

Reading and Understanding The US National Grid



The Federal Geographic Data Committee Online Education Program

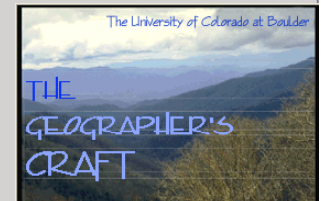
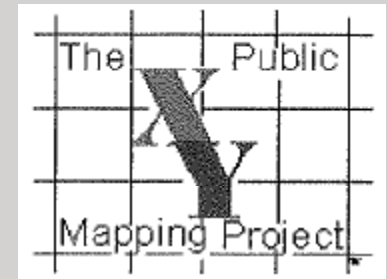
FGDC-STD-011-2001: The US National Grid

Narrated by Talbot Brooks, Director
Center for Interdisciplinary Geospatial Information Technologies
Delta State University

Acknowledgements

This work was completed by The Center for Interdisciplinary Geospatial Information Technologies at Delta State University with the fiscal support from the Federal Geographic Data Committee National Spatial Data Infrastructure Program 2008 Cooperative Agreements Program (Category 6) and USGS Cooperative Agreement 07ERAG0083.

Additional input and contributions courtesy Tom Terry and Jules McNeff at the Public X/Y Project, the Florida Division of Emergency Management's State Emergency Response Team, Peter Dana and the Geographer's Craft, and the Geospatial Information and Technology Association.



Reading USNG



Before Continuing...

Please visit:

<http://www.fgdc.gov/usng/educational-resources/index.html>

Download the USNG 1:24,000 training map and the USNG Grid Reader documents – you will need Adobe’s Free PDF reader to view and print them

Print the training map on regular paper, taking care to ensure that “Print to fit” and “Autorotate and center” options are turned OFF

Print the USNG Grid Reader document on an overhead transparency and cut one of the grid readers out

Finding Our Way



- **Understanding coordinate systems**
- **Interoperability between GPS and paper maps**
- **How to read and plot US National Grid Coordinates**

“Modern” Coordinate Systems: They all started here...

The Royal
Observatory

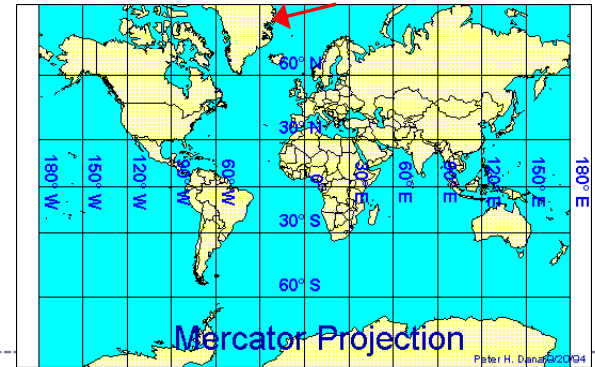
Greenwich,
UK







Understanding A Map



- A map is a representation of geographic features expressed on a flat surface.
- Some mathematical manipulation is required to transition from the globe shape of the Earth to the flat surface of a map. This is done using complex equations and results in what is called a map projection.
- The projection process introduces error, such as the distortion of areas and distances, into the resulting map product.
- Note the differences between Greenland (red arrow) depicted in the globe above and the Mercator Projection map above.

What Is A Coordinate System?



- A coordinate system is a means by which a geographic location is measured.
 - Two fundamental approaches
 - ✦ Angular displacement (Latitude and Longitude)
 - ✦ Ground or “grid” based coordinates
- There are a wide variety of coordinate systems in place today that were designed to meet specific needs (surveying, travel by sea, etc...).
- Some coordinate systems were designed to work with specific map projections.
- The US National Grid is designed to work with the Mercator Projection.

The Austin Capitol Dome Liberty Star Horizontal Control Station (The star in the hand of the Goddess of Liberty)

Datum	Coordinate System	Coordinates	Units
NAD-83	Geodetic Latitude, Longitude	30:16:28.82 N, 97:44:25.19 W	deg:min:sec
NAD-27	Geodetic Latitude, Longitude	30:16:28.03 N, 97:44:24.09 W	deg:min:sec
WGS-72	Geodetic Latitude, Longitude	30:16:28.68 N, 97:44:25.75 W	deg:min:sec
NAD-83	UTM Easting, Northing, Zone	621160.98, 3349893.53 14 R	meters
NAD-27	UTM Easting, Northing, Zone	621193.18, 3349688.21	meters
NAD-83	Military Grid Reference System	14RPU2116149894	meters
NAD-27	Military Grid Reference System	14RPJ2119349688	meters
NAD-83	State Plane, TX C 4203 Easting, Northing	949465.059, 3070309.475	meters
NAD-27	State Plane, TX C 4203 Easting, Northing	2818560.55, 230591.76	feet
NAD-83	State Plane, TX SC 4204 Easting, Northing	721201.977, 4271229.432	meters
NAD-27	State Plane, TX SC 4204 Easting, Northing	2397741.25, 889749.98	feet
WGS-72	World Geographic Reference System	FJHA4416	deg. and min.
	VOR-DME Bearing, Distance, VOR ID	230.46, 2.271, 114.6 Ch.93 AUS	deg,nmi,id
	Loran-C GRI 7980 W, X, Y, Z TDs	10998.9,24795.0,47040.8,63902.3	microsec.
	U.S. Postal Zip Code (5-digits)	78705	

One Location Described by Different Coordinate Systems

Peter H. Dana 9/9/94

Universal Transverse Mercator

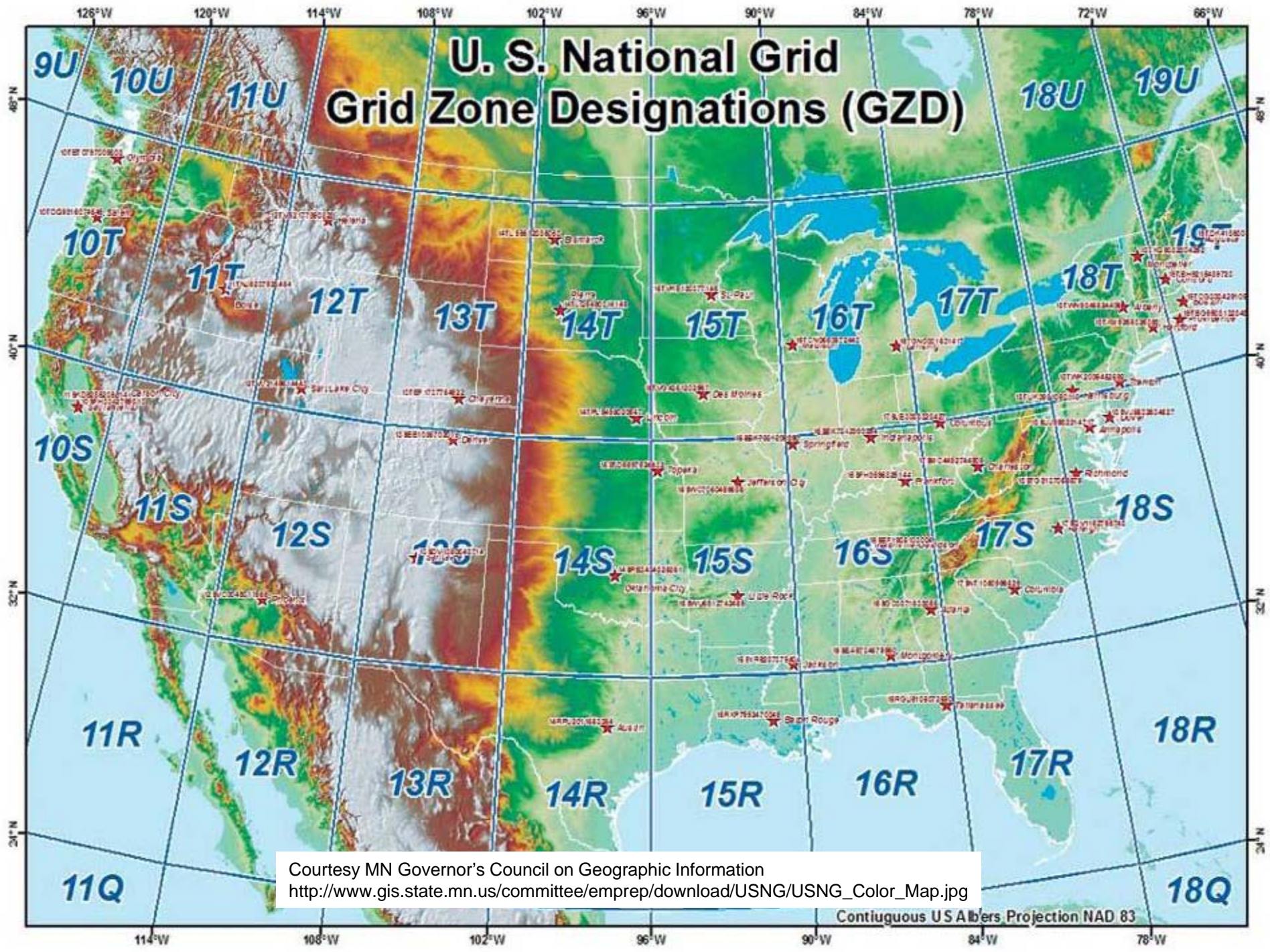


- Abbreviated UTM and is commonly used in GIS
- May be used with the North American Datum of 1927 (NAD 27) or the North American Datum of 1983 (NAD 83)
 - A datum is best described as the “anchor point” or origin of the coordinate system and is thus a very important piece of information that must be specified when using a coordinate system
- Divides earth into zones based on spherical (geographic) coordinate system
 - 60 zones total
 - The continental US lies between zones 10-19
- Each zone is projected in Transverse Mercator

UTM Continued



- **Each zone is subdivided into smaller blocks based on hemisphere**
 - Each block is 6° wide by 8° tall
 - North-south coordinates are called “Northings”
 - Measured in meters
 - Southpole is 0, Equator is 10 million
- **A similar process is used for creating east-west coordinates**
 - East-west coordinates are called “Easting”
 - Also measured in meters
- **USNG is based on the UTM coordinate system and uses the same basic principles with an additional subdivision called the 100,000-m square**

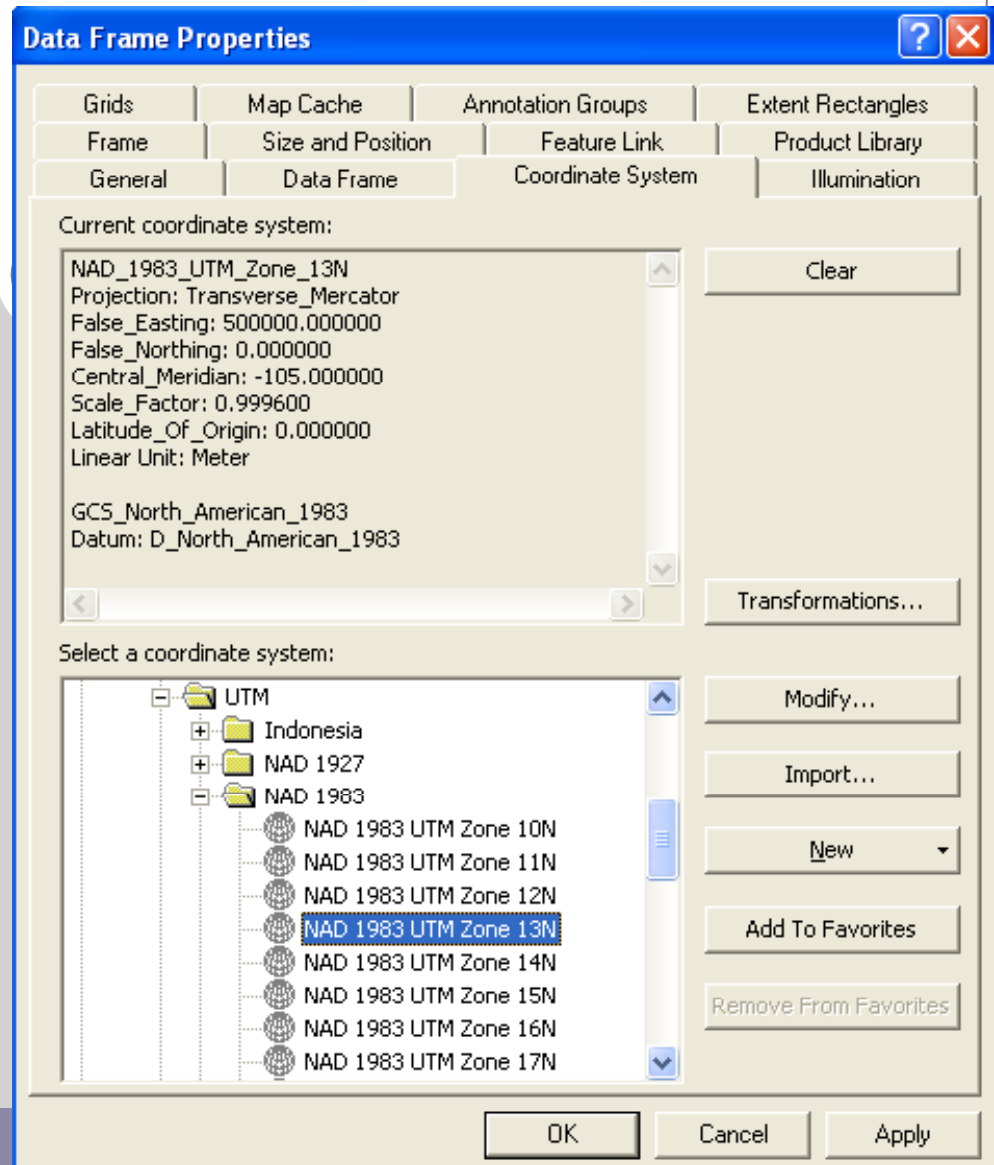


Courtesy MN Governor's Council on Geographic Information
http://www.gis.state.mn.us/committee/emprep/download/USNG/USNG_Color_Map.jpg

Contiguous US Albers Projection NAD 83

ESRI Users: Caveat Emptor!!!

- ESRI software treats UTM (and thus USNG) as a projected coordinate system.
- ESRI designates zones as only being northern or southern hemisphere and does not break them into 6 x 8 degree blocks
- This can be confusing as the letter designation following the number in ESRI software DOES NOT depict the correct zone – choose the correct zone number only



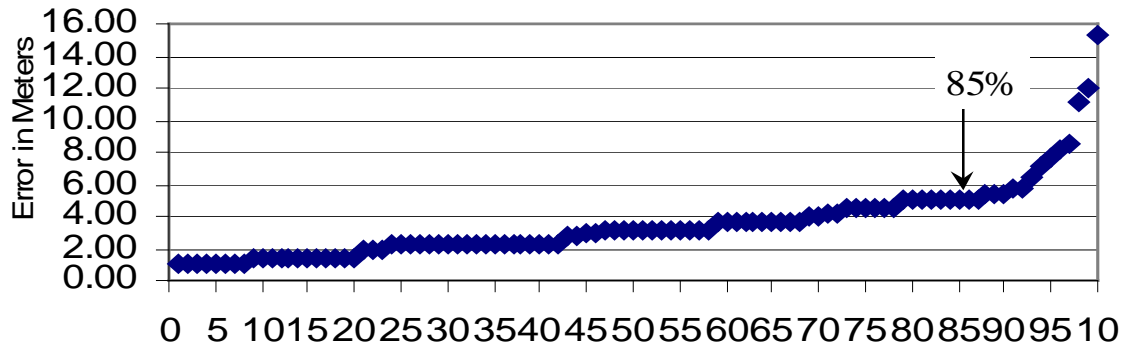
Map Accuracy

(National Map Accuracy Standards)

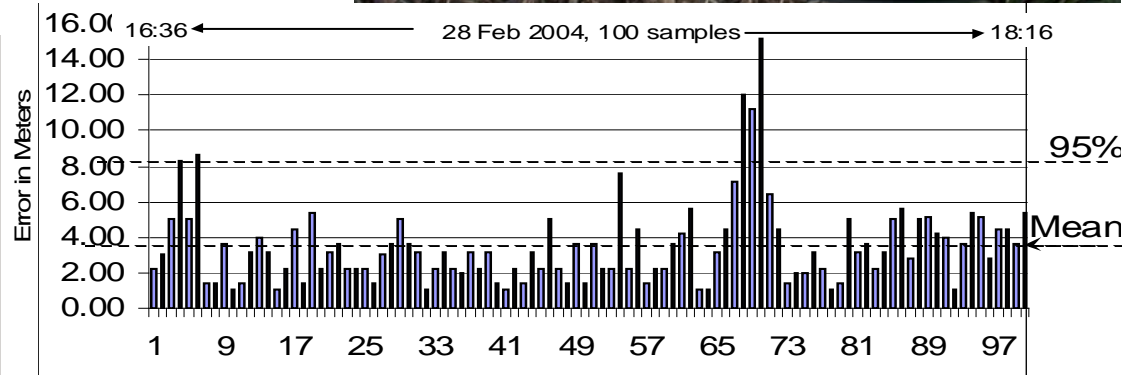


- **NMAS => 1:20,000 = 90% of well defined features will be within 1/50 inch on map of true position.**
- **USGS 1:24,000 series topographic maps = NMAS**
 - @ 1:24,000, 90% of well defined mapped features will be within 12.19-m of true position on the ground.
 - @ 1:24,000, 12-m = 0.5-mm...
...or dot from 0.5-mm pencil lead

GPS Accuracy



This chart depicts the 100 sample locations over a period of 100 minutes from a consumer GPS receiver, listed by miss distance. Y values represent the error (miss distance) between what the GPS receiver displayed and the true position of the receiver at horizontal control station GPS 112 on the GMU campus.



This chart depicts a temporal sequence of the 100 position samples taken at 1min intervals from a consumer GPS receiver. Y values represent the error (miss distance) between what the GPS receiver displayed and the true position of the receiver at horizontal control station GPS112 on the GMU campus. The average error was only 3.5-m, and 95% were within 8.2-m, an amazing capability given the cost and reliability of these consumer devices. Note the outlier excursion out to 15-m beginning at ~67 minutes.



In other words...

A 1:24,000 scale
topographic map sheet
matches GPS
in accuracy



It is worth noting, this accuracy was achieved at no trivial cost to the US Treasury over the last century.

- The lessons:
- 1) Do not point at position with your finger as your finger represents a significant portion of the map.
 - 2) Be aware of false accuracy in GPS.
 - 3) Pay attention to detail when working.

Reading USNG



Before Continuing...

Please visit:

<http://www.fgdc.gov/usng/educational-resources/index.html>

Download the USNG 1:24,000 training map and the USNG Grid Reader documents

Print the training map on regular paper, taking care to ensure that “Print to fit” and “Autorotate and center” options are turned OFF

Print the USNG Grid Reader document on an overhead transparency and cut one of the grid readers out

US National Grid Training Map



Produced by the United States Geological Survey

Topography compiled 1964. Planimetry derived from imagery taken 1998 and other sources. Public Land Survey System and survey control current as of 1967

North American Datum of 1983 (NAD 83). Projection and 1 000-meter grid: Universal Transverse Mercator, zone 16 10 000-foot ticks: Louisiana Coordinate System of 1983 (south zone)

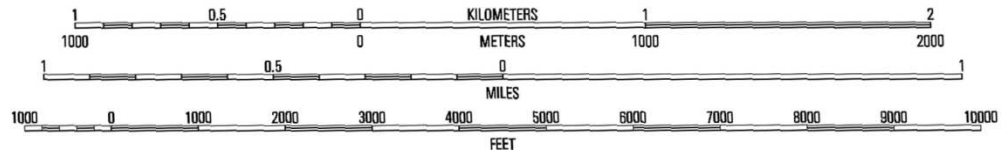
North American Datum of 1927 (NAD 27) is shown by dashed corner ticks. The values of the shift between NAD 83 and NAD 27 for 7.5-minute intersections are obtainable from National Geodetic Survey NADCON software

There may be private inholdings within the boundaries of the National or State reservations shown on this map

City of New Orleans and Orleans Parish are coextensive

This quadrangle covers a subsidence area

Landmark buildings verified 1967

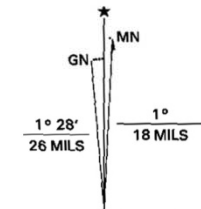


CONTOUR INTERVAL 5 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929
TO CONVERT FROM FEET TO METERS, MULTIPLY BY 0.3048

1	2	3	1 Spanish Fort 2 Little Woods 3 Chef Menteur 4 New Orleans East 5 Martello Castle 6 Bertrandoville 7 Belle Chasse 8 Delacroix
4		5	
6	7	8	

ADJOINING 7.5' QUADRANGLE NAMES
LA 200A

U.S. National Grid
100,000-m Square ID
BU
Grid Zone Designation
16R



UTM GRID AND 2000 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

Orientation on the Romer Scale



Orientation to the US National Grid format:

Pumping Station at grid: 16R BU 1028 0976



100,000-m Square ID

USNG format: 16R BU 1028 0976

Grid Zone Designation (GZD)
(6° lat x 8° longitude quad)

Easting Northing

Grid Coordinates

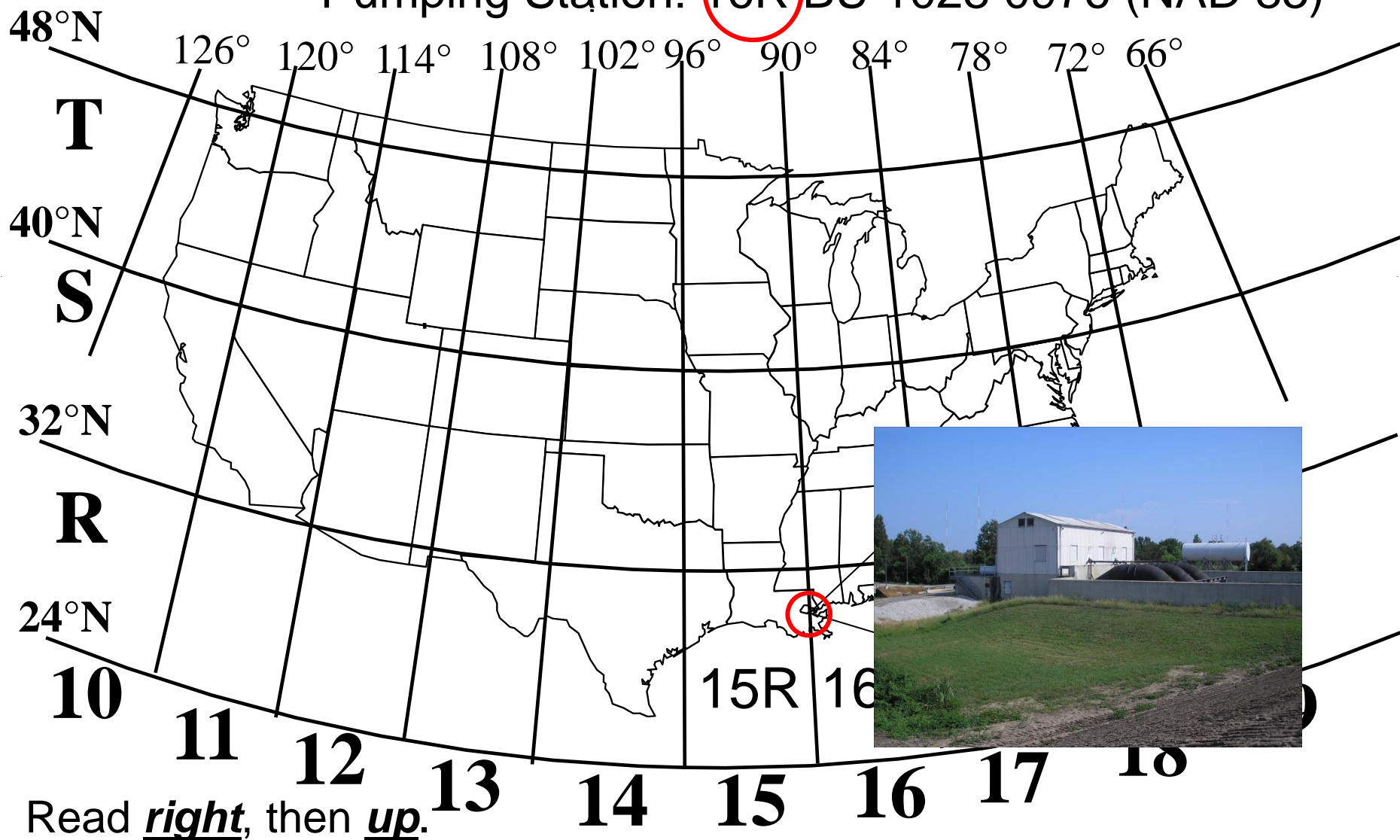
Read right, and up. ↑

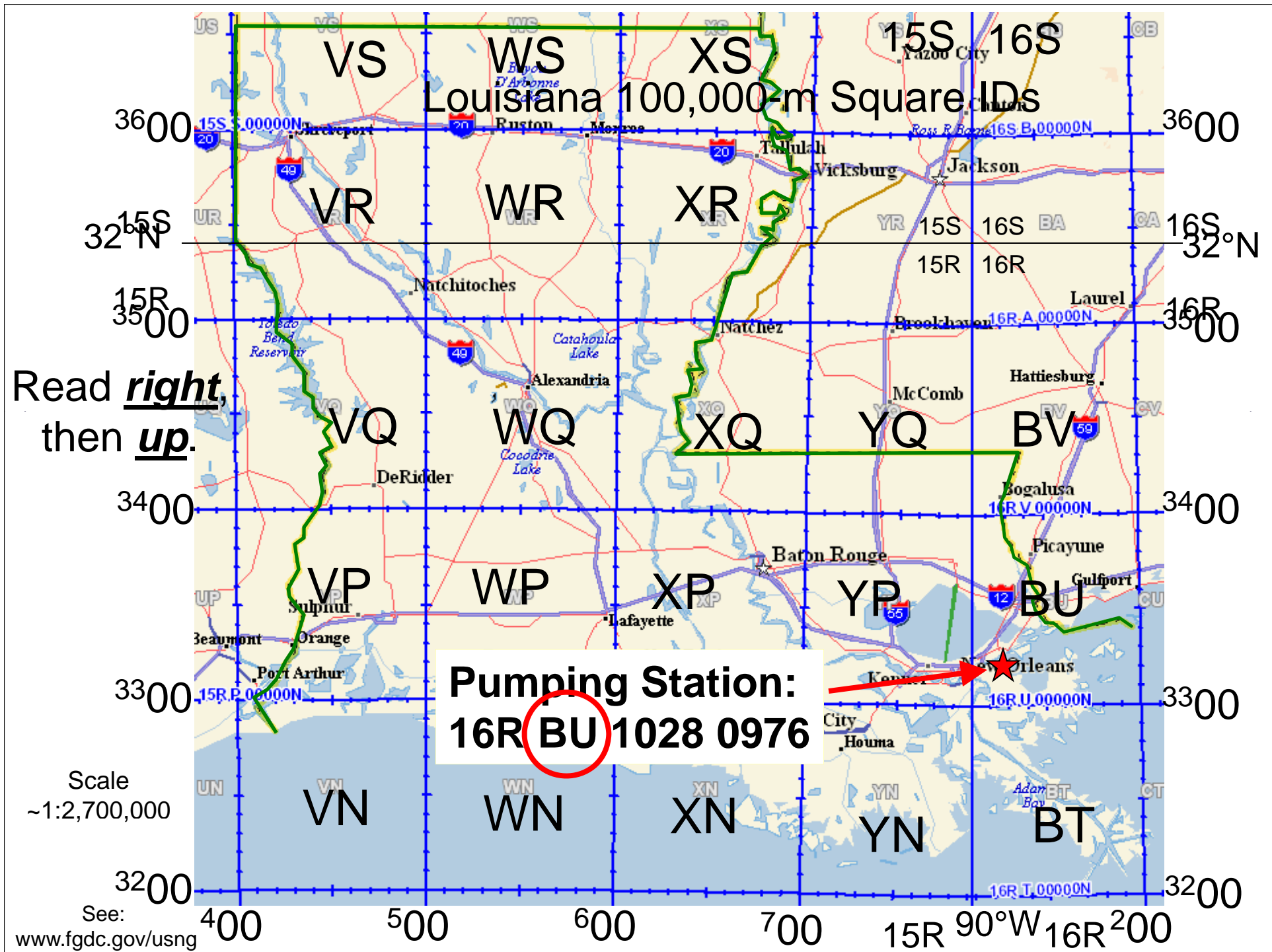
UTM format: 16R, 210280mE, 2309760mN
(Well suited for surveying / distance and direction calculations
and a component of the US National Grid.)

How to read the USNG...

UTM/USNG Grid Zone Designations

Pumping Station: **16R** BU 1028 0976 (NAD 83)

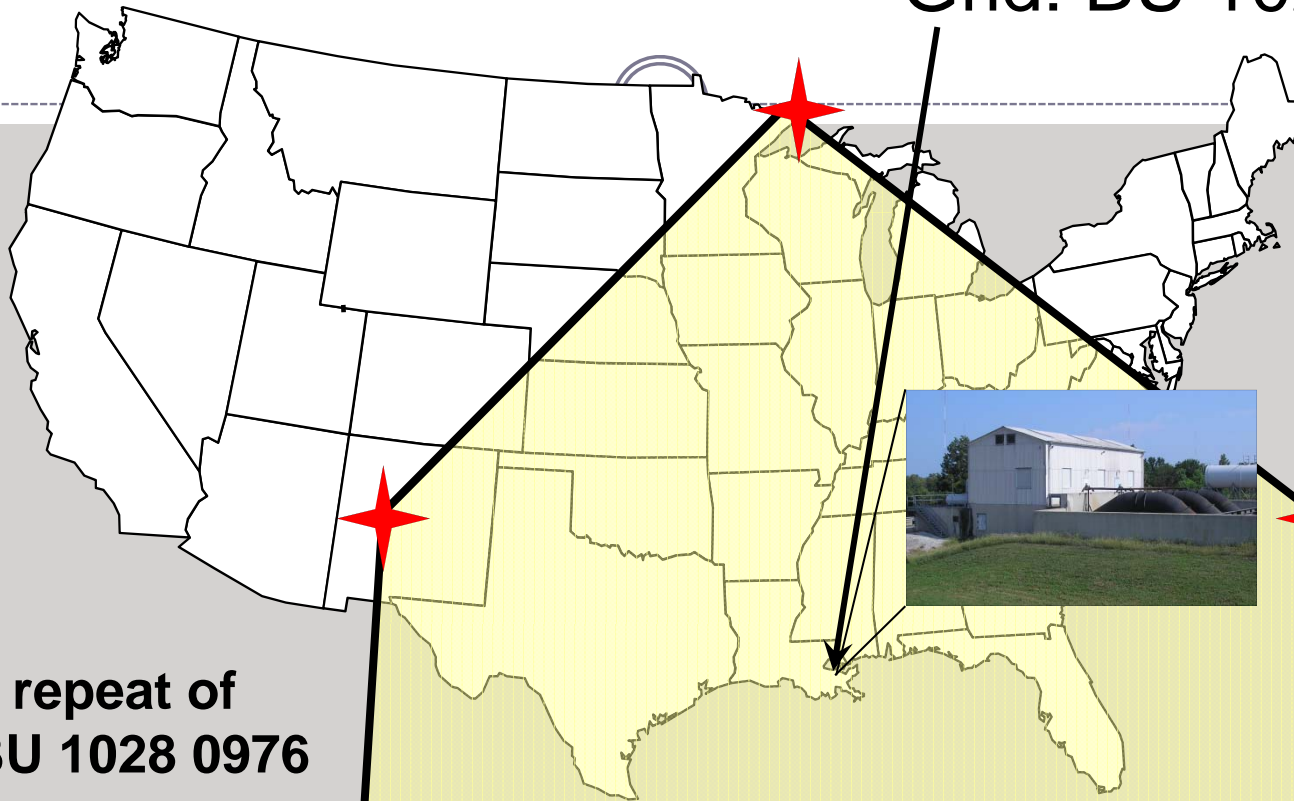




The Power of Truncated USNG Values

Pumping Station: 16R BU 1028 0976

Grid: BU 1028 0976



 = repeat of
BU 1028 0976


Each 2 letter/8 digit USNG value
(10-m posting) in the outlined area is unique.

The Power of Truncated USNG Values

Jefferson Pier, Washington, DC

Grid: UJ23370651



 = repeat of
UJ23370651

Each 2 letter/8 digit USNG value

(10-m posting) in the outlined area is unique.

Reading USNG Grid Coordinates

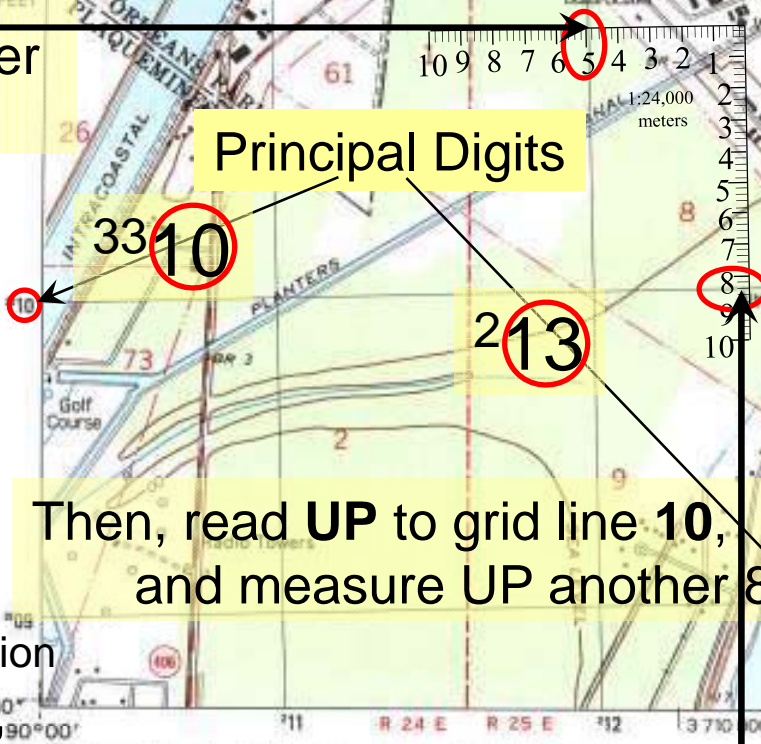
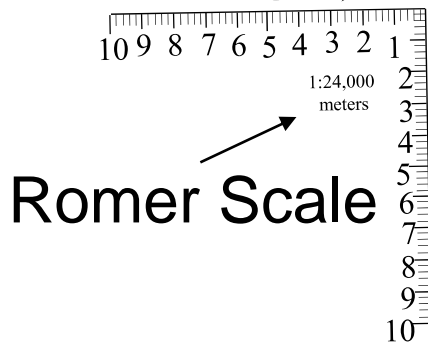
Water tank located at grid: 16R BU **1249 1084**

Read **RIGHT** to grid line **12**
Then measure right another 480-meters.

Water Tank at grid: 12491084
(think 1249 / 1084)

- 4-digit: 12 10 = 1,000m
- 6-digit: 124 108 = 100m
- 8-digit: 1249 1084 = 10m
- 10-digit: 12490 10840 = 1m precision

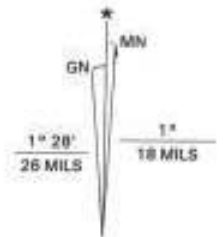
Read **Right**, Then **Up**



Then, read **UP** to grid line **10**, and measure UP another 840-meters.

Produced by the United States Geological Survey
 Topography compiled 1964. Planimetry derived from imagery taken 1998 and other sources. Public Land Survey System and survey control current as of 1967
 North American Datum of 1983 (NAD 83). Projection and 1 000-meter grid: Universal Transverse Mercator, zone 16 10 000-foot ticks: Louisiana Coordinate System of 1983 (south zone)
 North American Datum of 1927 (NAD 27) is shown by dashed corner ticks. The values of the shift between NAD 83 and NAD 27 for 7.5-minute intersections are obtainable from National Geodetic Survey NADCON software.
 There may be private inholdings within the boundaries of the National or State reservations shown on this map
 City of New Orleans and Orleans Parish are coextensive
 This quadrangle covers a subsidence area
 Landmark buildings verified 1967

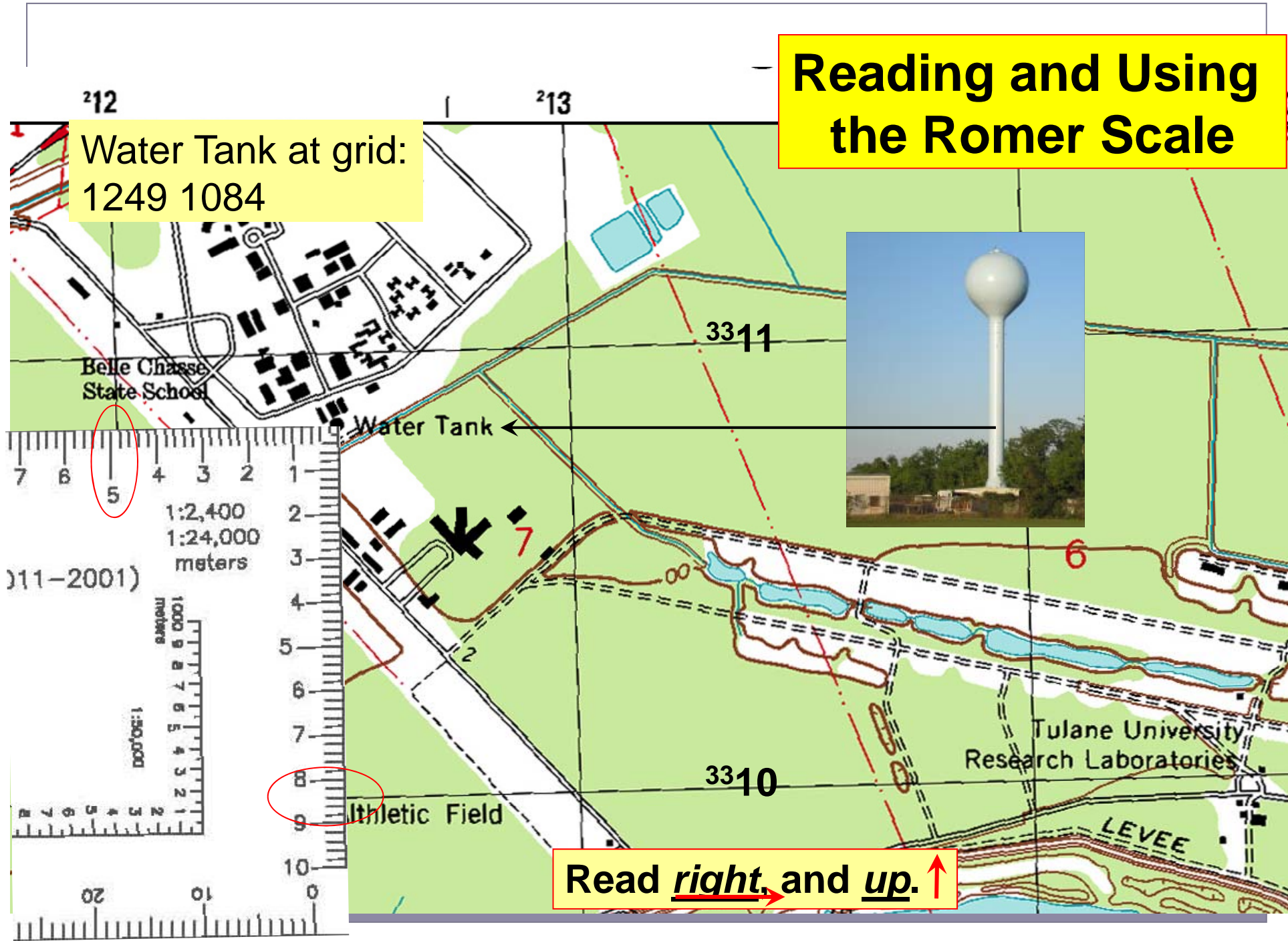
U.S. National Grid
100,000-m Square ID
BU
Grid Zone Designation
16R



UTM GRID AND 2000 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET
CHALMETTE, LA

Reading and Using the Romer Scale

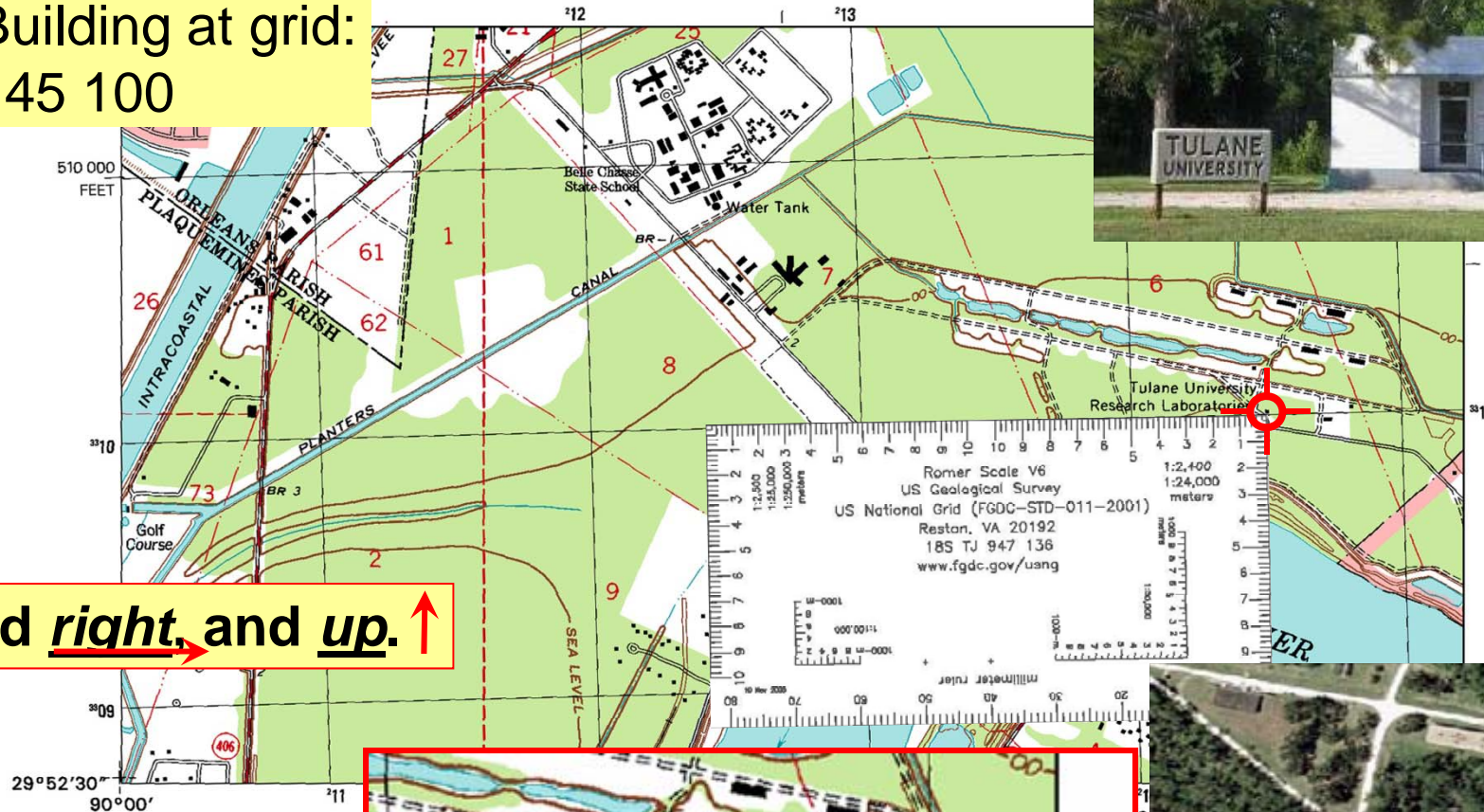
Water Tank at grid:
1249 1084



Read right, and up.

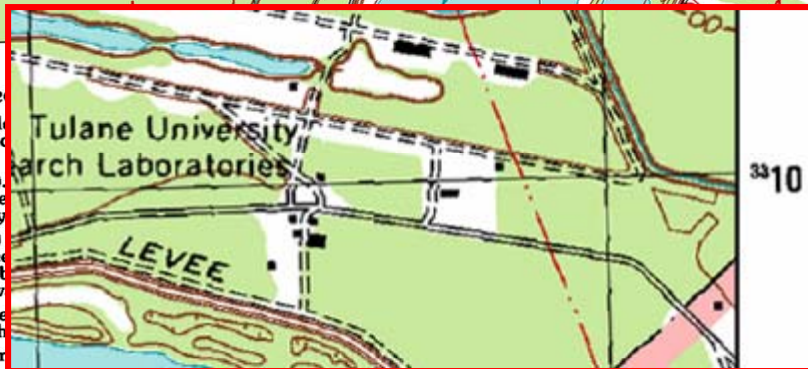
US National Grid Training Map

Building at grid:
145 100



Read right, and up. ↑

Produced by the United States Geological Survey
 Topography compiled 1964. Planimetry data taken 1998 and other sources. Public Land Survey control current as of 1967
 North American Datum of 1983 (NAD 83). 1 000-meter grid: Universal Transverse Mercator. 10 000-foot ticks: Louisiana Coordinate System
 North American Datum of 1927 (NAD 27) corner ticks. The values of the shift between NAD 27 for 7.5-minute intersections are of National Geodetic Survey NADCON software
 There may be private inholdings within the National or State reservations shown on this map
 City of New Orleans and Orleans Parish are shown in pink
 This quadrangle covers a subsidence area
 Landmark buildings verified 1967



4	5	5 Martello Castle
		6 Bertrandville
		7 Belle Chasse
		8 Delacroix

ADJOINING 7.5' QUADRANGLE NAMES
LA 200A

BU
 Grid Zone Designation
16R

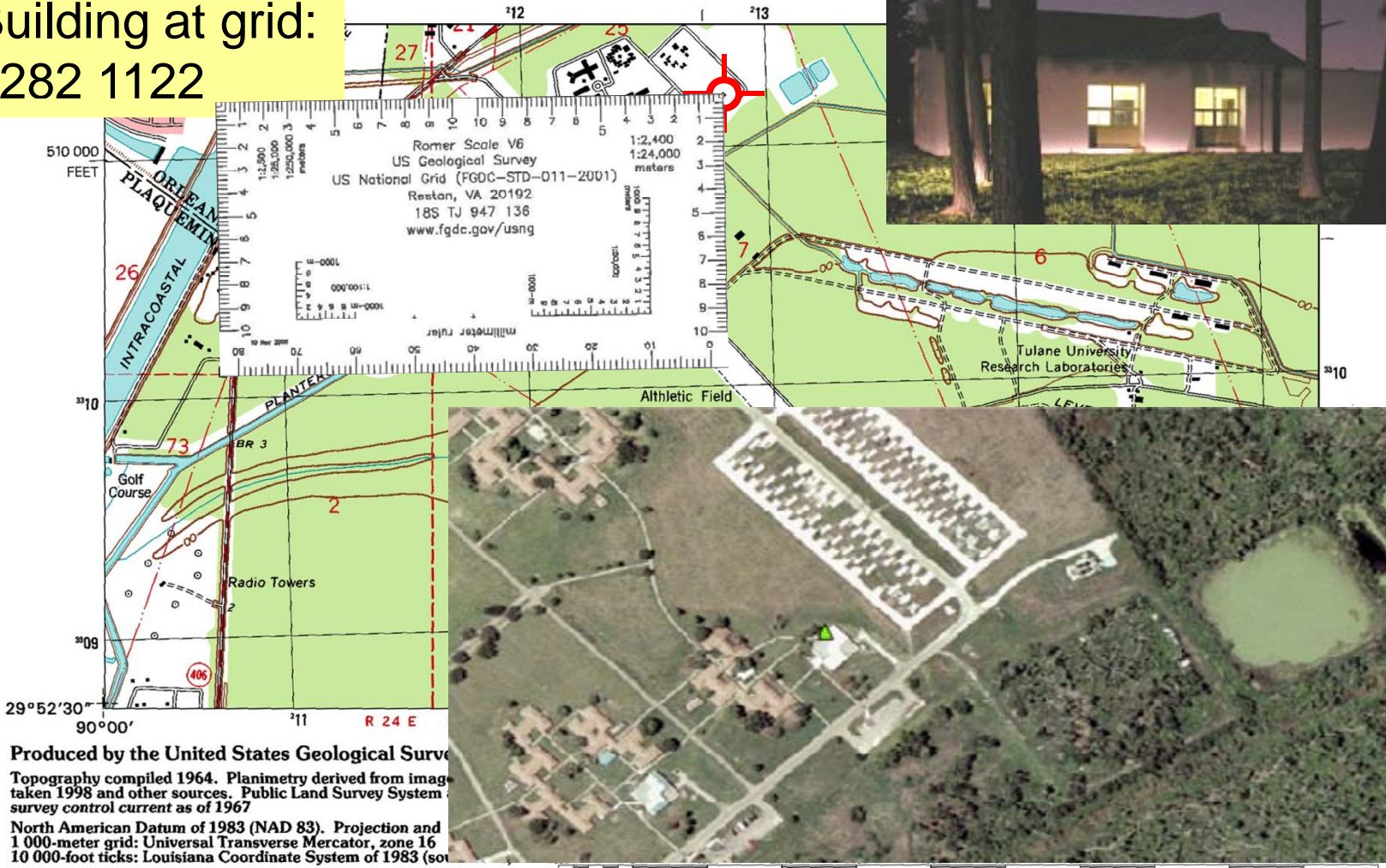


UTM GRID AND 2000 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

Ex 1

US National Grid Training

Building at grid:
1282 1122



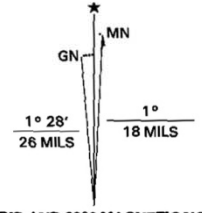
Produced by the United States Geological Survey
 Topography compiled 1964. Planimetry derived from imagery taken 1998 and other sources. Public Land Survey System survey control current as of 1967
 North American Datum of 1983 (NAD 83). Projection and 1 000-meter grid: Universal Transverse Mercator, zone 16 10 000-foot ticks: Louisiana Coordinate System of 1983 (southern)
 North American Datum of 1927 (NAD 27) is shown by dashed corner ticks. The values of the shift between NAD 83 and NAD 27 for 7.5-minute intersections are obtainable from National Geodetic Survey NADCON software
 There may be private inholdings within the boundaries of the National or State reservations shown on this map
 City of New Orleans and Orleans Parish are coextensive
 This quadrangle covers a subsidence area
 Landmark buildings verified 1967

1	2	3
4		5
6	7	8

ADJOINING 7.5' QUADRANGLE NAMES
LA 200A

CONTOUR INTERVAL 5 FEET
 NATIONAL GEODETIC VERTICAL DATUM OF 1929
 TO CONVERT FROM FEET TO METERS, MULTIPLY BY 0.3048

U.S. National Grid
 100,000-m Square ID
BU
 Grid Zone Designation
16R



UTM GRID AND 2000 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

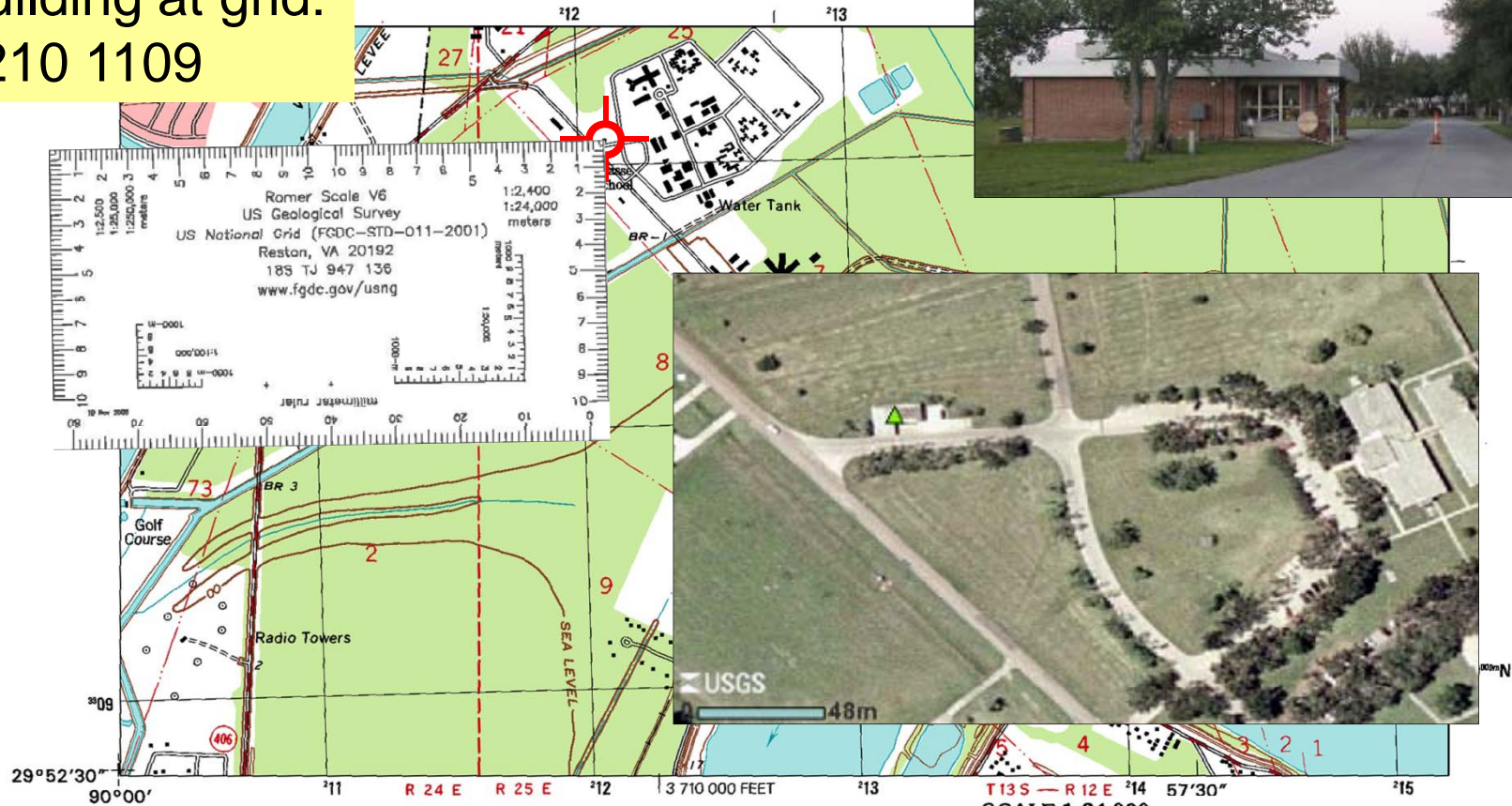


QUADRANGLE LOCATION

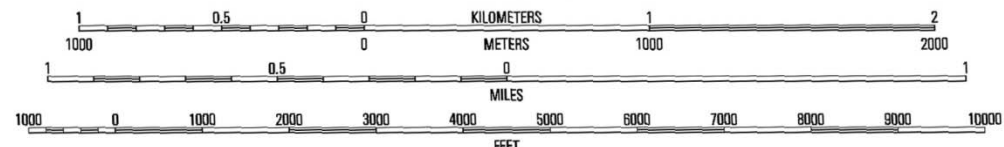
Ex 1

Building at grid:
1210 1109

US National Grid Training



Produced by the United States Geological Survey
 Topography compiled 1964. Planimetry derived from imagery taken 1998 and other sources. Public Land Survey System and survey control current as of 1967
 North American Datum of 1983 (NAD 83). Projection and 1:24,000 scale.



Read right, and up.

National Geodetic Survey NADCON software
 There may be private inholdings within the boundaries of the National or State reservations shown on this map
 City of New Orleans and Orleans Parish are coextensive
 This quadrangle covers a subsidence area
 Landmark buildings verified 1967

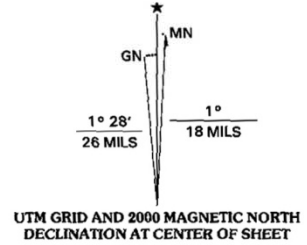


1	2	3	1 Spanish Fort
4		5	2 Little Woods
			3 Chef Menteur
			4 New Orleans East
			5 Martello Castle
			6 Bertrandville
			7 Belle Chasse
			8 Delacroix

ADJOINING 7.5' QUADRANGLE NAMES
LA 200A

CONTOUR INTERVAL 5 FEET
 NATIONAL GEODETIC VERTICAL DATUM OF 1929
 TO CONVERT FROM FEET TO METERS, MULTIPLY BY 0.3048

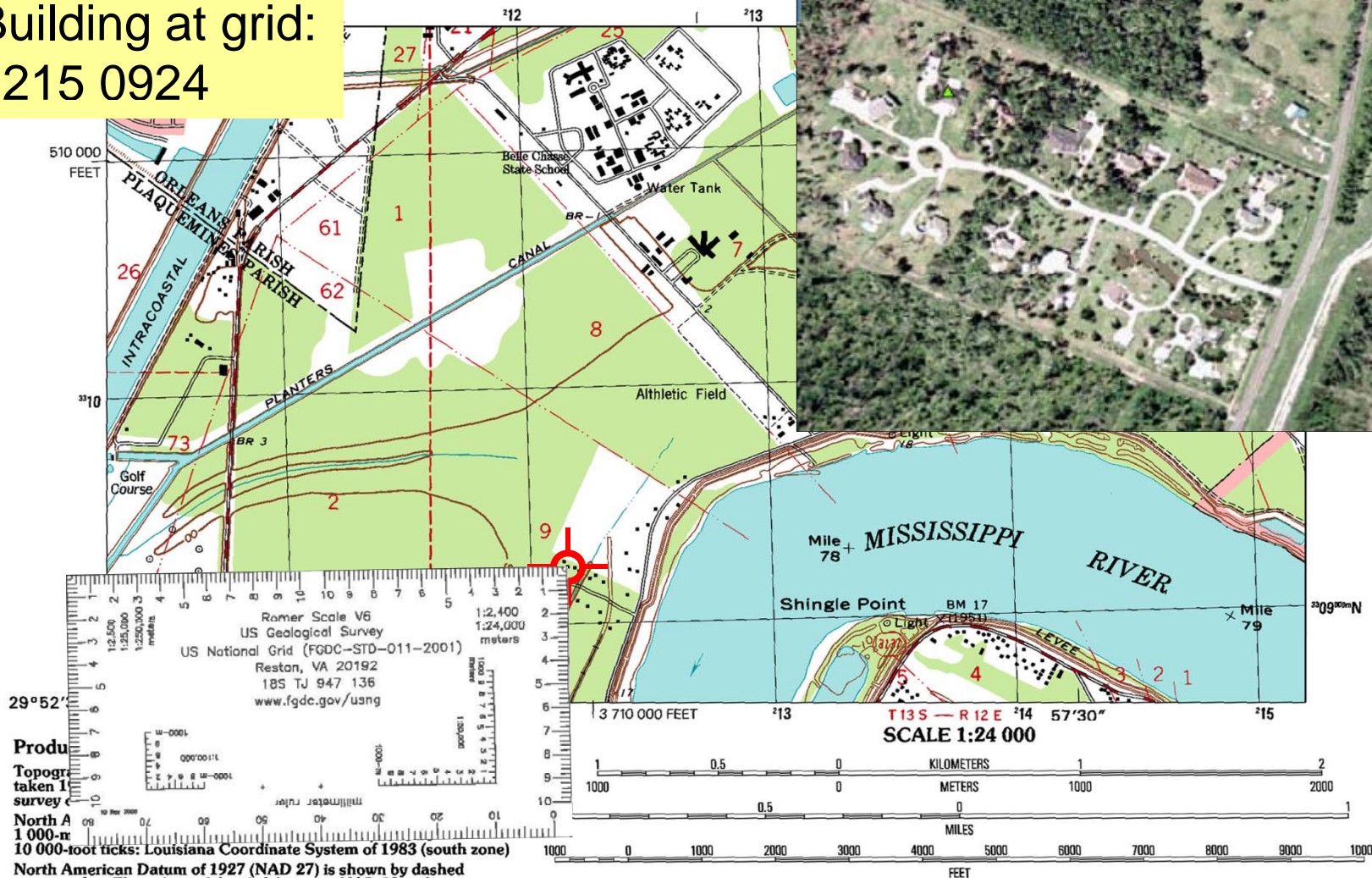
U.S. National Grid
 100,000-m Square ID
BU
 Grid Zone Designation
16R



Ex 2

US National Grid Training Map

Building at grid:
1215 0924



Romer Scale V6
US Geological Survey
US National Grid (FGDC-STD-011-2001)
Reston, VA 20192
185 TJ 947 136
www.fgdc.gov/usng

Product
Topographic
taken in
survey of
North A
1 000-m
10 000-foot ticks: Louisiana Coordinate System of 1983 (south zone)

North American Datum of 1927 (NAD 27) is shown by dashed corner ticks. The values of the shift between NAD 83 and NAD 27 for 7.5-minute intersections are obtainable from National Geodetic Survey NADCON software

There may be private inholdings within the boundaries of the National or State reservations shown on this map

City of New Orleans and Orleans Parish are coextensive

This quadrangle covers a subsidence area

Landmark buildings verified 1967

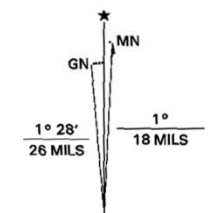


1	2	3	1 Spanish Fort 2 Little Woods 3 Chef Menteur
4		5	4 New Orleans East 5 Martello Castle
6	7	8	6 Bertrandville 7 Belle Chasse 8 Delacroix

ADJOINING 7.5' QUADRANGLE NAMES
LA 200A

CONTOUR INTERVAL 5 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929
TO CONVERT FROM FEET TO METERS, MULTIPLY BY 0.3048

U.S. National Grid
100,000-m Square ID
BU
Grid Zone Designation
16R



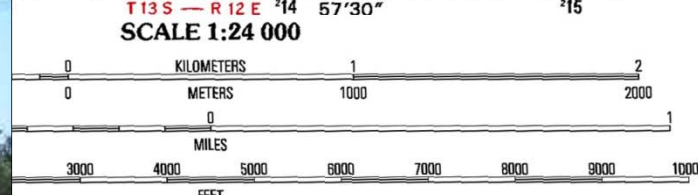
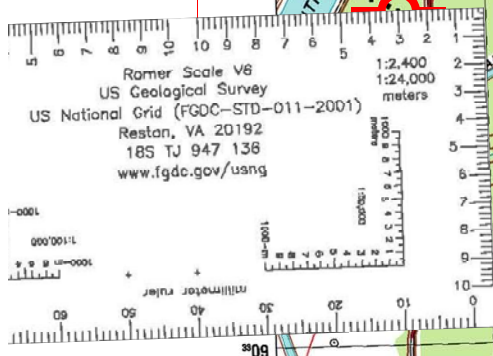
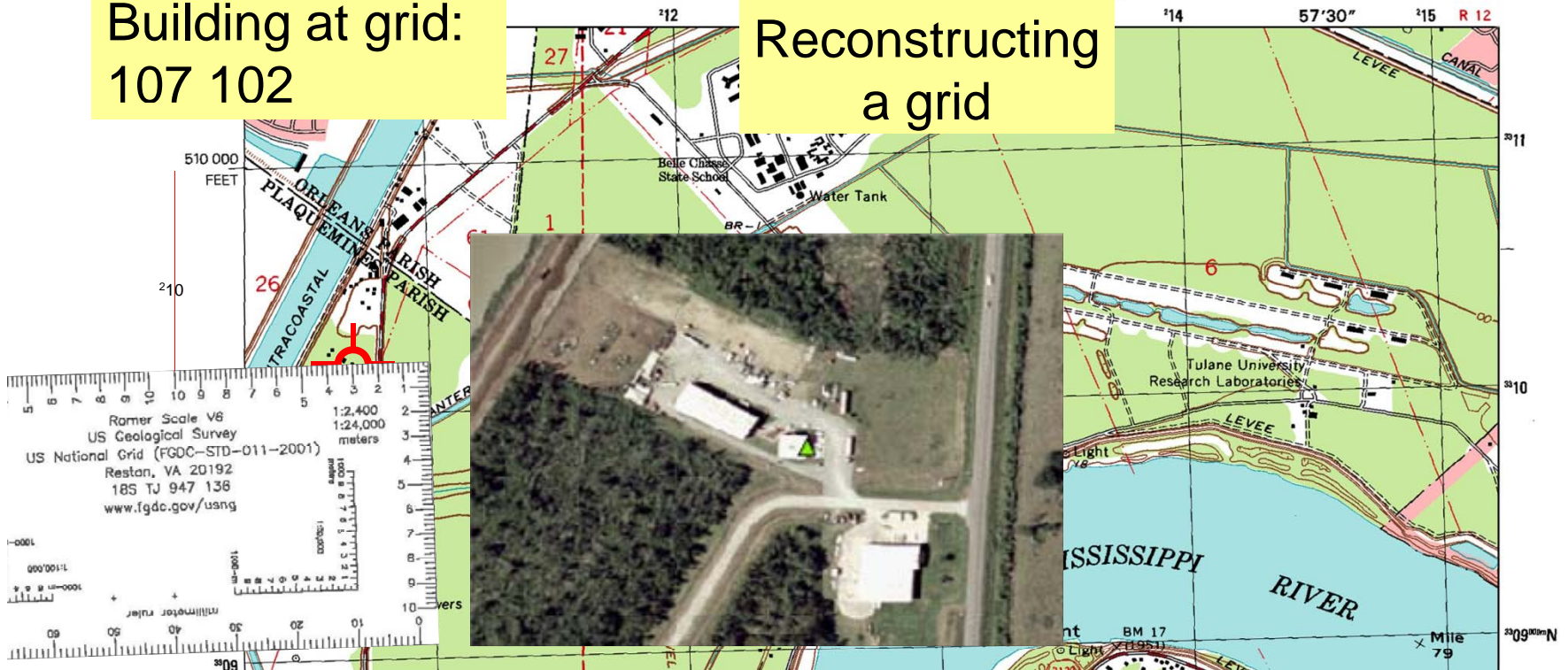
UTM GRID AND 2000 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

Ex 5

US National Grid Training Map

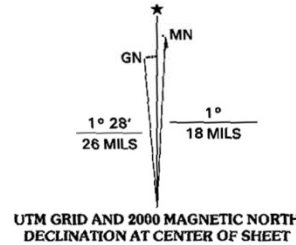
Building at grid:
107 102

Reconstructing
a grid



CONTOUR INTERVAL 5 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929
TO CONVERT FROM FEET TO METERS, MULTIPLY BY 0.3048

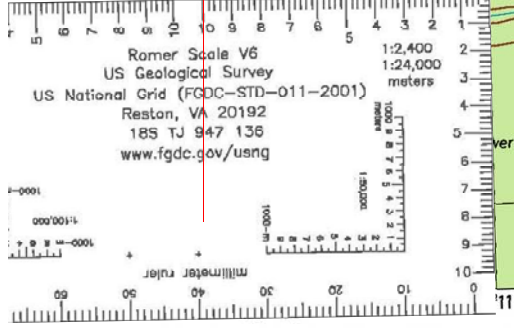
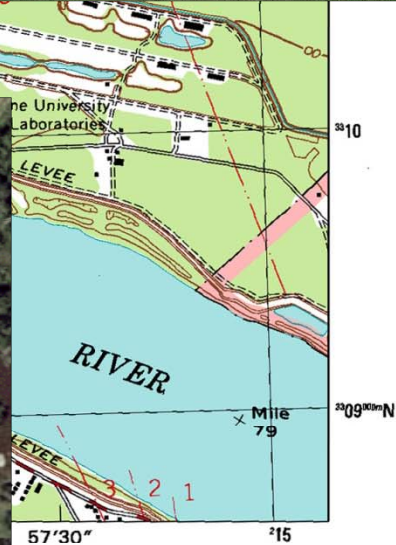
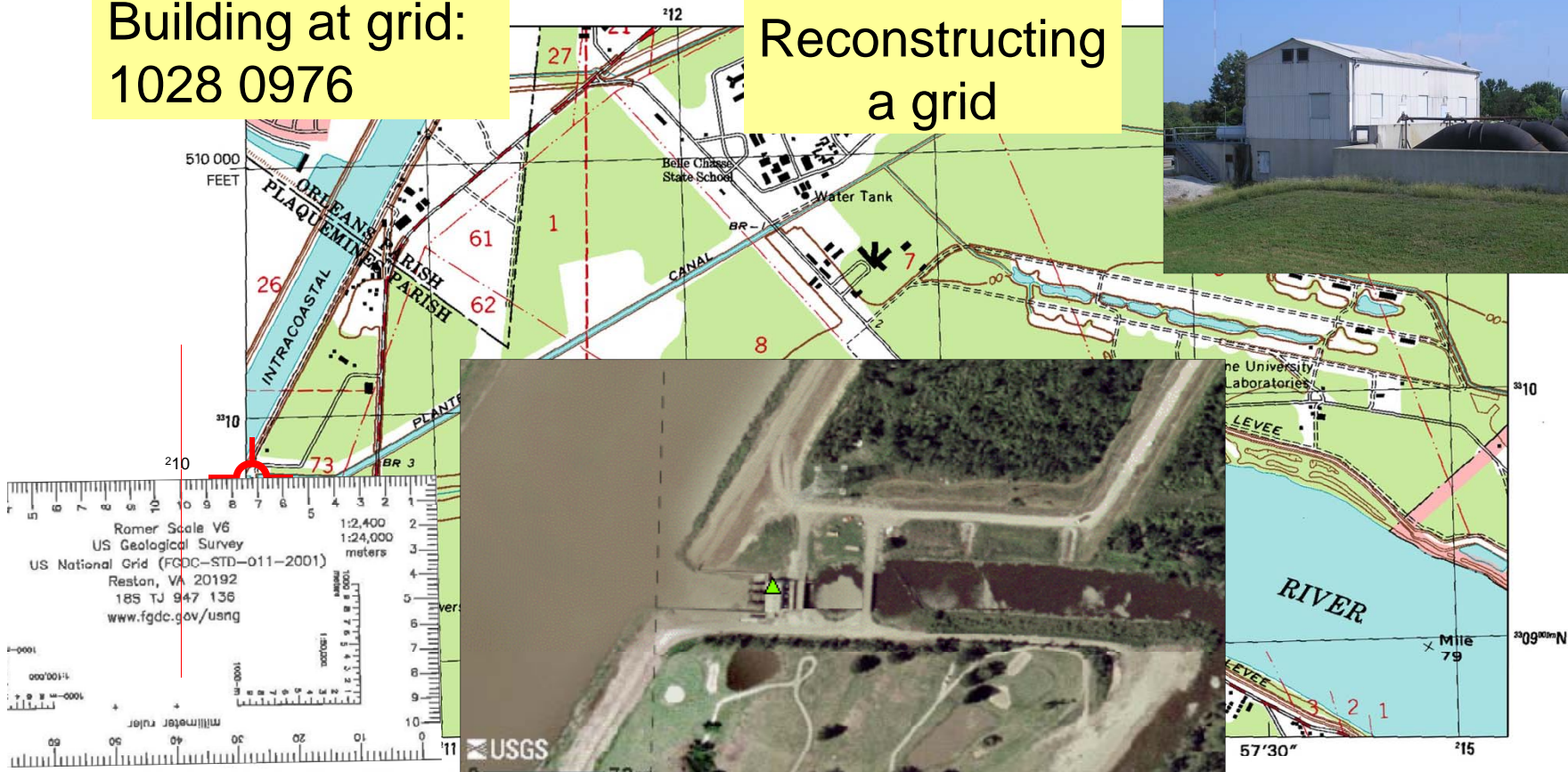
U.S. National Grid
100,000-m Square ID
BU
Grid Zone Designation
16R



US National Grid Training Map

Building at grid:
1028 0976

Reconstructing
a grid

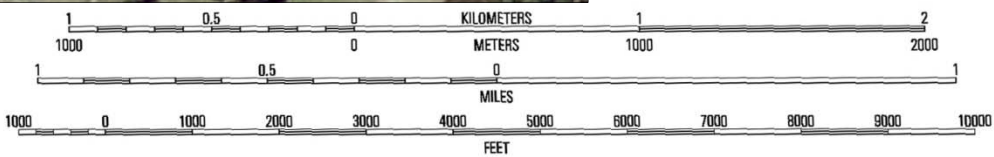


Produced by the United States Geological Survey
Topography compiled 1964. Planimetry derived from imagery taken 1998 and other sources. Public Land Survey System and survey control current as of 1967

North American Datum of 1983 (NAD 83). Projection and 1 000-meter grid: Universal Transverse Mercator, zone 16
10 000-foot ticks: Louisiana Coordinate System of 1983 (south zone)

North American Datum of 1927 (NAD 27) is shown by dashed corner ticks. The values of the shift between NAD 83 and NAD 27 for 7.5-minute intersections are obtainable from National Geodetic Survey NADCON software

There may be private inholdings within the boundaries of the National or State reservations shown on this map
City of New Orleans and Orleans Parish are coextensive
This quadrangle covers a subsidence area
Landmark buildings verified 1967

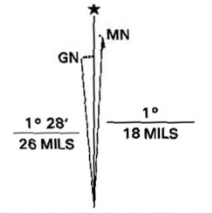


1	2	3	1 Spanish Fort
			2 Little Woods
			3 Chef Menteur
4		5	4 New Orleans East
			5 Martello Castle
			6 Bertrandoville
6	7	8	7 Belle Chasse
			8 Delacroix

ADJOINING 7.5' QUADRANGLE NAMES
LA 200A

CONTOUR INTERVAL 5 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929
TO CONVERT FROM FEET TO METERS, MULTIPLY BY 0.3048

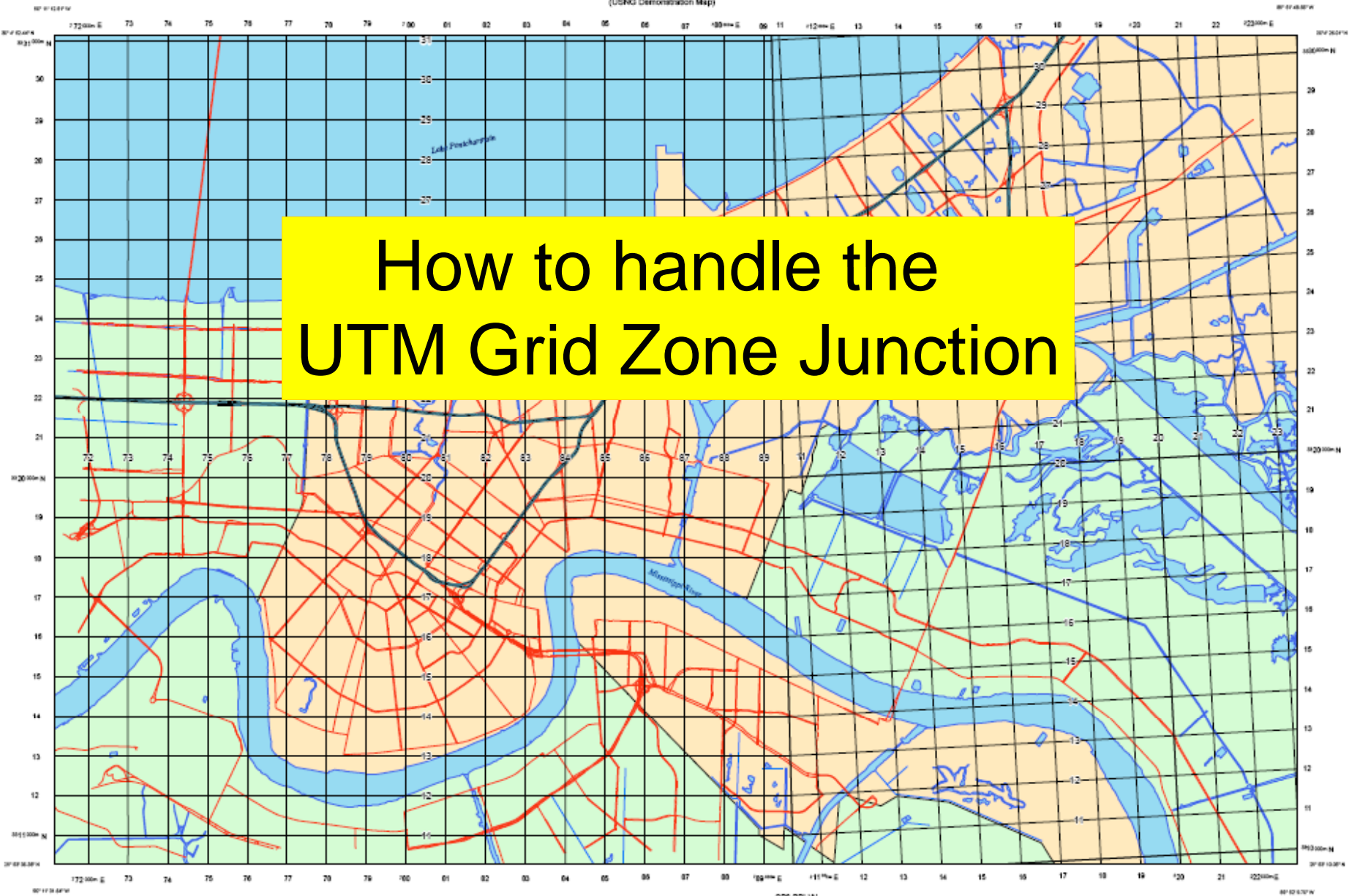
U.S. National Grid
100,000-m Square ID
BU
Grid Zone Designation
16R



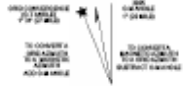
UTM GRID AND 2000 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

Ex 8

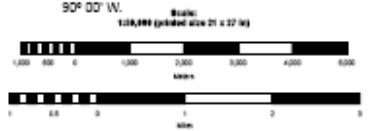
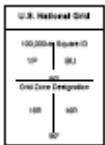
NEW ORLEANS, LA
(USNG Demonstration Map)



How to handle the
UTM Grid Zone Junction



USNG DEMONSTRATION MAP
MERCATOR PROJECTION
SCALE: 1:50,000
EASTING: 172000-223000
NORTHING: 101000-103000

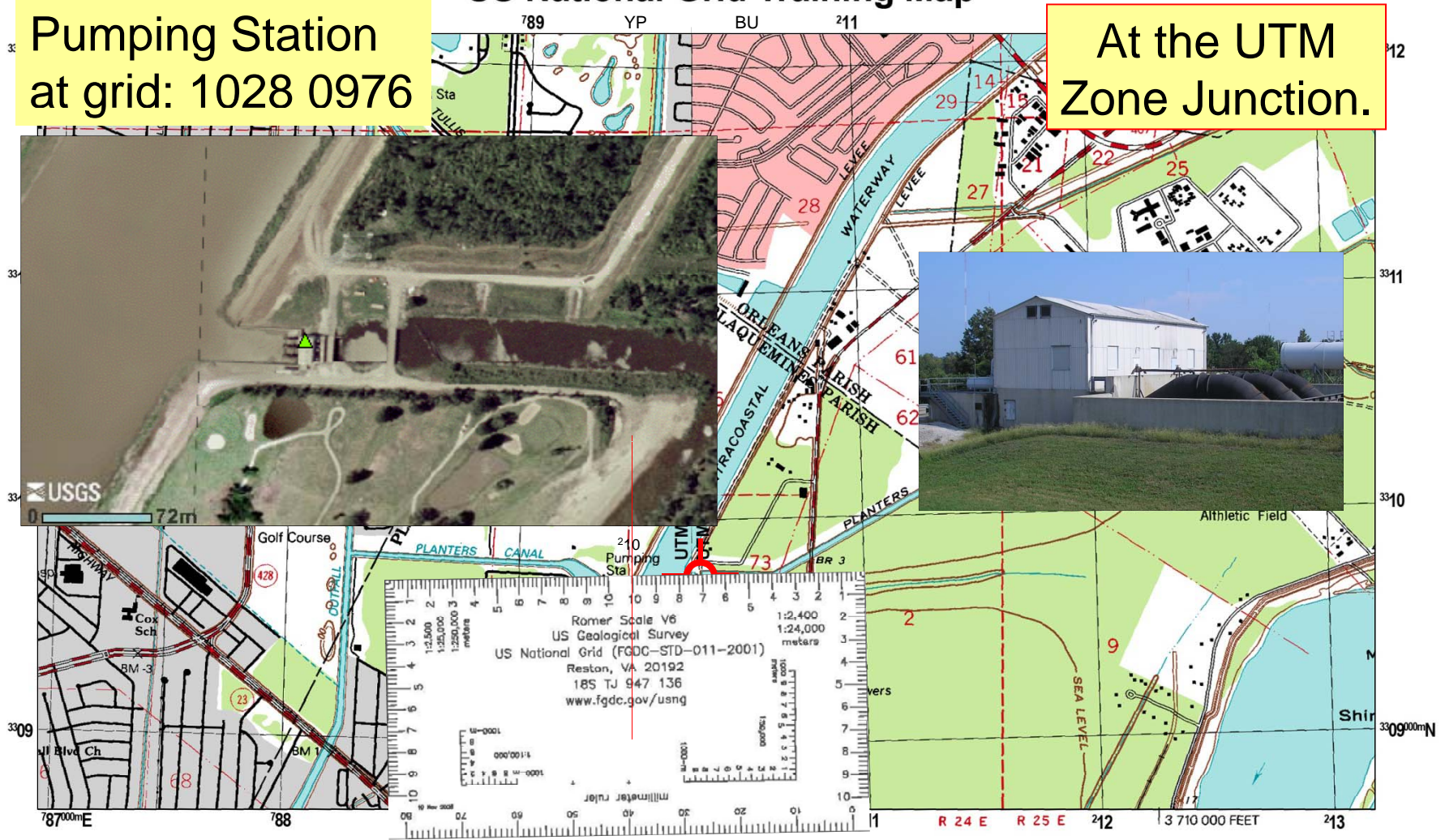


ROAD DATA COURTESY BY (2016) MAPS
SOURCE: NOAA/USNG, ET/USNG, WGS

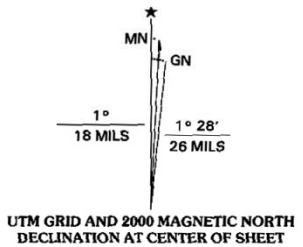
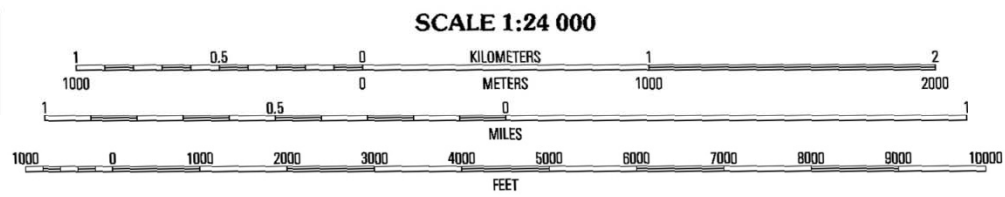
US National Grid Training Map

Pumping Station
at grid: 1028 0976

At the UTM
Zone Junction.



Romer Scale V6
US Geological Survey
US National Grid (FGDC-STD-011-2001)
Reston, VA 20192
185 TJ 947 136
www.fgdc.gov/usng



U.S. National Grid	
100,000-m Square ID	
90°	90°
YP	BU
Grid Zone Designation	
15R	16R
90°	

