Application of LA-QUAL in the Lower Rio Grande/Río Bravo Water Quality Initiative

The Virtue of Simplicity in Binational Water Quality Modeling

November 18, 2013

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Texas Commission on Environmental Quality
Austin, Texas

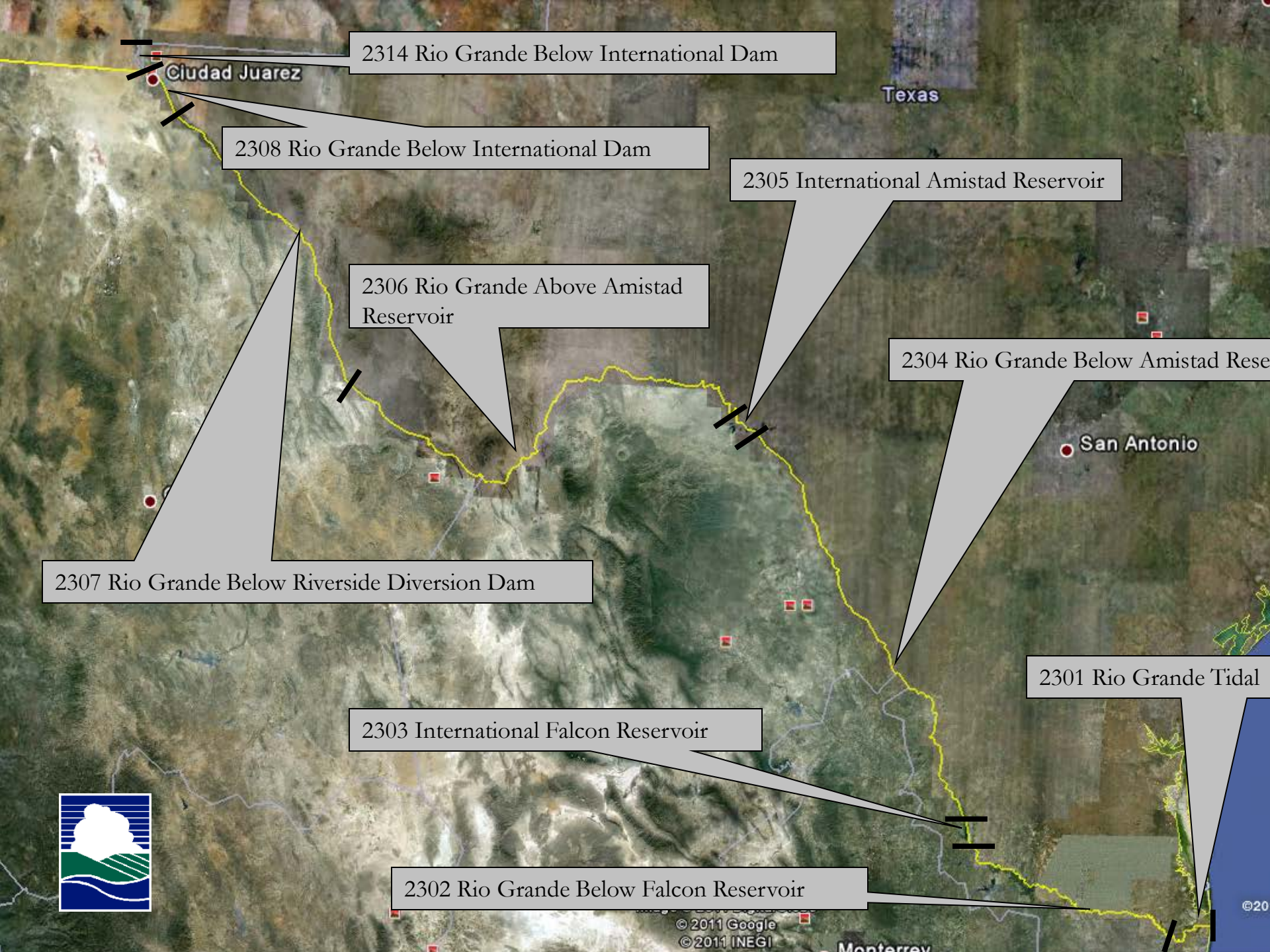
TCEQ

The Lower Rio Grande/Río Bravo Water Quality Initiative

*Binational effort to restore and protect water quality in the Lower Rio Grande/Río Bravo

*Conducted under the auspices of the International Boundary and Water Commission (IBWC)

*Six agencies involved, two US federal agencies (IBWC, USEPA) and the TCEQ, two Mexican federal agencies (CONAGUA, CILA) and CEAT


2314 Rio Grande Below International Dam
Ciudad Juarez
Texas
2308 Rio Grande Below International Dam
2305 International Amistad Reservoir
2306 Rio Grande Above Amistad Reservoir
2304 Rio Grande Below Amistad Rese
San Antonio
2307 Rio Grande Below Riverside Diversion Dam
2301 Rio Grande Tidal
2303 International Falcon Reservoir
2302 Rio Grande Below Falcon Reservoir
© 2011 Google
© 2011 INEGI
Monterrey

Impairments

Segment Number	Segment Description	Impairment	Year Listed
2302	Rio Grande Below Falcon Reservoir	Bacteria	1996
2304	Rio Grande Below Amistad Reservoir	Bacteria	1996
2306	Rio Grande Above Amistad Reservoir	Chloride, Sulfate, TDS	2010
2307	Rio Grande Below Riverside Dam	Bacteria, Chloride, TDS	2002, 1996
2314	Rio Grande Above International Dam	Bacteria	2002

Concerns

Segment Number	Segment Description	Concerns
2301	Rio Grande Tidal	Bacteria Chlorophyll a
2302	Rio Grande below Falcon Res.	Ammonia Bacteria Chlorophyll a Diss .Oxygen Mercury in Fish
2303	International Falcon Res.	Ammonia Nitrate Total and orthophos.
2304	Rio Grande Below Amistad Res.	Toxicity in Water
2305	International Amistad Res.	Nitrate
2306	Rio Grande Above Amistad Res.	Chlorophyll a Total phosphorus Fish Kills
2307	Rio Grande Below Riverside Diversion Dam	Ammonia Bacteria Chlorophyll a Diss .Oxygen Nitrate Total and orthophos.
2314	Rio Grande Above International Dam	Chlorophyll a

Impairments

Segment Number	Segment Description	Impairment	Year Listed
2302	Rio Grande Below Falcon Reservoir	Bacteria	1996
2304	Rio Grande Below Amistad Reservoir	Bacteria	1996
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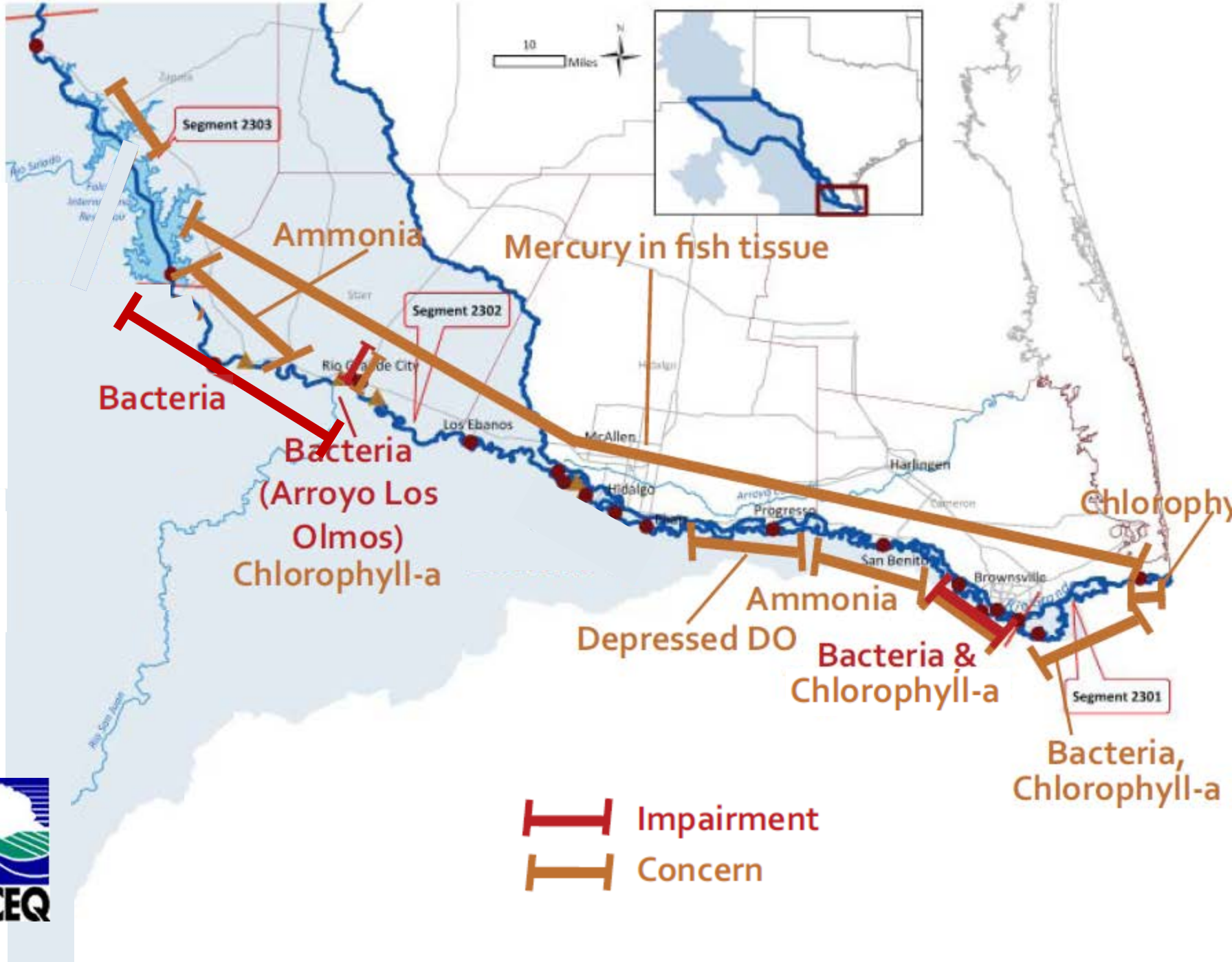
2307	Rio Grande Below Riverside Dam	Bacteria, Chloride, TDS	2002, 1996
2314	Rio Grande Above International Dam	Bacteria	2002


10
Miles
N
Segment 2303
Ammonia
Mercury in fish tissue
Segment 2302
Rio Grande City
Bacteria
Los Ebanos
Bacteria
(Arroyo Los
Olmos)
Chlorophyll-a
McAllen
Hidalgo
Harlingen
Progresso
San Benito
Brownsville
Chlorophy
Ammonia
Depressed DO
Bacteria &
Chlorophyll-a
Segment 2301
Bacteria,
Chlorophyll-a
Impairment
Concern

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TCEQ

Sporadic But Chronic Problems with Total Dissolved Solids

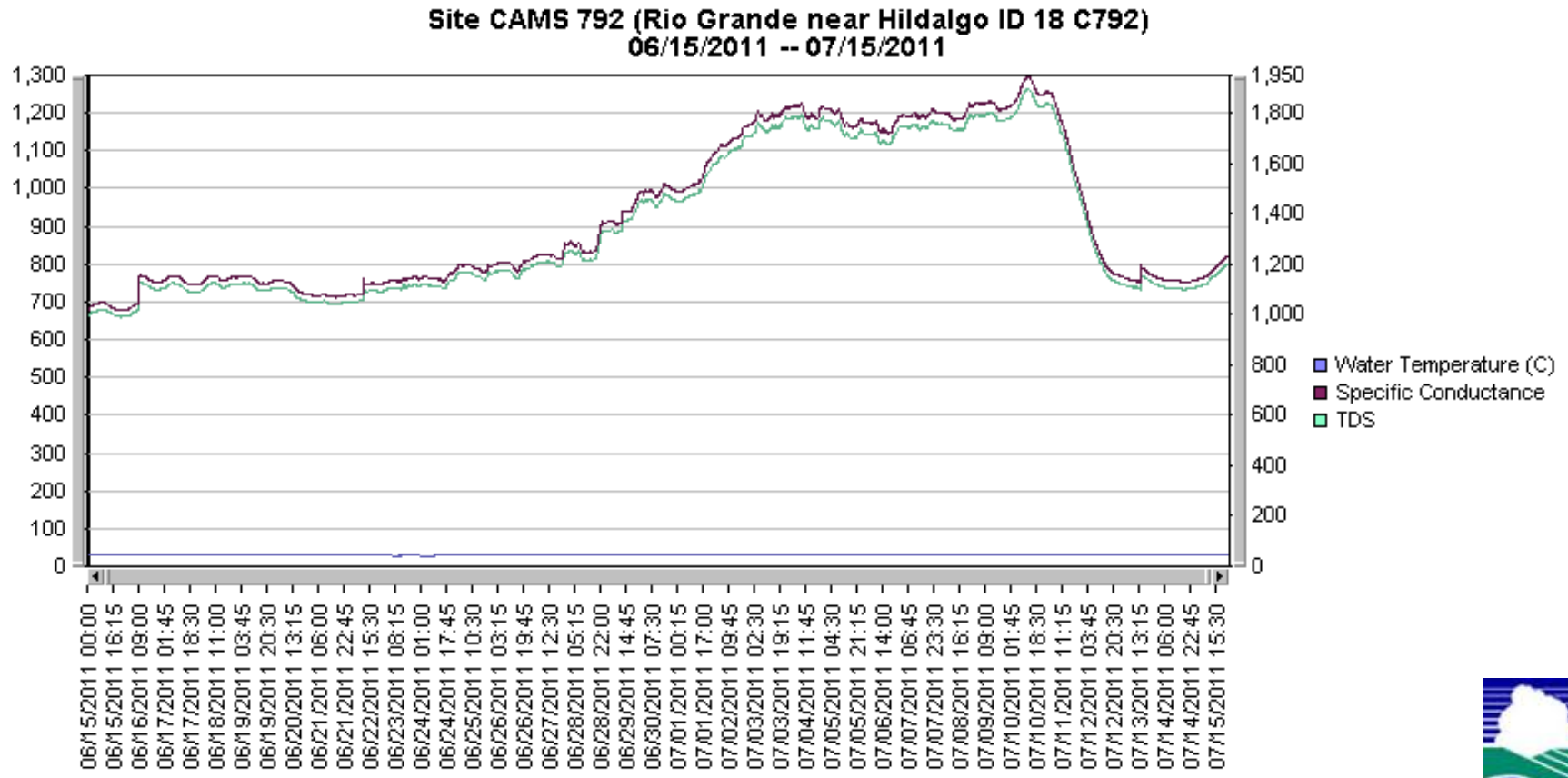


Chart Options: ☑ Three Dimensional Plot ☐ Vertical Grid Lines

TCEQ

Why Segments 2301 and 2302, Rio Grande Below Falcon Reservoir?

* Segment size/watershed size (smaller) than other RG Segments
* Data availability (more available data)
* Higher beneficial water use relative to watershed size
* Potential impact of bacteria impairment (high)
    * Contact recreation
    * Public water supply
    * Agricultural Irrigation
* Concurrence from Mexico (Reynosa 2008)
* "Pilot" Project: Lessons learned and technical approaches to be applied to other impaired segments of the Rio Grande

TCEQ

TCEQ Proposal in 2011

* TCEQ proposal to EPA and IBWC (3/30/11)
  * Focus on watershed-based plan development for Lower Rio Grande Below Falcon Reservoir
  * Detailed outline based on WBP (nine) elements
  * Phased approach (two components)
    * Short-term Performance Based (2-3 yrs)
    * Long-term Comprehensive
  * Suggestion that:
    * Analysis be legitimized by IBWC Joint Engineers Rpt. and
    * Agreements be Institutionalized by Treaty Minute

Why LA-QUAL?

*Ideal for short-term, performance based phase

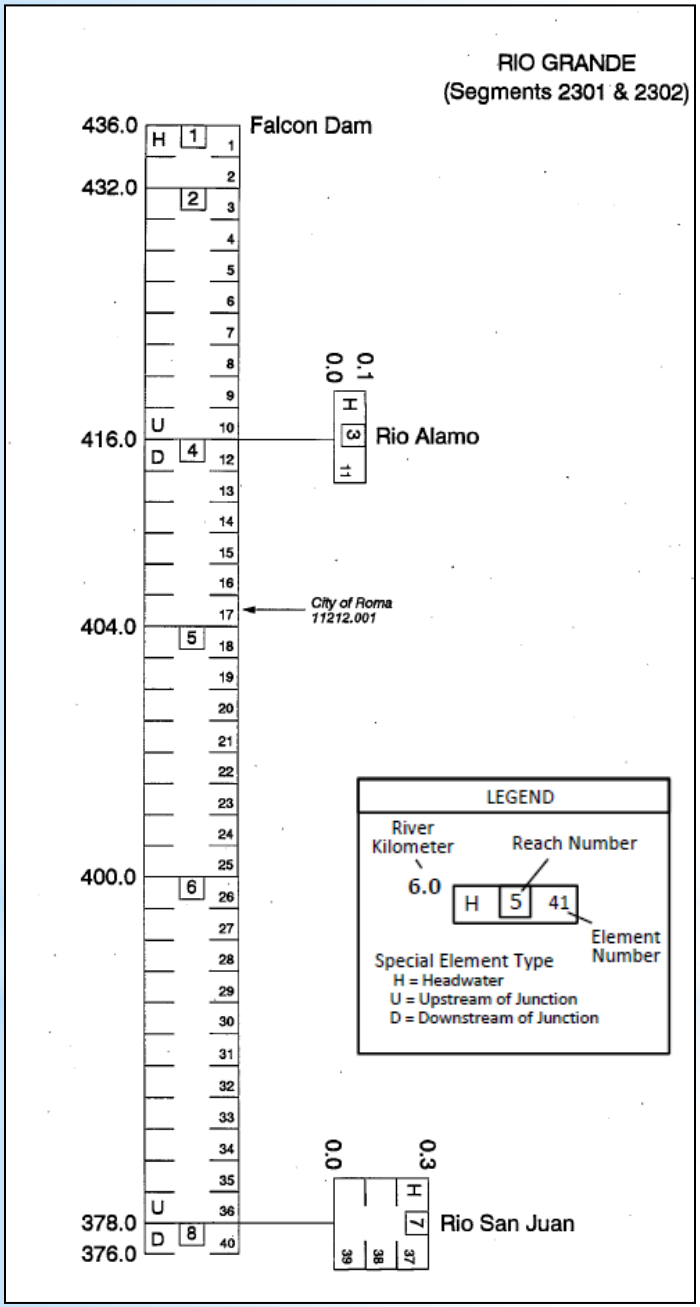
  *Mexico has not yet promulgated stormwater regulations ("let's not try to eat the cake in one bite")

  *Impairments manifest themselves at low flow conditions

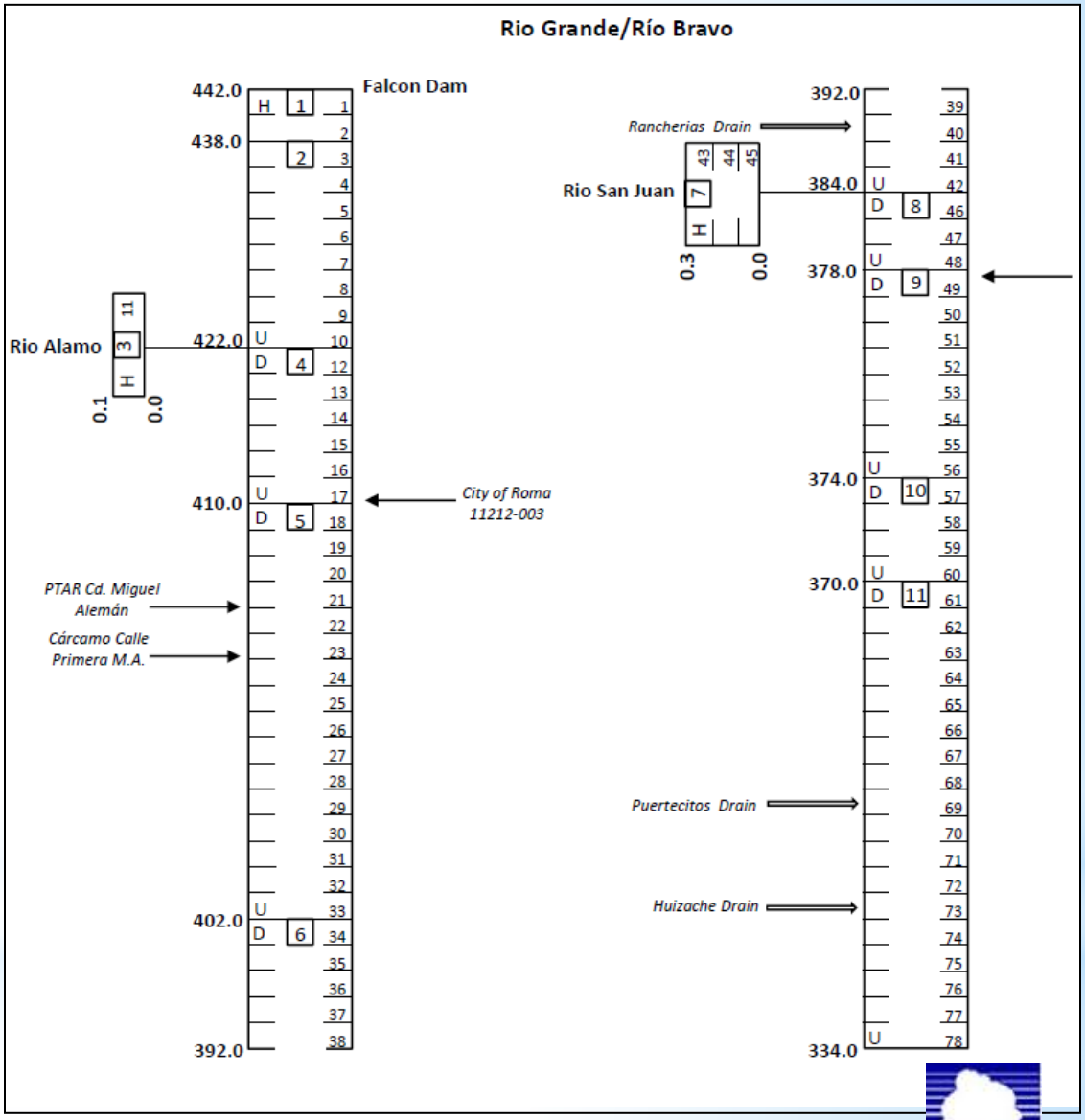
*<u>Simplicity of setup, calibration and operation</u>

*Similarity with QUAL-TX is appealing

1994


RIO GRANDE
(Segments 2301 & 2302)
Falcon Dam
Rio Alamo
City of Roma
11212.001
Rio San Juan
LEGEND
River Kilometer
Reach Number
Element Number
Special Element Type
H = Headwater
U = Upstream of Junction
D = Downstream of Junction

2013


Rio Grande/Río Bravo
Falcon Dam
Rio Alamo
City of Roma
11212-003
PTAR Cd. Miguel Alemán
Cárcamo Calle Primera M.A.
Rancherias Drain
Rio San Juan
Puertecitos Drain
Huizache Drain

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HC&CCID #9

C793

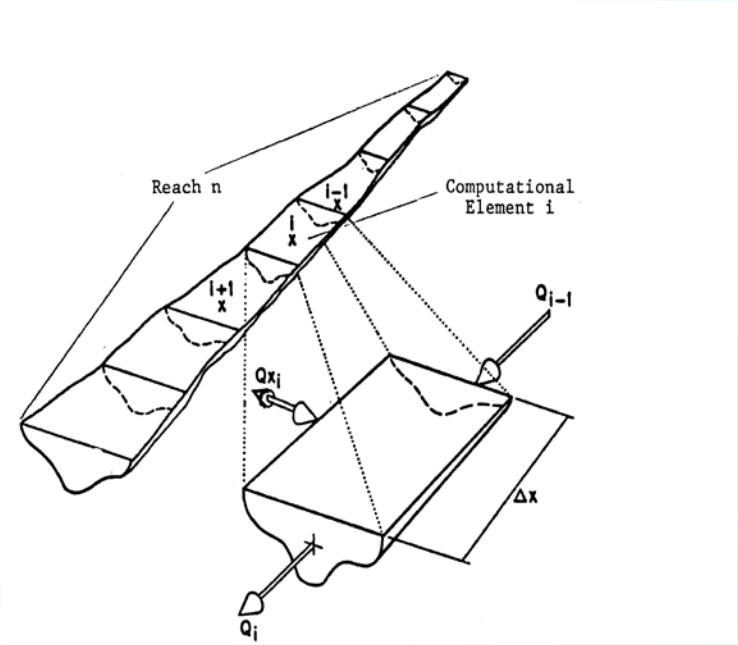
TCEQ

LA-QUAL Background

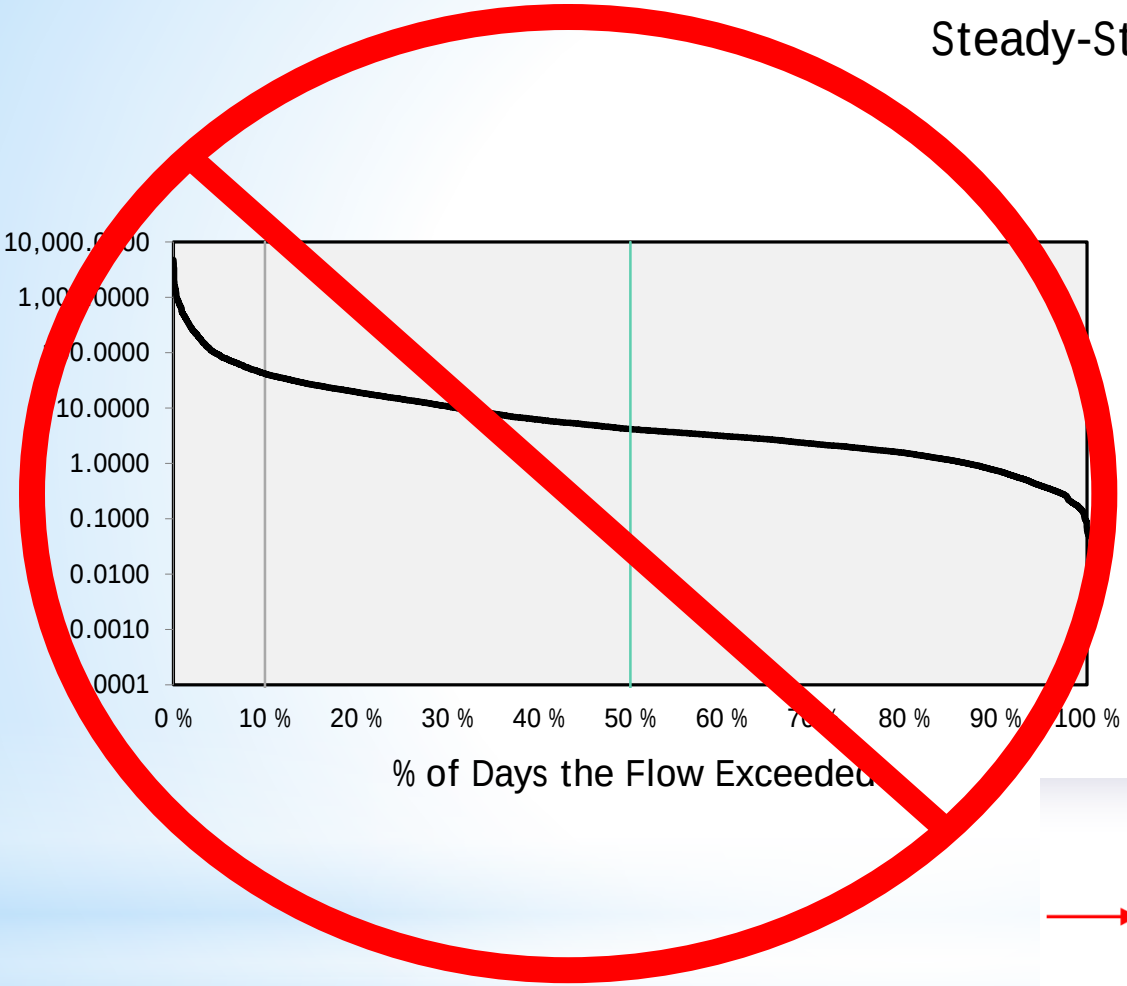
- Developed Louisiana DEQ
- Based Largely on the QUAL-TX model
- Key modifications:
  - Windows graphical interface with sensitivity analysis
  - Allows hydraulics to be based on width/depth as well as velocity/depth
  - Updates to various equations
  - Addition of LA-specific reaeration equations
- Available from LADEQ web site

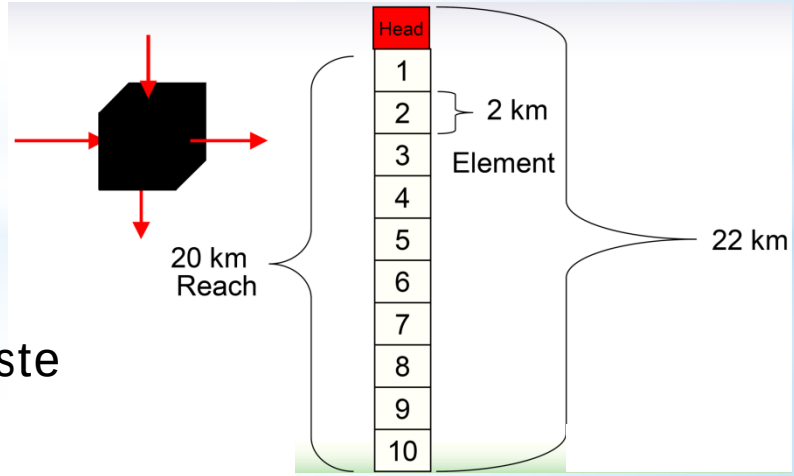
www.deq.louisiana.gov/portal/tabid/130/Default.aspx

One - Dimensional



Steady-State





200 reaches, 100 headwaters, 300 waste loads, and 3000 elements

Capabilities

* Headwater flows, branching tributaries, waste loads (point sources), incremental uniform lateral inflows and/or mass loads (nonpoint sources)
* Transport is by advection and dispersion
* Can disperse with downstream boundary
* Can simulate temperature
* Can simulate transport of most common pollutants
  * First order kinetics $[C]/[C_0] = \exp(-kt)$
  * Temperature corrected $\theta = [K_T = K_{20}{}^{(t-20)}]$
* Simulation of nutrient and algal productivity

Water Quality Constituents

*DO-BOD

  *BOD1, BOD2, NBOD

*Nutrients, Algae

  *Phytoplankton and Periphyton

*Conservatives (e.g., Chlorides, TDS, etc.)

*Non-conservatives

*Coliforms

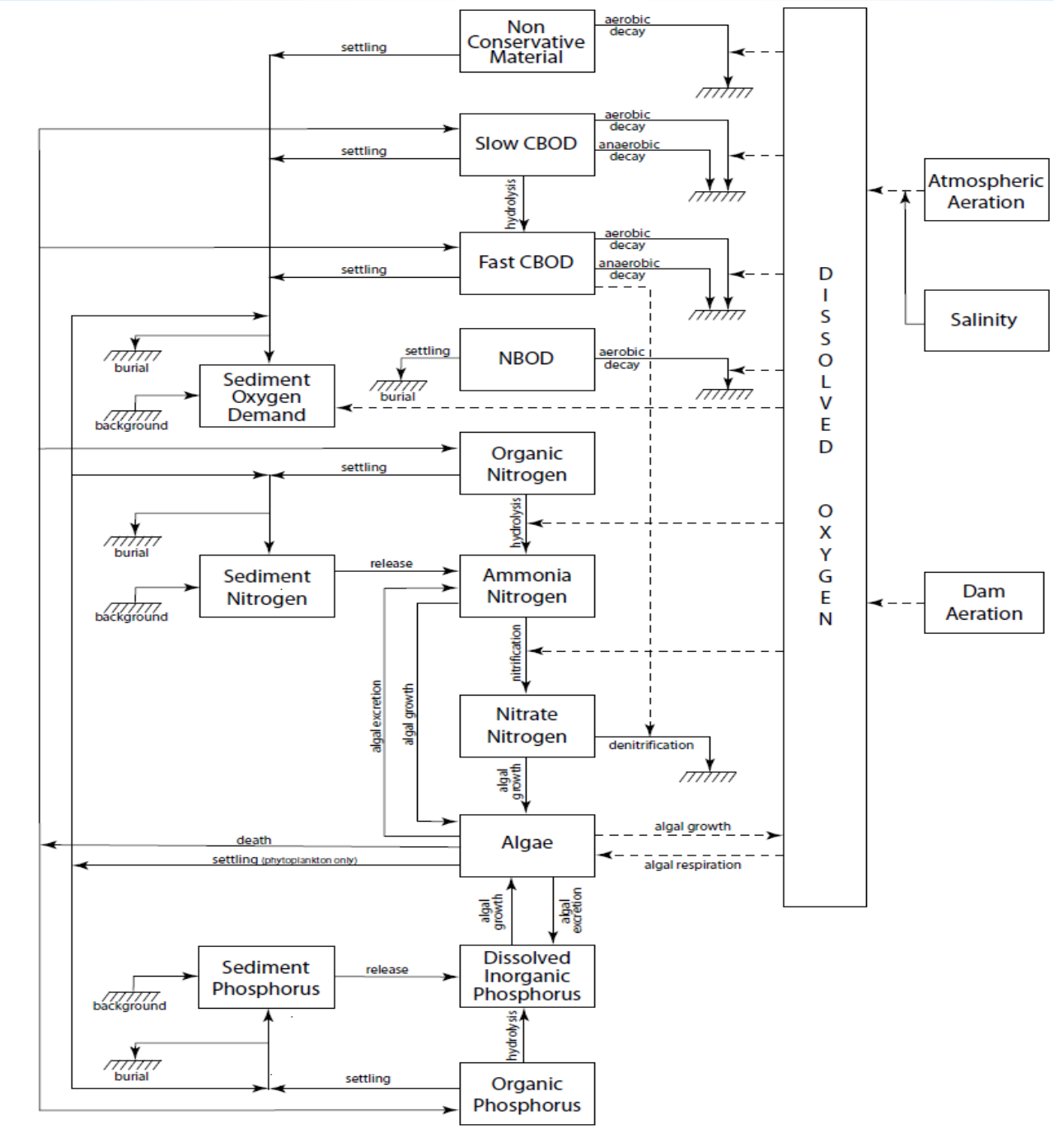
Over 20 Different Reaeration Equations

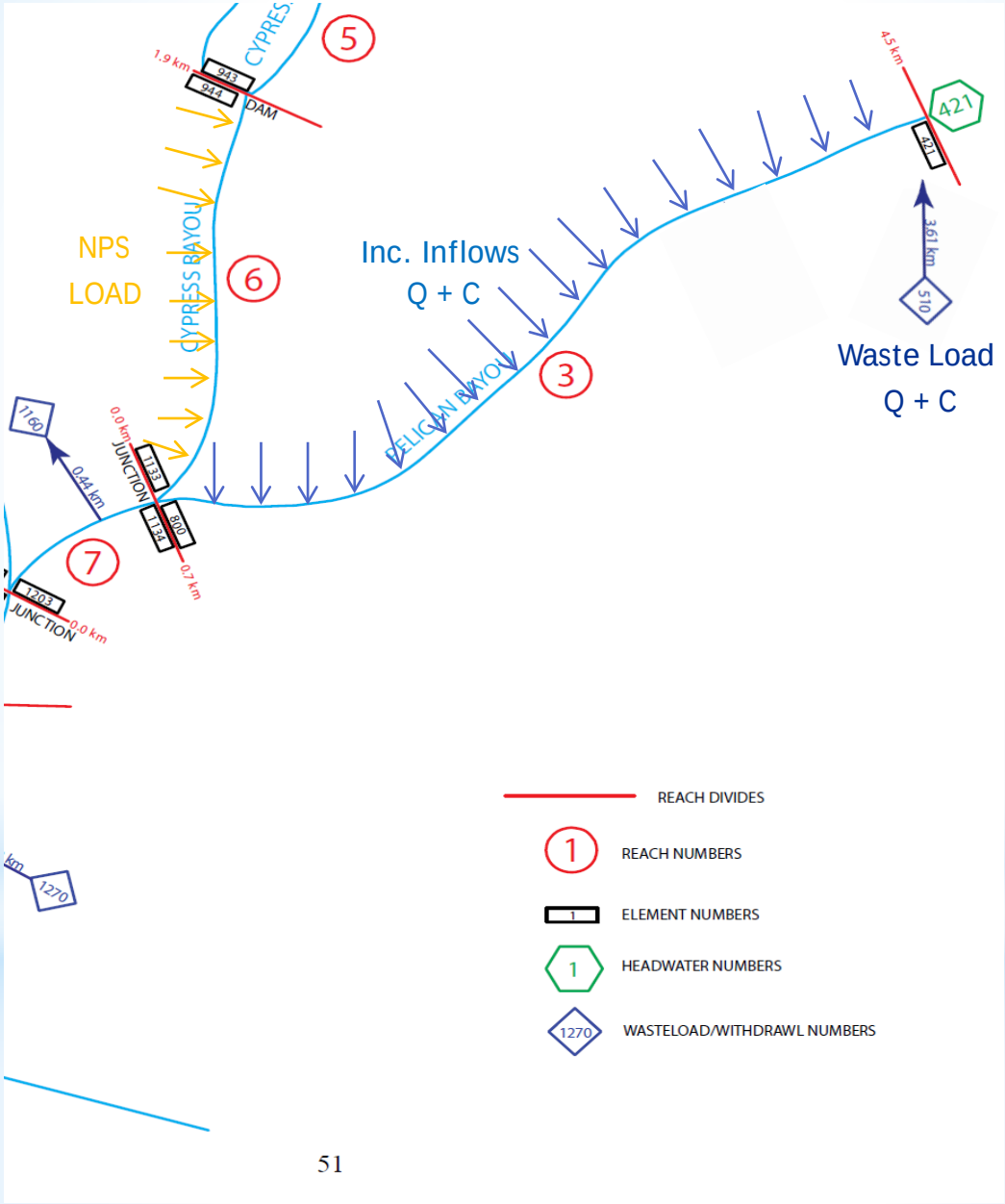
Option	Method	Equation (metric units)
1	Use equation $K_2 = a$	
2	Churchill-Elmore-Buckingham (1962)	$K_2 = \frac{5.026\ V^{0.969}}{D^{1.673}}$
3	O'Connor-Dobbins (1958)	$K_2 = \frac{3.932\ V^{0.500}}{D^{1.500}}$
4	Owens-Edwards-Gibbs <5.0 fps (1964)	$K_2 = \frac{6.932\ V^{0.670}}{D^{1.850}}$
5	Thackston-Krenkel (1966)	$K_2 = \frac{24.9\ (1+F^{0.5})\ U}{D}$ where $F=\frac{0.319\ V}{D^{0.5}}$ and $U=\frac{4.654\ V\ n}{D^{0.167}}$
6	Langien-Durum (1967)	$K_2 = \frac{5.135\ V^{1.000}}{D^{1.330}}$
7	Use equation $K_2 = a\ Q^{b}$	
8	Use equation $K_2 = a\ 86400\ V\ S$	
9	Use equation $K_2 = \frac{a\ V^{b}}{D^{c}}$	
10	Use equation $K_2 = \frac{a + b\ W^{c}}{D}$	
11	Texas Equation (1982)	$K_2 = \frac{1.923\ V^{0.273}}{D^{0.894}}$
12	Banks (1975)	$K_2 = \frac{0.362\ W^{0.5}}{D}$
13	Johanson (1977)	$K_2 = \frac{0.479 + 0.081\ W^{2}}{D}$
14	Banks-Herrera (1977)	$K_2 = \frac{0.728\ W^{0.5} - 0.317\ W + 0.0372\ W^{2}}{D}$
15	Louisiana Equation (1995)	$K_2 = \frac{0.664\ (1 + 21.52\ V)}{D}$
16	Bennett-Rathbun (1972)	$K_2 = \frac{5.585\ V^{0.607}}{D^{1.689}}$
17	Isaacs-Gaudy (1968)	$K_2 = \frac{4.759\ V^{1.000}}{D^{1.500}}$
18	Tsvioglou-Neal (1972)	$K_2 = 31182.6\ V\ S$ for $Q < 0.283\ m^3/s$ $K_2 = 15307.8\ V\ S$ for $Q > 0.708\ m^3/s$
19	Owens-Edwards-Gibbs <1.8 fps (1964)	$K_2 = \frac{6.935\ V^{0.730}}{D^{1.750}}$
20	Use equation $K_2 = a / D$	
21	Yu (1977)	$K_2 = 0.319\ W/D$

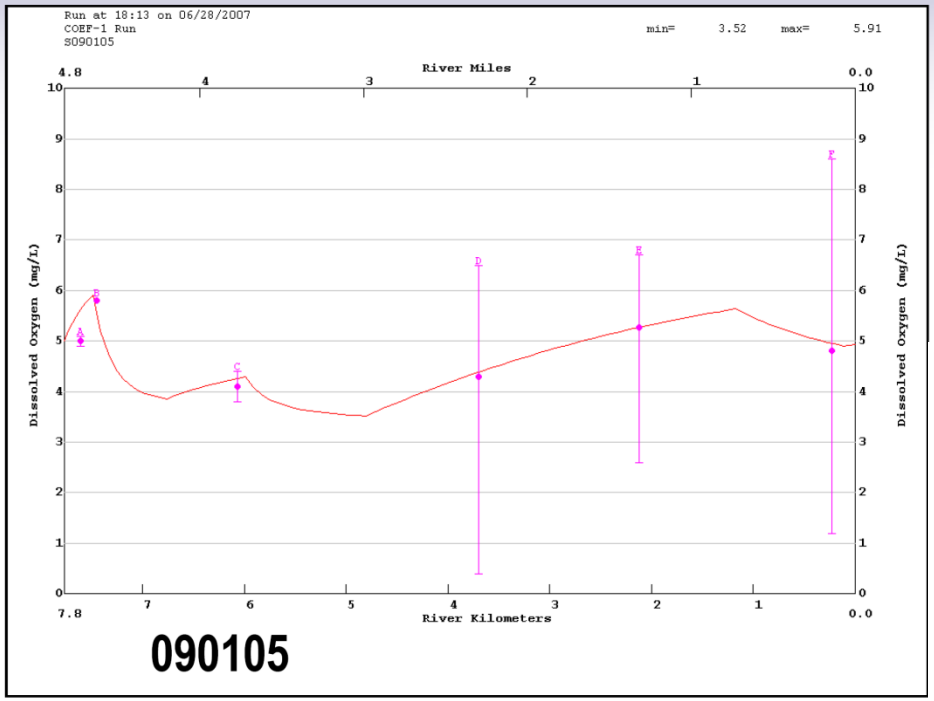
where:

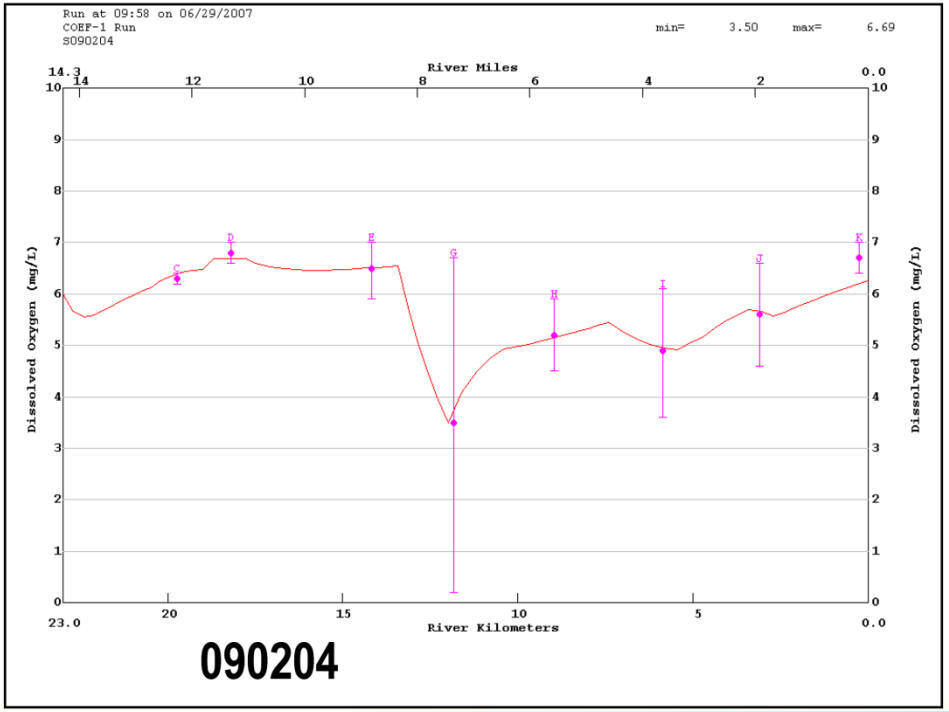
- K_2 = reaeration rate (1/day)
- Q = flow (m^3/s or ft^3/s)
- V = stream velocity (m/s or ft/s)
- D = depth (m or ft)
- S = slope (unitless, m/m or ft/ft)
- W = wind velocity (m/s) [input in Data Type 3 as km/hr]
- n = Manning's "n" as set in Data Type 9 (unitless)

TCEQ

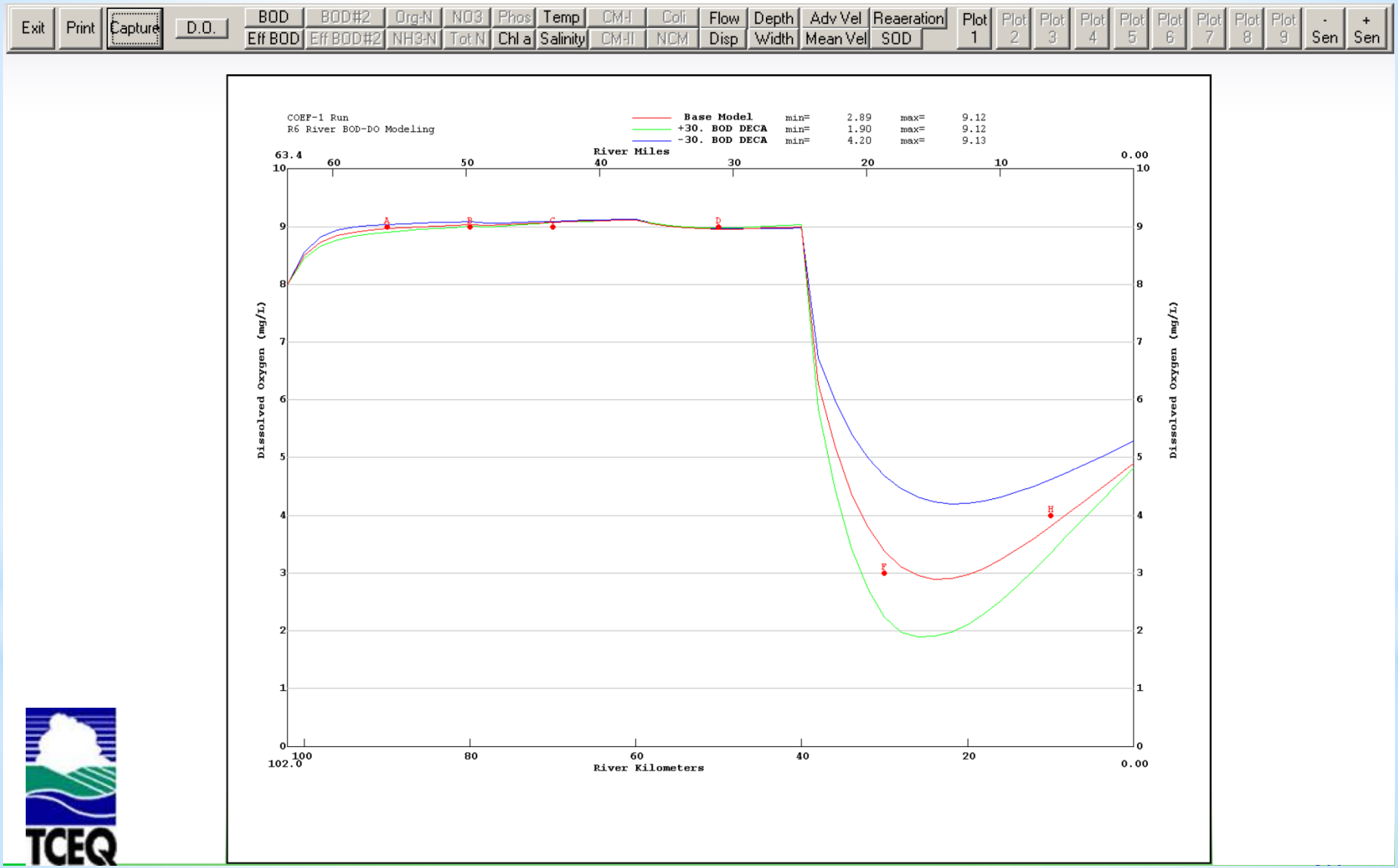

Non Conservative Material
aerobic decay
settling
Slow CBOD
aerobic decay
anaerobic decay
settling
hydrolysis
Fast CBOD
aerobic decay
anaerobic decay
settling
NBOD
aerobic decay
settling
burial
Sediment Oxygen Demand
burial
background
Organic Nitrogen
settling
hydrolysis
burial
Sediment Nitrogen
release
Ammonia Nitrogen
background
nitrification
algal excretion
algal growth
Nitrate Nitrogen
denitrification
algal growth
Algae
algal growth
death
settling (phytoplankton only)
algal respiration
algal growth
algal excretion
Sediment Phosphorus
release
Dissolved Inorganic Phosphorus
background
hydrolysis
burial
settling
Organic Phosphorus
DISSOLVED OXYGEN
Atmospheric Aeration
Salinity
Dam Aeration


CYPRES
5
1.9 km
943
944
DAM
NPS
LOAD
CYPRESS BAYOU
6
Inc. Inflows
Q + C
4.5 km
421
421
3.61 km
510
Waste Load
Q + C
3
PELICAN BAYOU
1160
0.44 km
0.0 km
JUNCTION
1133
1134
800
0.7 km
7
1203
JUNCTION
0.0 km
1270
REACH DIVIDES
REACH NUMBERS
ELEMENT NUMBERS
HEADWATER NUMBERS
WASTELOAD/WITHDRAWL NUMBERS

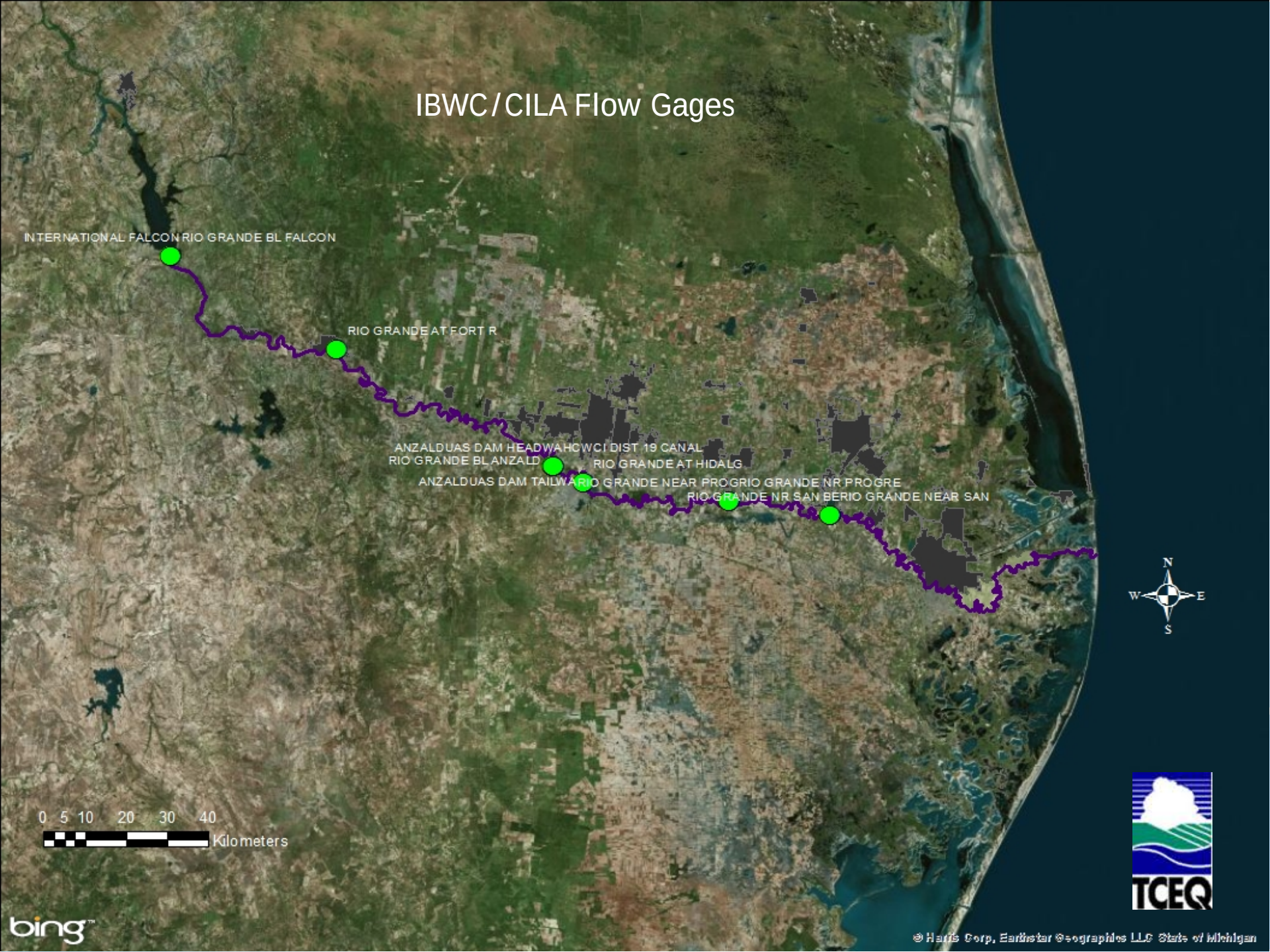

Run at 18:13 on 06/28/2007
COEF-1 Run
S090105
min= 3.52 max= 5.91
River Miles
4.8
0.0
Dissolved Oxygen (mg/L)
River Kilometers
7.8
0.0
090105


Run at 09:58 on 06/29/2007
COEF-1 Run
S090204
min= 3.50 max= 6.69
River Miles
14.3
0.0
Dissolved Oxygen (mg/L)
River Kilometers
23.0
0.0
090204

Sensitivity Analysis



IBWC/CILA Flow Gages



Irrigation Pumps and Diversions
0 5 10 20 30 40
Kilometers
TCEQ
N
W
E
S
bing
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UNITED STATES OF AMERICA
DEPARTMENT OF STATE

INTERNATIONAL BOUNDARY AND WATER COMMISSION
UNITED STATES AND MEXICO

WATER BULLETIN NUMBER 76

Flow of the Rio Grande

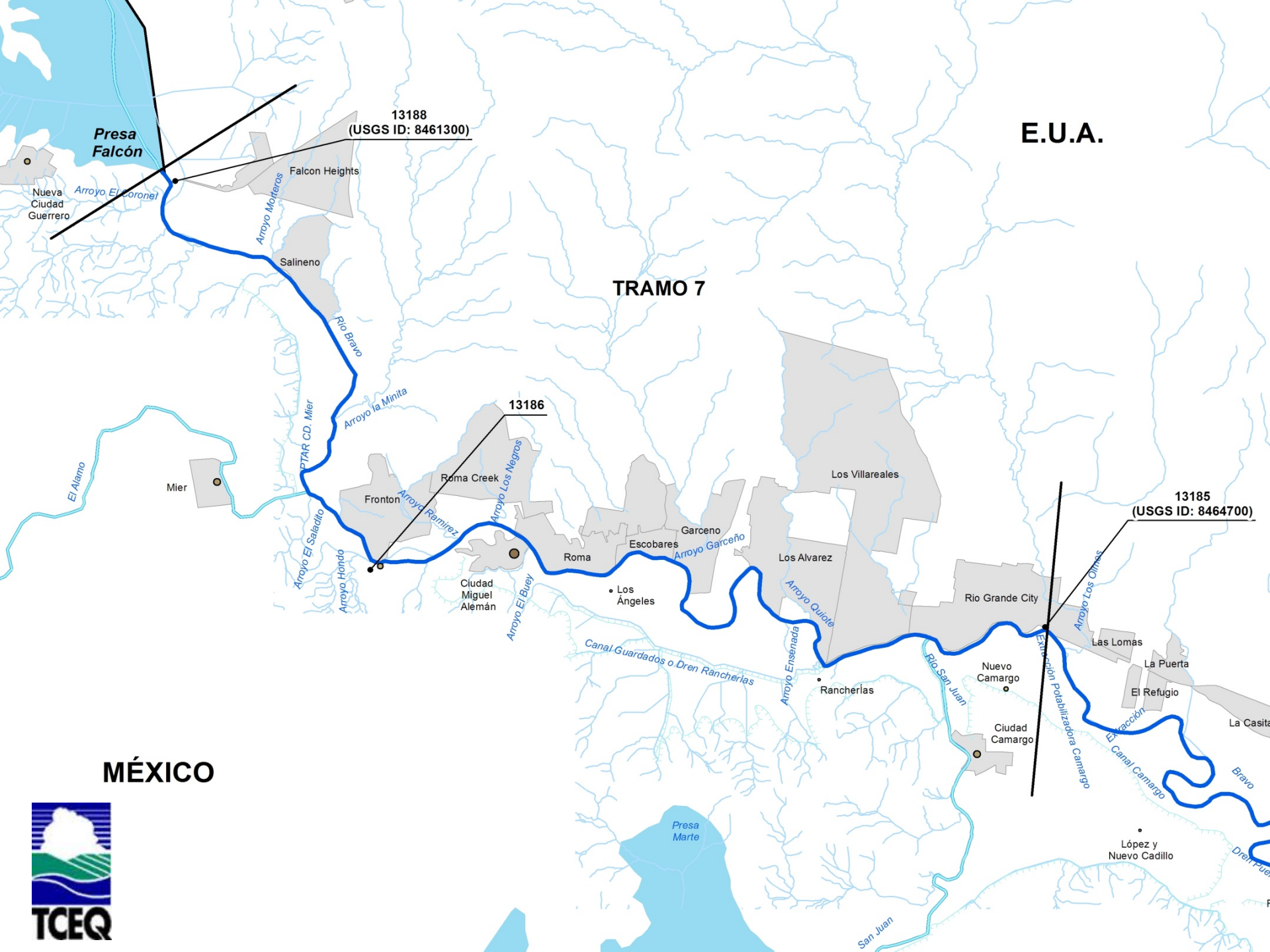
and

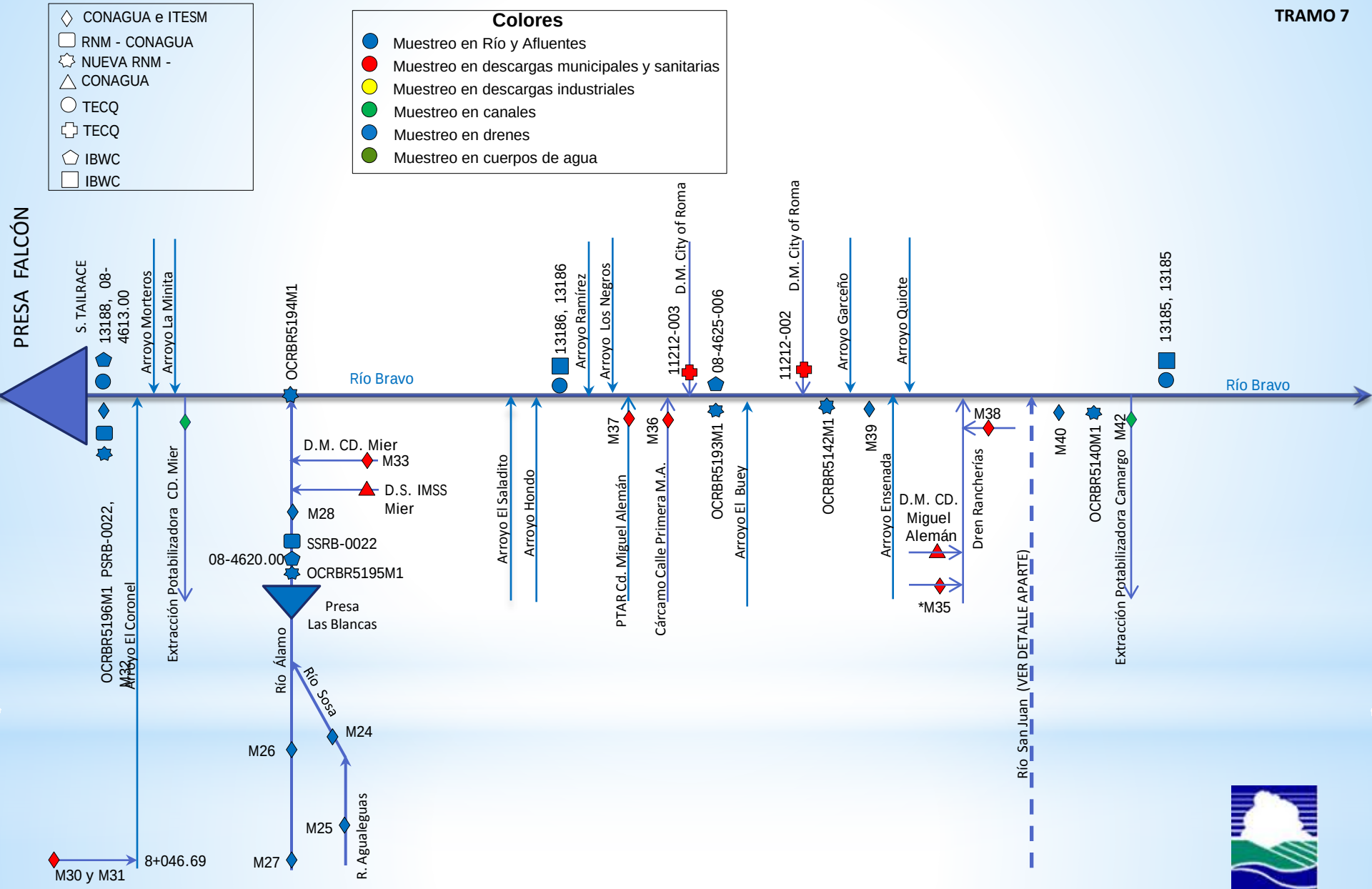
Related Data

From Elephant Butte Dam, New Mexico

to the Gulf of Mexico

2006


E.U.A.
MÉXICO
TRAMO 7
Presa Falcón
13188
(USGS ID: 8461300)
13186
13185
(USGS ID: 8464700)
Nueva Ciudad Guerrero
Arroyo El Coronel
Falcon Heights
Arroyo Molteros
Salineno
Rio Bravo
Arroyo la Minita
PTAR CD. Mier
El Alamo
Mier
Arroyo El Saladito
Arroyo Hondo
Fronton
Arroyo Ramirez
Roma Creek
Arroyo Los Negros
Ciudad Miguel Alemán
Arroyo El Buey
Roma
Escobares
Garceno
Arroyo Garceño
Los Ángeles
Canal Guardados o Dren Rancherías
Los Villareales
Los Alvarez
Arroyo Quiote
Arroyo Ensenada
Rancherías
Rio San Juan
Nuevo Camargo
Ciudad Camargo
Rio Grande City
Arroyo Los Olmos
Las Lomas
La Puerta
El Refugio
La Casita
Extracción Potabilizadora Camargo
El Canal Camargo
Bravo
López y Nuevo Cadillo
Presa Marte
San Juan


TRAMO 7
CONAGUA e ITESM
RNM - CONAGUA
NUEVA RNM - CONAGUA
TECQ
TECQ
IBWC
IBWC
Colores
Muestreo en Río y Afluentes
Muestreo en descargas municipales y sanitarias
Muestreo en descargas industriales
Muestreo en canales
Muestreo en drenes
Muestreo en cuerpos de agua
PRESA FALCÓN
S. TAILRACE
13188, 08-4613.00
Arroyo Morteros
Arroyo La Minita
OCRBR5194M1
Río Bravo
13186, 13186
Arroyo Ramírez
Arroyo Los Negros
11212-003
D.M. City of Roma
08-4625-006
11212-002
D.M. City of Roma
Arroyo Garceño
Arroyo Quiote
13185, 13185
Río Bravo
OCRBR5196M1 PSRB-0022, M32
Arroyo El Coronel
Extracción Potabilizadora CD. Mier
D.M. CD. Mier
M33
D.S. IMSS Mier
M28
SSRB-0022
08-4620.00
OCRBR5195M1
Presa Las Blancas
Río Álamo
Río Sosa
M24
M26
M25
M27
R. Agualeguas
M30 y M31
8+046.69
Arroyo El Saladito
Arroyo Hondo
M37
PTAR Cd. Miguel Alemán
M36
Cárcamo Calle Primera M.A.
OCRBR5193M1
Arroyo El Buey
OCRBR5142M1
M39
Arroyo Ensenada
D.M. CD. Miguel Alemán
*M35
M38
Dren Rancherías
Río San Juan (VER DETALLE APARTE)
M40
OCRBR5140M1
M42
Extracción Potabilizadora Camargo
TCEQ

HYDRAULIC CONSTANTS AND COEFFICIENTS

Mathematical relationships (power equations) between flow (discharge), stage(depth), surface width and stream velocity.

Method 1

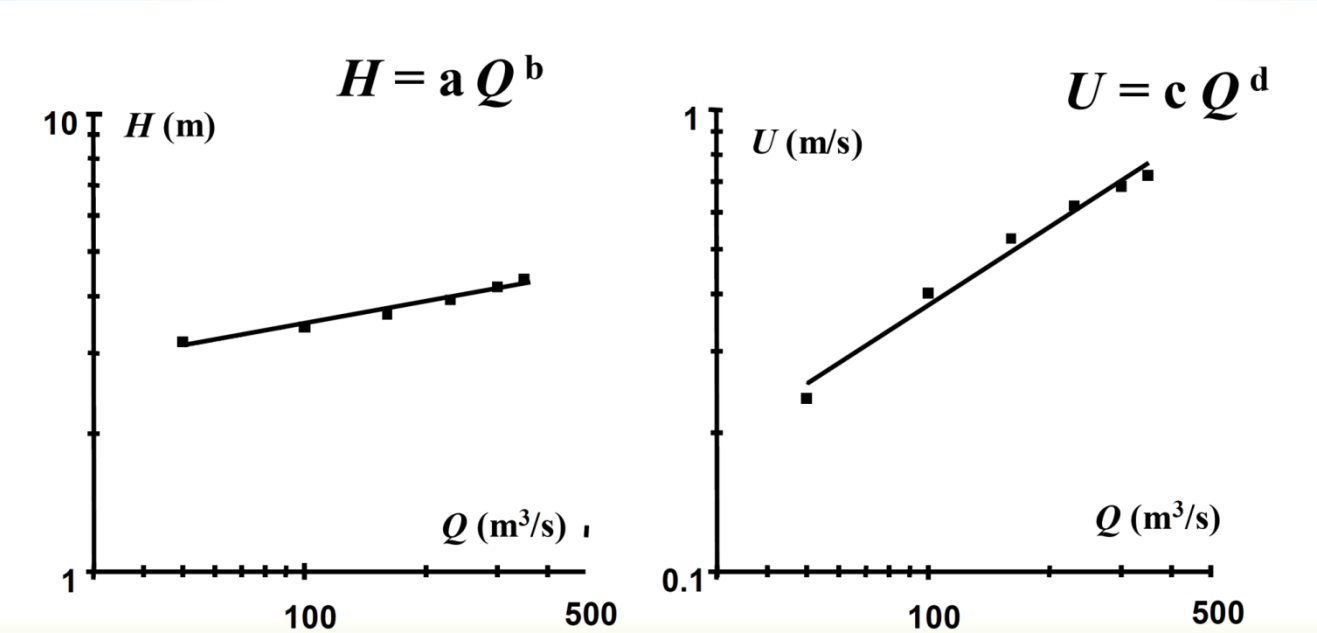
Velocity $V = aQ^b$

Depth $D = dQ^e+f$

Method 2

Width $W = aQ^b+C$

Depth $D = dQ^e+f$



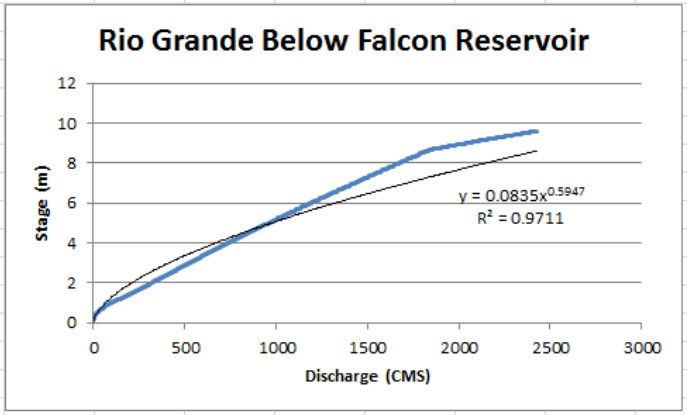
StageDischargeEquationsFromRatingTables20130611.xlsx - Microsoft Excel

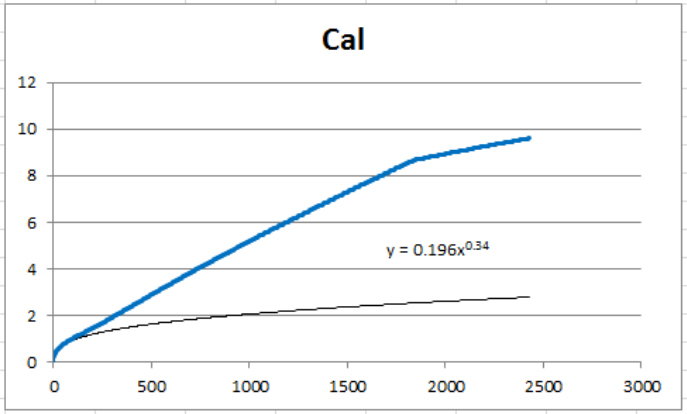
File | Home | Insert | Page Layout | Formulas | Data | Review | View | Acrobat

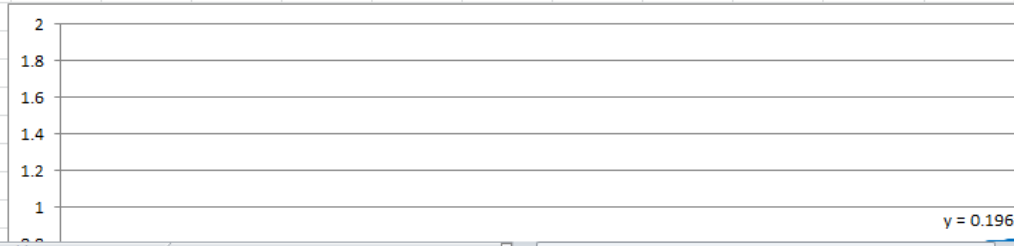
Normal | Page Layout | Page Break Preview | Custom Views | Full Screen | Workbook Views
Ruler | Formula Bar | Gridlines | Headings | Show
Zoom | 100% | Zoom to Selection | Zoom
New Window | Arrange All | Freeze Panes | Split | Hide | Unhide | View Side by Side | Synchronous Scrolling | Reset Window Position | Save Workspace | Switch Windows | Window
Macros | Macros

A13 | 0.024

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	Original			Minus zeros and Normalized			Calibrated for better low flow fit												RIO GRANDE BELOW F	
2	Discharge (CMS)	Stage (m)		Discharge	Stage (m)		Discharge	Stage (m)											Date	Discharge
3	0	0.2		0.001	0.001		0.001	0.018756											1/1/1958	26.4
4	0.001	0.201		0.003	0.002		0.003	0.02725											1/2/1958	21.5
5	0.003	0.202		0.005	0.003		0.005	0.032418											1/3/1958	22.3
6	0.005	0.203		0.007	0.004		0.007	0.036348											1/4/1958	18.7
7	0.007	0.204		0.009	0.005		0.009	0.03959											1/5/1958	11.7
8	0.009	0.205		0.012	0.006		0.012	0.043658											1/6/1958	11.5
9	0.012	0.206		0.015	0.007		0.015	0.047099											1/7/1958	23.7
10	0.015	0.207		0.018	0.008		0.018	0.050111											1/8/1958	23.9
11	0.018	0.208		0.021	0.009		0.021	0.052808											1/9/1958	24
12	0.021	0.209		0.024	0.01		0.024	0.05526											1/10/1958	23.8
13	0.024	0.21		0.027	0.011		0.027	0.057518											1/11/1958	24.2
14	0.027	0.211		0.031	0.012		0.031	0.060284											1/12/1958	23.6
15	0.031	0.212		0.035	0.013		0.035	0.062824											1/13/1958	23.9
16	0.035	0.213		0.038	0.014		0.038	0.064605											1/14/1958	22.4
17	0.038	0.214		0.042	0.015		0.042	0.066842											1/15/1958	21.9
18	0.042	0.215		0.046	0.016		0.046	0.068941											1/16/1958	21.6
19	0.046	0.216		0.05	0.017		0.05	0.070924											1/17/1958	21.7
20	0.05	0.217		0.054	0.018		0.054	0.072804											1/18/1958	20.7
21	0.054	0.218		0.058	0.019		0.058	0.074595											1/19/1958	20.8
22	0.058	0.219		0.063	0.02		0.063	0.076722											1/20/1958	21.5
23	0.063	0.22		0.067	0.021		0.067	0.078344											1/21/1958	21.2
24	0.067	0.221		0.071	0.022		0.071	0.079904											1/22/1958	21.5
25	0.071	0.222		0.076	0.023		0.076	0.081775											1/23/1958	20.7
26	0.076	0.223		0.08	0.024		0.08	0.083213											1/24/1958	21
27	0.08	0.224		0.085	0.025		0.085	0.084946											1/25/1958	21.3
28	0.085	0.225		0.09	0.026		0.09	0.086613											1/26/1958	20.5
29	0.09	0.226		0.095	0.027		0.095	0.08822											1/27/1958	21.5
30	0.095	0.227		0.1	0.028		0.1	0.089772											1/28/1958	20.8
31	0.1	0.228		0.104	0.029		0.104	0.090977											1/29/1958	19.7
32	0.104	0.229		0.109	0.03		0.109	0.092441												
33	[illegible]	0.23		0.115	0.031		0.115	0.094141												
34		0.231		0.12	0.032		0.12	0.095513												
35		0.232		0.125	0.033		0.125	0.096848												
36		0.233		0.13	0.034		0.13	0.098148												
37		0.234		0.135	0.035		0.135	0.099416												
38		0.235		0.141	0.036		0.141	0.100896												
39		0.236		0.146	0.037		0.146	0.102099												



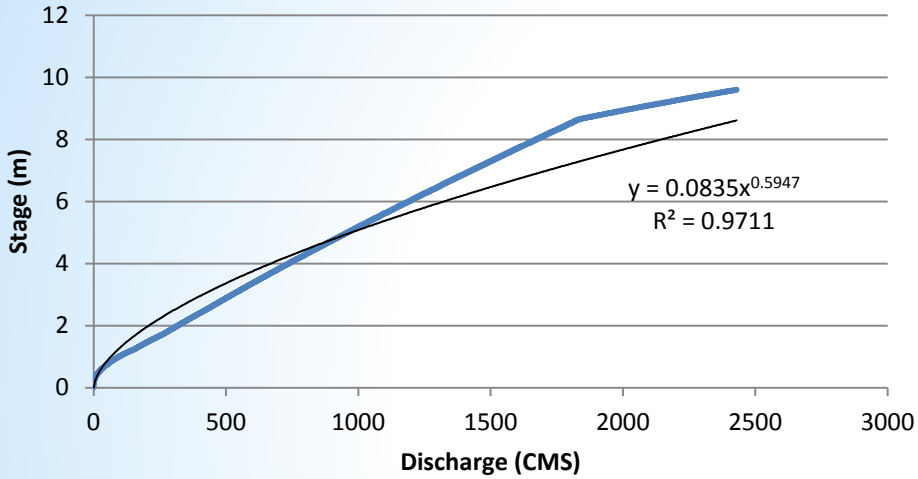




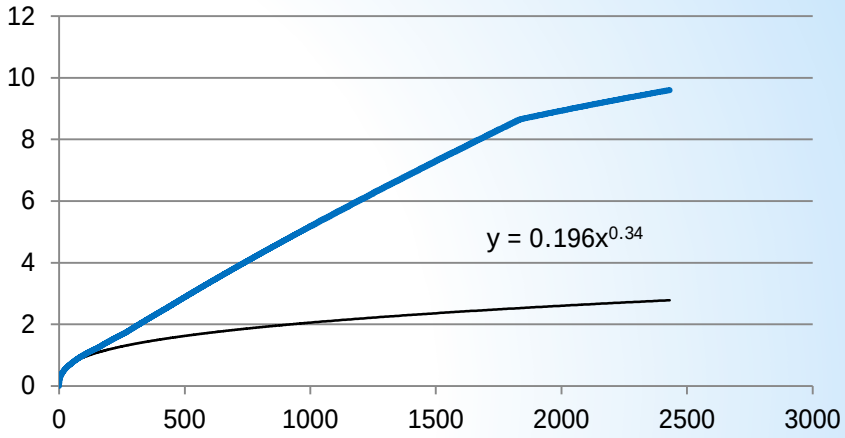
08461300-RGbelowFalconNodate | 08464700-RGatRGCity20120101 | 08469200-RGbeloAnzaldua20050405 | 08473700RGnearSanBenito20120101

Ready

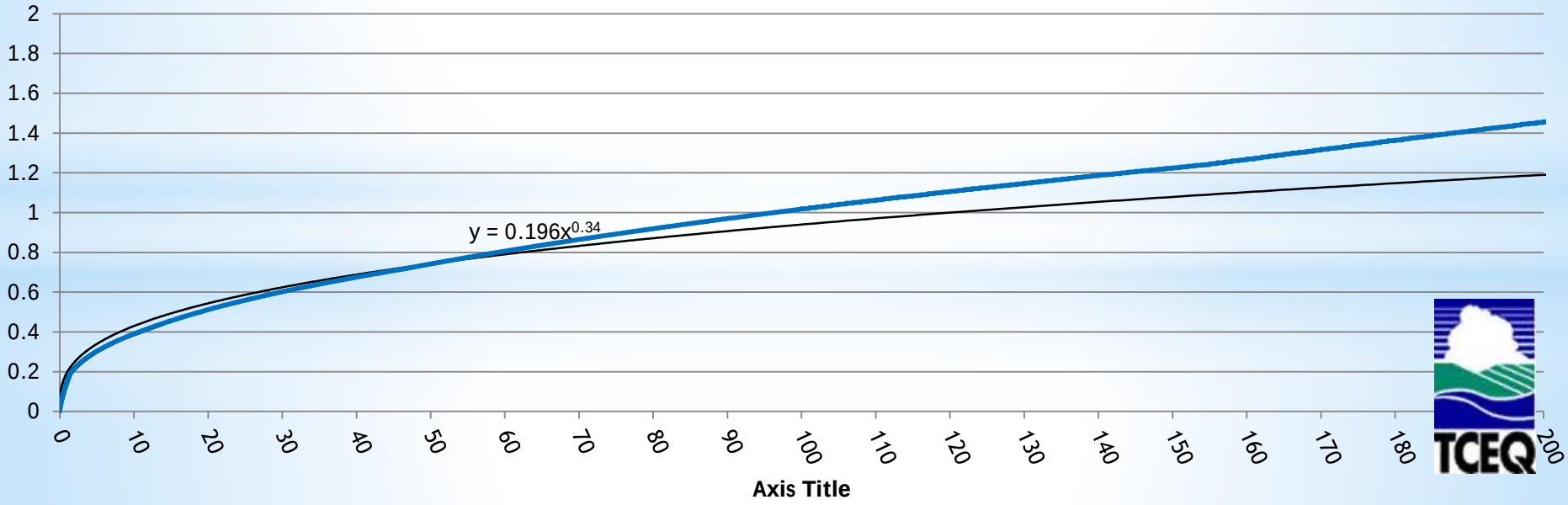
Rio Grande Below Falcon Reservoir



Cal

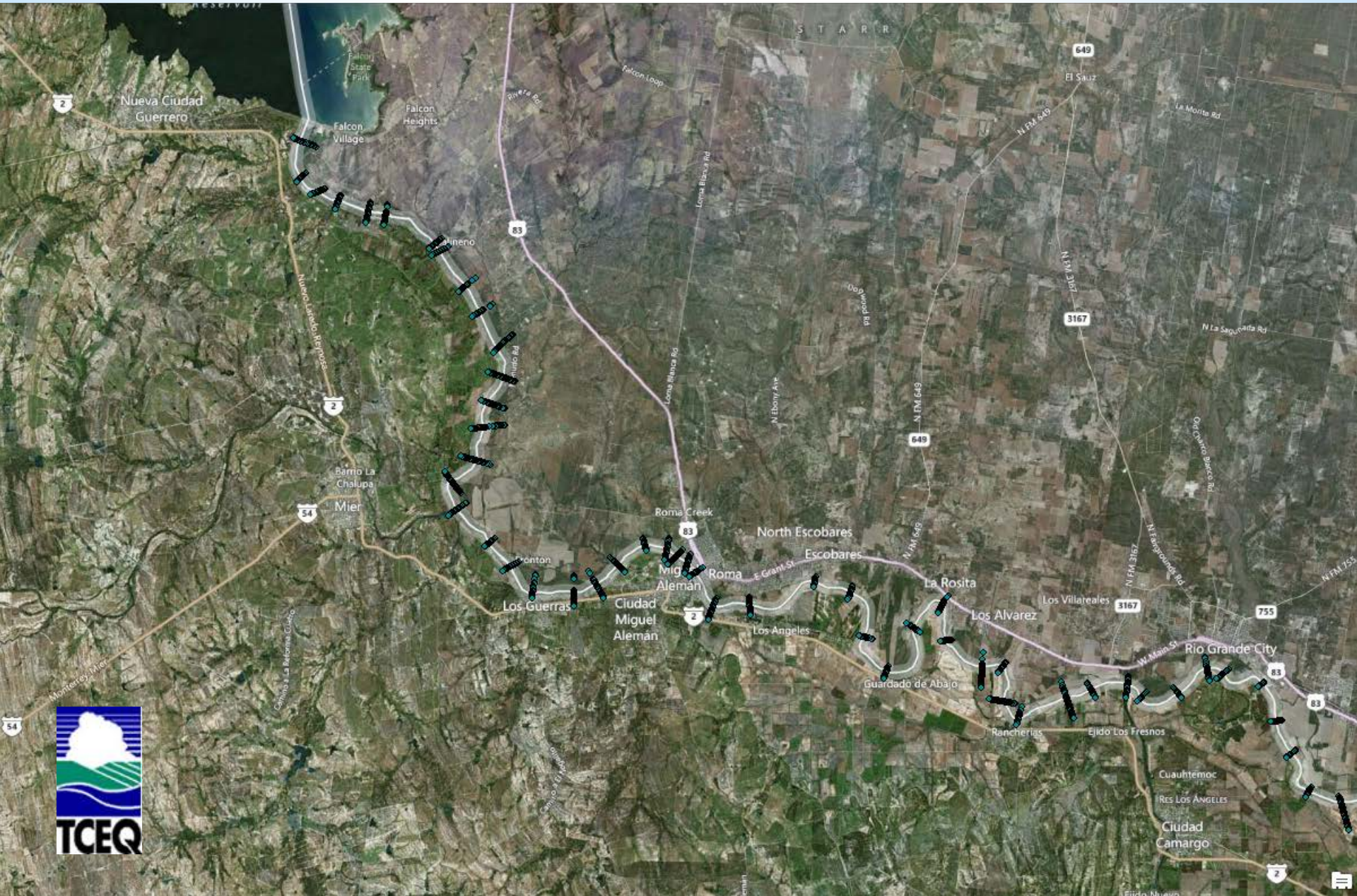


For Month=July 2000-2011				
Min	Max	Median	Mean	7Q2
5.5	98.5	40.7	42.68404	195



		a	b	d	e	f	n
ENDATA08							
HYDR-1	1.	.0477	.5	.1960	.34	.00	.025
HYDR-1	2.	.0477	.5	.1960	.34	.00	.025
HYDR-1	3.	.0477	.5	.1960	.34	.00	.025
HYDR-1	4.	.0477	.5	.1960	.34	.00	.025
HYDR-1	5.	.0477	.5	.1960	.34	.00	.025
HYDR-1	6.	.0477	.5	.1960	.34	.00	.025
HYDR-1	7.	.0477	.5	.1960	.34	.00	.025
HYDR-1	8.	.0477	.5	.1960	.34	.00	.025
HYDR-1	9.	.0477	.5	.3533	.4	.00	.025
HYDR-1	10.	.0477	.5	.3533	.4	.00	.025
HYDR-1	11.	.0477	.5	.3533	.4	.00	.025
HYDR-1	12.	.0477	.5	.3533	.4	.00	.025
HYDR-1	13.	.0477	.45	.1702	.55	.00	.025
HYDR-1	14.	.0477	.45	.1702	.55	.00	.025
HYDR-1	15.	.0477	.45	.1702	.55	.00	.025
HYDR-1	16.	.0477	.45	.1702	.55	.00	.025
HYDR-1	17.	.0477	.45	.1702	.55	.00	.025
HYDR-1	18.	.0477	.45	.1702	.55	.00	.025
HYDR-1	19.	.0477	.45	.1702	.55	.00	.025
HYDR-1	20.	.0477	.45	.1702	.55	.00	.025
HYDR-1	21.	.0477	.45	.1702	.55	.00	.025
HYDR-1	22.	.0477	.45	.1702	.55	.00	.025
HYDR-1	23.	.0477	.45	.1702	.55	.00	.025
HYDR-1	24.	.0477	.45	.1702	.55	.00	.025
HYDR-1	25.	.0477	.45	.1702	.55	.00	.025
HYDR-1	26.	.0832	.3	.0921	.70	.00	.025
HYDR-1	27.	.0832	.3	.0921	.70	.00	.025
HYDR-1	28.	.0832	.3	.0921	.70	.00	.025
HYDR-1	29.	.0832	.3	.0921	.70	.00	.025
HYDR-1	30.	.0832	.3	.0921	.70	.00	.025
HYDR-1	31.	.0832	.3	.0921	.70	.00	.025
HYDR-1	32.	.0832	.3	.0921	.70	.00	.025
HYDR-1	33.	.0832	.3	.0921	.70	.00	.025
HYDR-1	34.	.0832	.3	.0921	.70	.00	.025
HYDR-1	35.	.0832	.3	.0921	.70	.00	.025
HYDR-1	36.	.0832	.3	.0921	.70	.00	.025
HYDR-1	37.	.0758	.3	.0921	.70	.00	.025
HYDR-1	38.	.0758	.3	.0921	.70	.00	.025
HYDR-1	39.	.0758	.3	.0921	.70	.00	.025

IBWC FLOW-2D Cross Sections



Manning's Formula

$$V = \frac{k}{n} R_h^{2/3} S^{1/2}$$

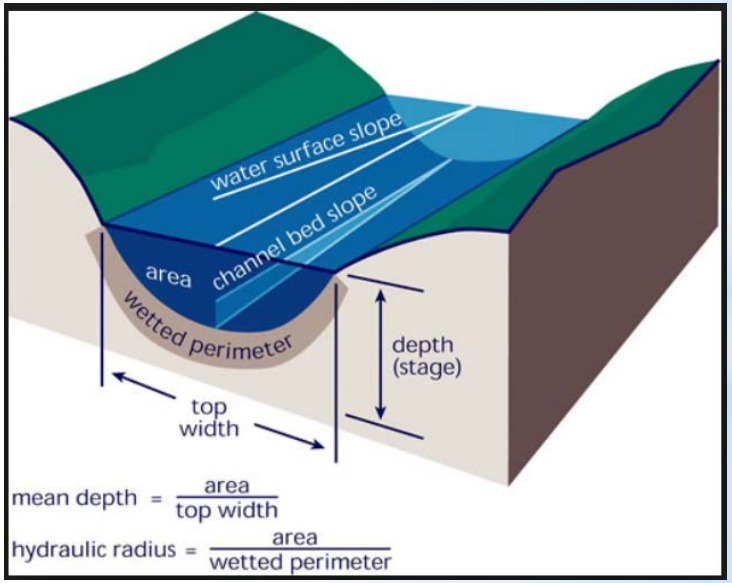
where:

- V is the cross-sectional average velocity (L/T; ft/s, m/s);
- k is a conversion factor of ($L^{1/3}/T$), 1 $m^{1/3}/s$ for SI, or 1.4859 $ft^{1/3}/s$ U.S. customary units, if required. (Note: $(1\ m)^{1/3}/s = (3.2808399\ ft)^{1/3}/s = 1.4859\ ft^{1/3}/s$);
- n is the **Gauckler–Manning coefficient**, it is unitless;
- R_h is the hydraulic radius (L; ft, m);
- S is the slope of the water surface or the linear hydraulic head loss (L/L) ($S = h_f/L$).

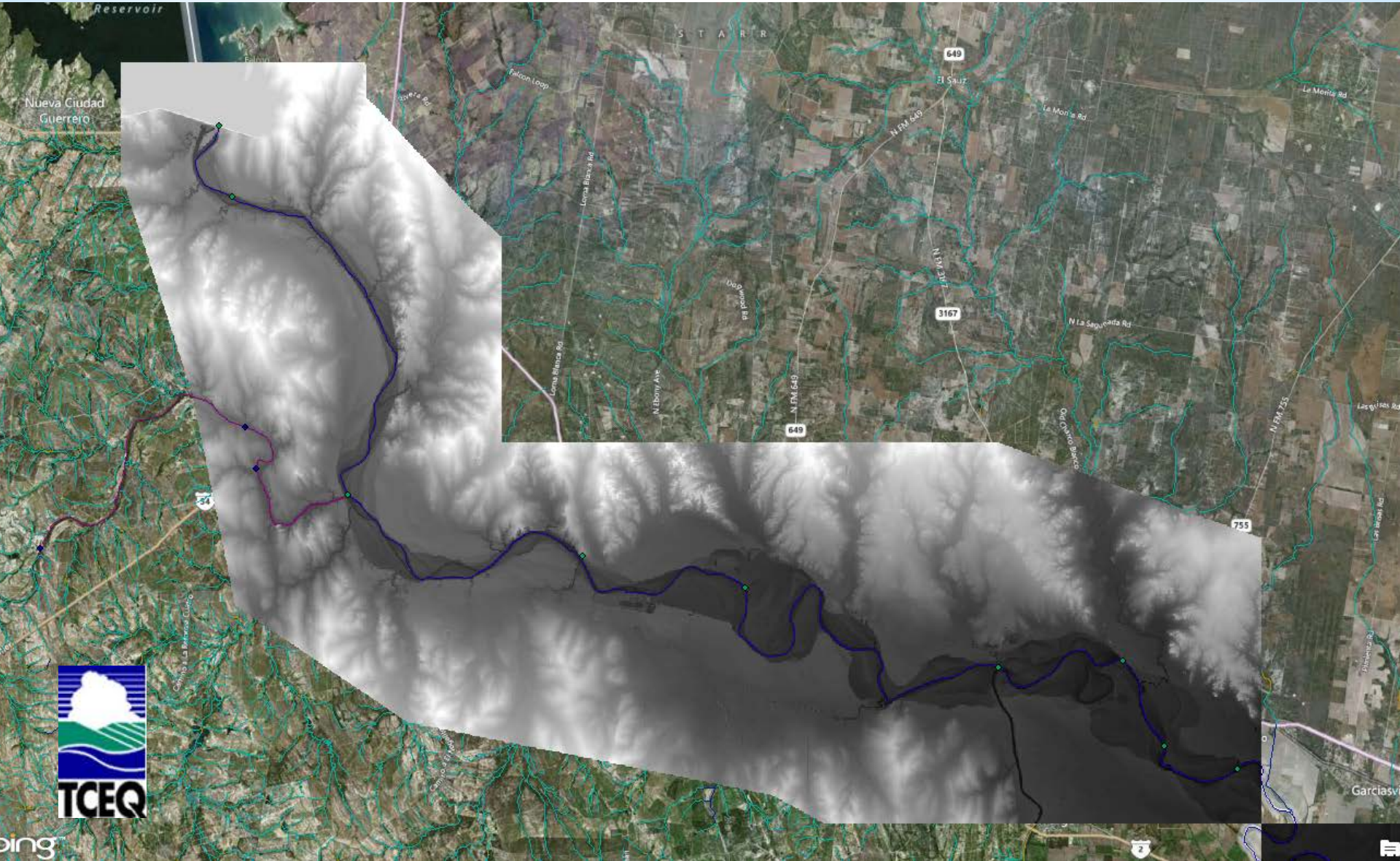
$$R_h = \frac{A}{P}$$

where:

- R_h is the hydraulic radius (L);
- A is the cross sectional area of flow (L^2);
- P || is wetted perimeter (L).

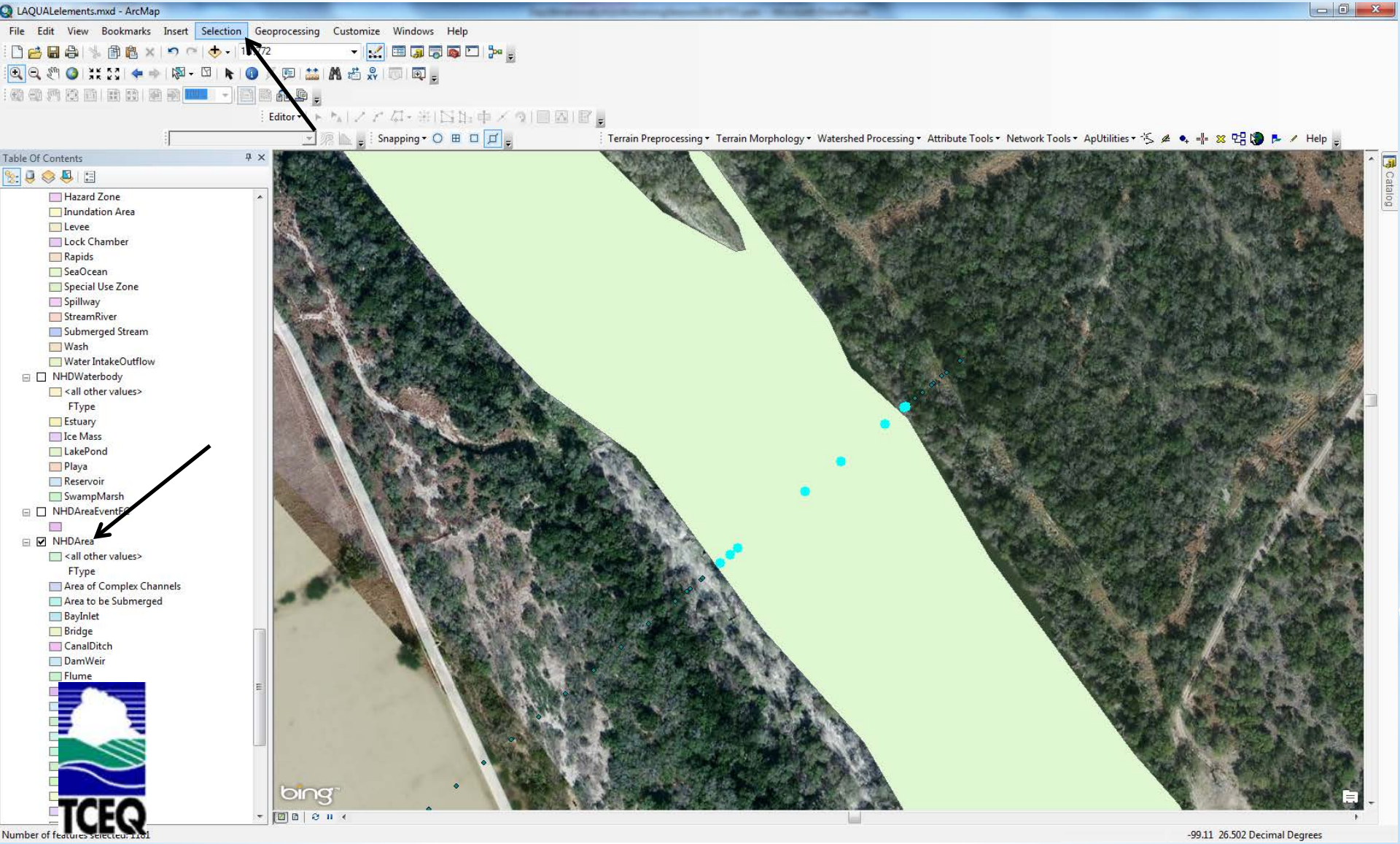


IBWC LIDAR DATA



IBWC FLOW-2D Cross Sections

IBWC FLOW-2D Cross Sections



$$V = \frac{k}{n} R_h^{2/3} S^{1/2}$$

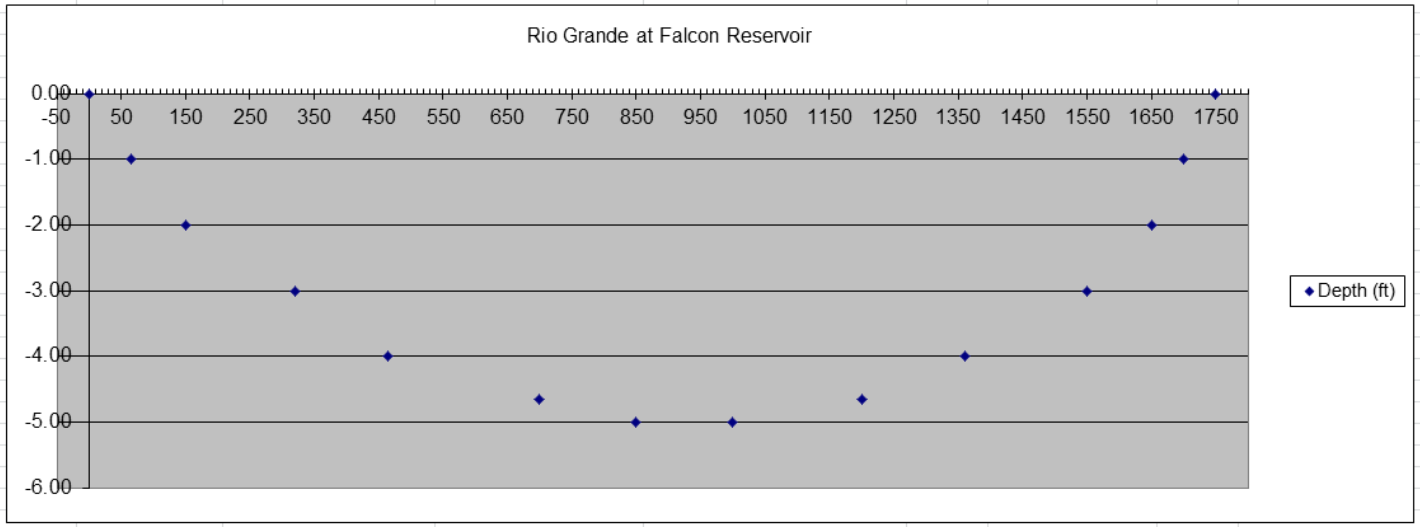
$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}} \sqrt{S} \quad [SI]$$

Slope from LiDAR data

Station (ft)	Depth (ft)		Depth (ft)	Area (ft^2)
0.00	0.00		-5	0
65.00	-1.00		-4	891
150.00	-2.00		-3	1266
320.00	-3.00		-2	2237
465.00	-4.00		-1	3244
700.00	-4.65		0	4348
850.00	-5.00			
1000.00	-5.00			
1200.00	-4.65			
1360.00	-4.00			
1550.00	-3.00			
1650.00	-2.00			
1700.00	-1.00			
1750.00	0.00			

Reach Length (ft)	Average Reach Width (ft)	Average Reach Depth (ft)	Average Reach Volume (acre-ft)
30881	380	5	1346.967401

"A" Crossectional	"P" Wetted Perimeter (ft)	"S" Channel Slope (ft/ft)	"Q" Computed Flow	Depth	Channel Width	Surface A	Volume (Acre-ft)
891	1000	0.0005	1018.052511	1	887	628.8211	628.8210973
1266	1520	0.0005	1382.932637	2	1217	862.7681	1725.536134
2237	1948	0.0005	3027.087991	3	1491	1057.015	3171.044835
3244	2391	0.0005	4905.948368	4	1622	1149.885	4599.53921
4348	2787	0.0005	7217.155514	5	1739	1232.83	6164.148186

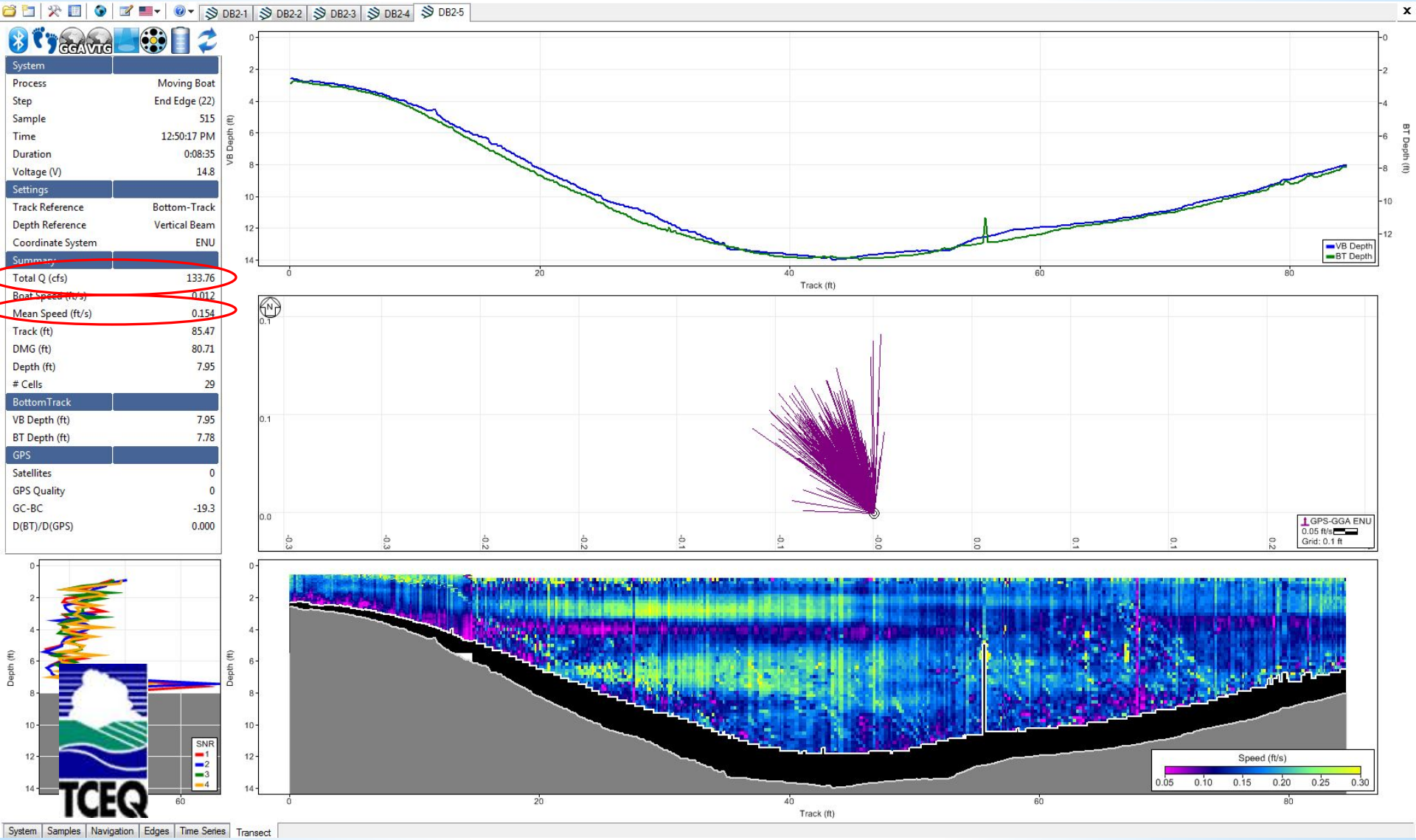


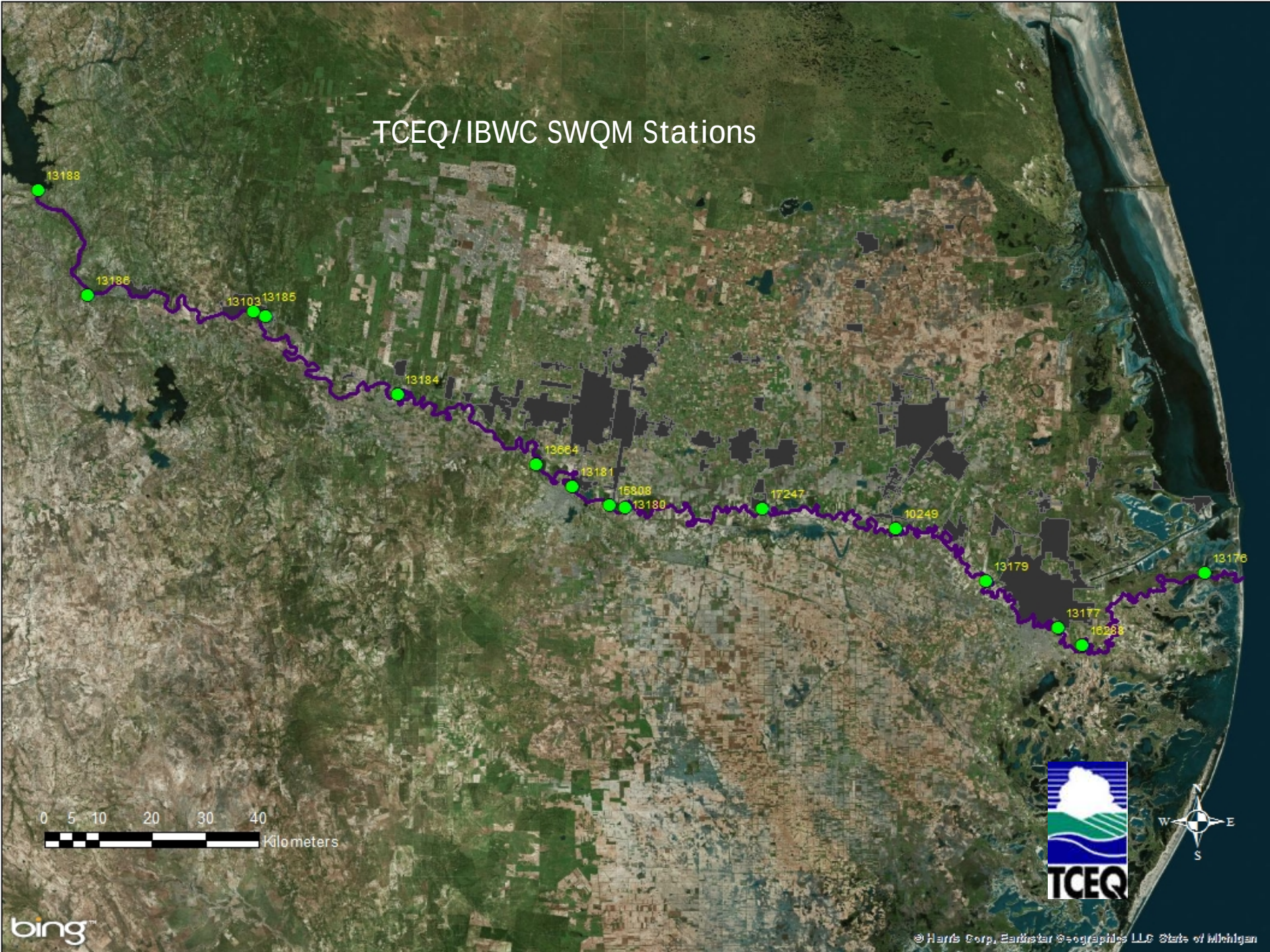
TCEQ

Dickinson at Dickinson Bay14578 | Dickinson below Gum Bayou DB-5 | Gum Bayou at FM517 (11436) | Dickinson at Hwy3 (DB-4) | Benson Bayou at

Calibration

IBWC M9 System ADCP Data

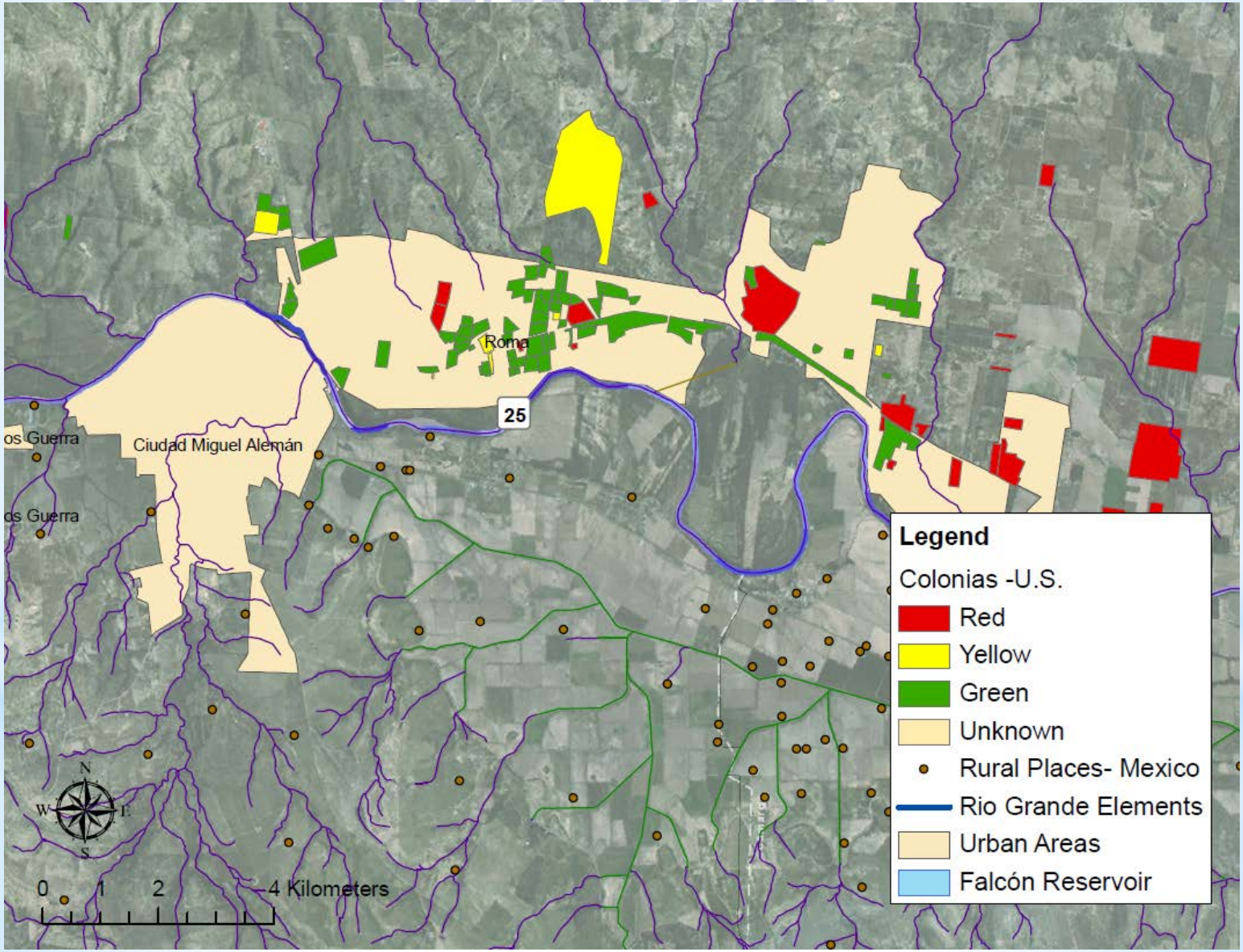



TCEQ/IBWC SWQM Stations
13188
13186
13103
13185
13184
13664
13181
15808
13180
17247
10249
13179
13176
13177
16288
0 5 10 20 30 40
Kilometers
N
W
E
S
TCEQ
bing
© Harris Corp, Earthstar Geographics LLC State of Michigan

Binational Study on the Presence of Toxic Substances in the Rio Grande

1993-1998

Methodology – Assessing Steady-State Nonpoint Source Pollution



Mexico

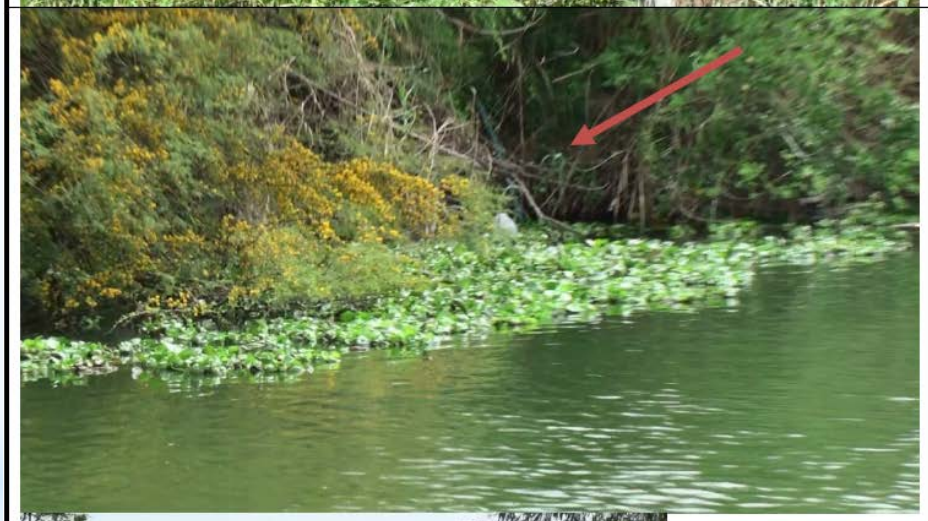
Structure **16**. Four large drain pipes on bank. Border Patrol mentioned this has "green stuff"" discharging at night. Parts of pipes have fallen off. Two pipes discharging, the other 2 wet.

Mexico

Structure **12**. Large drain cement structure with metal gates, which have a permanent rusted hole at bottom. Discharging.

(From Spring 2010 IBWC CRP Bacteria Characterization Study – Near Brownsville)

U.S.
Structure **18.** Large drain. Waterfall at the end of the tunnel falling into foam.



Mexico
Structure **17**. Small blue pipe coming down from residential area (and possibly chicken coup above)

(From Spring 2010 IBWC CRP Bacteria Characterization Study – Near

City	Municipality	Population	Average People Per Household	Households with Drainage	Households without Drainage	People With Drainage	People Without Drainage
Reynosa	Reynosa	589,466	3.62	139,526	5,237	505,084	18,958
Heroica Matamoros	Matamoros	449,815	3.68	112,307	5,781	413,290	21,274
Ciudad Rio Bravo	Rio Bravo	95,647	3.77	23,478	1,625	88,512	6,126
Ciudad Miguel Aleman	Miguel Aleman	19,997	3.48	5,613	61	19,533	212
Ciudad Gustavo Diaz Ordaz	Gustavo Diaz Ordaz	11,523	3.5	2,984	258	10,444	903
Nuevo Progreso	Rio Bravo	10,178	4.03	1,741	744	7,016	2,998
Ciudad Camargo	Camargo	7,984	3.4	2,184	101	7,426	343
Mier	Mier	4,762	3.3	1,375	33	4,538	109
Los Guerra	Miguel Aleman	4,566	4.02	1,108	11	4,454	44
Nueva Ciudad Guerrero	Guerrero	4,312	3.08	1,182	84	3,641	259
Ramirez	Matamoros	3,743	3.77	705	282	2,658	1,063
El Control	Matamoros	3,136	3.52	781	105	2,749	370
Comales	Camargo	2,429	3.31	694	26	2,297	86

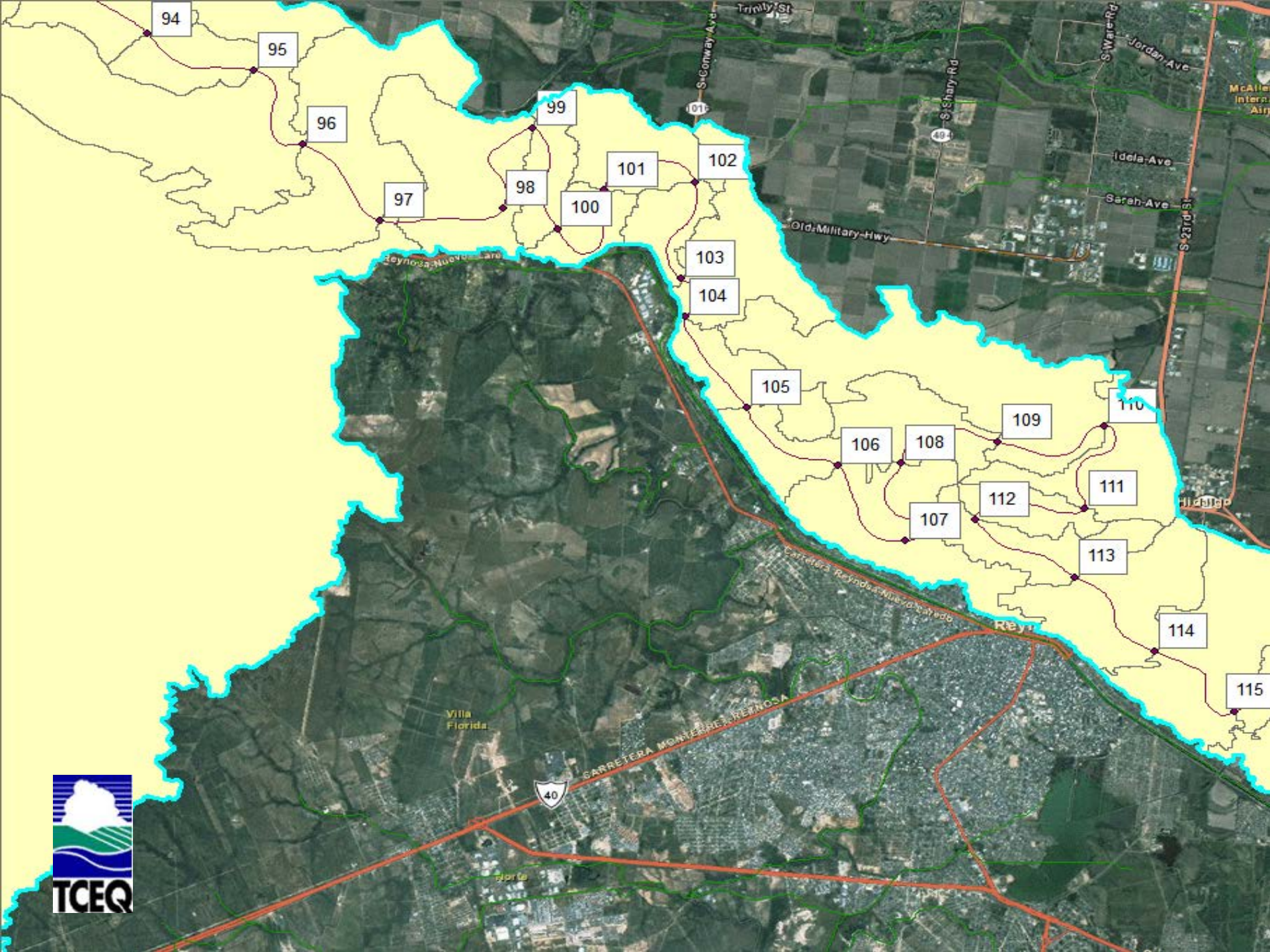
$$P = H * PPH$$

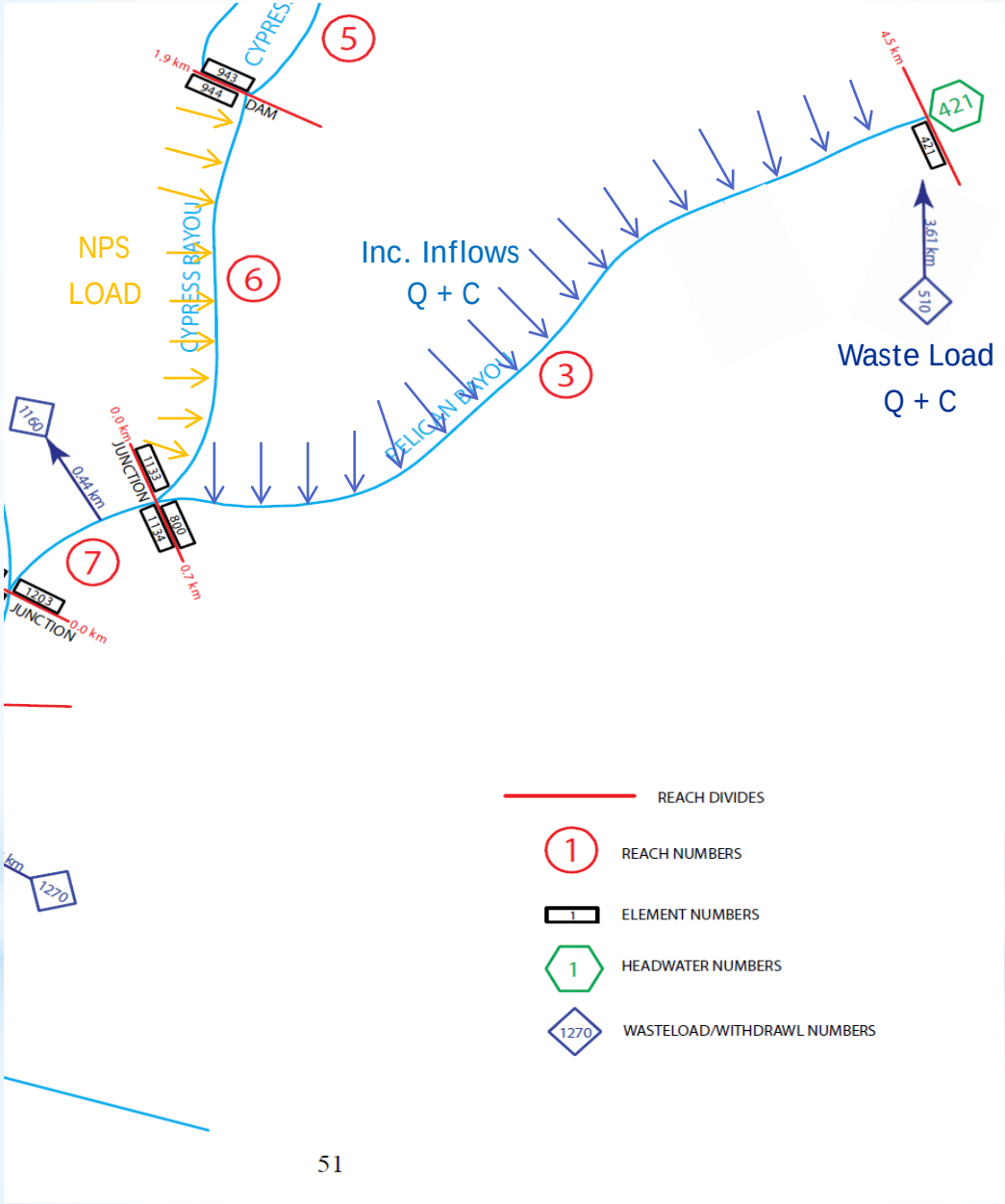
where P is the total population with or without drainage in each locality, H is the number of households with or without drainage in each locality, and PPH is the average number of people per household in each locality.

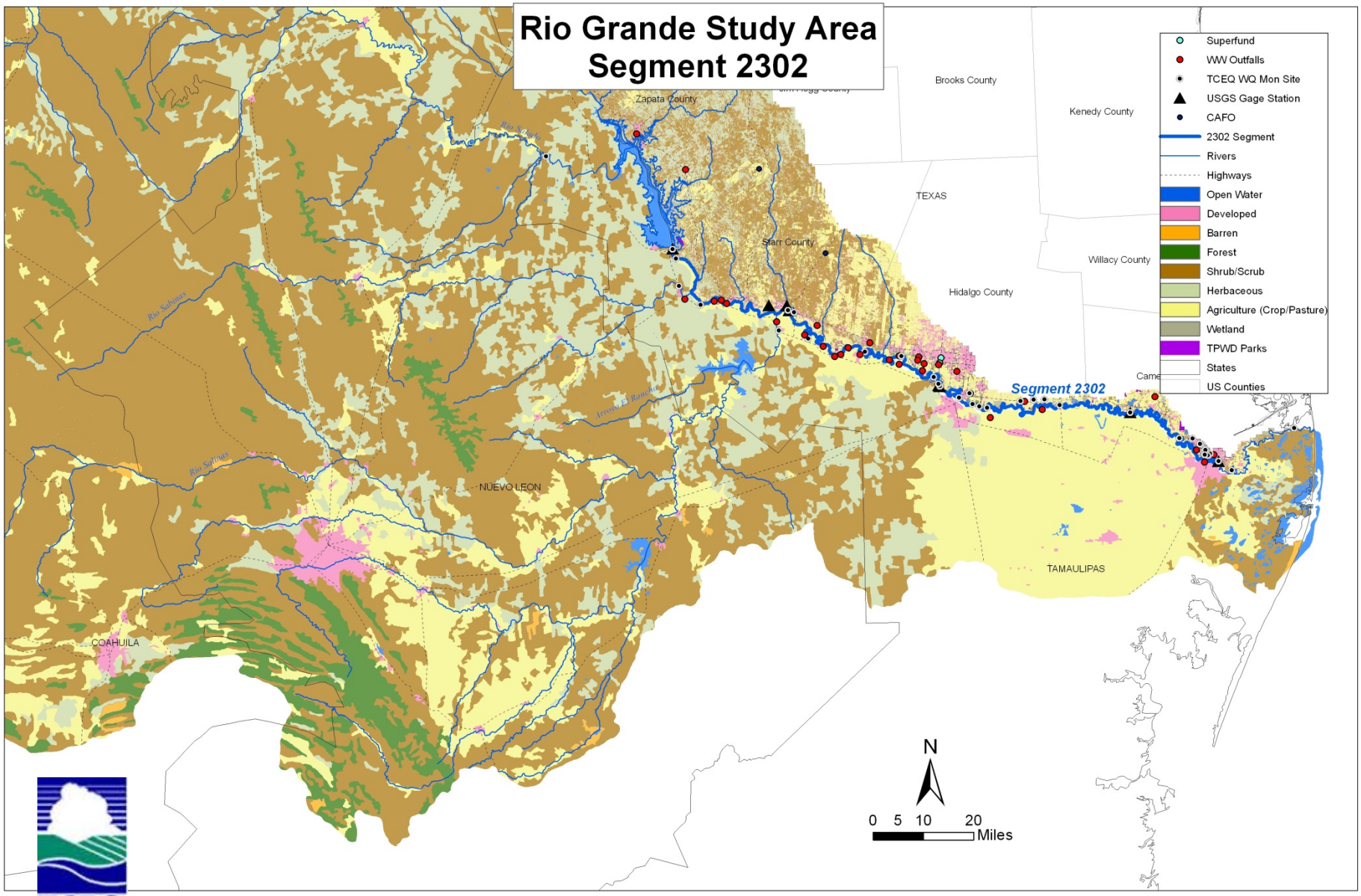
$$WW_l = POP_l * WWPD_l * CF \pm 15\%$$

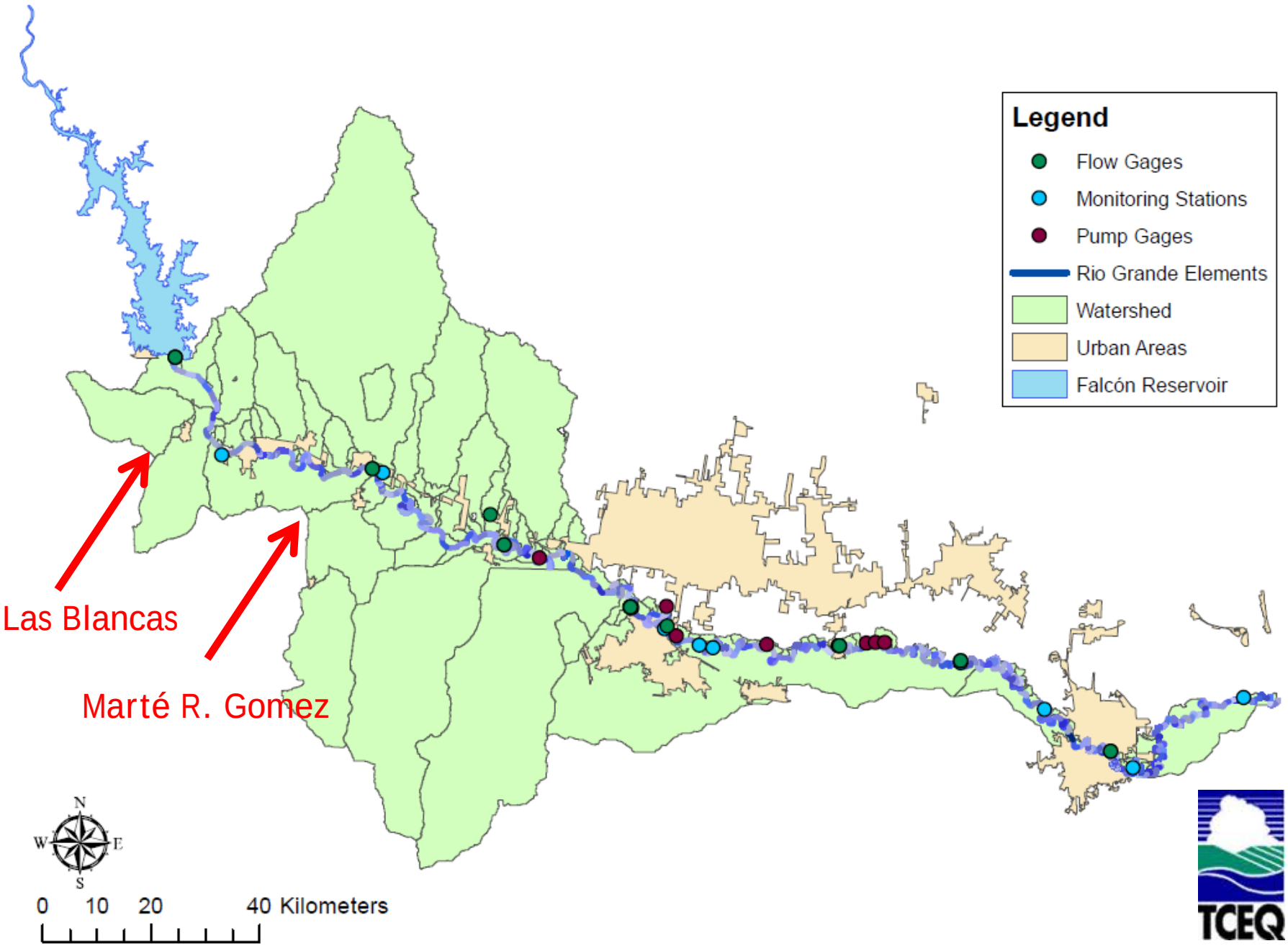
where WW_l is the wastewater produced per second per locality (L/s), POP_l is the population of each locality, $WWPD_l$ is the wastewater produced per person per day (L/day), and CF is a conversion factor of (1/86,400) days/seconds.

TCEQ


94
95
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
Trinity St
S Conway Ave
S Shary Rd
S Ware Rd
Jordan Ave
Idela Ave
Sarah Ave
Old Military Hwy
S 23rd St
Reynosa Nuevo Laredo
Carretera Reynosa Nuevo Laredo
Villa Florida
CARRETERA MONTERREY REYNOSA
40
Norte
TCEQ


CYPRES
5
1.9 km
943
944
DAM
NPS
LOAD
CYPRESS BAYOU
6
Inc. Inflows
Q + C
4.5 km
421
421
3.61 km
510
Waste Load
Q + C
3
PELICAN BAYOU
1160
0.44 km
0.0 km
JUNCTION
1133
1134
800
0.7 km
7
1203
JUNCTION
0.0 km
1270
REACH DIVIDES
REACH NUMBERS
ELEMENT NUMBERS
HEADWATER NUMBERS
WASTELOAD/WITHDRAWL NUMBERS


Rio Grande Study Area
Segment 2302
Superfund
WW Outfalls
TCEQ WQ Mon Site
USGS Gage Station
CAFO
2302 Segment
Rivers
Highways
Open Water
Developed
Barren
Forest
Shrub/Scrub
Herbaceous
Agriculture (Crop/Pasture)
Wetland
TPWD Parks
States
US Counties
Zapata County
Brooks County
Kenedy County
TEXAS
Starr County
Willacy County
Hidalgo County
Segment 2302
NUEVO LEON
TAMAULIPAS
COAHUILA
Rio Salinas
Arroyo El Rancho
N
0 5 10 20
Miles


Legend
Flow Gages
Monitoring Stations
Pump Gages
Rio Grande Elements
Watershed
Urban Areas
Falcón Reservoir
Las Blancas
Marté R. Gomez
N
W
E
S
0 10 20 40 Kilometers
TCEQ

Conclusions

*LA-QUAL adequately addresses the impairments and concerns identified for Segments 2301 and 2302 of the Lower RG

*The simplicity of LA-QUAL makes it ideal for Phase I of the LRGWQI (i.e., Partnership building)

*The US and Mexican partners can build on the successful technical partnership for Phase II