. 35</td>
</tr>
<tr>
<td>31.5 mm</td>
<td>1-1/4 in.</td>
<td>425 µm</td>
<td>No. 40</td>
</tr>
<tr>
<td>26.5 mm</td>
<td>1.06 in.</td>
<td>355 µm</td>
<td>No. 45</td>
</tr>
<tr>
<td>25.0 mm</td>
<td>1 in.</td>
<td>300 µm</td>
<td>No. 50</td>
</tr>
<tr>
<td>22.4 mm</td>
<td>7/8 in.</td>
<td>250 µm</td>
<td>No. 60</td>
</tr>
<tr>
<td>19.0 mm</td>
<td>3/4 in.</td>
<td>212 µm</td>
<td>No. 70</td>
</tr>
<tr>
<td>16.0 mm</td>
<td>5/8 in.</td>
<td>180 µm</td>
<td>No. 80</td>
</tr>
<tr>
<td>13.2 mm</td>
<td>0.530 in.</td>
<td>150 µm</td>
<td>No. 100</td>
</tr>
<tr>
<td>12.5 mm</td>
<td>1/2 in.</td>
<td>125 µm</td>
<td>No. 120</td>
</tr>
<tr>
<td>11.2 mm</td>
<td>7/16 in.</td>
<td>106 µm</td>
<td>No. 140</td>
</tr>
<tr>
<td>9.5 mm</td>
<td>3/8 in.</td>
<td>90 µm</td>
<td>No. 170</td>
</tr>
<tr>
<td>8.0 mm</td>
<td>5/16 in.</td>
<td>75 µm</td>
<td>No. 200</td>
</tr>
<tr>
<td>6.7 mm</td>
<td>0.265 in.</td>
<td>63 µm</td>
<td>No. 230</td>
</tr>
<tr>
<td>6.3 mm</td>
<td>1/4 in.</td>
<td>53 µm</td>
<td>No. 270</td>
</tr>
<tr>
<td>5.6 mm</td>
<td>No. 3-1/2</td>
<td>45 µm</td>
<td>No. 325</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>No. 4</td>
<td>38 µm</td>
<td>No. 400</td>
</tr>
<tr>
<td>4.00 mm</td>
<td>No. 5</td>
<td>32 µm</td>
<td>No. 450</td>
</tr>
<tr>
<td>3.35 mm</td>
<td>No. 6</td>
<td>25 µm</td>
<td>No. 500</td>
</tr>
<tr>
<td>2.80 mm</td>
<td>No. 7</td>
<td>20 µm</td>
<td>No. 635</td>
</tr>
</tbody>
</table>
BASE UNITS

There are seven base metric units of measurement. These are meter, kilogram, second, ampere, kelvin, mole, and candela. The base units which are used in highway design and construction are listed below.

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Unit</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>length</td>
<td>meter</td>
<td>m</td>
</tr>
<tr>
<td>mass*</td>
<td>kilogram</td>
<td>kg</td>
</tr>
<tr>
<td>time</td>
<td>second</td>
<td>s</td>
</tr>
<tr>
<td>electric current</td>
<td>ampere</td>
<td>A</td>
</tr>
<tr>
<td>temperature</td>
<td>kelvin</td>
<td>K</td>
</tr>
<tr>
<td>luminous intensity</td>
<td>candela</td>
<td>cd</td>
</tr>
</tbody>
</table>

# - Please note Upper vs Lower case symbols
* - "Weight" is commonly mistaken for Mass;
Weight refers to the force of gravity in Newtons.

DECIMAL PREFIXES

Only three decimal prefixes are commonly used with the base units in design and construction. These are as shown in the following table:

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Symbol</th>
<th>Order of Magnitude</th>
<th>Expression</th>
</tr>
</thead>
<tbody>
<tr>
<td>kilo</td>
<td>k</td>
<td>$10^3$</td>
<td>1000 (one thousand)</td>
</tr>
<tr>
<td>milli</td>
<td>m</td>
<td>$10^{-3}$</td>
<td>0.001 (one thousandth)</td>
</tr>
</tbody>
</table>

The prefixes mega (M) for one million ($10^6$), giga (G) for one billion ($10^9$), micro ($\mu$) for one millionth ($10^{-6}$), and nano (n) for one billionth ($10^{-9}$) are used in some engineering calculations.

Decimal prefixes to the tertiary power of 10 are preferred (meaning in multiples of 3 i.e., $10^3$, $10^6$ etc.) The prefixes deci (d) for one tenth ($10^{-1}$), centi (c) for one hundredth ($10^{-2}$), deca (da) for ten ($10^1$), and hecto (h) for one hundred ($10^2$) have limited application in design and construction.

TEMPERATURE

Celsius temperature ($^\circ$C) is more commonly used than kelvin (K), but both have the same temperature gradients. Celsius temperature is simply 273.15 degrees warmer than kelvin. Kelvin begins at absolute zero. For instance, water freezes at 273.15 K and at 0°C; it boils at 373.15 K and at 100°C. To move between Celsius and kelvin, add or subtract 273.15. Please note the use of the symbol, ($^\circ$), for degrees Celsius. The symbol, ($^\circ$), is not used for degrees K. The following formulas can be used for conversions from $^\circ$F to $^\circ$C and vice versa:

$$^\circ$C = 5/9($^\circ$F - 32)  \quad ^\circ$F = 9/5($^\circ$C) + 32
DERIVED UNITS

As shown previously, there are only seven base units in the metric system. There are, however, many derived units which are used in the metric system. Some of the derived units which are used in design are units such as (t) for metric ton which equals 1000 kilograms; square meter for area; and cubic meters per second for flow rate. For other units, see GENERAL CIVIL ENGINEERING CONVERSION FACTORS in these guidelines.

PLANE AND SOLID ANGLES

The radian (rad) and steradian (sr) denote plane and solid angles. They are used in lighting work and in various engineering calculations. In surveying, the units degree (°), minute (′), and second (″) will continue to be used because of the required precision.

LITER, HECTARE, AND METRIC TON

The liter (L) is the measurement for liquid volume. The hectare (ha) is a metric measurement used to replace the acre. The metric ton (t) is used to denote large loads such as those used in surfacing aggregates and will replace the conventional English ton. The metric ton is equal to 1000 kilograms (commonly used in the Untied States) and one (1) megagram (Mg). Caution should be exercised when using and computing tonne(s), since the metric tonne is abbreviated (t) and it could easily be confused with the conventional English ton.

PRONUNCIATION

candela
kilometer
hectare
joule
pascal
siemens

Accent the second syllable: can-dell-ah
Accent the first syllable: kill-o-meter
Accent the first syllable: heck-tare. The second syllable rhymes with care.
Rhymes with pool
Rhymes with rascal
Sounds like seamen's
RULES FOR WRITING METRIC SYMBOLS AND NAMES

- Print unit symbols in upright type and in lower case except for liter (L) or unless the unit name is derived from a proper name.

- Print unit names in lower case, even those derived from a proper name except for Celsius.

- Print decimal prefixes in lower case for magnitudes $10^3$ and lower (for example: k, m, $\mu$, and n) and print prefixes in upper case for magnitudes $10^6$ and higher (for example: M and G).

- Leave a space between the numeral and the symbol (for example: write 45 kg, not 45kg) except for temperature in Celsius (for example: 37$^\circ$C).

- Do not use a degree mark (°) with kelvin temperature (for example: write K, not °K).

- Do not leave a space between a unit symbol and its decimal prefix (for example: write kg, not k g).

- Do not use the plural of unit symbols (for example: write 40 kg, not 40 kgs), but do use the plural of written unit names (for example: forty kilograms).

- For technical writing, use symbols in conjunction with numerals (the area is 10 m); write out units names if numerals are not used (carpet is measured in square meters). Numerals may be combined with written unit names in non-technical writing (10 meters).

- Indicate the product of two or more units in symbolic form by using a dot positioned above the line (for example: kg·m·s).

- Do not mix names and symbols (for example: write N·m or newton·meter, not N·meter nor newtow·m).

- Do not use a period after a symbol (for example: write “12 g”, not “12 g.”) except when it occurs at the end of a sentence.

RULES FOR WRITING NUMBERS

- Always use decimals, not fractions (for example: write 0.75 g, not 3/4 g).

- Use a zero before the decimal marker for values less that one (1) (for example: write 0.45 g, not .45 g).

- Commas shall continue to be used to separate digits into groups of three greater than four digits (current practice in the United States) (for example: write 1000 m or 10,000 t, not 1,000 m nor 10000 t). Spaces will not be used to separate the groups.
CONVERSION AND ROUNDING

- When converting values from miles to kilometers, round off the resultant metric value to the same number of digits as there were in the mile number (for example: 11 miles at 1.609 km/mi equals 17.699 km, which rounds off to 18 km. 12.26 miles at 1.609 km/mi equals 19.726 km, which rounds off to 19.73 km, etc.)

- Convert mixed inch-pound units (feet and inches, pounds and ounces) to the smaller unit, inch-pound, before converting to metric and rounding off (10 feet, 3 inches = 123 inches; 123 inches x 25.4 mm/inch = 3,124.2 mm; round to 3124 mm).

- In a “soft” conversion, an English measurement is mathematically converted to its exact (or nearly exact) metric equivalent. With “hard” conversion, a new rounded-rationalized metric number is created that is convenient to work with.

GENERAL CIVIL ENGINEERING

One metric unit is used to measure length, area, and volume in most design and construction work. This unit is:

- meter (m)

RULES FOR LINEAR MEASUREMENT (LENGTH)

- Use the kilometer for long distances and the millimeter for precision measurements.

- Measurements done in millimeter will typically be in whole numbers. Those done in meters will typically have at least one decimal place.

- Avoid use of the centimeter.

- For survey measurement, use the meter and kilometer.

- Use only the meter and millimeter in building design and architectural construction.
RULES FOR AREA

- The square meter is preferred.

- Very large areas may be expressed in square kilometers and very small areas, in square millimeters.

- Use the hectare (10,000 square meters) for land and water measurements only.

- Avoid use of the square centimeter.

- Linear dimensions such as: 40 x 90 mm may be used; if so, indicate width first and height second.

RULES FOR VOLUME AND FLUID CAPACITY

- Cubic meter is preferred for volumes in construction and for measurements such as large storage tanks.

- Use liter (L) and milliliter (mL) for fluid capacity (liquid volume). One liter is 1/1000 of a cubic meter or 1000 cubic centimeters.

- Since a cubic meter equals one billion cubic millimeters, the cubic decimeter and cubic centimeter may be used in limited applications, because they are multiples of 1000 in volume measurement.

RULES FOR CIVIL ENGINEERING

- Plane angles in surveying (cartography) will continue to be measured in degrees (either decimal degrees or degrees, minutes, and seconds) rather than the metric radian or grads.

- Slope is expressed in non-dimensional ratios. The vertical component is shown first and then the horizontal. For instance, a rise of one meter in four meters is expressed as 1:4. The units that are compared should be the same (meters to meters, millimeters to millimeters, etc.). Please note that a slope measured as a rise of one meter to a run of four meters is equivalent to a slope measured as a rise of one foot to a run of four feet.
## GENERAL CIVIL ENGINEERING CONVERSION FACTORS

<table>
<thead>
<tr>
<th>Quantity</th>
<th>To Convert From</th>
<th>English Units</th>
<th>To Metric Units</th>
<th>Multiply by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>mile</td>
<td>km</td>
<td>1.609347</td>
<td></td>
</tr>
<tr>
<td></td>
<td>yard</td>
<td>m</td>
<td>0.9144</td>
<td></td>
</tr>
<tr>
<td></td>
<td>foot</td>
<td>m</td>
<td>0.3048006</td>
<td></td>
</tr>
<tr>
<td></td>
<td>foot</td>
<td>mm</td>
<td>304.8006</td>
<td></td>
</tr>
<tr>
<td></td>
<td>inch</td>
<td>mm</td>
<td>25.4</td>
<td></td>
</tr>
<tr>
<td>Mass</td>
<td>pound</td>
<td>g</td>
<td>453.5924</td>
<td></td>
</tr>
<tr>
<td>(weight)</td>
<td>pound</td>
<td>kg</td>
<td>0.4535924</td>
<td></td>
</tr>
<tr>
<td></td>
<td>pound</td>
<td>t (1000 kg)</td>
<td>0.00045359</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ton</td>
<td>kg</td>
<td>907.1847</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ton</td>
<td>t (1000 kg)</td>
<td>0.9071847</td>
<td></td>
</tr>
<tr>
<td>Area</td>
<td>square mile</td>
<td>km²</td>
<td>2.59000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>acre</td>
<td>m²</td>
<td>4046.873</td>
<td></td>
</tr>
<tr>
<td></td>
<td>acre</td>
<td>ha (10,000 m²)</td>
<td>0.4046873</td>
<td></td>
</tr>
<tr>
<td></td>
<td>square yard</td>
<td>m²</td>
<td>0.83613070</td>
<td></td>
</tr>
<tr>
<td></td>
<td>square foot</td>
<td>m²</td>
<td>0.09290341</td>
<td></td>
</tr>
<tr>
<td></td>
<td>square inch</td>
<td>mm²</td>
<td>645.16</td>
<td></td>
</tr>
<tr>
<td>Volume</td>
<td>acre-foot</td>
<td>m³</td>
<td>1233.49</td>
<td></td>
</tr>
<tr>
<td></td>
<td>cubic yard</td>
<td>m³</td>
<td>0.764559</td>
<td></td>
</tr>
<tr>
<td></td>
<td>cubic foot</td>
<td>m³</td>
<td>0.028317</td>
<td></td>
</tr>
<tr>
<td></td>
<td>cubic foot</td>
<td>cm³</td>
<td>28,317.02</td>
<td></td>
</tr>
<tr>
<td></td>
<td>cubic foot</td>
<td>l (1000 cm³)</td>
<td>28.31702</td>
<td></td>
</tr>
<tr>
<td></td>
<td>gallon</td>
<td>l (1000 cm³)</td>
<td>3.78541</td>
<td></td>
</tr>
<tr>
<td></td>
<td>cubic inch</td>
<td>cm³</td>
<td>16.387162</td>
<td></td>
</tr>
<tr>
<td></td>
<td>cubic inch</td>
<td>mm³</td>
<td>16,387.162</td>
<td></td>
</tr>
<tr>
<td>Velocity</td>
<td>mph</td>
<td>km/h</td>
<td>1.609347</td>
<td></td>
</tr>
<tr>
<td>Pressure</td>
<td>p.s.i.</td>
<td>Pa</td>
<td>6,894.76</td>
<td></td>
</tr>
<tr>
<td>or</td>
<td>p.s.i.</td>
<td>kPa</td>
<td>6,894757</td>
<td></td>
</tr>
<tr>
<td>stress</td>
<td>k.s.i.</td>
<td>MPa</td>
<td>6,894757</td>
<td></td>
</tr>
<tr>
<td></td>
<td>lb/ft²</td>
<td>Pa</td>
<td>47.88026</td>
<td></td>
</tr>
<tr>
<td>Force</td>
<td>pound-force</td>
<td>N</td>
<td>4.448222</td>
<td></td>
</tr>
<tr>
<td></td>
<td>kip</td>
<td>N</td>
<td>4,448.222</td>
<td></td>
</tr>
<tr>
<td>Unit</td>
<td>lbs/ft³</td>
<td>kg/m³</td>
<td>16.01846</td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>lbs/yd³</td>
<td>kg/m³</td>
<td>0.5932764</td>
<td></td>
</tr>
<tr>
<td>Flow</td>
<td>cubic ft./min.</td>
<td>m³/s</td>
<td>0.000471947</td>
<td></td>
</tr>
<tr>
<td></td>
<td>cubic ft./sec</td>
<td>m³/s</td>
<td>0.02831685</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** All conversion factors are approximate and are based on the US Survey foot where one meter = 39.37 inches exactly.
SAMPLE METRIC CONVERSION CALCULATIONS

The following sample calculations are intended to aid in the conversion of existing data. Hopefully it will also aid in providing alternatives to methods used in the conversion calculations. The General Civil Engineering Conversion Factors included in these guidelines have multiplication factors for converting from one unit to another. Some may prefer to use ratios to help in maintaining the dimensional consistency. Factors are good when doing many repetitious calculations. The use of ratios are excellent when trying to convert complicated unit of measurement or when converting for units which are not listed such as from pounds per square yard to kilograms per square meter which might be used for a blotter sand application. Examples of the use of both methods are included here.

LENGTH

Convert 1,137.5 feet (ft.) to meters (m):

From the conversion chart, multiply by 0.3048006 to get meters.

\[ 1,137.5 \text{ ft.} \times 0.3048006 = 346.71068 \text{ m} \quad \text{Use} \quad 346.7 \text{ m} \]

or

Find the equivalent ratio such as: 1 m = 39.37 in., and 12 in. = 1 ft., then:

\[ \frac{12 \text{ in.}}{1 \text{ ft.}} \times \frac{1 \text{ m}}{39.37 \text{ in.}} = 346.7107 \text{ m} \quad \text{Use} \quad 346.7 \text{ m} \]

MASS

Convert 11,500 pounds (lbs.) to kilograms (kg):

\[ 0.4535924 \text{ kg} \]

\[ 11,500 \text{ lbs.} \times \frac{0.4535924 \text{ kg}}{1 \text{ lbs.}} = 5,216.3126 \text{ kg} \quad \text{Use} \quad 5216 \text{ kg} \]

Convert 8,453.5 pounds (lbs.) to metric tons (t):

Note that the metric ton (sometimes written as tonne) is equal to 1000 kilograms. The (English ton or short) ton is equal to 2,000 lbs.

\[ \frac{1 \text{ ton}}{2,000 \text{ lbs.}} \times \frac{907.1847 \text{ kg}}{1 \text{ ton}} \times \frac{t}{1000 \text{ kg}} = 3.834216 \text{ t} \quad \text{Use} \quad 3.8 \text{ t} \]
AREA

Convert 875.45 square feet to square meters (m²):

From the conversion chart multiply by 0.09290341 to get m²

875.45 sq. ft. \times 0.09290341 = 81.33229 \text{ m}^2

Use 81.33 \text{ m}^2

Notice that the round off is done to the same number as the least of the significant figures in the problem, i.e. 2 digits to the right of the decimal place.

or

\[
\frac{1 \text{ m}}{3.2808 \text{ ft}} \times \frac{1 \text{ m}}{3.2808 \text{ ft}} = 81.339 \text{ m}^2
\]

Use 81.33 \text{ m}^2

Notice that the format of the units (sq. ft. Vs ft²) is changed. This is done for illustration purposes and for clarity.

Convert 230,458.0 sq. ft. to hectares (ha):

Please note that the factors for area or volume can be derived by using multiple factors for length such as:

If you know that 1 m = 3.2808 ft., then you can derive a factor for area by using the following:

\[
\frac{1 \text{ m}}{3.2808 \text{ ft}} \times \frac{1 \text{ m}}{3.2808 \text{ ft}} = \frac{1 \text{ m}^2}{10.7636 \text{ ft}^2}
\]

The new factor is used in this conversion problem. This concept is used in the next conversion problem to derive a factor for square meters vs. square yards. One can use this concept for volume or any other units of measure as necessary.

\[
230,458.0 \text{ ft}^2 = 230,458.0 \text{ ft}^2 \times \frac{1 \text{ m}^2}{10.7636 \text{ ft}^2} = 2.14109 \text{ ha}
\]

USE 2.1 ha
VOLUME

Convert 175,468 square yard-inches (yd²-in.) to cubic meters (m³):

\[
175,468 \text{ yd}^2\text{-in.} = 175,468 \text{ yd}^2\text{-in.} \times \frac{1 \text{ m}^2}{1.19599 \text{ yd}^2} \times \frac{1 \text{ m}}{39.37 \text{ in.}} = 3,726.5329 \text{ m}^3
\]

Use 3727 m³

OTHER COMMON UNITS OF MEASURE

Convert 65 feet per second (ft./s) to kilometers per hour (km/h):

\[
65 \frac{\text{ft.}}{\text{s}} = 65 \frac{\text{ft.}}{\text{s}} \times \frac{1 \text{ mi.}}{5,280 \text{ ft.}} \times \frac{1.609347 \text{ km}}{1 \text{ mi.}} \times \frac{3,600 \text{ s}}{1 \text{ h}} = 71.3233 \text{ km/h}
\]

USE 71 km/h

Convert 3,450 p.s.i. to pascal (Pa) using conversion factors:

\[
3,450 \text{ p.s.i.} = 3,450 \text{ p.s.i.} \times 6,894.757 = 23,786,911.65 \text{ Pa}
\]

or

\[
23,786,911.65 \text{ Pa} = 23,786,911.65 \text{ Pa} \times 1 \text{ MPa} / 1,000,000 \text{ Pa}
\]

\[
= 23.78691165 \text{ Megapascals}
\]

USE 23.787 MPa

Convert 40 lbs. per square yard (lbs./yd²) to kilograms per square meter (kg/m²):

\[
40 \text{ lbs./sq. yd.} = 40 \frac{\text{lbs.}}{\text{yd}^2} \times \frac{1 \text{ kg}}{2.204622 \text{ lbs.}} \times \frac{1 \text{ yd}^2}{0.8361274 \text{ m}^2} = 21.699683 \text{ kg/m}^2
\]

USE 22 kg/m²
OTHER COMMON UNITS OF MEASURE (CONTINUATION)

Convert 145.3 lbs. per cubic foot (lbs./ft\(^3\)) to kilograms per cubic meter (kg/m\(^3\)) using factors:

\[
145.3 \text{ lbs./cu. ft.} = 145.3 \text{ lbs./ft}^3 \times 16.01846 = 2,327.482238 \text{ kg/m}^3
\]

or using ratios:

\[
\text{USE } 2,327.5 \text{ kg/m}^3
\]

Convert the Prime Coat factor of 256.86 gal/ton to liters/Tonne:

\[
\text{USE } 1,071.80 \text{ L/t}
\]

Determine the metric tons/m\(^2\) of PMBP using a depth of 10” and a unit weight of 3,950 lbs. per cubic yard. For each square yard of PMBP, the following calculation applies:

\[
1 \text{ yd} = 10” \times \frac{0.9071847 \text{ t}}{2,000 \text{ lbs.}} \times \frac{1.1959854 \text{ yd}^2}{1 \text{ m}^2} \times \frac{0.5952319 \text{ metric}}{\text{m}^2}
\]

\[
\text{USE } 0.60 \text{ t/m}^2 \text{ or } 0.60 \text{ t for each m}^2 \text{ of 10” PMBP}
\]
METRIC UNITS-OF-MEASUREMENT

The New Mexico State Highway & Transportation Department units-of-measure used in the bidding documents are listed below. The metric units-of-measure are shown here in both the abbreviated form and also are spelled out with the recommended use of uppercase letters.

<table>
<thead>
<tr>
<th>Current Pay</th>
<th>Units (Spelled out)</th>
<th>Metric Pay</th>
<th>Units* (Spelled out)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acre</td>
<td>Acre</td>
<td>ha</td>
<td>hectare</td>
</tr>
<tr>
<td>Acre-unit</td>
<td>Ac-unit</td>
<td>haun</td>
<td>hectare-unit</td>
</tr>
<tr>
<td>Cal. Day</td>
<td>Calendar Day</td>
<td>CAL. DAY</td>
<td>calendar day</td>
</tr>
<tr>
<td>Cu. Ft.</td>
<td>cubic Foot</td>
<td>cu. m</td>
<td>cubic meter</td>
</tr>
<tr>
<td>Cu. Yd.</td>
<td>cubic Yard</td>
<td>cu. m</td>
<td>cubic meter</td>
</tr>
<tr>
<td>Each</td>
<td>Each</td>
<td>EACH</td>
<td>each</td>
</tr>
<tr>
<td>Gallon</td>
<td>Gallon</td>
<td>L</td>
<td>liter</td>
</tr>
<tr>
<td>Hour</td>
<td>Hour</td>
<td>HOUR</td>
<td>hour</td>
</tr>
<tr>
<td>Lin. Ft.</td>
<td>Linear Foot</td>
<td>m</td>
<td>meter</td>
</tr>
<tr>
<td>L.S.</td>
<td>Lump Sum</td>
<td>L.S.</td>
<td>lump sum</td>
</tr>
<tr>
<td>Mile</td>
<td>Mile</td>
<td>km</td>
<td>kilometer</td>
</tr>
<tr>
<td>1/4 M. Y.</td>
<td>1/4 Mile-Yard</td>
<td>1/4 km-m</td>
<td>1/4 kilometer-meter</td>
</tr>
<tr>
<td>M-Gal</td>
<td>Thousand Gallons</td>
<td>cu. m</td>
<td>cubic meter</td>
</tr>
<tr>
<td>Pound</td>
<td>Pound</td>
<td>kg</td>
<td>kilogram</td>
</tr>
<tr>
<td>Sq. Ft.</td>
<td>Square Foot</td>
<td>sq. m</td>
<td>square meter</td>
</tr>
<tr>
<td>Sq. Yd.</td>
<td>Square Yard</td>
<td>sq. m</td>
<td>square meter</td>
</tr>
<tr>
<td>Sq. Yd.-In.</td>
<td>Square Yard-Inch</td>
<td>sq. m-mm</td>
<td>cubic meter</td>
</tr>
<tr>
<td>Ton</td>
<td>Ton</td>
<td>t</td>
<td>metric ton</td>
</tr>
<tr>
<td>Tn-Mile</td>
<td>Ton-Mile</td>
<td>t-km</td>
<td>ton-kilometer</td>
</tr>
<tr>
<td>Ver. Ft.</td>
<td>Vertical Foot</td>
<td>m</td>
<td>meter</td>
</tr>
</tbody>
</table>

* Please note that the metric units are in the recommended upper-/lower case as defined by the metric guidelines.
Rule 500.10. Monuments

A. Except as prescribed in Paragraphs B and C, monuments shall be metal, at least one-half inch in diameter, at least 6 inches long and shall be set flush with or slightly below ground level. They shall bear a metal or plastic cap stamped with the surveyor’s registration number.

B. Corners which fall upon a concrete surface shall be monumented with a chiseled cross or a nail.

C. When a corner is located at a place where it is not practical to set a monument or a monument at the corner is likely to be destroyed, at least one reference monument shall be set and dimensioned on the plat such that the location of the corner can be reestablished.

D. Monuments for the exterior corners of a subdivision shall be set by the surveyor who certified the plat of the subdivision prior to recordation of the subdivision plat. Interior corners of a subdivision shall be set within thirty (30) days after completion of the construction of infrastructure improvements but within one (1) year after recordation of the subdivision plat. The surveyor certifying the subdivision plat shall be responsible for setting interior corners and shall certify on the plat that the monuments shall be set by the surveyor in accordance with these Standards.

Rule 500.11. Definitions

Dimensions means the direction, expressed either as a bearing or an azimuth, and the length of a survey line.

Easement means a right that a person or an entity holds in the land of another.

Engineering Survey as used in Section 61-23-3P, NMSA 1978, means topographic surveying as defined in Rule 500.2.C or unclassified surveying as defined in Rule 500.2.F.

Monument means an object intended to mark a property boundary corner.

Surveyor means a professional surveyor registered under the Engineering and Surveying Practice Act.

Tract or Lot means a parcel of land in separate ownership or set off for separate ownership.

Rule 500.12. General

A. Authority. These rules are authorized by the Engineering and Surveying Practice Act.

B. Penalties. The New Mexico Board of Registration for Engineers and Surveyors may take those actions prescribed in the Engineering and Surveying Practice Act against any surveyor who has been found in violation of these standards.

C. Disclaimers. Any disclaimer by a surveyor purporting to disavow compliance with any of these standards is prohibited.

D. Interpretation. The words "offers surveying services to the public" as used in Paragraph B of Section 61-23-27.10 NMSA 1978, includes the certification by a surveyor of a plat or map which may be used by the public.

E. Advisory Opinions. The Surveying Committee of the Board of Registration may issue its opinion explaining the application of these standards to a specific situation.
APPENDIX H

MINIMUM STANDARDS FOR SURVEYING IN NEW MEXICO
NEW MEXICO BOARD OF REGISTRATION
FOR PROFESSIONAL ENGINEERS AND SURVEYORS

1010 Marquez Place
Santa Fe, New Mexico 87501

(505) 827-7561

Title 12, Chapter 8, Part 2, New Mexico Administrative Code

MINIMUM STANDARDS FOR SURVEYING IN NEW MEXICO

Effective October 1, 2000

12.8.2 NMAC
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12.8.2 NMAC
TITLE 12  TRADE, COMMERCE AND BANKING
CHAPTER 8  TRADE PRACTICES AND REGULATIONS
PART 2  MINIMUM STANDARDS FOR SURVEYING IN NEW MEXICO

12.8.2.1  ISSUING AGENCY: New Mexico Board of Licensure for Professional Engineers and Professional Surveyors, 4001 Office Court Drive, Suite 903, Santa Fe, NM 87507, telephone no. (505) 827-7561.
[12.8.2.1 NMAC - Rp, 12.8.2.1 NMAC, 5/01/2007]

12.8.2.2  SCOPE: Provisions for Part 2 apply to licensed professional surveyors engaging in the practice of surveying and to licensed professional engineers who are authorized by the Engineering and Surveying Practice Act.
[12.8.2.2 NMAC - Rp, 12.8.2.2 NMAC, 5/01/2007]

12.8.2.3  STATUTORY AUTHORITY: NMSA 1978, Section 61-23-10 (D) prescribes that "the professional surveying committee shall adopt and promulgate rules of professional responsibility exclusive to the practice of surveying. All such bylaws and rules shall be binding upon all individuals licensed pursuant to the Engineering and Surveying Practice Act."
[12.8.2.3 NMAC - Rp, 12.8.2.3 NMAC, 5/01/2007]

12.8.2.4  DURATION: Permanent.
[12.8.2.4 NMAC - Rp, 12.8.2.4 NMAC, 5/01/2007]

12.8.2.5  EFFECTIVE DATE: 5/01/2007, unless a later date is cited at the end of a section.
[12.8.2.5 NMAC - Rp, 12.8.2.5 NMAC, 5/01/2007]

12.8.2.6  OBJECTIVE: The objective of Part 2 is to define the types of surveying, and establish minimum requirements to govern the performance of surveying and other survey-related services by registered professional surveyors in New Mexico.
[12.8.2.6 NMAC - Rp, 12.8.2.6 NMAC, 5/01/2007]

12.8.2.7  DEFINITIONS:

A.  Types of Surveying.
(1)  Boundary surveying is the determination, description, portraying, measuring or monumentation of the boundaries of a tract of land. Other types of surveying, except as indicated, are not boundary surveying.
(2)  Improvement location reporting is the preparation of a report which complies with all of the requirements and limitations of an improvement location report as set forth in 12.8.2.10 NMAC, and which is issued to a title, abstract or escrow company or a lending institution for their exclusive use in determining such things as insurability or value of a tract of land.
(3)  Topographic surveying is the measurement and portrayal of the configuration of the ground and/or the location and description of objects thereon. It can include the plotting and description of property boundary monuments and property lines on a topographic map provided:
   (a) only existing monuments found at the time of the survey are shown, and no boundary
       monuments are set;
   (b) the following words are prominently shown on the topographic map: THIS IS NOT A
       BOUNDARY SURVEY, APPARENT PROPERTY CORNERS AND PROPERTY LINES ARE SHOWN FOR
       INFORMATION ONLY. BOUNDARY DATA SHOWN IS FROM PREVIOUS SURVEY REFERENCED
       HEREON.
(4)  Easement surveying is the description, portrayal, or monumentation of easement(s) only.
(5)  Right of way surveying is the boundary surveying of right of way for acquisition or for locating
    existing right of way.
(6)  Condominium surveying - when performing or preparing a survey that falls under the
Condominium Act (Article 7B), the survey requirements (Article 47-7B-9 or subsequent amendments) of said act
shall be the standards to which the survey shall be held.
(7) Preparation of legal descriptions - the preparation of legal descriptions is a form of surveying and, other than the citing of a lot or parcel for reference or identification purposes of a duly recorded plat, must be performed by a licensed professional surveyor.

(8) An ALTA/ACSM survey is a boundary survey. Therefore, a plat of survey must be recorded only if it is a survey of a parcel for which no previously recorded plat exists or, in the case of remonumentation, the surveyor finds that field measurements are significantly different from record dimensions. The filed survey can be a separate plat and need not include all the detail of the ALTA/ACSM Survey but only the improvements affecting the boundary (See Subsection J of 12.8.2.9 NMAC).

(9) Control surveying is the establishment of horizontal and vertical controls which will be the basis for all geospatial data used for design including construction staking surveys, surveys to layout horizontal and vertical alignments, topographic surveys, control surveys for aerial photography for the collection of topographic and planimetric data using photogrammetric methods, construction surveys of engineering and architectural public works projects.

(10) Unclassified surveying is surveying not defined above.

B. Dimensions means the direction, expressed either as a bearing or an azimuth, and the length of a survey line.
C. Easement means a right that the public, a person or an entity holds in the land of another.
D. Monument means an object intended to mark a property boundary or a point of reference.
E. Surveyor means a professional surveyor licensed under the Engineering and Surveying Practice Act.
F. Tract or lot means a parcel of land in separate ownership or a leasehold or set off for separate ownership or a leasehold.
G. Supplemental surveying work means surveying work performed in order to densify, augment and enhance previously performed surveying work or site information but excludes the surveying of real property for the establishment of land boundaries, rights of way, easements and the dependent or independent surveys or resurveys of the public land system.
H. GPS is global positioning system.
I. Classes of surveys.

(1) Urban means a survey within or adjoining a municipality or a survey, regardless of location, of land zoned for or intended for use for multifamily, commercial or industrial purposes.
(2) Suburban means a survey, which is not an Urban survey, of land zoned for or intended for use for residential purposes.
(3) Rural means a survey, which is neither an Urban nor Suburban survey.
(4) Positional error means the error inherent in setting or measuring from a monument and is added to the error expressed as a ratio for a closed traverse.

[12.8.2.7 NMAC - Rp, 12.8.2.7 NMAC, 5/01/2007]

12.8.2.8 REQUIREMENTS: Whenever a professional surveyor or a professional engineer undertakes any surveying as authorized in the Engineering and Surveying Practice Act, the licensee shall determine which type of surveying activity is being conducted from the definitions in Subsection A of 12.8.2.7 NMAC shall then conform to the requirements set forth in 12.8.2.9 NMAC through 12.8.2.14 NMAC for that type of surveying and must also comply with accuracy standards in 12.8.2.16 NMAC when applicable. If the surveying is not defined, then the surveyor shall conform to the requirements for unclassified surveying set forth in 12.8.2.15 NMAC.

[12.8.2.8 NMAC - Rp, 12.8.2.8 NMAC, 5/01/2007]

12.8.2.9 BOUNDARY SURVEYING: When performing a boundary survey, the surveyor shall be responsible for accomplishing all of the following.

A. Obtain copies of relevant documents necessary to perform the survey and when available a copy of the title search for the tract being surveyed.
B. Review all recorded plats and all plats known to and available to the surveyor that are germane to the tract being surveyed.
C. Make a site visit and inspect the subject property and look for evidence of existing monuments and for evidence of possession and usage.
D. Determine the relative location on the ground of all found existing monuments which pertain to the survey using procedures which achieve the minimum accuracy standards in 12.8.2.16 NMAC.
E. Tag found monuments which are accepted by the surveyor and pertain to the boundary being surveyed with a metal tag, bearing the surveyor's license number, attached to the monument with a metal wire or strap; monuments set by a government agency which are clearly identified by their markings need not be tagged.

F. Set new monuments in conformance with 12.8.2.17 NMAC at all corners of the tract being surveyed using procedures which achieve the minimum accuracy standards in 12.8.2.16 NMAC, unless a permanent monument already exists.

G. Follow the rules and procedures, except for the accuracy and monumentation standards, in the manual of instructions for the survey of the public lands of the United States (manual of surveying instructions available at www.blm.gov/az/cadastral/manual/manindex.htm) prepared by the United States bureau of land management, if the tract being surveyed pertains to the United States survey of public lands in any way including the following:

(1) is a section or an aliquot part of a section;
(2) is a small holding claim, private claim, land grant, mining claim or any other tract described in the manual of instructions for the survey of the public lands of the United States (manual of surveying instructions);
(3) has a boundary which is a boundary of a tract described in Subsection G of 12.8.2.9 NMAC, paragraphs (1) or (2) above;
(4) prior surveys and physical evidence within and adjacent to the section being surveyed should be carefully considered as evidence of original corner locations.

H. Never move, remove nor obscure an existing monument unless it is first properly referenced and all dimensions necessary to preserve its location are reported on a recorded plat.

I. Updating a prior survey - If an existing survey is updated for any reason, the surveyor shall comply with the minimum standards in effect at the time of the update unless the update is only to correct a minor scribener's error. If the update is solely to bring the survey into compliance with the minimum standards and the location of the boundary has not changed, remonumentation is not required unless the original monumentation was not in compliance with the minimum standards in effect at the time the original survey was performed.

J. Prepare a plat of the survey, unless the survey is only the re-monumentation of corners of a tract, shown on a recorded plat, where some of the existing corners of the tract are recovered, whose measured dimensions on the ground are reasonably close to the record dimensions. A plat of survey must be recorded only if it is a survey of a parcel for which no previously recorded plat exists or, in the case of remonumentation, the surveyor finds that field measurements are significantly different from record dimensions. The plat may contain as many sheets as required, which meet the size and material requirements of the state statute and shall contain at least the following:

(1) the name, address and registration number of the surveyor responsible for the survey;
(2) a certificate followed by the dated signature and seal of the surveyor responsible for the survey stating that the surveyor conducted an actual survey on the ground and is responsible for the survey and that the survey and plat meet the minimum standards for surveying in New Mexico; only one surveyor’s signature and seal shall appear on a plat; and the following model certification is considered to be an example of the minimum that the surveyor should certify to:

I,__________________________, New Mexico Professional Surveyor No. (surveyors’ license number), do hereby certify that this Boundary Survey Plat and the actual survey on the ground upon which it is based were performed by me or under my direct supervision; that I am responsible for this survey; that this survey meets the Minimum Standards for Surveying in New Mexico; and that it is true and correct to the best of my knowledge and belief. I further certify that this survey is not a land division or subdivision as defined in the New Mexico Subdivision Act and that this instrument is a Boundary Survey Plat of an existing tract or tracts.

(Surveyor’s Name) ____________________________

PS No. ____________________________ Date __________;

(3) a title which shall include the county in which the survey is located and at least the following:

(a) the lot, block or tract number and subdivision or district name if the survey is within a subdivision or conservancy district;
(b) the city, grant, small holding, mining or private claim, or similar area in which the survey is located;
(c) if neither subparagraph (a) nor (b) applies, then the section(s), township(s) and range(s) in which the survey is located; if the survey is not within a section, then the projected section(s) shall be stated and designated as such if required by the county clerk;
(d) a north arrow, equivalent scale and graphic scale for each sheet of the main drawing;
(e) a description of all monuments found or set including the size and material and all pertinent information stamped or printed on any cap or tag; a found monument which the surveyor has rejected as a true property corner shall be designated as such;

12.8.2 NMAC
(6) the basis of bearings used in the survey which shall be based upon a procedure such as a solar observation or geodetic control stations or a line shown on a prior recorded document and defined on the ground by existing monuments; the use of assumed bearings is prohibited;

(7) a description of all documents used to determine the boundaries and to prepare the plat of survey; the recording information shall be stated; if the document is not of record, all information used from the document shall be shown on the plat;

(8) the boundary being surveyed including the dimensions as measured on the ground and the record dimensions unless the two are equivalent in which case it shall be so stated; all dimensions which pertain to the determination of the tract boundaries, and a tie to a suitable, permanent, existing monument;

(9) all dimensions which pertain to the restoration of a lost or obliterated corner or the subdividing of a section under Subsection G of 12.8.2.9 NMAC;

(10) the location and description of any evidence of a boundary or line of occupation including such things as a fence, building, hedge, wall or the remains thereof which is on a boundary or close enough to a boundary to be confused with the boundary;

(11) the location and description of all easements known or disclosed to the surveyor which cross, adjoin or serve a surveyed tract together with the recording data for the document that created the easement and the location and description of any visible structures which encroach upon said easement;

(12) the radius, central angle, length and chord dimensions for all curves;

(13) the lot number, tract number, other designation or the apparent owner of all adjoining tracts with the recording data of the last recorded plat;

(14) [reserved];

(15) the location and description of any evidence of use by a nonowner of the surveyed tract including such things as a road, trail, path, pipeline or utility which crosses a boundary of the tract;

(16) a letter or number providing a unique designation of each surveyed tract on a plat with more than one tract;

(17) [reserved];

(18) access easement; if the surveyed tract is not contiguous to a public right-of-way, any access easement of record which is known to the surveyor shall be described on the plat and its location shall be determined; if no easement is known to the surveyor, a note prominently shown shall disclose that fact;

(19) the area of each surveyed tract.

K. Record the plat prepared under Subsection J of 12.8.2.9 NMAC with the county clerk of the county or counties in which the survey is located. A plat of survey must be recorded only if it is a survey of a parcel for which no previously recorded plat exists or, in the case of remonumentation, the surveyor finds that field measurements are significantly different from record dimensions. The plat shall be recorded within sixty days of completion. A plat which requires the approval of a government agency is complete upon final approval. Any other plat is complete when the surveyor signs or seals it.

[12.8.2.9 NMAC - Rp, 12.8.2.9 NMAC, 5/01/2007]

12.8.2.10 IMPROVEMENT LOCATION REPORT:

A. Improvement location reporting is the preparation of an improvement location report which is a narrative report, which may be accompanied by a sketch, and which is issued only to a title, abstract or escrow company or a lending institution for their exclusive use in determining such things as insurability or value of a tract of land; it shall not be represented by the surveyor as being a property boundary survey.

B. If the report contains a sketch, the sketch shall contain the following words which are printed as large and as prominently as any other words upon the sketch: “This report is not for use by a property owner for any purpose. This is not a boundary survey and may not be sufficient for the survey exception from an owner’s title policy. It may or may not reveal encroachments, overlaps, conflicts in boundary lines, shortages in area, or other matters which would be disclosed by an accurate boundary survey.”

[12.8.2.10 NMAC - Rp, 12.8.2.10 NMAC, 5/01/2007]

12.8.2.11 TOPOGRAPHIC SURVEYING: On topographic surveys with contour lines, the vertical accuracy of 90% of the points tested shall be within one half of the contour interval, unless otherwise stated on the survey.

[12.8.2.11 NMAC - Rp, 12.8.2.11 NMAC, 5/01/2007]

12.8.2.12 EASEMENT SURVEYING:
A. When performing easement surveying, the surveyor shall use procedures in any field measurements which achieve the minimum accuracy standards in 12.8.2.16 NMAC.

B. If the easement does not run parallel to a boundary of the tract in which it is located, then the surveyor shall prepare a plat which shows the dimensions of the easement and conforms with Paragraphs (1), (2), (3), (4), (5) and (6) of Subsection J of 12.8.2.9 NMAC, and complies with one of the following:

(1) shows ties to record monuments at the beginning and ending of the easement and at least at every mile along the easement, or

(2) shows the coordinates of the beginning, ending and all angle points in accordance with the New Mexico coordinate system and shows the grid bearing and ground distance between said points, or

(3) shows ties to existing corners of a subdivision in which the easement is located.

C. These field procedures and subsequent plat preparation or legal description must be conducted under the responsible charge of a professional surveyor.

[12.8.2.12 NMAC - Rp, 12.8.2.12 NMAC, 5/01/2007]

12.8.2.13 RIGHT OF WAY SURVEYING: When performing right of way surveying, the surveyor shall do all of the following.

A. Obtain a copy of the last recorded deed for the tract(s) affected by the existing or contemplated right of way and obtain copies of all existing right of way maps and conveyance documents available.

B. Obtain a copy of all recorded plats and all plats and maps known to be available to the surveyor for the tract(s) affected by the existing or contemplated right of way.

C. Make a diligent search on the ground, including the use of a metal detector, for all existing monuments, which pertain to the property boundaries intersecting the public highway right of way corridor being surveyed.

D. Determine the relative location on the ground of all found existing monuments, which pertain to the survey using procedures, which achieve the minimum accuracy standards in 12.8.2.16 NMAC.

E. Tag all found and accepted monuments, which pertain to the survey, with a metal tag, bearing the surveyor's registration number, attached to the monument with a metal wire or strap.

F. Set new monuments conforming to 12.8.2.17 NMAC on the right of way limit lines at all changes in direction and at all points where property lines intersect, using procedures which achieve the minimum accuracy standards in 12.8.2.16 NMAC, unless a permanent monument exists; when monumenting existing right of way limit lines, monuments at intersecting property lines need not be set.

G. Follow the rules and procedures, except for the accuracy and monumentation standards, in the manual of instructions for the survey of the public lands of the United States (manual of surveying instructions) prepared by the United States bureau of land management, if the tract being surveyed pertains to the United States survey of public lands in any way including the following:

(1) is a section or an aliquot part of a section;

(2) is a small holding claim, private claim, land grant, mining claim or any other tract described in the manual of instructions for the survey of the public lands of the United States (manual of surveying instructions);

(3) has a boundary which is a boundary of a tract described in Subsection G of 12.8.2.13 NMAC, paragraphs (1) or (2) above.

H. Whenever a tract of land is to be severed by right of way acquisition, the surveyor shall locate property lines that intersect the right of way limits. The surveyor shall use all available documents, field data, including parol evidence and land title information to determine the length, location and bearing of the severed property line relative to the right of way limits. This includes surveying as many additional parcel boundaries as necessary which connect to the property lines intersecting the right of way in order to accurately locate the property lines affected by the contemplated right of way.

I. [Reserved]

J. Prepare a plat of survey, containing as many sheets as required, and which contains at least the following:

(1) the name, address, and registration number of the surveyor responsible for the survey;

(2) a certificate followed by the signature and seal of the surveyor responsible for the survey and stating that the survey and plat meet the minimum standards for surveying in New Mexico;

(3) a title which shall include at least the following:

(a) the project number.

(b) the project's control number (PCN) of the project (if applicable);
(4) the section(s), township(s), range(s), grant or reservation, municipality, and county(s) in which the project is located;

(5) a north arrow, equivalent scale, graphic scale, date of the fieldwork and a location/vicinity map showing where the project is located;

(6) a description of all monuments found or set; a found monument, which the surveyor rejected as a property corner, shall be designated as such;

(7) the basis of bearing used in the survey which shall be a procedure such as solar observation or a line shown on a plat and defined on the ground by existing monuments;

(8) a description of all documents used to determine the boundary of any tract surveyed and to prepare the plat of survey; the recording information shall be stated; if the document is not of record, all information used from the document shall be shown on the plat;

(9) the pertinent boundaries of the tract abutting the right of way being surveyed including the dimensions as measured on the ground and the record dimensions unless the two are equivalent;

(10) the location and description of any evidence of a boundary line or occupation including such things as a fence, building, hedge, wall or the remains thereof which is on a boundary or close enough to a boundary to be confused with the boundary;

(11) all dimensions which pertain to the restoration of a lost corner or the subdivision of a section under Subsection G of 12.8.2.13 NMAC;

(12) the location of permanent improvements lying in close proximity to the new right of way limit line and which may be affected by the contemplated acquisition of land for public use;

(13) the radius, central angle, length and the chord bearing and dimension for all curves;

(14) the lot number, tract number, other designation or the apparent owner of all adjoining tracts with the recording data of the last recorded plat;

(15) the name of the owner of the parcel from which right of way is being acquired;

(16) the location and description of all easements known or disclosed to the surveyor which cross, or adjoin the right of way;

(17) a letter/number or combined letter and number designation of each parcel acquired for right of way.

K. Record the plat prepared under Subsection J of 12.8.2.13 NMAC with the county clerk of the county or counties in which the project is located. The plat shall be recorded within sixty days of completion. The plat is considered complete when the surveyor signs and seals it. For the New Mexico Department of Transportation (NMDOT) right of way surveys, the plat(s) may carry multiple surveyor certifications, if necessary, in order to reflect specific areas of individual responsibility when the scope, duration, or complexity of a NMDOT right of way project so requires. Certifications of all other right of way surveys shall carry a single signature and seal of the surveyor responsible for the survey.

[12.8.2.13 NMAC - Rp, 12.8.2.13 NMAC, 5/01/2007]

12.8.2.14 CONTROL SURVEYING REPORTING: Whenever a professional surveyor undertakes control surveying as defined in 12.8.2.7 NMAC, the licensee shall prepare a control survey report which will contain the following information as appropriate when being performed.

A. A listing of the final adjusted coordinates and elevations for all points within the control network along with a complete description of all monuments established or recovered.

B. A complete description of the horizontal and vertical datum used including the basis of bearings (GPS, plat etc.) if the coordinate system is not based on a published datum.

C. A complete description of the state plane and/or UTM zone used, if appropriate.

D. Units used for coordinates and elevations.

E. Description of monument(s) used to constrain the control network including the reference coordinates and elevations used for said monument(s).

F. If the final adjusted coordinates are based on a modified (ground datum) state plane coordinate system, a complete description of the method(s) used to generate the modified coordinates shall be included in the report.

G. A brief description detailing the field methods and equipment used to conduct the control survey.

H. The date when the control monuments were set, the date when the control monuments were positionally observed, and the date of the final network adjustment.

I. The geospatial positional accuracy shall be reported pursuant to the accuracy classifications contained within Subsection C of 12.8.2.16 NMAC. The surveyor shall report both the geospatial positional
accuracy and the estimated network accuracy as defined in Subsection C of 12.8.2.16 NMAC and will report the geospatial positional accuracy separately for horizontal and vertical components.

J. A certificate followed by the dated signature and seal of the surveyor responsible for the control survey stating that the surveyor conducted an actual survey on the ground and is responsible for the survey along with a statement of accuracy pursuant to the accuracy standards contained within 12.8.2.16 NMAC. The following model certification is considered to be an example of the minimum that the surveyor should certify to:

I, (surveyor's name) , New Mexico Professional Surveyor No. (surveyor's license number), do hereby certify that this Control Survey Report was prepared by me or under my direct supervision based on an actual survey on the ground as described herein; that I am responsible for this survey; and that the survey and report meets the minimum standards for surveying in New Mexico.

[12.8.2.14 NMAC - N, 5/01/2007]

12.8.2.15 UNCLASSIFIED SURVEYING: When a surveyor does surveying of a type not described in these standards, the surveyor shall do all that is necessary to fully determine and report all information which is relevant to the project. The scope of the project may be stated and limited. The surveyor shall not prepare or sign a document, which could mislead or misinform. If a surveyor issues a plat with the surveyor's signature and seal, which was not required by these minimum standards, the plat shall comply with the applicable portions of Subsection J of 12.8.2.15 NMAC.

[12.8.2.15 NMAC - Rp, 12.8.2.14 NMAC, 5/01/2007]

12.8.2.16 ACCURACY:

A. Topographic map accuracy standards.

(1) Horizontal accuracy - For maps compiled at scales larger than 1:20,000, not more than 10 percent of the points tested shall be in error by more than 1/30 inch, measured at the compiled scale. For maps compiled at scales of 1:20,000 or smaller, not more than 10 percent of the points tested shall be in error by more than 1/50 inch, measured at the compiled scale. These limits of accuracy shall apply in all cases to positions of well-defined points only. Well-defined points are those that are easily visible or recoverable on the ground, such as the following: monuments or markers, such as benchmarks, property boundary monuments; intersections of roads, railroads, etc.; corners of large buildings or structures (or center points of small buildings). In general, what is well defined will be determined by what is plottable on the scale of the map within 1/100 inch. Thus while the intersection of two roads or property lines meeting at right angles would come within a sensible interpretation, identification of the intersection of such lines meeting at an acute angle would obviously not be practicable within 1/100 inch. Similarly, features not identifiable upon the ground within close limits are not to be considered as test points within the limits quoted, even though their positions may be scaled closely upon the map. This class would include timberlines, soil boundaries, etc.

(2) Vertical accuracy - As applied to contour maps on all publication scales, shall be such that not more than 10 percent of the elevations tested shall be in error more than one-half the contour interval.

(3) Accuracy test guidelines - When testing a topographic map for compliance with Paragraphs (1) and (2) of Subsection A of 12.8.2.16 NMAC, a minimum of 20 check points evenly distributed throughout the topographic map shall be tested. Horizontal accuracy shall be tested by comparing the planimetric coordinates of the well-defined points in the mapping with coordinates of the same points from an independent source of higher accuracy. Vertical accuracy shall be tested by comparing the elevations in the mapping with elevations of the same points as determined from an independent source of higher accuracy.

(4) Accuracy reporting - If testing by an independent source of higher accuracy has not or cannot be followed, the final topographic map shall contain the following statement: "This map has been produced according to procedures that have been demonstrated to produce data that meets or exceeds the minimum standards for a topographic map compiled at a scale of (insert map scale here) with a contour interval of (insert contour interval here)." If testing by an independent source of higher accuracy has been conducted pursuant to the guidelines contained herein, the final topographic map shall contain the following statement: "This map has been tested from an independent source of higher accuracy and meets the Minimum Standards for a topographic map compiled at a scale of (insert map scale here) with a contour interval of (insert contour interval here)."

(5) Alteration of original mapping (scale): When the presentation scale of a map is other than that of the compilation scale, that fact shall be stated in the legend. "This map is an enlargement of a 1:2,400 map" or "This map is a reduction of a 1"=200' map."

B. Boundary surveying, easement surveying and right-of-way surveying accuracy standards. The surveyor shall determine the class of a survey using the definitions in Paragraphs (1) through (3) of Subsection I of
12.8.2.7 NMAC, and achieve the accuracy specified for the class of survey. It is the responsibility of the surveyor to select the appropriate procedures and equipment to obtain the accuracy required by the minimum field accuracy standards below for boundary surveying, easement surveying and right-of-way surveying:

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<th>Urban</th>
<th>Suburban</th>
<th>Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unadjusted Closure (Traverse)</td>
<td>1 part in 15,000</td>
<td>1 part in 10,000</td>
<td>1 part in 7,500</td>
</tr>
<tr>
<td>Positional Error</td>
<td>0.05 ft.</td>
<td>0.10 ft.</td>
<td>0.25 ft.</td>
</tr>
<tr>
<td>Location of Improvements</td>
<td>0.15 ft.</td>
<td>0.25 ft.</td>
<td>1.0 ft.</td>
</tr>
</tbody>
</table>

C. Geospatial positional accuracy standards for control surveys. The geospatial positional accuracy for control surveys shall be as follows:

1. Horizontal control networks using GPS relative positioning techniques - the horizontal positional accuracy shall be reported in terms of relative positioning accuracy according to the order classifications contained within the geometric geodetic accuracy standards and specifications for using GPS relative positioning techniques, version 5.0 dated August 1, 1989, federal geodetic control committee;

2. Horizontal control networks using conventional field traversing techniques - the horizontal positional accuracy shall be reported in terms of distance accuracy according to the order classifications contained within the standards and specifications for geodetic control networks dated September, 1984, federal geodetic control committee;

3. Vertical control networks - the vertical positional accuracy shall be reported in terms of elevation difference accuracy according to the order classifications contained within the standards and specifications for geodetic control networks dated September, 1984, federal geodetic control committee;

4. The estimated network accuracy is a statement disclosing the order (and class, if appropriate) of the published monument or monuments used to constrain the final network adjustment and is intended to inform the end user of how well the data may fit with an established geodetic datum.

[12.8.2.16 NMAC - Rp, 12.8.2.15 NMAC, 5/01/2007]

12.8.2.17 MONUMENTS:

A. Except as prescribed in Subsections B and C of 12.8.2.16 NMAC, monuments set by the surveyor shall be ferrous metal, at least one-half inch in diameter and at least sixteen inches long. They shall bear a metal or plastic cap stamped with the surveyor’s registration number.

B. Corners which fall upon a hard surface shall be monumented with a chiseled cross or a nail in a disk or tag bearing the surveyor’s registration number.

C. When a corner is located at a place where it is not practical to set a monument or a monument at the corner is likely to be destroyed, at least one reference monument shall be set and dimensioned on the plat such that the location of the corner can be reestablished.

D. Monuments for the exterior corners of a subdivision shall be set by the surveyor who certified the plat of the subdivision prior to recordation of the subdivision plat. It is the responsibility of the divider to ensure that interior corners of a subdivision are set within thirty (30) days of completion of the construction of infrastructure improvements but within one (1) year after recordation of the subdivision plat. The board of licensure may elect to extend the time period upon the showing of good cause. The surveyor certifying the subdivision plat shall be responsible for notifying the subdivider by either including a statement regarding this responsibility in the executed contract for services or by letter sent certified mail, return receipt requested. The requirements of this section are met if any surveyor takes the interior corners of the subdivision. If the subdivision is developed in phases, the interior corners of each phase may be staked by separate surveyors, provided the above stated time limits are met or extended by decision of the board of licensure. Under this section, it is the responsibility of each surveyor who stakes the interior corners of a subdivision to record an affidavit with the county clerk. Said affidavit shall be signed and sealed by the surveyor and shall contain at least the following: subdivision name as shown on the recorded plat, all recording information, name of subdivider, type of monuments set and, if the surveyor is staking a phase of the subdivision, the limits of responsibility. If the surveyor is required to record a plat of survey under the requirements of Subsection J of 12.8.2.9 NMAC, the affidavit may be included on said plat.

E. A surveyor shall perpetuate monuments established by the public land survey system which the surveyor finds in need of rehabilitation or replacement. A description of the monument as found and as restored or referenced and all available dimensions to other monuments shall be reported on a recorded plat. Said plat may be a
boundary survey plat. If circumstances do not require a boundary survey plat, a plat depicting only the rehabilitated or replaced monuments will satisfy the requirements of this section.
[12.8.2.17 NMAC - Rp, 12.8.2.16 NMAC, 5/01/2007]

12.8.2.18 GENERAL:
A. Authority. These rules are authorized by the Engineering and Surveying Practice Act.
B. Penalties. The New Mexico board of licensure for professional engineers and professional surveyors may take those actions prescribed in the Engineering and Surveying Practice Act against any surveyor who has been found in violation of these standards, or against non-licensed practitioners.
C. Disclaimers. Any disclaimer by a surveyor purporting to disavow compliance with any of these standards is prohibited.
D. Certifications. Professional surveyors should be prepared to certify to those things required in the execution of their duties and those mandated by law or rule. They should be cautious, however, in certifying only to conditions and facts falling within their areas of competency. Certification language that goes beyond the obligations prescribed by law and the responsibilities assumed by the surveyor in the normal course of boundary surveying should be carefully considered by the surveyor before signing and sealing any document.
E. Interpretation. The words “offers surveying services to the public” as used in Paragraph B of Section 61-23-27 (10), NMSA 1978, includes the certification by a surveyor of a plat or map which may be used by the public.
F. Advisory Opinions. The surveying committee of the board of licensure may issue its opinion explaining the application of these standards to a specific situation.
[12.8.2.18 NMAC - Rp, 12.8.2.17 NMAC, 5/01/2007]

HISTORY OF 12.8.2 NMAC:
Pre-NMAC History:
Material in this Part is derived from that previously filed with the commission of public records - state records center & archives under: PELS Rule No. 83-1, Standards for Land Surveyors in New Mexico, filed 3-21-83; PELS Rule No. 83-1, Amendment No. 1, filed 6-25-84; PE/PS rule No. 89-3 Minimum Standards for Land Surveying in New Mexico, filed 10-25-89; Rule 91-1, Minimum Standards for Surveying in New Mexico - Purpose, filed 11-19-91, Rule 500.1, Minimum Standards for Surveying in New Mexico/Requirements, filed 12-29-93; Rule 91-2, Minimum Standards for Surveying in New Mexico- Authority, filed 11-19-91; Rule 500.12, Minimum Standards for Surveying in New Mexico - General, filed 12-29-93, Rule 91-3, Minimum Standards for Surveying in New Mexico - Definitions, filed 11-19-91; Rule 500.2, Minimum Standards for Surveying in New Mexico - Types of Surveying, filed 12-29-93; Rule 91-4, Minimum Standards for Surveying in New Mexico - Requirements for Surveys, filed 11-19-91; Rule 500.10 Minimum Standards for Surveying in New Mexico - Monuments, filed 12-29-93; Rule 91-5, Minimum Standards for Surveying in New Mexico - Minimum Accuracy Standards, filed 11-19-91; Rule 500.9, Minimum Standards for Surveying in New Mexico - Accuracy, filed 12-29-93; Rule 91-6, Minimum Standards for Surveying in New Mexico - Penalties, filed 11-19-91; Rule 500.3, Minimum Standards for Surveying in New Mexico/Property Boundary Surveying, filed 12-29-93; Rule 500.4, Minimum Standards for Surveying in New Mexico/Inspection Report Surveying, filed 12-29-93; Rule 500.5, Minimum Standards for Surveying in New Mexico/Topographic Surveying, filed 12-29-93; Rule 500.6, Minimum Standards for Surveying in New Mexico/Easement Surveying, filed 12-29-93; Rule 500.7, Minimum Standards for Surveying in New Mexico/Highway Right of Way Surveying, filed 12-29-93; Rule 500.8, Minimum Standards for Surveying in New Mexico/Unclassified Surveying, filed 12-29-93; Rule 500.11, Minimum Standards for Surveying in New Mexico/Definitions, filed 12-29-93.

History Repealed Material:
12.8.2 NMAC, Minimum Standards for Surveying in New Mexico (filed 08-15-00) repealed 5/01/2007.

Other History:
Rule 91-6, Minimum Standards for Surveying in New Mexico - Penalties, filed 11-19-91;
Rule 500.1, Minimum Standards for Surveying in New Mexico/Requirements (filed 12-29-93);
Rule 500.2, Minimum Standards for Surveying in New Mexico - Types of Surveying (filed 12-29-93);
Rule 500.3, Minimum Standards for Surveying in New Mexico/Property Boundary Surveying (filed 12-29-93);
Rule 500.4, Minimum Standards for Surveying in New Mexico/Inspection Report Surveying (filed 12-29-93);
Rule 500.5, Minimum Standards for Surveying in New Mexico/Topographic Surveying (filed 12-29-93);
Rule 500.6, Minimum Standards for Surveying in New Mexico/Easement Surveying (filed 12-29-93);
Rule 500.7, Minimum Standards for Surveying in New Mexico/Highway Right of Way Surveying (filed 12-29-93);
Rule 500.8, Minimum Standards for Surveying in New Mexico/Unclassified Surveying (filed 12-29-93);
Rule 500.9, Minimum Standards for Surveying in New Mexico - Accuracy (filed 12-29-93);
Rule 500.10 Minimum Standards for Surveying in New Mexico - Monuments (filed 12-29-93);
Rule 500.11, Minimum Standards for Surveying in New Mexico/Definitions (filed 12-29-93);
Rule 500.12, Minimum Standards for Surveying in New Mexico - General (filed 12-29-93) were all renumbered, reformatted and replaced by 12 NMAC 8.2, Minimum Standards for Surveying in New Mexico, effective 03-02-03. 12 NMAC 8.2, Minimum Standards for Surveying in New Mexico (filed 01-18-00) was renumbered, reformatted, and replaced by 12.8.2 NMAC, Minimum Standards for Surveying in New Mexico, effective 10-01-2000. 12.8.2 NMAC, Minimum Standards for Surveying in New Mexico (filed 08-15-00) was replaced by 12.8.2 NMAC, Minimum Standards for Surveying in New Mexico, effective 5/01/2007.
APPENDIX I

NMSHTD
SURVEY REQUEST
FORMS (SAMPLE)
LOCATION SURVEY REQUEST
Use for Location Request Only.
(Survey for R/W & Properties should be requested on R/W & Property Request.)

PDE __________________ PHONE __________________ DATE __________________
C.N.# __________________ LETTING DATE __________________
Project No. __________________ Route __________________
County __________________ City __________________ Project Length __________________
Existing Mileposts __________________ to __________________

Exact BOP & EOP Locations (Please attach Scoping Report and Annotated Quad,
Vicinity Map or other Location Map, Right-of-Way Map or As-built plans)

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Brief Description of Project & Proposed Improvements:
________________________________________________________________________
________________________________________________________________________

Is project Access Controlled? Yes No

If project intersects Indian Lands, Include a copy of the permission to enter lands with
this request. Contact R/W Bureau (Don Trujillo 505-490-2163) for more information

PROJECT SCOPE
Full Construction __________________ Other __________________
Widening/Slope Flattening __________________ Rehab __________________ WideningWork __________________
Bridges-Replace __________________ Rehab __________________ Widening __________________
Culverts-Replace __________________ Rehab __________________ Widening __________________
Other Work (Explain) __________________
Realignment __________________ Intersections __________________
Signals __________________ Signing __________________ Railroad __________________
Rest Areas-New __________________ Rehab __________________
Weigh Stations-New __________________ Rehab __________________
Other Work (Explain) __________________

LOCATION SURVEY NEEDS
Units—Metric __________________ Imperial __________________ Survey Band Width __________________
Stake Alignment? Yes No __________________ Interval __________________
Drainage DTM --- Upstream Length __________________ Downstream Length __________________
Drainage DTM --- Upstream Width __________________ Downstream Width __________________
Special Structure Requirements __________________

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Other __________________
________________________________________________________________________
LOCATION SURVEY REQUEST
SPECIAL TOPOGRAPHY & UTILITY CONSIDERATIONS

Do all utilities need to be located? ___________ Survey band width ___________

Any other special topography to be located?

PHOTOGRAMMETRY & MAPPING NEEDS

Mapping Scales ____________________________________________

Developing software requirements?-- Microstation _________ Other _________

Contour Interval ____________________________________________

Additional Profile length BOP/EOP _________ Turnouts _________

Crossroads _________ Intersections _________

Overhead Clearances _________________________________________

Does Approximate Existing Right-of-way need to be mapped?-- Yes _____ No _____

MISCELLANEOUS

Please list any special or non standard survey needs that may be required on this project.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
EXISTING R/W & PROPERTY SURVEY REQUEST
Use for Existing Right-of-Way & Adjoining Property Surveys
(Location Surveys should be requested on another form.)

PDE __________ PHONE __________ DATE __________
C.N.# __________ LETTING DATE ________
Project No. __________________________ Route __________________________
County _______________ City _______________ Project Length _______________
Existing Mileposts __________ to __________

Exact BOP & EOP Locations (Please attach Scoping Report and Annotated Quad or other Location Map, Right-of-way Map or As-built plans)

___________________________________________________________________________

___________________________________________________________________________

Existing Right-of-way Maps available and/or As-built plans

___________________________________________________________________________

Title Reports requested? Yes ______ No ______ Date ______
Survey Field Review Required? Yes ______ No ______ Date ______
Interview with Lands Engineering? Yes ______ No ______ Date ______
Interview with R/W Surveyor? Yes ______ No ______ Date ______

Is project Access Controlled? Yes ______ No ______

If project intersects Indian Lands, Include a copy of the permission to enter lands with this request. Contact R/W section Art Gurule (827-5279) for more information

Survey Units--- Metric _______ Imp _______ Dual _______

AREAS OF ADDITIONAL RIGHT-OF-WAY REQUIREMENTS

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<th>Remarks/Need</th>
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Page 1 of 3
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### AREAS OF TCP REQUIREMENTS

<table>
<thead>
<tr>
<th>Start Station</th>
<th>End Station</th>
<th>Left</th>
<th>Right</th>
<th>Remarks/Need</th>
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</table>

Developing software requirements? -- Microstation _______ Other _____

Mapping Scales __________________________
MISCELLANEOUS

Please list any special or non standard survey needs that may be required on this project.
APPENDIX J

FIELD NOTE TOPO SYMBOLS (SAMPLE)
APPENDIX K

STANDARD ARM SIGNALS
STANDARD ARM SIGNALS

1. SIGNS

LINE

1) Instrumentman wants sight on a point or to set a new setup point.

2) Levelman wants a rod reading on the bench mark or on the TP.

WANTS LINE

Hold line rod, plumb bob, stake, latch or hand above head.

MOVE RIGHT OR LEFT

Move one arm outward horizontally on side toward which change is desired. Slow motion means a large distance and quick motion a small distance.

GOOD

Extend arms sideward and wave up and down.

GRADE

Place open palms flat against each other in horizontal plane.

NO GOOD

Start with arms outward and downward; move them back and forth, crossing in front of body.

CLEAR LINE OR CAN'T SEE

Start with arm held outward and downward, wave back and forth in front of body.

PICKUP, COME IN, OR COME AHEAD

Extend arms sideward and downward; raise them quickly.
STANDARD ARM SIGNALS

2. NUMBERS

* Often, it is quicker and more understandable to signal either "Cut" or "Fill" and then signal, by "Numbers", the distance down or up.
APPENDIX L

BASIC TRIGONOMETRY
1 UNIT CIRCLE and FORMULAS

Hypotenuse of $a = AB = r$; Adjacent Side $= AC = x$; Opposite Side $= BC = y$

- $\sin a = \frac{y}{r} = \cos \theta$
- $\cos a = \frac{x}{r} = \sin \theta$
- $\tan a = \frac{y}{x} = \cot \theta$
- $\cot a = \frac{x}{y} = \tan \theta$
- $\sec a = \frac{r}{x} = \csc \theta$
- $\csc a = \frac{r}{y} = \sec \theta$
- $\text{vers } a = \frac{r-x}{r} = 1 - \frac{x}{r}$
- $\text{exsec } a = \frac{r-x}{x} = 1 - \frac{r}{x}$
- $\text{covers } a = \frac{r-y}{r} = 1 - \frac{y}{r}$
- $\text{coexsec } a = \frac{r-y}{y} = 1 - \frac{r}{y}$

$y = \sqrt{(r+x)(r-x)} = \sqrt{r^2 - x^2}$

$x = \sqrt{(r+y)(r-y)} = \sqrt{r^2 - y^2}$

$r = \sqrt{x^2 + y^2}$

$\text{Radius} = \text{Unity} = 1$
AF $= \text{AB} = \text{AH} = 1$

$a = \text{angle BAC}$
$\theta = \text{angle ABC}$

- $\text{sine } a = BC = \frac{1}{\csc a}$
- $\text{cosine } a = AC = \frac{1}{\sec a}$
- $\text{tangent } a = DF = \frac{1}{\cot a}$
- $\text{cotangent } a = GH = \frac{1}{\tan a}$
- $\text{secant } a = AD = \frac{1}{\cos a}$
- $\text{cosecant } a = AG = \frac{1}{\sin a}$
- $\text{versine } a = BE = CF = 1 - \cos a$
- $\text{coversine } a = BK = HL = 1 - \sin a$
- $\text{exsecant } a = BD = \sec a - 1$
- $\text{coexsecant } a = BG = \csc a - 1$
- $\text{haversine } a = \frac{1}{2} \text{ vers } a$
- $\text{chord } a = BF$
- $\text{chord } 2a = 2BC = 2\sin a$
### BASIC TRIGONOMETRY

#### 2. TRIGONOMETRIC FUNCTIONS in ANY QUADRANT

#### a. Functions in terms of angles in the first quadrant –

<table>
<thead>
<tr>
<th>ANGLE FUNCTION</th>
<th>$90^\circ \pm a$</th>
<th>$180^\circ \pm a$</th>
<th>$270^\circ \pm a$</th>
<th>$360^\circ \pm a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sine</td>
<td>$+ \cos a$</td>
<td>$\mp \sin a$</td>
<td>$- \cos a$</td>
<td>$\pm \sin a$</td>
</tr>
<tr>
<td>Cosine</td>
<td>$\mp \sin a$</td>
<td>$- \cos a$</td>
<td>$\pm \sin a$</td>
<td>$+ \cos a$</td>
</tr>
<tr>
<td>Tangent</td>
<td>$\pm \cot a$</td>
<td>$\pm \tan a$</td>
<td>$\pm \cot a$</td>
<td>$\pm \tan a$</td>
</tr>
<tr>
<td>Cotangent</td>
<td>$\pm \tan a$</td>
<td>$\pm \cot a$</td>
<td>$\pm \tan a$</td>
<td>$\pm \cot a$</td>
</tr>
<tr>
<td>Secant</td>
<td>$\mp \csc a$</td>
<td>$- \sec a$</td>
<td>$\pm \csc a$</td>
<td>$+ \sec a$</td>
</tr>
<tr>
<td>Cosecant</td>
<td>$+ \sec a$</td>
<td>$\mp \csc a$</td>
<td>$- \sec a$</td>
<td>$\pm \csc a$</td>
</tr>
</tbody>
</table>

#### b. Signs and value range of functions in all quadrants –

<table>
<thead>
<tr>
<th>Quadrant</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angles</td>
<td>$0^\circ$ to $90^\circ$</td>
<td>$90^\circ$ to $180^\circ$</td>
<td>$180^\circ$ to $270^\circ$</td>
<td>$270^\circ$ to $360^\circ$</td>
<td>$30^\circ$</td>
</tr>
<tr>
<td>Functions</td>
<td>Sine</td>
<td>$+0$ to $+1$</td>
<td>$+1$ to $0$</td>
<td>$-0$ to $-1$</td>
<td>$-1$ to $0$</td>
</tr>
<tr>
<td></td>
<td>Cosine</td>
<td>$+1$ to $+0$</td>
<td>$-0$ to $-1$</td>
<td>$-1$ to $0$</td>
<td>$+0$ to $+1$</td>
</tr>
<tr>
<td></td>
<td>Tangent</td>
<td>$+0$ to $+\infty$</td>
<td>$-\infty$ to $-0$</td>
<td>$+0$ to $+\infty$</td>
<td>$-\infty$ to $-0$</td>
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<tr>
<td></td>
<td>Cotangent</td>
<td>$+\infty$ to $+0$</td>
<td>$-0$ to $-\infty$</td>
<td>$+\infty$ to $+0$</td>
<td>$-0$ to $-\infty$</td>
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<tr>
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<td>Secant</td>
<td>$+1$ to $+\infty$</td>
<td>$-\infty$ to $-1$</td>
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<td>Cosecant</td>
<td>$+\infty$ to $+1$</td>
<td>$+1$ to $+\infty$</td>
<td>$-\infty$ to $-1$</td>
<td>$-1$ to $-\infty$</td>
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</tbody>
</table>
## Basic Trigonometry

### 3. Right Triangles

![Right Triangle Diagram](image)

- **C** = 90°

<table>
<thead>
<tr>
<th>Given</th>
<th>To Find</th>
<th>Formulas</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a, c)</td>
<td>(b)</td>
<td>(\sqrt{c^2 - a^2})</td>
</tr>
<tr>
<td>(A)</td>
<td>(\sin A = a/c)</td>
<td></td>
</tr>
<tr>
<td>(B)</td>
<td>(\cos B = a/c)</td>
<td></td>
</tr>
<tr>
<td><strong>Area</strong></td>
<td>(\frac{b\sqrt{c^2 - a^2}}{2})</td>
<td></td>
</tr>
<tr>
<td>(b, c)</td>
<td>(a)</td>
<td>(\sqrt{c^2 - b^2})</td>
</tr>
<tr>
<td>(A)</td>
<td>(\cos A = b/c)</td>
<td></td>
</tr>
<tr>
<td>(B)</td>
<td>(\sin B = b/c)</td>
<td></td>
</tr>
<tr>
<td><strong>Area</strong></td>
<td>(\frac{b\sqrt{c^2 - b^2}}{2})</td>
<td></td>
</tr>
<tr>
<td>(a, b)</td>
<td>(c)</td>
<td>(\sqrt{a^2 + b^2})</td>
</tr>
<tr>
<td>(A)</td>
<td>(\tan A = a/b; \cot A = b/a)</td>
<td></td>
</tr>
<tr>
<td>(B)</td>
<td>(\tan B = b/a; \cot B = a/b)</td>
<td></td>
</tr>
<tr>
<td><strong>Area</strong></td>
<td>(ab/2)</td>
<td></td>
</tr>
<tr>
<td>(A, a)</td>
<td>(b)</td>
<td>(a \cot A)</td>
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<tr>
<td>(c)</td>
<td>(a/\sin A)</td>
<td></td>
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<tr>
<td>(B)</td>
<td>(90° - A)</td>
<td></td>
</tr>
<tr>
<td><strong>Area</strong></td>
<td>(\frac{a^2 \cot A}{2})</td>
<td></td>
</tr>
<tr>
<td>(A, b)</td>
<td>(a)</td>
<td>(b \tan A)</td>
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<tr>
<td>(c)</td>
<td>(b/\cos A)</td>
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<tr>
<td>(B)</td>
<td>(90° - A)</td>
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<tr>
<td><strong>Area</strong></td>
<td>(\frac{b^2 \tan A}{2})</td>
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</tr>
<tr>
<td>(A, c)</td>
<td>(a)</td>
<td>(c \sin A)</td>
</tr>
<tr>
<td>(b)</td>
<td>(c \cos A)</td>
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<tr>
<td>(B)</td>
<td>(90° - A)</td>
<td></td>
</tr>
<tr>
<td><strong>Area</strong></td>
<td>(\frac{c^2 (\sin A)(\cos A)}{2} = \frac{c^2 \sin 2A}{4})</td>
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### BASIC TRIGONOMETRY

#### 4. OBLIQUE TRIANGLES

![Diagram of an oblique triangle](image)

**Law of Sines:** \[ \frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C} \]

**Law of Cosines:**
\[ a^2 = b^2 + c^2 - 2bc \cos A \]

or
\[ \cos A = \frac{b^2 + c^2 - a^2}{2bc} \]

---

#### GIVEN TO FIND FORMULAS

<table>
<thead>
<tr>
<th>GIVEN</th>
<th>TO FIND</th>
<th>FORMULAS</th>
</tr>
</thead>
</table>
| a, b, c | A, B, & C using "s" | **Law of Cosines,** \[ \sin \frac{1}{2} A = \sqrt{\frac{(s-b)(s-c)}{bc}}; \cos \frac{1}{2} A = \sqrt{\frac{s(s-a)}{bc}} \]
| | | \[ \sin A = \frac{2\sqrt{s(s-a)(s-b)(s-c)}}{bc} \] **The value "s" = \( \frac{1}{2}(a+b+c) \)**
| | Area | \[ \sqrt{s(s-a)(s-b)(s-c)} \] **The value "s" = \( \frac{1}{2}(a+b+c) \)**

| a, A, B | b | **Law of Sines,** \[ A + B + C = 180 \] \[ a \sin \left( \frac{A + B}{2} \right) \] **Law of Sines**
| | 180 - (A + B) | **Law of Sines**
| | c | \[ \frac{a}{\sin A} \]
| | Area | \[ \frac{a^2 \sin B \sin (A+B)}{2 \sin A} \]

| a, b, A | B | **Law of Sines** \[ 180 - (A + B) \]
| | 180 - (A + B) | **Law of Sines**
| | c | \[ \frac{a \sin (A + B)}{\sin A} \] **Law of Sines**

| a, b, C | c | **Law of Cosines**
| | A | \[ \tan A = \frac{a \sin C}{b - (a \cos C)} \]
| | B | \[ 180 - (A + C) \]
| | Area | \[ \frac{1}{2} ab \sin C \]

| ABC, a | Area | \[ \frac{a^2 (\sin B)(\sin C)}{2 \sin A} \]
5. INTERSECTION FORMULAS

a. Case I  Adjacent unknown distances

\[BD = \frac{(AE)(\cos BC) - (AN)(\sin BC)}{\sin \theta}\]

\[BC = \frac{(AE)(\cos AB) - (AN)(\sin AB)}{\sin \phi}\]

Given:
1. Bearings of Lines $\overline{AB}$ & $\overline{BC}$
2. Coords. of pts. A & C
3. $\Delta N$: Difference in Northing $= N_C - N_A$
4. $\Delta E$: Difference in Easting $= E_C - E_A$

TO FIND: Distances $AB$ and $BC$

NOTE: Observe all algebraic signs of the functions, $\Delta E$, and $\Delta N$. Signs of the functions are determined by the quadrant of the bearing used in the calculations as follows:

\[
\begin{align*}
\sin (+) & : \sin (+) \\
\cos (-) & : \cos (+) \\
\cos (+) & : \cos (-) \\
\sin (-) & : \sin (+)
\end{align*}
\]

b. Case II  Unknown distance and adjacent unknown bearing

GIVEN:
1. Bearing of $\overline{BC}$
2. Distance $AB$
3. Coordinates of pts. A and C
4. $\Delta N$: Difference in Northing $= N_C - N_A$
5. $\Delta E$: Difference in Easting $= E_C - E_A$

FORMULA:
\[\sin \phi = \frac{(\Delta E)(\cos \; BC) - (\Delta N'; \sin BC)}{AB \; (\text{known distance})}\]

(see "NOTE" above.)

Use $\phi$ to establish the bearing of $\overline{AB}$, then solve $CB$ by coordinating pt. B and inverting the distance $CB$. 
5. INTERSECTION FORMULAS

c. Case III - Two adjacent unknown bearings (such as the intersection of two curves or the adjacent sides of a traverse)

GIVEN:
1. Coordinates of pts A and C
2. Distances AB and CB

TO FIND:
1. Bearing of AB
2. Bearing of CB

SOLUTION

1. Inverse between pts. A & C to find distance AC and bearing AC.

2. With all three sides known use the Law of Cosines to solve for angle A or angle C or use —

\[ \cos \frac{A}{2} = \sqrt{\frac{S(S-BC)}{(AC)(AB)}} \]

where \( S = \frac{1}{2} (AB + BC + AC) \)

3. Solve the other angle of the two (A or C) by either the Law of Cosines or the Law of Sines.

d. Case IV - Two Unknowns, nonadjacent sides of a closed traverse

Since any closed figure is a closed traverse, the positions of the sides can be rearranged to make the two unknown sides adjacent, as shown in the above figures. Make these two sides the last two traverse courses. Solve by —

1. Case I, if both unknowns are distances
2. Case II, if one unknown is distance and the other is bearing
3. Case III, if both unknowns are bearings.
APPENDIX M

CURVES
1. CIRCULAR

a. Terminology —
- BC = Beginning of Curve
- T = Semi-Tangent
- PI = Intersection Pt. of Back and Forward Tangents
- EC = End of Curve
- R = Radius (length of)
- RP = Radius Point (center of curve)
- $\Delta$ = Central Angle of Curve at RP, or Deflection Angle between Back and Forward Tangents
- $L = \text{Length of Curve}$
- MPC = Mid-Point of Curve
- POC = Point on Curve
- POT = Point on Tangent
- POST = Point on Semi-Tangent
- LC = Long Chord
- C = Chord
- $M = \text{Middle Ordinate}$
- $E = \text{External Distance}$
- $D = \text{Deflection Angle}$

b. Formulas —
- $T = R \tan \frac{\Delta}{2}$
- $E = T \tan \frac{\Delta}{4}$
- $= R \left( \frac{1 - \cos \frac{\Delta}{2}}{\cos \frac{\Delta}{2}} \right)$
- $= R \left( \sec \frac{\Delta}{2} - 1 \right)$
- $= R \left( 1 - \cos \frac{\Delta}{2} \right)$
- $= R \frac{\Delta}{2}$
- $L = \frac{\Delta}{2} R$
- $C = 2R \sin D$
- $L = \frac{\Delta}{2} R$
- $\frac{180}{\Delta}$
- $= R \cdot \Delta$ (in radians)
- $D = \frac{1718.873386}{R}$
- $D$ = Deflection in minutes for one foot of arc.

c. Tangent offset formulas —
$$x = R - \sqrt{R^2 - y^2}$$
$$y = \frac{y^2}{2R}$$
CIRCULAR

d. Orientation of an instrument at a POC —

I. Set the circle of the instrument to "read" the deflection angle of the station sighted.

II. On a curve to the right use the clockwise circle.

III. On a curve to the left use the counter-clockwise circle.

---

Example:

Instrument at sta. 3 + 00,
sight on either —

- sta. 0 + 00 BC
- or, sta. 6 + 00, \( \frac{1}{2} \Delta \)
- or, sta. 8 + 00 EC

\[ \Delta = 80^\circ 00' \]
\[ L = 800' \]

---

e. Turning tangent to the curve at a POC —

I. Orient the instrument as shown in "d", above.

II. Turn to the deflection angle of the station occupied.

---

Example:

Instrument at sta. 3 + 00,
sight on either

- sta. 0 + 00 BC
- or, sta. 8 + 00 EC

Deflection angle = 15\( ^\circ \) 00'
1. CIRCULAR

f. Turning radial at a POC—

Procedure:

I. Orient the instrument as shown in "d" above.

II. Mentally or actually turn tangent to the curve as shown in "e" above.

III. Add or subtract $90^\circ$ to the circle reading for tangency for the radial value. Turn to this value.

Example:

Instrument at sta. $3 + 00$; sight on sta. $0 + 00$

$\Delta = 80^\circ 00'$  $L = 800'$

Example:

Instrument at sta. $3 + 00$; sight on sta. $7 + 00$
2. PARABOLIC – VERTICAL

a. Terminology —

L = Length of Curve; in stations.

\( G \) = Grade Rates, in percentages (not decimals), with proper signs.

m = Middle Ordinate; in feet.

d = Correction with proper sign, from grade line to curve; in feet.

S = Slope, in percentage, of the tangent to the curve at any point on the curve.

X = Distance, in feet, from P' to VPI.

H = Elevation of pt. H, which is on grade “G” produced.

P', P' = Elevations on respective grades.

D₀ = Distance, in stations, to low or high point from BVC or EVC.

D = Distance, in stations, from BVC or EVC to any point on the curve.

b. Formulas —

\[ m = \frac{(G' - G)L}{8} \]

or,

\[ \frac{1}{2} \left[ \frac{(BVC \text{ el.} + EVC \text{ el}) - VPI \text{ el.}}{2} \right] \]

\[ d = \frac{mD^2}{(L/2)^2} \]

or,

\[ \frac{D^2(G' - G)}{L} \]

\[ X = \frac{100(H - P')}{(G - G')} \]

\[ S = G - \frac{D(G - G')}{L} \]

\[ D₀ = \frac{L}{G - G'} \]

Note:

A rising grade carries a plus sign
while a falling grade carries a minus sign.

Thus, in a crest vertical curve, as the one shown above, G carries a plus sign and G' carries a minus sign when progressing in the direction of the stationing.

When progressing in the opposite direction, the signs are reversed.

---

c. Slide rule computation of “d” —

I. Set hairline over value of \((G' - G)\) on A scale

II. On B scale, move the value of “2L” under the hairline.

III. Move the hairline to each value of “D” on the C scale.*

IV. Read the value of “d” on the A scale, under the hairline.

* The value of “D” ranges from 0 to ½ “L”.

---
1. **CIRCLE**

a. **Linear (see App - E - 1)**

i. Circumference = $c$
   
   $c = 2\pi r$
   
   $c = \pi d$

ii. Diameter = $d$
   
   $d = 0.3183c$
   
   $d = c \div \pi$

iii. Radius = $r$
   
   $r = 0.15915c$
   
   $r = c \div 2\pi$

iv. Arc (or curve length) = $a$
   
   $a = r\theta \cdot \frac{180}{\pi}$

b. **Area**

i. Whole circle = $A$
   
   $A = \pi r^2$
   
   $A = \pi d^2 \div 4 = 0.7854d^2$

ii. Sector = $A_{\text{Sec}}$
   
   $A_{\text{Sec}} = \frac{1}{2}r^2\theta$ (in radians)

or

$A_{\text{Sec}} = 0.00872665r^2\theta$ (in degrees)

$A_{\text{Sec}} = \frac{\pi}{360} \cdot \frac{1}{2} r^2 \cdot \theta$

iii. Segment = $A_{\text{Seg}}$

$A_{\text{Seg}} = A_{\text{Sec}} - \Delta \text{CBA}$

$A_{\text{Seg}} = \frac{1}{2}r^2\theta - \frac{1}{2}r^2\sin\theta$

$A_{\text{Seg}} = \frac{1}{2}r^2(\theta - \sin\theta)$

2. **POLYGON** — A closed plane figure bounded by straight lines (or sides).

a. **Interior angles, sum**

   sum = $S = (180^\circ)(\text{number of sides} - 2)$

   $S = (180^\circ)(n - 2)$

b. **Area of regular polygon (all sides equal)**

   Area = $A = \frac{1}{2}nsp$; or by trigonometry

   $A = \frac{1}{4}ns^2\cot\frac{180}{n}$

   $n = 3$

   $p = 0.288675s$

   $n = 4$

   $p = 0.500000s$

   $n = 6$

   $p = 0.866025s$

   $n = 5$

   $p = 0.688191s$
3. **TRIANGLE** — A 3-Sided polygon (see App-D-3 and App-D-4).

   a. \( \text{Area} = A \)

   i. \( A = \frac{1}{2} bh \)

   ![Diagram of triangle with area formula]

   ii. \( A = 0.433013b^2 \)

      by trigonometry

      \[
      A = \frac{\sin 60^\circ b^2}{2}
      \]

   ![Diagram of triangle with 3-4-5 ratio]

   b. **3-4-5 triangle** (for laying off perpendicular)

4. **QUADRILATERAL** — A 4-sided polygon (see formulas below).

5. **PARALLELOGRAM** — A quadrilateral with opposite sides equal and parallel.

   See formulas below

   ![Diagram of parallelogram]

6. **RECTANGLE** — A parallelogram with 90° angles.

   \[ \text{Area} = A = bh \]

   ![Diagram of rectangle]

7. **SQUARE** — An equal-sided rectangle.

   \[ \text{Area} = A = b^2 \]

   ![Diagram of square]

8. **RHOMBOID** — A parallelogram having all angles different than 90°.

   \[ \text{Area} = A = bh \]

   by trigonometry

   \[ A = ab \sin \phi \]

9. **RHOMBUS** — An equal-sided rhomboid.

   \[ \text{Area} = A = bh \]

   by trigonometry

   \[ A = b^2 \sin \phi \]
10. **TRAPEZOID** — A quadrilateral with only two parallel sides.

\[
\text{Area} = A = \frac{1}{2} h (b + b')
\]

11. **TRAPEZIUM** — A quadrilateral without any parallel sides.

\[
\text{Area} = A = \left(\frac{1}{2} dh\right) + \frac{1}{2} b (h' + h'')
\]

12. **PENTAGON, IRREGULAR**

For Area, A, use the trapezium formula, above.
APPENDIX O

AREA OF IRREGULAR POLYGONS
G. AREA of IRREGULAR POLYGONS

1. DOUBLE MERIDIAN DISTANCE, DMD

a. DMD of a course, or side, is the algebraic sum of—
   i. Departure of the course itself, D
   ii. Departure of the previous course, PD
   iii. DMD of the previous course, PDMD

   NOTE: The DMD of the first course is equal to the departure of that course.

b. Double area for a course, DAC, equals—

   "(DMD of the course) × (latitude, i, of the course)".

   NOTE: Observe algebraic signs.

c. Double area of the polygon, DAP, equals—"algebraic sum of DACs of all courses".

d. Area of irregular polygon, or closed traverse, equals—"DAP ÷ 2".

---

<table>
<thead>
<tr>
<th>Cse.</th>
<th>D</th>
<th>PD</th>
<th>PDMD</th>
<th>DMD; × Lat./ = +'s</th>
<th>−'s</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>+141.421</td>
<td>000.000</td>
<td>000.000</td>
<td>+141.421</td>
<td>19,999.9</td>
</tr>
<tr>
<td>2-3</td>
<td>+86.603</td>
<td>+141.421</td>
<td>+141.421</td>
<td>+369.445</td>
<td>18,472.3</td>
</tr>
<tr>
<td>3-4</td>
<td>000.000</td>
<td>+86.603</td>
<td>+369.445</td>
<td>+456.048</td>
<td>34,445.3</td>
</tr>
<tr>
<td>4-5</td>
<td>-50.000</td>
<td>000.000</td>
<td>+456.048</td>
<td>+406.048</td>
<td>35,164.6</td>
</tr>
<tr>
<td>5-6</td>
<td>-107.313</td>
<td>-50.000</td>
<td>+406.048</td>
<td>+248.735</td>
<td>00.000</td>
</tr>
<tr>
<td>6-1</td>
<td>-70.711</td>
<td>-107.313</td>
<td>+248.735</td>
<td>+70.711</td>
<td>5,000.0</td>
</tr>
<tr>
<td>Sums</td>
<td>000.000</td>
<td></td>
<td></td>
<td></td>
<td>24,999.9</td>
</tr>
</tbody>
</table>

Double Areas

DAP = Σ +'s and −'s = 63,082.3

DAP ÷ 2 = A = 31,541.2 sq. ft.
2. COORDINATE CROSS MULTIPLICATION

a. Double the area, DAP, is calculated by —

i. Determine the plus value — Multiply the northing of each corner by the easting of the next corner — \((1N \times 2E) + (2N \times 3E) - \ldots - (nN \times 1E)\).

ii. Determine the minus value — Multiply the easting of each corner by the northing of the next corner — \((1E \times 2N) + (2E \times 3N) - \ldots - (nE \times 1N)\).

iii. DAP = Algebraic sum of plus and minus values.

b. \(A = \frac{DAP}{2}\)

(See App-G-1.)

TRaverse COMPUTATION WORK SHEET

<table>
<thead>
<tr>
<th>STATION</th>
<th>DISTANCE</th>
<th>BEARING</th>
<th>FUNCTION</th>
<th>COORDINATES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pt. 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-2</td>
<td>20,000</td>
<td>45000000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-3</td>
<td>100,000</td>
<td>56000000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-4</td>
<td>75530</td>
<td>50000000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-5</td>
<td>100,000</td>
<td>30000000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-6</td>
<td>107313</td>
<td>90000000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-1</td>
<td>100,000</td>
<td>45000000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PLUS VALUES

\[\begin{align*}
1N \times 2E &= 1,414,421.0 \\
2N \times 3E &= 1,401,692.4 \\
3N \times 4E &= 1,340,291.2 \\
4N \times 5E &= 1,196,744.0 \\
5N \times 6E &= 995,000.0 \\
6N \times 1E &= 929,289.0 \\
\end{align*}\]

\[\Sigma \text{of} \, +E = 7,004,437.6 \]

MINUS VALUES

\[\begin{align*}
1E \times 2N &= 1,414,421.0 \\
2E \times 3N &= 1,401,692.4 \\
3E \times 4N &= 1,340,291.2 \\
4E \times 5N &= 1,196,744.0 \\
5E \times 6N &= 995,000.0 \\
6E \times 1N &= 929,289.0 \\
\end{align*}\]

\[\Sigma \text{of} \, -N = 6,941,795.2 \]

\[\Sigma \text{of} \, +N = 6,941,795.2 \]

\[\Sigma \text{of} \, -E = 6,941,795.2 \]

\[\Sigma \text{of} \, +E = 7,004,437.6 \]

\[\Sigma \text{of} \, -N = 6,941,795.2 \]

\[DAP = 63,082.4 \text{ sq. ft.} \]

\[A = \frac{DAP}{2} = 31,541.2 \text{ sq. ft.} \]
APPENDIX P

VOLUME
VOLUME

1. PARALLELOPIPEDS — A six sided solid; all sides are parallelograms and opposite sides are parallel.
   a. Right rectangular prism — a parallelopiped with all angles 90°.
      \[ \text{Volume} = Bh \]
      where, \( B \) = area of base
      \( h \) = height
   
   b. Cube — An equal-sided right rectangular prism.
      \[ V = h^3 \]

   c. Rhombic prism — A parallelopiped without any 90° angles.
      \[ \text{Volume} = Bh \]
      Note: "h" = Perpendicular distance between opposite faces.

   d. Rhombohedron — An equal-sided rhombic prism.
      \[ \text{Volume} = Bh \]

2. CYLINDER
   \[ \text{Volume} = Bh = \pi r^2 h \]

3. SPHERE
   \[ \text{Volume} = \frac{4}{3} \pi r^3 \]

4. PYRAMID and CONE
   \[ \text{Volume} = \frac{1}{3} Bh \]

5. FRUSTRUMS
   (with base & top parallel)
   \[ \text{Volume} = \frac{1}{3} h (T + B + \sqrt{TB}) \]
5. **PRISM** — A solid whose two ends are parallel, similar, and equal, and whose sides are parallelograms. (A parallelopiped is a prism.)

\[
\text{Volume} = Bh
\]

(see App-F for formulas for areas of Bases)

---

7. **EARTHWORK** (*"Three-Elevation" Sections*)

a. **Volume by "Average End Areas" (approx.)** —

i. **End areas in square feet (approx.)** —

\[
\text{Area} = A = \frac{1}{2} dh + \frac{1}{2} b (h' + h'')
\]

ii. **Volume in cu. yds.** —

\[
V = \frac{L(A_1 + A_2)}{27}
\]

where, \(L\) = Distance between end areas, \(A_1\) and \(A_2\), in feet.

iii. **Volume correction in cu. yds.** —

\[
V_c = \frac{L}{324} (h_1 - h_2) (d_1 - d_2)
\]

iv. **Corrected volume** —

\[
V = V' - V_c
\]

b. **Prismoidal formula (exact)** —

\[
V = \frac{L}{6}(A_1 + A_2 + 4A_m)
\]

The area of \(A_m\) is calculated by using formula 7ai., above. The values used for \(d, h, b, h',\) and \(h''\) are derived by averaging the corresponding values of end sections \(A_1\) and \(A_2\).
APPENDIX Q

CONSTANTS & USEFUL DATA
1. **Pi, \( \pi \) — The number which denotes, "the ratio of the circumference of a circle to its diameter".
   
   a. **Approximate**
      
      \[
      \frac{22}{7} \text{ or } 3.14
      \]
   
   b. **More exact**
      
      \[
      3.1415926536
      \]

2. **Radian** — The central angle of a circular arc which is equal, in length, to the radius of the arc.
   
   \[
   180^\circ = \frac{\pi}{\pi} = 57.29577951^\circ = \text{One Radian}
   \]

3. **Earth's Mean Radius**
   
   a. **Feet** — 20,906,000
   
   b. **Miles** — 3959.5
   
   c. **Kilometres** — 6372

4. **Temperature Conversion**

<table>
<thead>
<tr>
<th></th>
<th>F</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freezing</td>
<td>32°</td>
<td>0°</td>
</tr>
<tr>
<td>Boiling</td>
<td>212°</td>
<td>100</td>
</tr>
<tr>
<td>Ratios</td>
<td>1°:0.55°C</td>
<td>1°:1.8°F</td>
</tr>
<tr>
<td>C to F</td>
<td>% C + 32°</td>
<td></td>
</tr>
<tr>
<td>F to C</td>
<td>% (F - 32°)</td>
<td></td>
</tr>
</tbody>
</table>

5. **Lengths of Arches of the Earth's Surface per Degree of Arc**

<table>
<thead>
<tr>
<th>LAT.</th>
<th>Along Meridian</th>
<th>Along Parallel</th>
</tr>
</thead>
<tbody>
<tr>
<td>32°</td>
<td>68.901 st. mi.</td>
<td>58.716 st. mi.</td>
</tr>
<tr>
<td>33°</td>
<td>68.912 &quot;</td>
<td>58.071 &quot;</td>
</tr>
<tr>
<td>34°</td>
<td>68.923 &quot;</td>
<td>57.407 &quot;</td>
</tr>
<tr>
<td>35°</td>
<td>68.935 &quot;</td>
<td>56.725 &quot;</td>
</tr>
<tr>
<td>36°</td>
<td>68.946 &quot;</td>
<td>56.027 &quot;</td>
</tr>
<tr>
<td>37°</td>
<td>68.958 &quot;</td>
<td>55.311 &quot;</td>
</tr>
<tr>
<td>38°</td>
<td>68.969 &quot;</td>
<td>54.579 &quot;</td>
</tr>
<tr>
<td>39°</td>
<td>68.981 &quot;</td>
<td>53.829 &quot;</td>
</tr>
<tr>
<td>40°</td>
<td>68.993 &quot;</td>
<td>53.063 &quot;</td>
</tr>
<tr>
<td>41°</td>
<td>69.006 &quot;</td>
<td>52.281 &quot;</td>
</tr>
<tr>
<td>42°</td>
<td>69.018 &quot;</td>
<td>51.483 &quot;</td>
</tr>
<tr>
<td>43°</td>
<td>69.030 &quot;</td>
<td>50.669 &quot;</td>
</tr>
</tbody>
</table>
APPENDIX R

SURVEYOR'S MEASURES
3. **LINEAR — METRIC**

   a. **Metres** —

   0.001 m = 1 mm
   0.01 m = 1 cm
   0.1 m = 1 dm
   1 m = 1 dkm
   100 m = 1 hm
   1000 m = 1 km
   10000 m = 1 mym
   1852 m = 1 nautical mi.

   b. **Millimetres** —

   1 mm = 1000 μ
   10 mm = 1 cm
   100 mm = 1 dm
   1000 mm = 1 m

4. **AREA — U.S.**

   a. **Acre** —

   1 A = 43,560 ft²
   1 A = 160 rd.²
   1 A = 10 ch²
   640 A = 1 mi²
   640 A = 1 section, S

   b. **Square miles** —

   1 mi² = 6400 ch²
   1 mi² = 640 A
   1 mi² = 1S
   36 mi² = 1T

5. **AREA — METRIC**

   a. **Square metres** —

   1 m² = 1 ca
   100 m² = 1 dkm² = 1a
   10,000 m² = 1 hm² = 1 ha
   1,000,000 m² = 1 km² = 100 ha
   100,000,000 m² = 1 mym²

   b. **Land area terms** —

   1 ca = 1 m²
   1 a = 100 m²
   1 ha = 100 a
   1 km² = 100 ha
   1 mym² = 10,000 ha
SURVEYOR’S MEASURES

1. ABBREVIATIONS

a. U.S. — linear —

<table>
<thead>
<tr>
<th>Unit</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inch</td>
<td>in. or ’</td>
</tr>
<tr>
<td>Link</td>
<td>lk.</td>
</tr>
<tr>
<td>Foot</td>
<td>ft. or ’</td>
</tr>
<tr>
<td>Yard</td>
<td>yd.</td>
</tr>
<tr>
<td>Fathom</td>
<td>fm.</td>
</tr>
<tr>
<td>Rod</td>
<td>rd.</td>
</tr>
<tr>
<td>Pole</td>
<td>pl.</td>
</tr>
<tr>
<td>Chain</td>
<td>ch.</td>
</tr>
<tr>
<td>Furlong</td>
<td>fur.</td>
</tr>
<tr>
<td>Mile</td>
<td>mi.</td>
</tr>
</tbody>
</table>

b. Metric — linear —

<table>
<thead>
<tr>
<th>Unit</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Micron</td>
<td>µ</td>
</tr>
<tr>
<td>Millimetre</td>
<td>mm</td>
</tr>
<tr>
<td>Centimetre</td>
<td>cm</td>
</tr>
<tr>
<td>Decimetre</td>
<td>dm</td>
</tr>
<tr>
<td>Metre</td>
<td>m</td>
</tr>
<tr>
<td>Decametre</td>
<td>dkm</td>
</tr>
<tr>
<td>Hectometre</td>
<td>hm</td>
</tr>
<tr>
<td>Kilometre</td>
<td>km</td>
</tr>
<tr>
<td>Myriametre</td>
<td>mym</td>
</tr>
</tbody>
</table>

c. Square measure — U.S. and metric — Preface the linear abbreviation with “sq.,” as “2 sq. mi.,” or add the exponent, “2,” as “2 mi².” Do not confuse these two terms which indicate an area of 2 square miles with the term, “2 miles squared,” which indicates an area of 4 square miles.

d. Land area terms — U.S. and metric —

<table>
<thead>
<tr>
<th>Unit</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acre</td>
<td>A</td>
</tr>
<tr>
<td>Section</td>
<td>S</td>
</tr>
<tr>
<td>Township</td>
<td>T</td>
</tr>
<tr>
<td>Centiare</td>
<td>ca</td>
</tr>
<tr>
<td>Acre</td>
<td>a</td>
</tr>
<tr>
<td>Hectare</td>
<td>ha</td>
</tr>
</tbody>
</table>

2. LINEAR — U.S.

a. Links —

<table>
<thead>
<tr>
<th>Unit</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 lk.</td>
<td>7.92 in.</td>
</tr>
<tr>
<td>25 lk.</td>
<td>16½ ft. = 1 rd.</td>
</tr>
<tr>
<td>100 lk.</td>
<td>1 ch.</td>
</tr>
</tbody>
</table>

b. Chains —

<table>
<thead>
<tr>
<th>Unit</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ch.</td>
<td>66 ft. = 100 lk. = 4 rd.</td>
</tr>
<tr>
<td>10 ch.</td>
<td>1 fur. = ½ mi.</td>
</tr>
<tr>
<td>80 ch.</td>
<td>1 mi.</td>
</tr>
</tbody>
</table>

c. Rods, or poles —

<table>
<thead>
<tr>
<th>Unit</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 rd.</td>
<td>16½ ft. = 25 lk.</td>
</tr>
<tr>
<td>4 rd.</td>
<td>1 ch.</td>
</tr>
<tr>
<td>40 rd.</td>
<td>1 fur.</td>
</tr>
<tr>
<td>320 rd.</td>
<td>1 ml.</td>
</tr>
<tr>
<td>1 rd.</td>
<td>1 pl.</td>
</tr>
</tbody>
</table>

d. Inches, feet, and yards —

<table>
<thead>
<tr>
<th>Unit</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 in.</td>
<td>1 ft.</td>
</tr>
<tr>
<td>3 ft.</td>
<td>1 yd.</td>
</tr>
<tr>
<td>5½ yds.</td>
<td>1 rd.</td>
</tr>
<tr>
<td>5280 ft.</td>
<td>1 statute mi.</td>
</tr>
<tr>
<td>6076.1033 ft.</td>
<td>1 nautical mi*</td>
</tr>
<tr>
<td>6 ft.</td>
<td>1 fm.</td>
</tr>
</tbody>
</table>

* see note on App-J-3
APPENDIX S

MONUMENTATION MAP (SAMPLE)
APPENDIX T

SUBSTITUTING SIMPLE CURVES FOR TRANSITIONS (SPIRAL CURVES)
SIMPLE CURVE SUBSTITUTED FOR TRANSITION FOR PURPOSES OF RIGHT OF WAY DESCRIPTIONS ONLY. CENTRAL ANGLE $\theta$, TANGENT DISTANCE $D$, SHORT TAN. DIST.
APPENDIX U

SURVEY RESEARCH PROJECT DATA CHECKLIST
SUBJECT: SURVEY PROJECT DATA CHECKLIST  
DATE: ____________

TO: SURVEY CREW SUPERVISOR ________________________________

FROM: RESEARCH UNIT ________________________________

THE FOLLOWING IS A LIST OF INFORMATION INCLUDED IN THIS PACKAGE:

CONTROL NUMBER: ____________________________________________

PROJECT NUMBER: ____________________________________________

[ ] SURVEY REQUEST

[ ] PRELIMINARY SCOPING REPORT

[ ] AS-BUILT PLANS, CONSTRUCTION PLANS ________________________

[ ] RIGHT-OF-WAY MAPS _______________________________________

[ ] RIGHT-OF-DOCUMENTS

[ ] PROJECT SURVEY CONTROL DATA (GPS)

[ ] HORIZONTAL & VERTICAL CONTROL DATA

[ ] AERIAL PHOTOS (CONTROLLED OR UNCONTROLLED FLIGHTS)

[ ] U.S.G.S. QUADRANGLE MAPS

[ ] U.S.G.L.O. PLATS w/wo FIELD NOTES

[ ] GENERAL PROPERTY OWNERSHIP MAPS

[ ] COUNTY ASSESSORS MAPS

[ ] CURRENT OWNERSHIP DEEDS

[ ] SURVEY PLATS (PRIVATE SURVEYORS)

[ ] RAILROAD RIGHT-OF-WAY MAPS

[ ] UTILITY COMPANY INFORMATION

[ ] PERMISSION TO SURVEY FORMS

[ ] OTHER ________________________________
APPENDIX V

CHECK LIST FOR LOCATION SURVEYS
CHECK LIST
FOR
LOCATION SURVEYS

All Location Surveys will contain the following:

1. __ Basis of bearings.
2. __ Basis of elevation.
3. __ Basis of stationing.
4. __ Basis of coordinates.
5. __ Number of field books.
6. __ Identification of B.O.S. and E.O.S.
7. __ Name of, and mileage to nearest city or town.
8. __ 1000 feet of topography before and after the B.O.P. and E.O.P.
9. __ Identification of major roads, streets, canals, laterals, arroyos, etc.
10. __ Listing of all the utility owners within the field notes.
11. __ Identification of the project.
12. __ Identification of township(s), range(s), section(s), conservancy district, grant, subdivision, city and/or county in which the survey is located.
13. __ Compute Alignment.
14. __ All stations involved with the alignment should be noted along the alignment such as; P.O.T., P.O.S.T., P.C., P.T., P.I., P.O.C., P.R.C., Equations, etc.
15. Curve Data: Curve data must be shown in the following order; 
   P.I. (Station) 
   Delta Angle (deg. min. sec.) 
   D (Degree of Curve) (deg. min. sec.) 
   T (Tangent) 
   L (Length of Curve) 
   R (Radius) 
   Note: Round off degree of curve along the Alignment to the nearest quarter of a degree, unless otherwise specified by the PDE.

16. Topography with the proper descriptor codes.

17. Identification of utilities, description of, condition of, and owner name.


19. Structures: description of, field sketch, located, dimensioned.

20. Alignments for major roads, streets, laterals, canals, structures, channels, irrigation ditches, etc.


22. Identification of project bench marks.


Company name and address

_________________________________________________________________________
_________________________________________________________________________

Project surveyor’s name and registration number

_________________________________________________________________________
APPENDIX W

R/W PLANS VERIFICATION CHECK LIST
CHECKLIST FOR FINAL R/W MAPPING PROJECTS

(FIRST REVIEW SUBMITTAL)

AN APPROPRIATE LETTER OF TRANSMITTAL CONTAINING NM SH&T D PROJECT NUMBER, PROJECT CONTROL NUMBER, AND A LIST OF ALL ITEMS SUBMITTED, AND WHAT ACTION IS REQUESTED.

SUBMITTAL SHALL INCLUDE TWO SETS OF PRE-FINAL R/W DESIGN PLANS (100% COMPLETE), A LIST OR LETTER WITH TOTAL NUMBER OF PARCELS, CME’S, TCP’S AND TITLE REPORTS SUBMITTED, A CHECKLIST COPY WITH EACH ITEM AS NOTED BELOW INITIATED BY PROFESSIONAL SURVEYOR; LEGAL DESCRIPTIONS FOR AFFECTED PARCELS, ONE SET OF LATEST PROJECT DESIGN PLAN AND PROFILE SHEETS, A HARD COPY OF THE COORDINATE SYSTEM LISTING FOR ALL POINTS PERTINENT TO THE R/W MAP WITH POINT NUMBER, DESCRIPTOR, X, Y, Z, AND STATION OFFSET; A HARD COPY OF TRAVERSE CLOSURE FOR EACH PARCEL (SHOWING PARCEL NUMBER TOGETHER WITH POINT NUMBERS, DISTANCES AND BEARINGS, AND WITH AREA IN BOTH HECTARES/ACRES AND SQUARE METERS/SQUARE FEET); SUBMIT ALL CERTIFIED TITLE REPORTS FOR EACH AFFECTED PARCEL. INCOMPLETE SUBMITTALS WILL BE RETURNED.

BLANK SPACES PROVIDED BELOW FOLLOWING EACH NUMERICAL DESIGNATION ARE TO BE INITIATED BY THE PROFESSIONAL SURVEYOR IN RESPONSIBLE CHARGE WHEN THE PARTICULAR ITEM HAS BEEN COMPLETED.

(SECOND REVIEW SUBMITTAL)

AN APPROPRIATE LETTER OF TRANSMITTAL CONTAINING PROJECT NUMBER, PROJECT CONTROL NUMBER, AND A LIST OF ALL ITEMS SUBMITTED AND WHAT ACTION IS BEING REQUESTED. SUBMITTAL SHALL INCLUDE ALL FIRST REVIEW RED-LINED R/W MAP PRINTS AND RED-LINED LEGAL LAND DESCRIPTIONS, 2 PRINT SETS OF CORRECTED MAPS, 1 SET LEGAL LAND DESCRIPTIONS, NEW P & P’S IF CHANGES HAVE BEEN MADE, AND ANY NEW REVISIONS TO COMPUTATIONS BEFORE THE SECOND REVIEW CAN BEGIN. INCOMPLETE SUBMITTALS WILL BE RETURNED.

IF ANY PORTION OF THE ALIGNMENT HAS CHANGED OR IF SUBSTANTIAL CHANGES HAVE OCCURRED AFTER FIRST REVIEW, THESE CHANGES, REVISIONS, ETC. SHOULD BE BROUGHT TO THE ATTENTION OF THE SUPERVISOR.
TITLE SHEET

1. _____ VICINITY MAP (SEE SAMPLE)
   USE COUNTY OR STATE MAP; PROJECT NUMBER WITH ARROWS.

2. _____ LOCATION MAP
   USE QUAD MAP, QUADRANGLE MAP, OR CITY MAP IF APPROPRIATE

3. _____ BEGINNING OF PROJECT STATIONS WITH ARROWS (ON LOCATION MAP)

4. _____ END OF PROJECT STATIONS WITH ARROWS (ON LOCATION MAP)

5. _____ LANDS ENGINEER SIGNATURE BLOCK (SEE EXAMPLE).

6. _____ LENGTH OF PROJECT (MILES/KILOMETERS TO THREE DECIMALS)

7. _____ NORTH ARROW ON TOP CENTER OF SHEET.

8. _____ CERTIFICATION OF SURVEYOR NOT REQUIRED ON TITLE SHEET

9. _____ FINAL MAP AND DATE FORMAT (BOLD AND NEAR LOWER RIGHT HAND CORNER)

10. _____ TITLE BLOCK IN LOWER RIGHT HAND CORNER WITH PROJECT NO. IN
     LARGE BOLD HEAVY LETTERS AND PROJECT CONTROL NO. ABOVE TITLE BLOCK.

11. _____ RIGHT OF WAY MAPS PREPARED BY (PRIME CONSULTANT AND
     SUBCONTRACTOR, IF APPLICABLE, NAME AND ADDRESS) OR COMPANY
     LOGO WITH NAME AND ADDRESS.

12. _____ INDEX OF SHEETS IN UPPER RIGHT HAND CORNER.
     (STATIONS SHOULD BE TO THE NEAREST PULL STATION)

13. _____ REVISION BOX IN LOWER LEFT OR RIGHT CORNER

14. _____ STICK-ONS OR PENCIL DRAFTING ARE NOT ACCEPTABLE ON ORIGINAL
     FINAL MAPS. STICK-ON COMPANY LOGOS CAN BE USED.

15. _____ "ACCESS CONTROLLED" IN BOLD LETTERS ON LOWER RIGHT CORNER,
     IF APPLICABLE.
PARCEL BLOCK SHEETS

1. ____ PARCEL NUMBERS
   LIST EACH ONE IN ORDER
   SKIP 1 SPACE BETWEEN PARCEL NUMBERS.
   CME'S KEPT TOGETHER IN SEPARATE BLOCK.
   TCP’S KEPT TOGETHER IN SEPARATE BLOCK.

2. ____ OWNER’S NAME
   USE FULL NAME AS SHOWN ON TITLE REPORT (MAP SHEETS AND
   DESCRIPTION SHALL MATCH PARCEL BLOCK NAME).

3. ____ AREA OF TAKE
   SHOW SQUARE FEET TO NEAREST SQUARE FOOT AND METERS TO THE
   NEAREST SQUARE METER.
   AREA IN ACRE'S OR HECTARE'S SHALL BE SHOWN TO FOUR DECIMAL
   PLACES. REMAINDER AREAS SHOULD BE SHOWN FOR ALL PARCELS,
   CME'S. FOR REMAINDER AREAS GREATER THAN 100 ACRES INSERT
   AS "> 100 ACRES."
   A NOTE SHOULD BE PLACED AT THE BOTTOM OF THE SHEET NOTING
   THAT LARGER PARCEL AREA WAS OBTAINED FROM RECORD INFORMATION
   OR OTHER CONVEYANCE DOCUMENTS. A +/- SYMBOL IS TO BE PLACED
   AFTER LARGER PARCEL AREA. ADDITIONAL CALCULATIONS FOR
   SEPARATE AREA REMAINDERS MAY BE REQUESTED BY VERIFICATIONS
   UNIT WHEN A TRACT OF LAND IS SPLIT BY ROADWAY CORRIDOR.

4. ____ RIGHT OF WAY MAPS PREPARED BY (CONSULTANT NAME AND ADDRESS)
   OR COMPANY LOGO WITH NAME AND ADDRESS

5. ____ TITLE BLOCK IN LOWER RIGHT HAND CORNER (NO EXCEPTIONS)
   PROJECT NO. IN LARGE BOLD HEAVY LETTERS AND PROJECT CONTROL
   NO. ABOVE TITLE BLOCK

6. ____ THE PARCEL BLOCK SHEETS ARE NUMBERED 1-A, 1-B, ETC.

7. ____ FINAL MAP AND DATE FORMAT (NEAR LOWER RIGHT HAND CORNER) (DO
   NOT SET DATE UNTIL DIRECTED BY RIGHT OF WAY VERIFICATION
   UNIT SUPERVISOR.

8. ____ REVISION BOX IN LOWER LEFT OR RIGHT CORNER
MAP SHEETS

1. AERIAL PHOTOS ARE **NOT ACCEPTABLE** AS A BASIS FOR R/W MAPS. ALL SHEETS MUST BE 24”X36” AND DRAFTED IN INK ON MYLAR WITH MECHANICAL LETTERING (**NO PENCIL DRAFTING**) AND MUST BE OF RECORATION QUALITY.

2. BEGIN WITH SHEET NO. 2 LAST SHEET NUMBER SHOULD BE SAME AS TOTAL SHEET NUMBER.

3. CROWDING IN MORE THAN ONE LENGTH OF CENTERLINE PER SHEET IS **NOT ACCEPTABLE**.

4. ALL CENTERLINE CURVE DATA, CENTERLINE BEARINGS AND STATIONING OF BOTH R/W MAP AND CONSTRUCTION PLANS SHOULD AGREE.

5. ALL STATIONS SHOULD BE SHOWN AS P.O.C., P.O.T., P.O.S.T., P.R.C., P.C.C., P.C., P.T., P.I., ETC.

6. ALL BEARINGS AND CURVE DATA SHOULD BE COMPATIBLE.

7. ALL CENTERLINES - BEARINGS AND CURVE DELTAS MUST AGREE.

8. TIC MARKS ON ALL CENTERLINES SHOULD BE SHOWN AND LABELED.

9. STATIONS SHOWN EVERY 500 FEET - ABOVE TIC MARKS AND TOWARDS TOP OF SHEET DESIGNATING CONSTRUCTION CENTERLINE. RAMPS OR FRONTAGE ROAD STATIONING, IF APPLICABLE, SHOULD ALSO BE SHOWN BUT WITH SMALLER LETTERING.

10. BASIS OF BEARINGS SHOULD BE SHOWN ON EACH SHEET.

11. TIES TO CONTROL MONUMENTS (NMSHTD, Section Corners, Etc.) SHALL BE SHOWN.

12. NORTH ARROW AND BAR SCALE ON EVERY SHEET - ARROW ORIENTED IN CORRECT DIRECTION AT TOP OF SHEET.

13. CERTIFICATION OF SURVEYOR AND LEGEND INFORMATION ON EVERY SHEET, EXCEPT PARCEL BLOCK AND TITLE SHEET (SEE SHEET 7).

14. RIGHT OF WAY MAPS PREPARED BY (CONTRACTANT NAME AND ADDRESS) OR COMPANY LOGO WITH NAME AND ADDRESS.
15. ALL CENTERLINE CURVE DATA SHALL BE SHOWN AS FOLLOWS AND IN THE ORDER GIVEN: (large bold lettering)

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\begin{align*}
\text{P.I. STATION} \\
\Delta \text{elta} \\
D \\
T \\
L \\
R
\end{align*}
\]

DEGREE OF CURVE IS NOT REQUIRED ON METRIC UNITS.

16. ALL R/W CURVE DATA SHALL BE SHOWN AS FOLLOWS AND IN THE ORDER GIVEN: (small lettering)

\[
\begin{align*}
\Delta \text{elta} \\
D \\
L \\
R \\
\text{CH: BEARING} \\
\text{CH: DISTANCE}
\end{align*}
\]

DEGREE OF CURVE IS NOT REQUIRED ON METRIC UNITS.

17. PROVIDE FOR SMALL AMOUNT OF OVERLAP FROM SHEET TO SHEET. MATCH LINES ARE NOT ACCEPTABLE.

18. TABLES OR BOXES MAY BE USED FOR CURVE DATA, TANGENT DISTANCE, BEARING, ETC. TO REDUCE CROWDED AND CLUTTERED CONDITIONS.

19. TITLE BLOCK IN LOWER RIGHT HAND CORNER.

20. REVISION BOX IN LOWER LEFT OR RIGHT CORNER (LEFT OF TITLE BLOCK).

21. ONLY THE FOLLOWING CONSTRUCTION DATA IS TO BE SHOWN ON EVERY SHEET: EDGE OF LANES/CURB AND GUTTER, DRAINAGE STRUCTURES, TURNOUTS, SLOPE LIMITS. SHOW STRUCTURE NOTES AND TURNOUT NOTES AT TOP OF SHEETS AWAY FROM PRIMARY SURVEY AND RIGHT OF WAY INFORMATION.

22. STICK-ONS OR PENCIL DRAFTING ARE NOT ACCEPTABLE ON ORIGINAL FINAL MAPS WITH THE EXCEPTION OF COMPANY LOGO.
23. ONLY NEW R/W LINES SHALL BE TIED TO CONSTRUCTION CENTERLINE.

24. ALL CENTERLINES (RAMPS, SURVEY, LOCATION ETC.) SHALL BE TIED AND A MATHEMATICAL CLOSURE MUST BE MADE.

25. ALL CENTERLINES AND R/W LINES MUST CLOSE MATHEMATICALLY.

26. DIMENSIONS FROM CONSTRUCTION CENTERLINE TO EXISTING R/W AND NEW R/W SHOULD BE SHOWN AT LEAST TWICE ON EACH SHEET IF R/W IS PARALLEL TO CENTERLINE.

27. SHOW STATION AND OFFSET FROM CONSTRUCTION CENTERLINE TO R/W AT EVERY CHANGE IN DIRECTION OF R/W.

28. ALL CONSTRUCTION FEATURES MUST BE SECURED BY R/W. (CHECK THAT ALL SLOPE LIMITS ETC. ARE SECURED BY PERMANENT R/W).

29. TIES TO CONTROL STATIONS (FIRST OR SECOND ORDER - IF USED FOR BASIS OF Bearings FOR INSTANCE) SHOULD BE SHOWN ON MAP USING THIN DASHED LINES. USE BROKEN LINES IF NECESSARY TO COMPENSATE FOR DISTANCES INVOLVED.

30. ALL INTERSECTING PROPERTY LINES SHALL BE SOLID LINES AND LABELED AS PROPERTY LINES.

31. WHEN PROPERTY LINES INTERSECT CENTERLINE, SHOW CENTERLINE STATION AT INTERSECTION.

32. IDENTIFY MONUMENTS AND POINTS AS TO WHETHER BRASS CAP, REBAR, SECTION CORNER, 1/4 CORNER, ETC. AND GIVE A THOROUGH AND COMPLETE INFORMATION AND DESCRIPTION.

33. LABEL CORNERS AS FOUND (ACCEPTED/REJECTED/USED, ETC.), SET, NOT FOUND, ETC., AND USE A LEGEND ON EACH SHEET.

34. AT BOTTOM OF SHEET SHOW IN BOLD LETTERS SECTION, TOWNSHIP AND RANGE, CITY, GRANT, NATIONAL FOREST, ETC., WHICHEVER IS APPLICABLE.

35. RIGHT OF WAY PARCELS SHOULD BE NUMBERED ACCORDING TO THE SHEET NUMBERS ON WHICH THEY ARE LOCATED.

36. FOR EACH R/W PARCELS/CME SHOW OWNER'S COMPLETE NAME, PARCEL/CME NUMBER AND AREA OF TAKE. THE AREA OF REMAINDER SHALL BE SHOWN ON THE PARCEL BLOCK SHEET.
37. _____ CROSSSHATCH AND ACCURATELY DELINEATE DOCUMENTED EXISTING R/W BUT DO NOT COVER ANY PERTINENT INFORMATION WITH CROSSSHATCHING. USE 1/8" SPACING FOR CROSSSHATCHING. A NOTE STATING DOCUMENTATION FOR EXISTING R/W GIVING PROJECT NUMBER, IF DEDICATED STREET, ETC. UNDER WHICH R/W WAS SECURED. NOTE: UNDOCUMENTED OR QUESTIONABLE AREAS WHICH MAY BE SUBJECT TO HIGHWAY RIGHT OF WAY, FENCED, OR PUBLIC USE SHOULD BE BROUGHT TO THE ATTENTION OF THE SURVEYS AND LANDS ENGINEER AS EARLY IN THE PROJECT DEVELOPMENT PROCESS AS PRACTICABLE.

38. _____ ALL SECTION LINES SHALL BE SOLID LINES. ALL 1/4 AND 1/16 LINES SHALL BE DASHED UNLESS THEY ARE PROPERTY LINES, IN WHICH CASE THEY SHALL BE SOLID.

39. _____ ALL CONSTRUCTION MAINTENANCE EASEMENTS (CME'S) SHALL BE SOLID LINES AND ONE STATION AND OFFSET SHALL BE SHOWN TO THE POINT OF BEGINNING ON THE RIGHT OF WAY LINE TOGETHER WITH BEARINGS AND DISTANCES.

40. _____ CENTERLINE OF CONSTRUCTION SHALL BE A SOLID LINE AND EQUIVALENT TO A #1 LINWEIGHT PEN.

41. _____ R/W LINE SHALL BE A SOLID LINE AND EQUIVALENT TO A #0 LINWEIGHT PEN IN CROWDED SITUATION, A HEAVIER LINE MAY BE USED IN ORDER FOR IT TO STAND OUT.

42. _____ CENTERLINE OF CONSTRUCTION CURVE DATA SHALL BE LOCATED RADially AND TOWARD THE INSIDE PORTION OF THE CURVE IN LARGE BOLD LETTERING.

43. _____ FINAL MAP DATE FORMAT SHOULD BE IN LARGE BOLD LETTERING NEAR LOWER RIGHT HAND CORNER.

44. _____ EACH PARCEL SHALL SHOW ONE TIE AT NEW R/W LINE TO THE CENTERLINE OF CONSTRUCTION BY STATION AND OFFSET. PARCEL SHOULD BE TIED TO A CONTROL MONUMENT AND THE TIE SHOWN ON THE MAP WITH A THIN DASHED LINES.

45. _____ WHEN APPLICABLE "ACCESS CONTROLLED" SHOULD BE SPELLED OUT IN LARGE BOLD LETTERS IN LOWER RIGHT HAND CORNER OF SHEETS.
46. ALL EXISTING IMPROVEMENTS (BUILDINGS, SEPTIC TANKS, WELLS, WALLS, ETC.) WITHIN 100 FEET OF RIGHT OF WAY SHALL BE SHOWN WITH SET-BACK DISTANCES TO THE NEW RIGHT OF WAY LINE.

52. DO NOT SHOW UTILITIES, POWER LINES, LIGHT POLES, TELEPHONE LINES, FIRE HYDRANTS, SEWER LINES, MANHOLES, MAIL BOXES, ETC.

54. THE FOLLOWING CERTIFICATION OR ONE SIMILAR IN CONTEXT SHALL BE USED ON ALL NMSHTD RIGHT OF WAY DESIGN PLANS:

I CERTIFY THAT I AM A REGISTERED PROFESSIONAL SURVEYOR AND THAT THESE R/W MAPS ARE AN INTERIM PRODUCT OF PROJECT DESIGN DEVELOPMENT AND WERE PREPARED BY ME OR UNDER MY DIRECTION AND ARE BASED ON AN ACTUAL FIELD SURVEY PERFORMED UNDER MY DIRECTION ON __________, 19__. CONFORMANCE WITH THE STATE OF NEW MEXICO'S MINIMUM STANDARDS FOR RIGHT OF WAY SURVEYING WILL OCCUR FOLLOWING ACTUAL ACQUISITION OF RIGHT OF WAY REQUIRED BY PROJECT NUMBER ____________________.

XXX x. XXXXXXXXX N.M.P.S. NO. XXXX DATE
(ADDRESS)
DESCRIPTIONS

1. ALL CALLS WHEN REFERRED TO IN THE DESCRIPTION SHALL BE SHOWN ON MAP.

2. CHECK LEGAL DESCRIPTION THOROUGHLY.

3. EACH DESCRIPTION SHALL HAVE THE PROJECT NUMBER, PARCEL NUMBER, ITS INTENDED PURPOSE (FEATURE), IF CME. THE NAME OF THE PROPERTY OWNER, DATE WRITTEN AND REVISION DATE IF ANY. (SEE SAMPLE)

4. USE COMPLETE CURVE DATA AS ON MAPS, INCLUDING CHORD BEARING AND DISTANCE. FOLLOW SAMPLES AVAILABLE FROM LANDS ENGINEERING UNIT.

5. IN PREAMBLE, INCLUDE QUARTER, SECTION, TOWNSHIP, RANGE, GRANT, COUNTY, AND/OR OTHER INFORMATION AS NEEDED OR APPLICABLE.

6. IN PREAMBLE, BREAK DOWN THE LOCATION OF A PARCEL AS FAR AS A QUARTER OF A QUARTER SECTION (WHERE APPLICABLE). NO FURTHER DIVISION IS NECESSARY. DO NOT INCLUDE EXCEPTIONS.

7. TIES TO CONTROL MONUMENTS SHOULD BE SHOWN ON MAP. USE TIES TO EXISTING (FOUND OR SET) MONUMENTS ONLY.

8. THE POINT OF BEGINNING WHEN APPLICABLE, SHALL BE TIED TO THE CENTERLINE OF CONSTRUCTION BY STATION AND OFFSET AS WELL AS BEING TIED TO A SECTION CORNER, 1/4 CORNER OR OTHER ACCEPTABLE CONTROL MONUMENT.

9. CME'S SHOULD BE TIED TO A SECTION CORNER OR OTHER FOUND MONUMENTS, AS WELL AS BEING TIED TO CENTERLINE.

10. TCP'S ARE TO BE DESCRIBED ON A STANDARD FORM CALLED OUT AS STATION TO STATION AND DISTANCE AWAY FROM R/W. FORMS ARE AVAILABLE FROM THE LANDS ENGINEERING UNIT. WHEN TCP'S ARE LOCATED WITHIN AREAS BEING MAPPED, THE TCP'S SHALL BE SHOWN ON THE MAPS AND ON THE PARCEL BLOCK SHEET.
GOVERNMENT PLATS ARE USED IN CONJUNCTION WITH LEGAL DOCUMENTS TO MAKE APPLICATION FOR THE ACQUISITION OF HIGHWAY RIGHT OF WAY INVOLVING BUREAU OF LAND MANAGEMENT PROPERTIES AND PROPERTIES UNDER THE JURISDICTION OF THE STATE LAND OFFICE. SAMPLES OF BOTH THE PLAT AND LEGAL DESCRIPTIONS ARE AVAILABLE THROUGH THE LANDS ENGINEERING UNIT SUPERVISOR.

1. GOVERNMENT APPLICATION PLATS (8½"X11") ON A SCALE OF 1"=1000' ARE REQUIRED WHEN TAKING R/W THROUGH BUREAU OF LAND MANAGEMENT LANDS AND STATE LAND UNDER THE JURISDICTION OF THE STATE LAND OFFICE.

2. THE LANDS ENGINEERING UNIT OF NMSHTD WILL PROVIDE THE FORMS AND PLAT FORMAT FOR DRAFTING THE GOVERNMENT PLATS.

3. ON STATE LAND OFFICE APPLICATION PLATS (8½"X11"), AREA OF TAKE OF EVERY 1/16 SECTION SHALL BE SHOWN ON PLAT (SEE SAMPLE).

4. ON STATE LAND OFFICE APPLICATION PLATS, THE LENGTH OF RIGHT OF WAY MAY BE REQUIRED IN "RODS". THE LANDS ENGINEERING UNIT SUPERVISOR SHALL CLARIFY THIS INFORMATION REQUIRED IN ORDER TO MAKE APPROPRIATE APPLICATION TO THE STATE LAND OFFICE.

NOTE:

1) ON PROJECTS THOROUGH NATIONAL FORESTS, NEW RIGHT OF WAY EASEMENT DESCRIPTION APPLICATIONS WILL BE REQUIRED AS PER MEMORANDUM OF UNDERSTANDING DATED 9-18-96. EARLY ATTENTION SHOULD BE GIVEN TO DETERMINING IF FOREST LANDS ARE INVOLVED WITHIN THE PROJECT LIMITS AND IF SO, BROUGHT TO THE ATTENTION OF THE LANDS ENGINEERING UNIT SUPERVISOR.

2) THIS CHECKLIST AND RELATED SAMPLE DOCUMENTS FURNISHED BY THE LANDS ENGINEERING UNIT OF THE SURVEYING AND LANDS ENGINEERING SECTION ARE PROVIDED AS INSTRUMENTS OF ASSISTANCE TO THE CONSULTANT AND ARE NOT INTENDED TO BE AN EXHAUSTIVE OR LIMITING TREATISE ON RIGHT OF WAY MAPPING REQUIREMENTS AND SERVES ONLY AS AN AID FOR THE USER. THE CONSULTANT REMAINS RESPONSIBLE FOR THE EFFICIENT AND TIMELY DEVELOPMENT AND COMPLETION OF THE PROJECT WORK IN ACCORDANCE WITH THE CONTRACT PROVISIONS, APPLICABLE PROFESSIONAL ENGINEERING/SURVEYING PRINCIPLES AND PRACTICES, REGULATIONS, MINIMUM STANDARDS FOR SURVEYING IN NEW MEXICO, MANUALS, AND LAWS AND STANDARDS. THE USER SHOULD CONTACT THE RIGHT OF WAY VERIFICATIONS UNIT SUPERVISOR OF THE SURVEYING AND LANDS ENGINEERING SECTION AT 827-5435 WITH ANY QUESTIONS ON RIGHT OF WAY MAPPING COMPONENT OF EACH PROJECT.
APPENDIX X

QUALITY CONTROL CHECKLISTS
QUALITY CONTROL CHECK LIST

G. P. S. SURVEY

Survey and Lands Engineering Section

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# QUALITY CONTROL CHECK LIST

## RIGHT-OF-WAY SURVEY

**Project** - Survey and Lands Engineering Section

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Project - Survey and Lands Engineering Section

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DESIGN TOPO

Project - Survey and Lands Engineering Section

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TRAVERSE CALCULATIONS

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