WATER QUALITY MODEL FOR EL CAJON AND AGUAMILPA RESERVOIRS

by

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ABSTRACT

The Aguamilpa Dam, located along the Santiago River, was built with the purpose of supplying power energy and for flooding control. Some of the issues that arose with the construction of Aguamilpa Dam are the effects of the water quality along the river, the environmental impact and the social impact in the surrounding areas. Recently the El Cajon dam was build upstream of the Aguamilpa Dam which caused a decrease in its flow and improved its water quality. It is important to understand the environmental impacts of these dams before other actions are taken to build more dams. Therefore to better understand these issues, a two-dimensional, laterally averaged hydrodynamic model, CE-EQUAL-W2, have been developed to know the water quality for the El Cajon and Aguamilpa reservoirs according to extreme weather changes. This project was performed in collaboration with the students at the ITESO University in Guadalajara. As part of this work the previous El Cajon uncalibrated model was modified by improving its bathymetry and control files. For the Aguamilpa Dam a new uncalibrated water quality model was developed. The El Cajon and Aguamilpa reservoirs models are still in progress, but this work helped to the identification of missing data, future monitoring plans and site recognition.

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1. Introduction

1.1 Background

1.1.1 Aguamilpa Reservoir

The Aguamilpa-Solidaridad reservoir was developed to meet the demand for electric energy in the northwestern area of Mexico. The reservoir is part of the Santiago and Huaynamota hydrologic system. The Aguamilpa Hydrologic Project was completed in 1994. The dam is located in the Santiago River in the state of Nayarit (104°25' and 104°46' longitude West and 21°23' and 21°53' latitude North), 52 km north from the capital, Tepic. The embankment height is 187 m and it has 14 million m^3 of rockfill. This is one of the highest concrete faced rockfill dams under operation in the world. This project has an underground hydroelectric power plant, the annual mean generation rate is 2131 GW·h (Figure 1 and Figure 2)

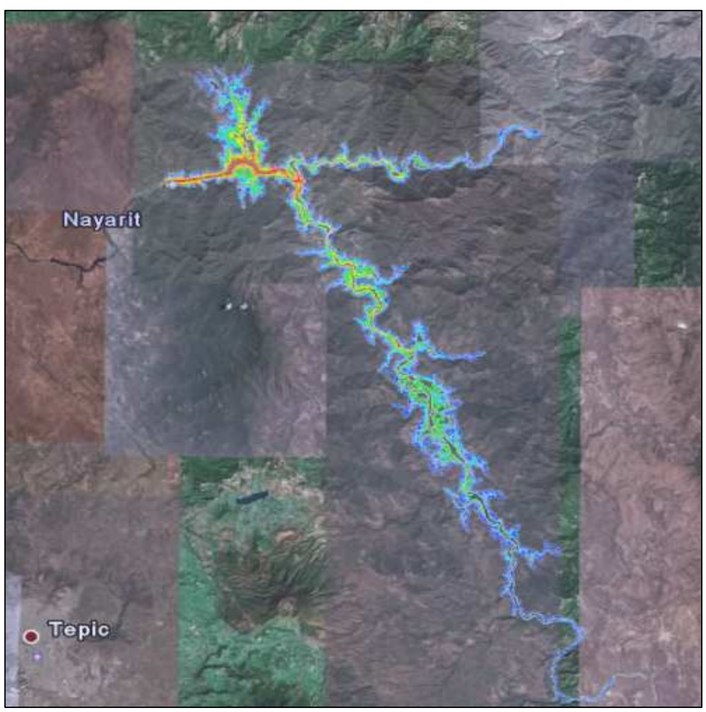


Figure 1: Google Earth Image of Aguamilpa

Figure 2: Aguamilpa Dam

1.1.2 El Cajon Reservoir

El Cajon reservoir was developed as part of the El Cajon Hydroelectric Project in order to meet the demand for electric energy. The hydropower plant El Cajon is part of the hydrological system of Santiago River, located in the hydrological region Lumber 12, known as Lerma – Santiago – Pacific. This system is capable of a hydroelectric potential of 4300 MW. El Cajon is second only to Aguamilpa-Solidaridad Station in power and generation. The El Cajon dam and reservoir are located in the state of Nayarit (21°25’41” N, 104°27’14” W), 47 km from the capital Tepic (Barlow and Obregon, 2007). Construction on the dam was completed in June 2006 and the reservoir was filled that November. (Figure 3 and Figure 4)

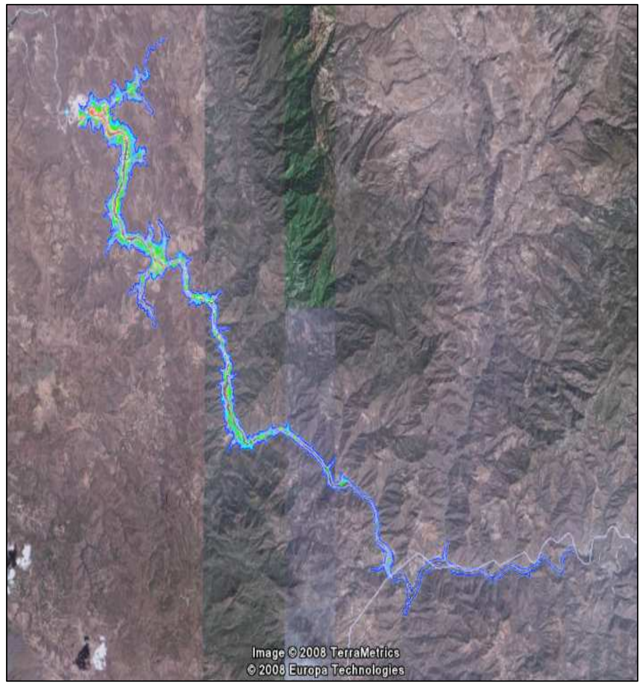


Figure 3: Google Earth El Cajon image

Figure 4: El Cajon Dam

1.2 Issues

Approximately 90% of the water bodies in Mexico present a degree of contamination. The city of Guadalajara, the third largest city in Mexico, currently discharges nearly all of its wastewater directly into the Santiago River. The Rio Santiago is among Mexico's most polluted rivers, with high levels of aluminum, lead, arsenic, copper and manganese. The polluted water emits a powerful stench and is unsuitable for recreation, irrigation, and does not support any aquatic life. For this reason, the need for evaluating the water quality of the main reservoirs in Mexico has arisen.

2. Objectives

- The main objective for this project was to design an uncalibrated water quality model for the Aguamilpa reservoir. This model was developed using the water quality and quantity data obtained from government agencies in Mexico and research center (CIATEJ).
- Another objective was to assist ITESO students to improve the water quality model for El Cajon reservoir developed last year.

3. Materials and Methods

3.1 Understand the Model

The model that was built for this project is based on the CE-EQUAL-W2 program. This program is used to analyze and stimulate the hydrodynamic behavior and also the water quality and characteristics. To be able to analyze these data the program computes calculations based on the longitudinal and vertical dimensions (Cole and Wells, 2003). By the longitudinal dimension, the reservoir length was considered and for the vertical dimension, the depth of the reservoir was referred. Taking this into consideration, the variation in width of the reservoir is not accounted for this model making it ideal for long and deep reservoirs with minimum variation on the width.

3.2 Understand the Site

An important part of the project is to better understand the site in which the mode is being developed. After getting the coordinates of the studied sites, aerial pictures of the locations were used to know the dimensions of the reservoirs. Because the reservoirs were to long it was difficult to decide where the boundaries of the reservoirs are. Also, it was important to know and understand the source of the water and if any contamination exists on the modeled reservoirs. The trip down to Santiago River was really helpful to better understand the situation and realize that there is an excessive amount of untreated waste that is being discharged in the Santiago River. These uncontrolled discharges have been creating serious environmental and health hazards for the people that live close to the river.

3.3 Gathered Data

In order to create the model, digital elevation models (DEM's) scale 1:50000 were downloaded from Instituto Nacional de Estadistica, Geografia e Informatica (INEGI) website (INEGI, 2008). Climatological data, such as air temperature, dew point temperature, wind speed, wind direction and cloud cover were obtained from the CFE. Also, the storage capacity data of the studied reservoirs were obtained from CFE for the Aguamilpa reservoir and from ITESO students for El Cajon reservoir (Appendix).

Assuming that the reservoirs water quality monitoring will include the effects of nutrients and primary production on other water quality variables, e.g., dissolved oxygen (DO), the following types of data is required:

- Boundary conditions
- Initial conditions
- Site description/geometry/bathymetry
- Parameters (e.g. coefficients)
- In-pool/release observations (for calibration/verification)

The types of boundary conditions required for reservoir water quality models consist of the following:

- Inflowing tributaries
- Other non-point source runoff
- Point source loadings
- Outflows
- Meteorology
- Sediment fluxes (for older models)

3.4 Create Model Input Files

To be able to set up this model it is important not only to collect the data but also to create the necessary files for CE -EQUAL-W2 program to make it run. The main files that are needed to be generated are the geometry files also the flow data and the meteorological data. This information is needed before the model can be started processing with any other steps. There are some software that could be used to create these files (Nelson, 2006). Two of the recommended ones by previous researches are Watershed Modeling System (WMS8.0) by EMS-I and also AGPM by W2i. The WMS 8.0 software was used to create the bathymetry and control files for Aguamila and El Cajon reservoirs models. However, after these files were created, some manually modifications were made in order to open the created files in the AGPM-W2i software. These modifications included adjustments in the inflow and outflow codes for the three created branches for the Aguamilpa model. Also segments and layer information and geometry for both of the modeled reservoirs were modified in order to avoid future errors when the files would be read in CE-QUAL-W2 model.

4. Results and Discussion

4.1 Aguamilpa Reservoir Model

4.1.1 TIN

The TIN was created in WMS by converting a series of DEM files downloaded from the INEGI website (Figure 5).

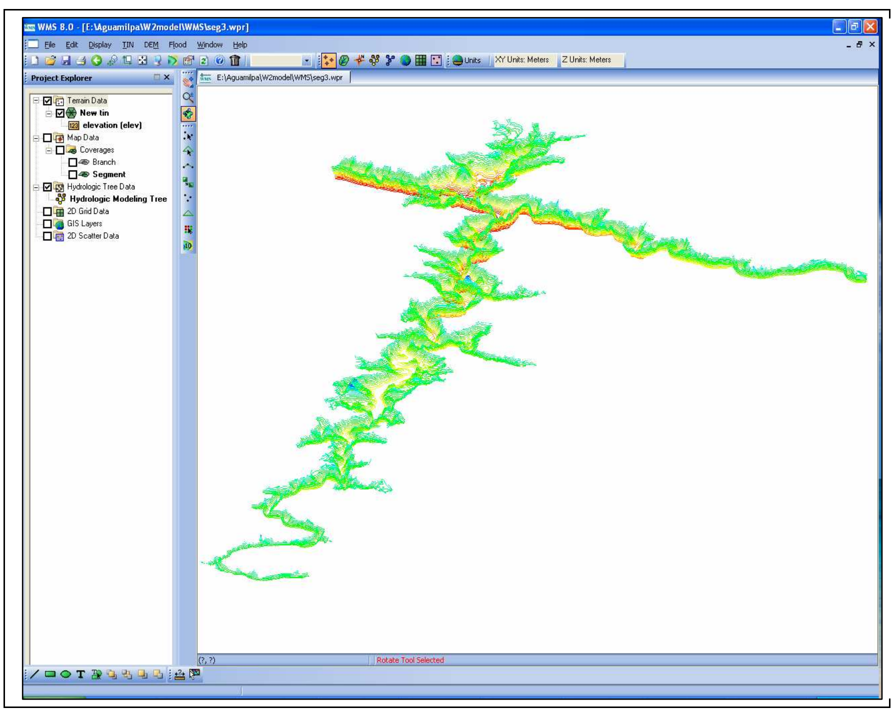


Figure 5: Aguamilpa Tin generated in WMS

4.1.2 Bathymetry

After creating the TIN using WMS the bathymetry and control files were generated. These files were used to create branches and their respective segments (Figure 6 to Figure 13).

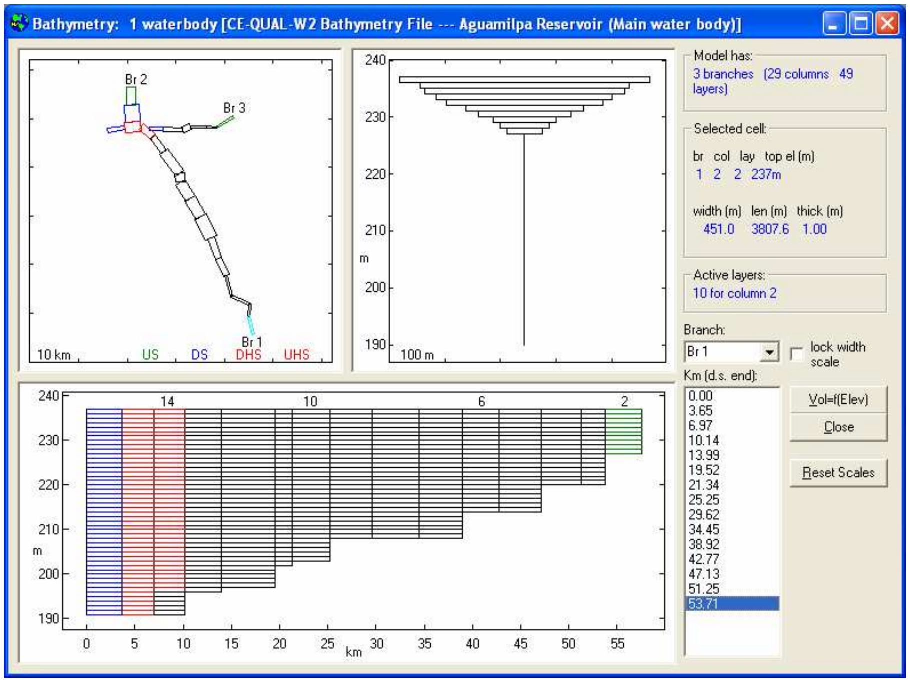


Figure 6: Aguamilpa Bathymetry Most Upstream Segment (Main Branch)

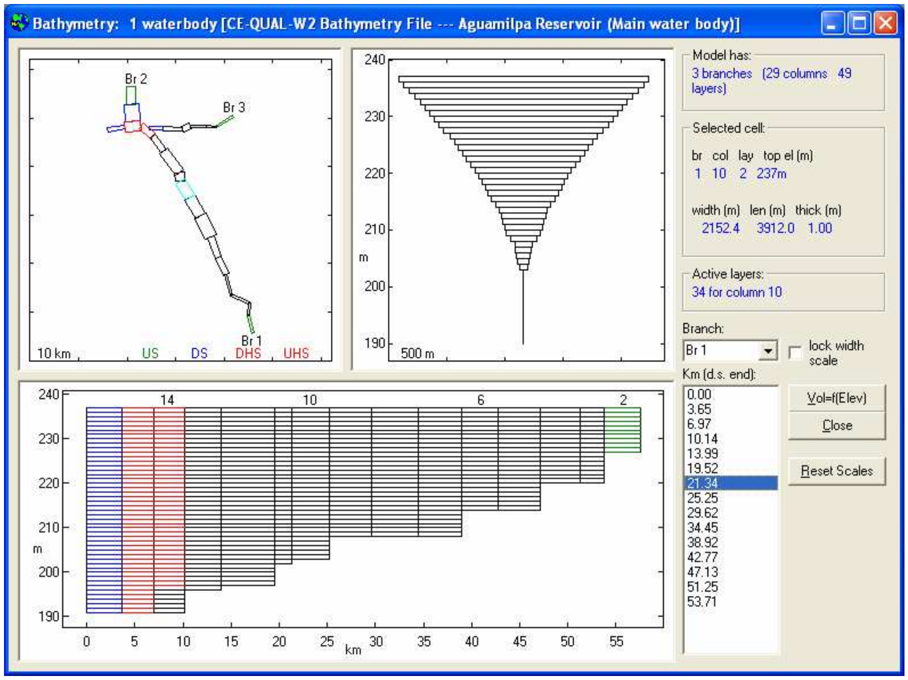


Figure 7: Aguamilpa Bathymetry Middle Segment (Main Branch)

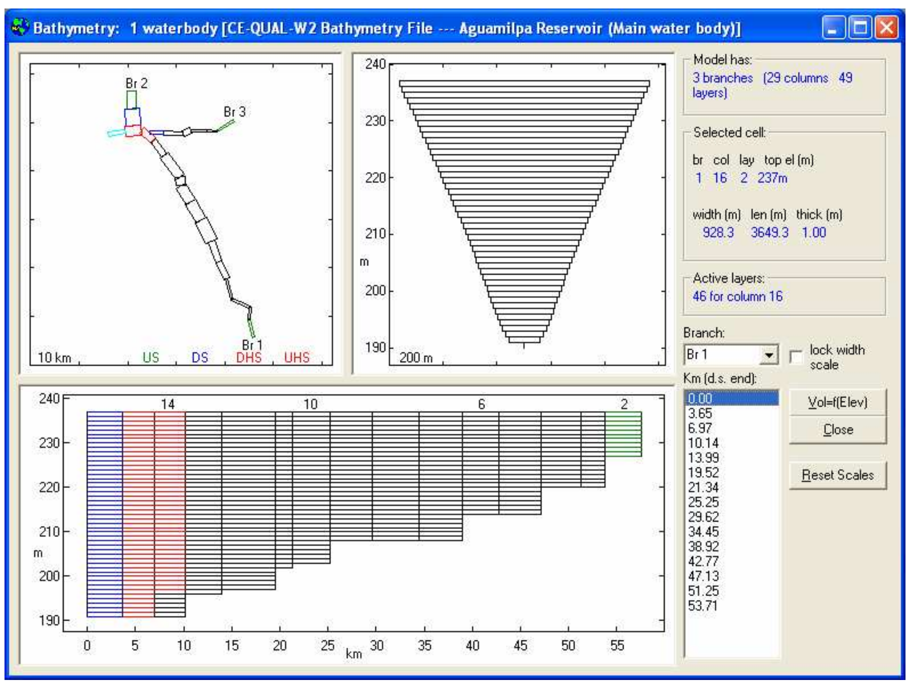


Figure 8: Aguamilpa Bathymetry Most Upstream Segment (Main Branch)

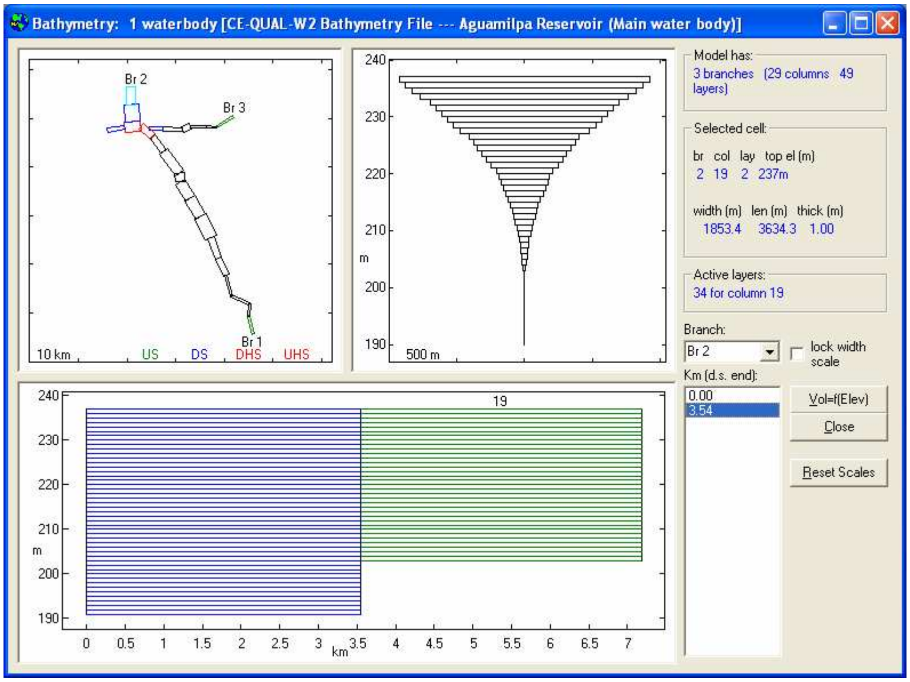


Figure 9: Aguamilpa Bathymetry Most Upstream Segment (Branch 2)

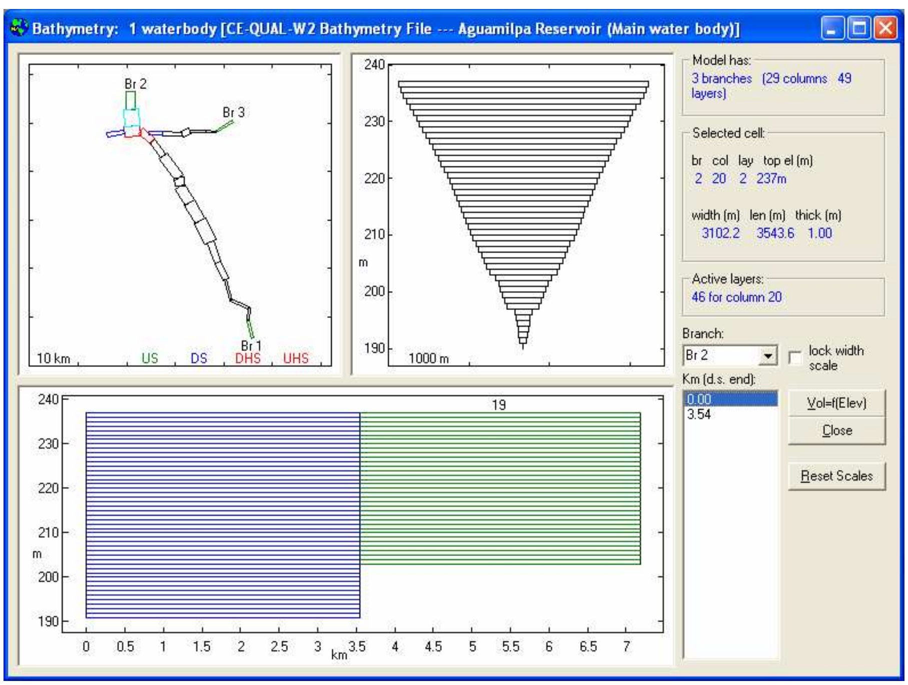


Figure 10: Aguamilpa Bathymetry Middle and Most Downstream Segments (Branch 2)

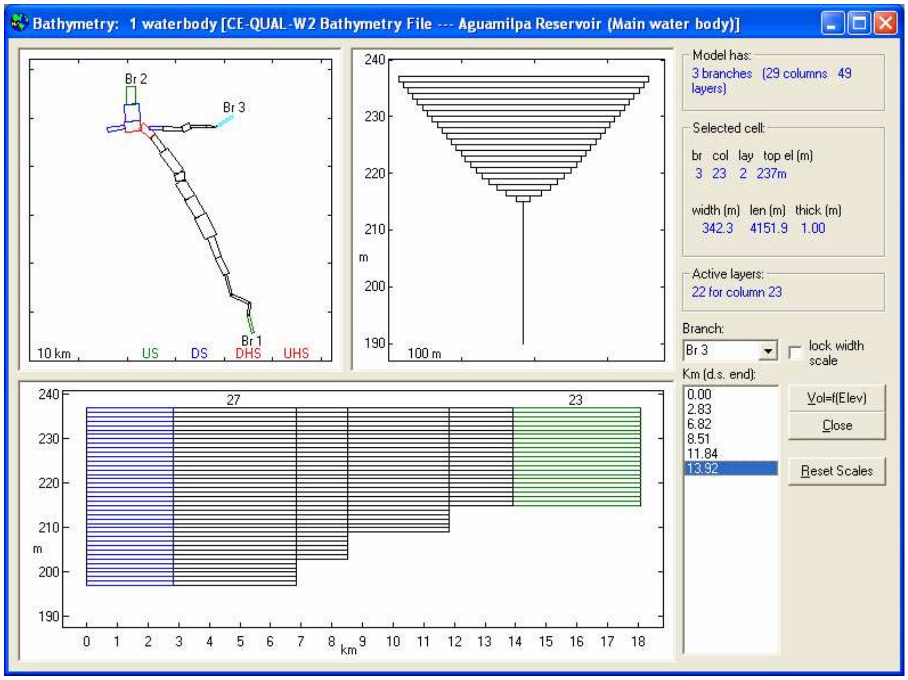


Figure 11: Aguamilpa Bathymetry Most Upstream Segment (Branch 3)

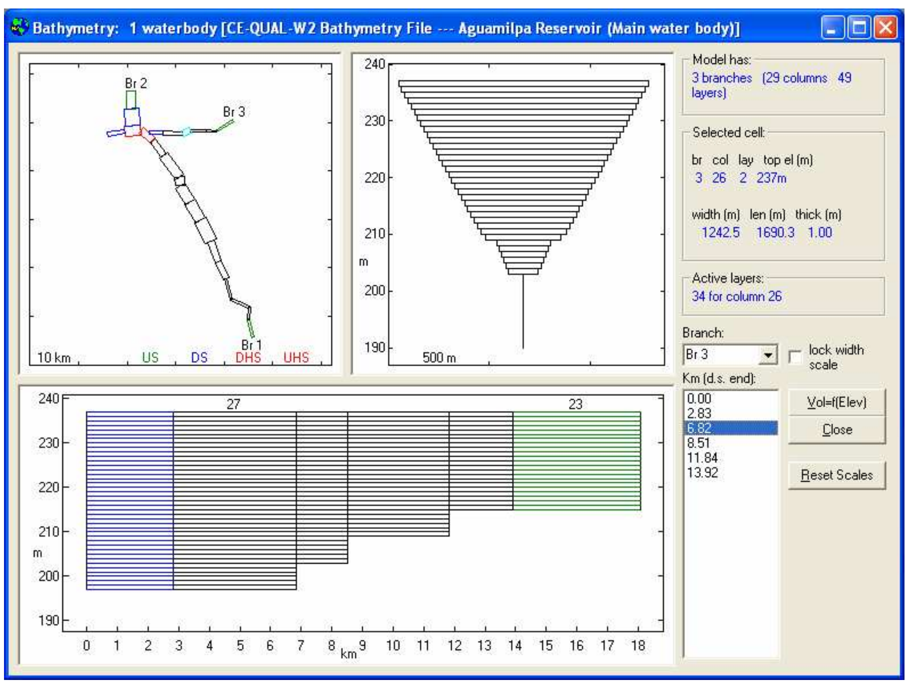


Figure 12: Aguamilpa Bathymetry Middle Segment (Branch 3)

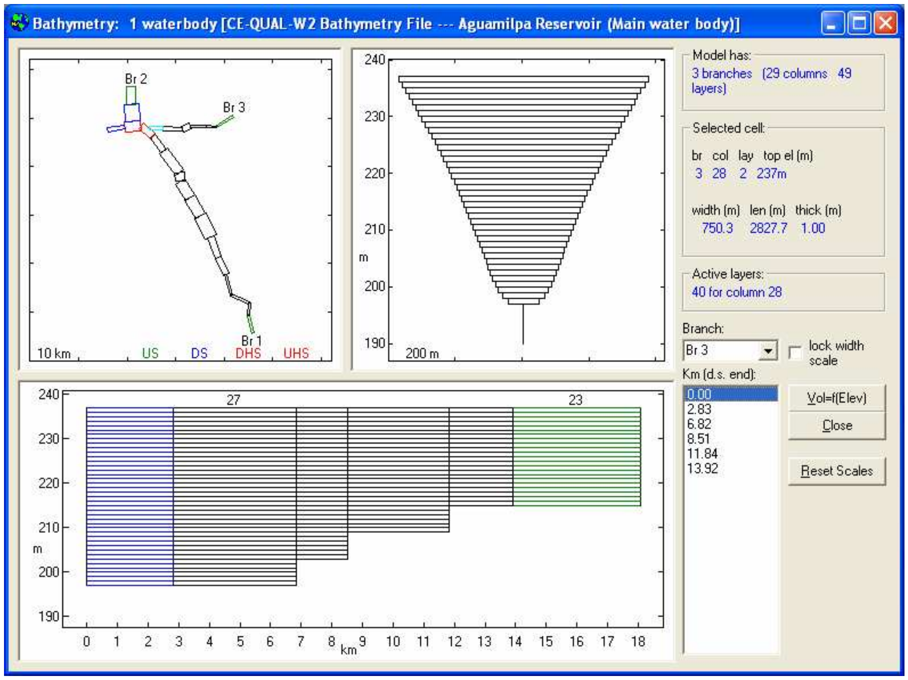


Figure 13: Aguamilpa Bathymetry Most Downstream Segment (Branch 3)

4.1.3 Storage Capacity Curves

The first curve was generated in WMS using DEM elevations (Figure 14). Elevations for the second graph (Figure 15) where obtained from the CFE (Appendix).

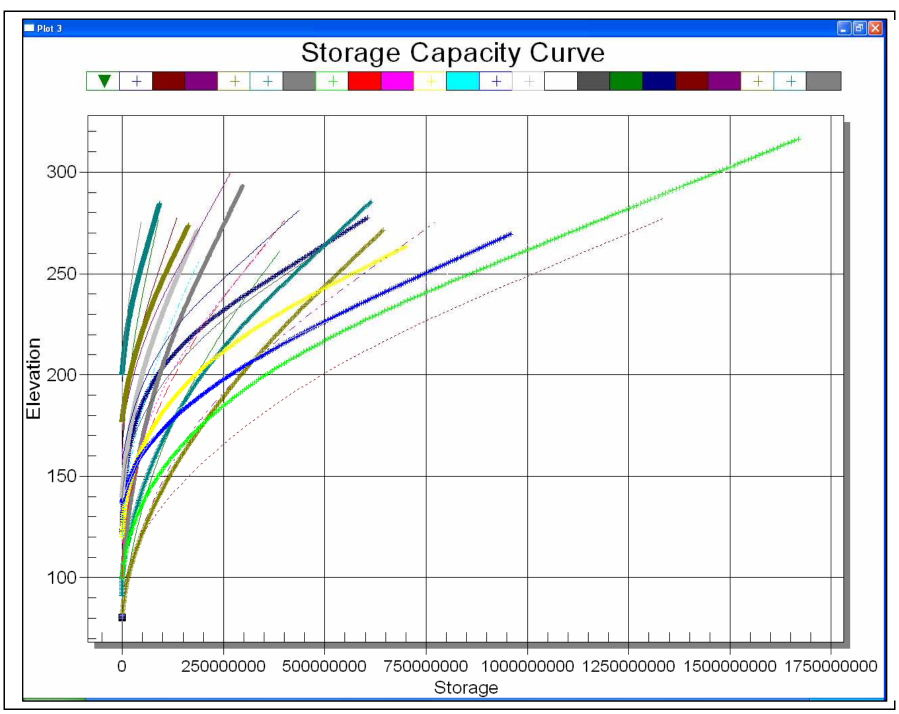


Figure 14: WMS Storage Curve Capacity for Aguamilpa

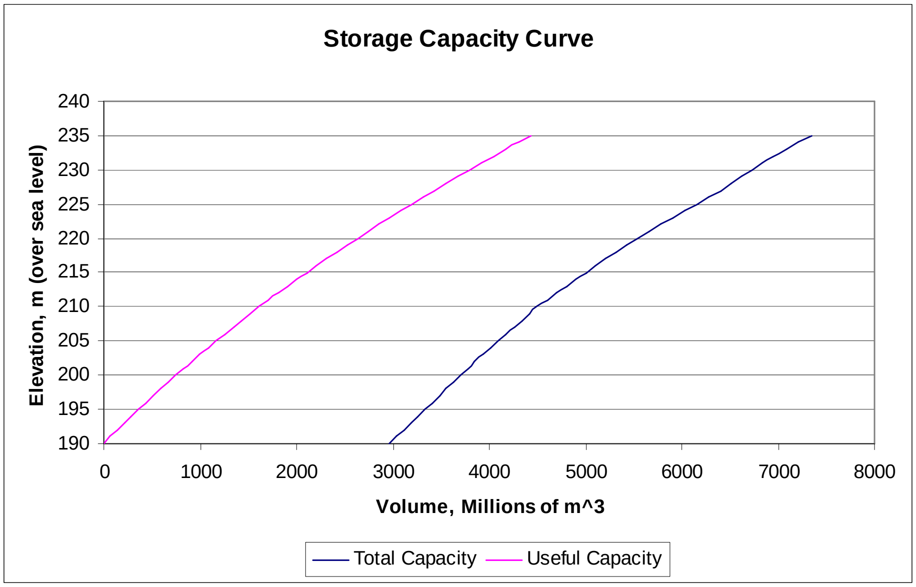
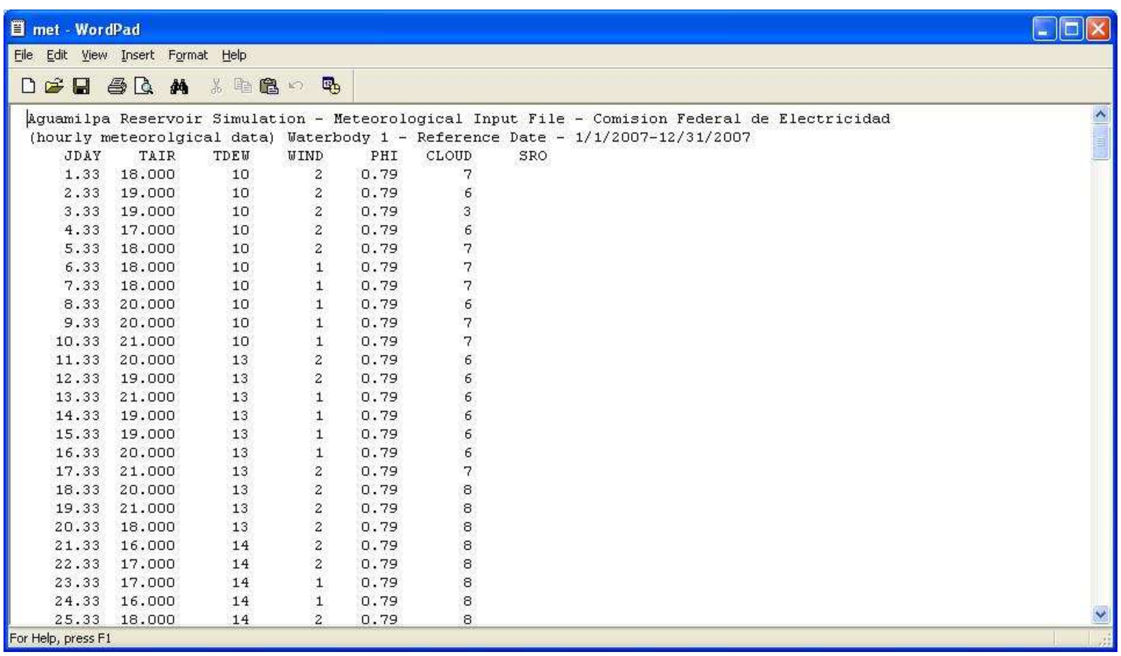


Figure 15: Storage Curve Capacity for Aguamilpa

4.1.4 Meteorological File

For the meteorological file we manually enter the parameters needed in Excel. Then we save our worksheet as a "space delimited (.prn)" file and then once it's saved, we manually change the extension to .npt which is the extension CE-QUAL-W2 recognizes (Figure 16).



Aguamilpa Reservoir Simulation - Meteorological Input File - Comision Federal de Electricidad
(hourly meteorolgical data) Waterbody 1 - Reference Date - 1/1/2007-12/31/2007

JDAY	TAIR	TDEW	WIND	PHI	CLOUD	SRO
1.33	18.000	10	2	0.79	7	
2.33	19.000	10	2	0.79	6	
3.33	19.000	10	2	0.79	3	
4.33	17.000	10	2	0.79	6	
5.33	18.000	10	2	0.79	7	
6.33	18.000	10	1	0.79	7	
7.33	18.000	10	1	0.79	7	
8.33	20.000	10	1	0.79	6	
9.33	20.000	10	1	0.79	7	
10.33	21.000	10	1	0.79	7	
11.33	20.000	13	2	0.79	6	
12.33	19.000	13	2	0.79	6	
13.33	21.000	13	1	0.79	6	
14.33	19.000	13	1	0.79	6	
15.33	19.000	13	1	0.79	6	
16.33	20.000	13	1	0.79	6	
17.33	21.000	13	2	0.79	7	
18.33	20.000	13	2	0.79	8	
19.33	21.000	13	2	0.79	8	
20.33	18.000	13	2	0.79	8	
21.33	16.000	14	2	0.79	8	
22.33	17.000	14	2	0.79	8	
23.33	17.000	14	1	0.79	8	
24.33	16.000	14	1	0.79	8	
25.33	18.000	14	2	0.79	8	

Figure 16: Meteorological File for Aguamilpa

4.2 El Cajon Reservoir Model

A preliminary model for El Cajon was generated last year. This model was used as a base for the development of a more accurate model. The following images will show the TIN for El Cajon reservoir, bathymetry and storage capacity curves from last year's preliminary model and for the actual model.

4.2.1 TIN

This TIN was generated in WMS (Figure 17) using contours which were obtained from the National Power Commission of Mexico (CFE).

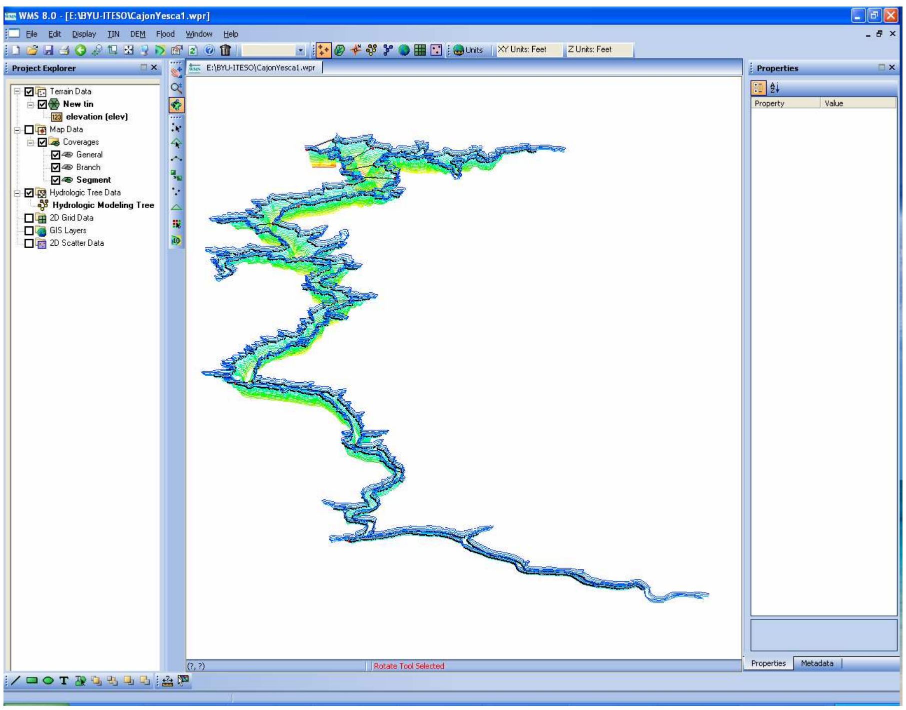


Figure 17: El Cajon TIN generated in WMS

4.2.2 Bathymetry

A bathymetry file was generated in last year preliminary project. AGPM V3.2 was used to view the bathymetry file, fix the size of layers and change the orientation of segments. A new and more accurate bathymetry file was created for El Cajon this year. AGPM V3.5 was used to view the bathymetry file, fix the size of layers and change the orientation of segments. Figure 18 shows the old bathymetry file, and the improved bathymetry can be seen in Figure 19, Figure 20 and Figure 21 showing different segments of the reservoir.

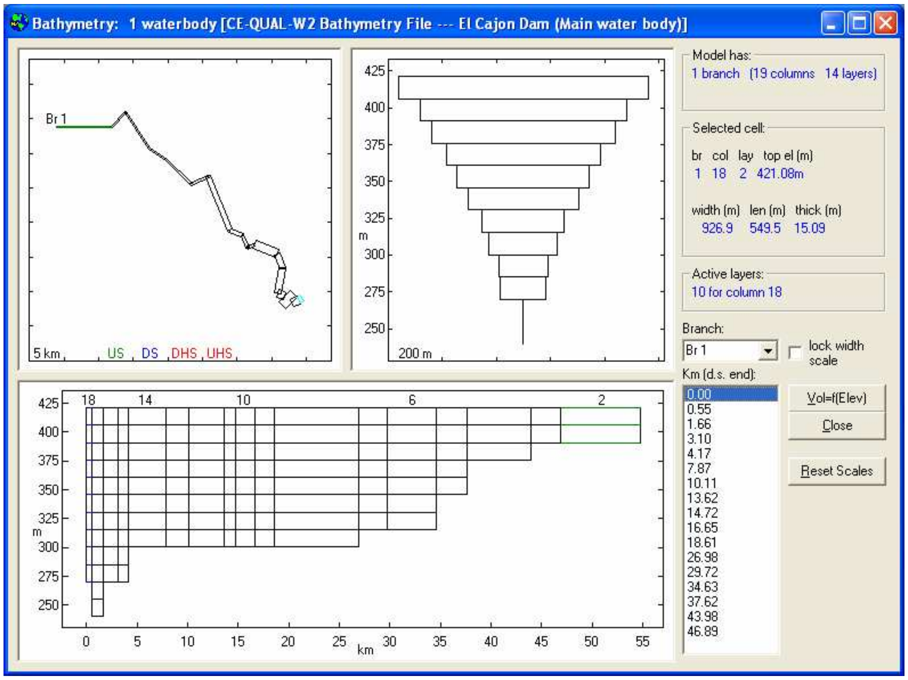


Figure 18: El Cajon Old Bathymetry (2007)

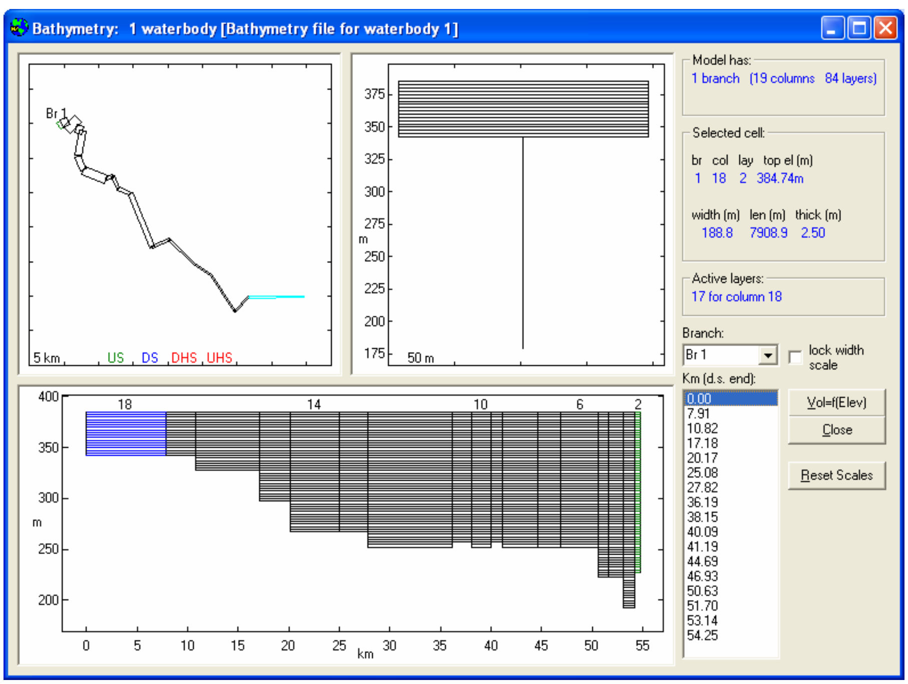


Figure 19: El Cajon Bathymetry Most Upstream Segment

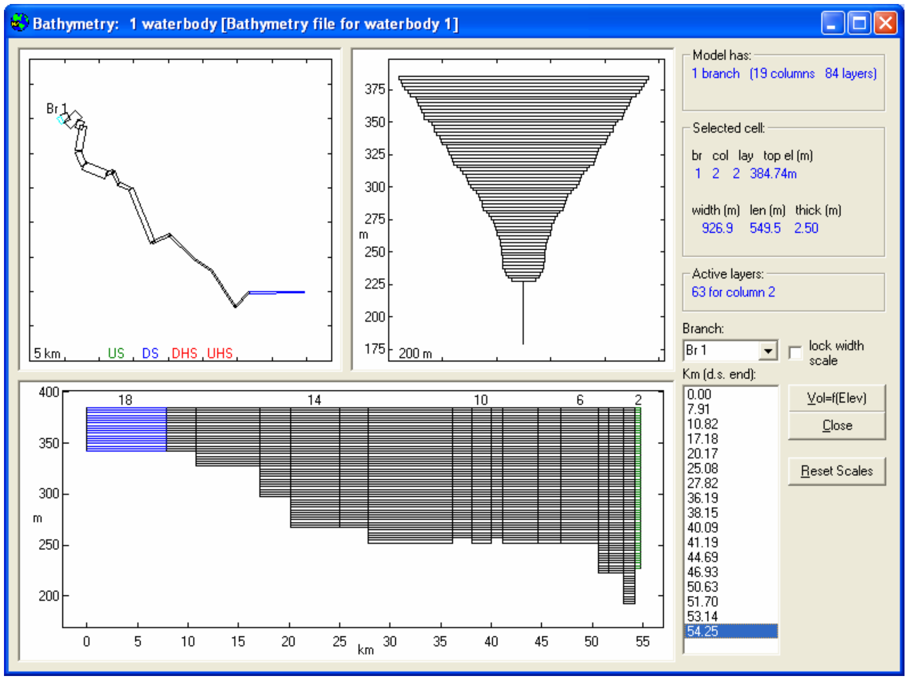


Figure 20: El Cajon Bathymetry Most Downstream Segment (Dam)

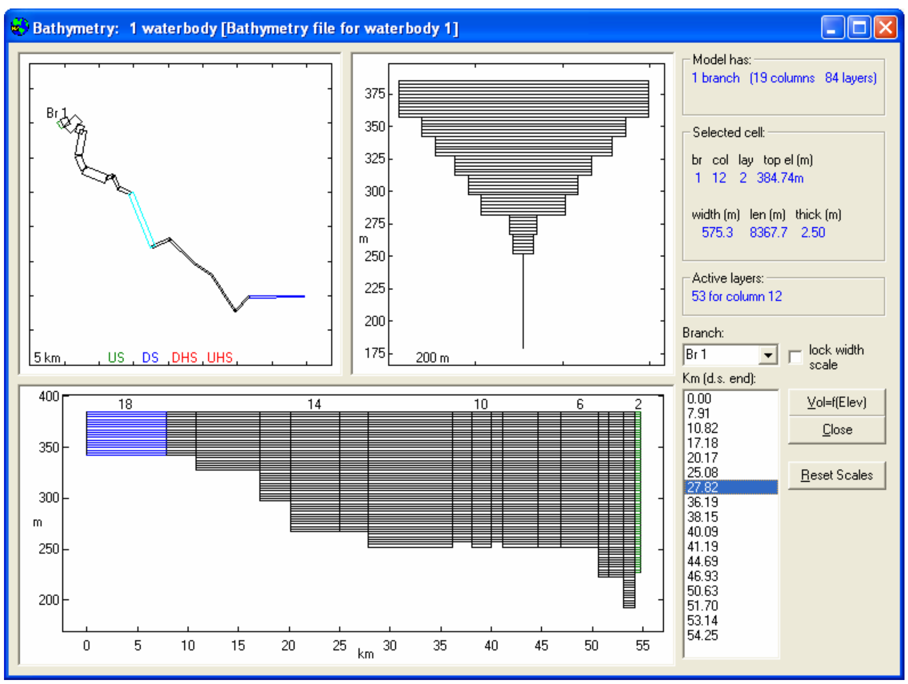


Figure 21: El Cajon Bathymetry Middle Segment

4.2.3 Storage Capacity Curves

The first storage capacity curve was generated in WMS (Figure 22). For the purpose of comparing and calibrating, a second capacity curve was generated using data obtained from CFE and ITESO (Figure 23).

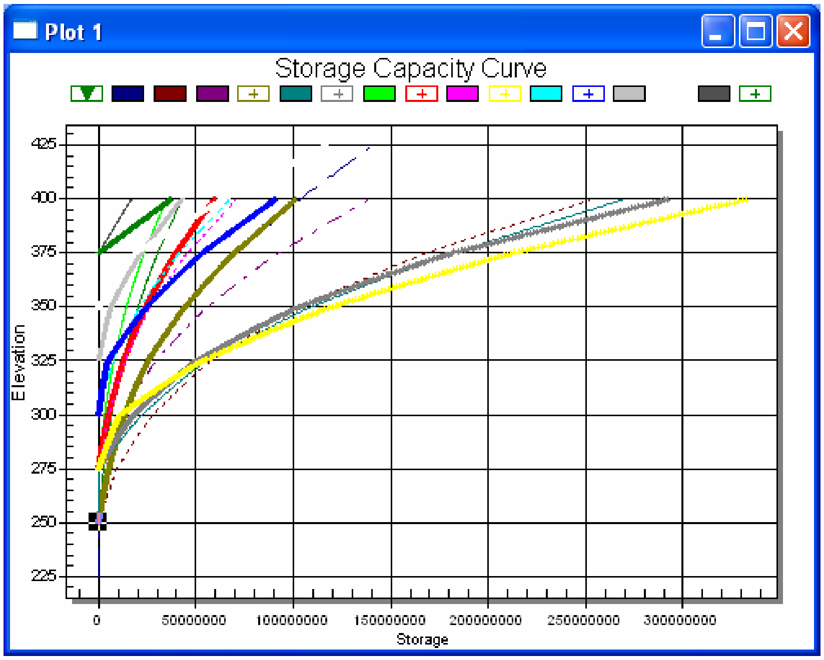


Figure 22: WMS Storage Capacity Curve El Cajon

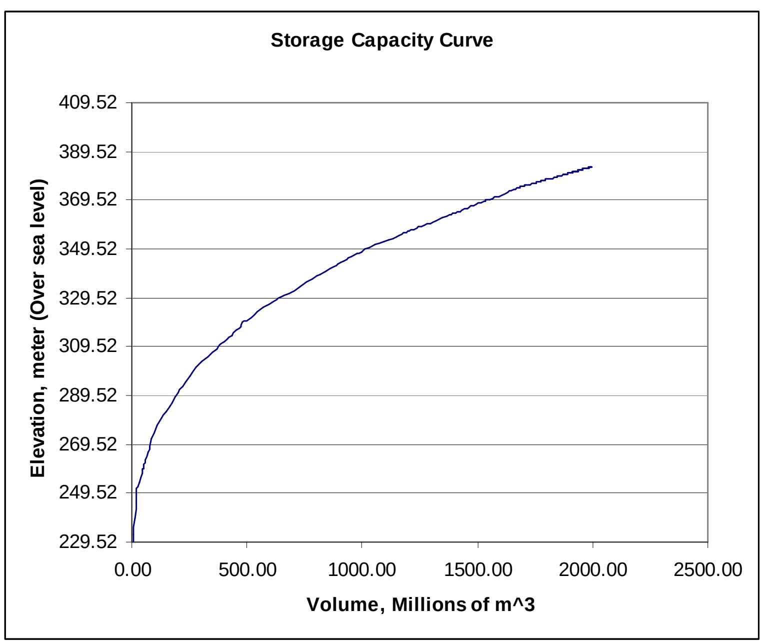


Figure 23: Storage Capacity Curve for El Cajon

5. Conclusion

Even though, neither Aguamilpa nor El Cajon models have been run yet, a great progress was achieved. A more accurate bathymetry and control files were created for El Cajon reservoir improving the ones which were made last year. These improved files will let ITESO students keep working on developing the uncalibrated model for El Cajon reservoir. For the Aguamilpa reservoir model, we also obtained a good progress, because the bathymetry file, control file, and meteorological file were created using the best data available. Visiting the studied areas let us answer several questions and misinformation that we had during the development of the Aguamilpa and El Cajon water quality models. ITESO students were using different software to verify the bathymetry and control files (Array Viewer Compaq) for El Cajon model than the one we used for the Aguamilpa model (AGPM-W2i Modeling System UI for CE-QUAL-W2 v3.5). This caused that they were not able to see the created files and check the possible errors. Going down to Mexico let us give them a license of AGPM-W2i v3.2 and trained them. Moreover, up to this point in both models, we can anticipate that they would be run because we defined what data is missing. We suggested them to design and follow a monitoring plan to collect more accurate water quality and quantity data that will help them to develop an uncalibrated model and calibrate it later using the collected data. Finally, we concluded that the most important lesson learned from this project was to know how to work as a team and collaborate with engineers from different countries and backgrounds.

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Appendix

Reference for Elevations of Aguamilpa Reservoir

VASO AGUAMILPA, NAY.
TABLAS DE ELEVACIONES - CAPACIDADES TOTALES
Página 1 de 9

	VOLUMEN EN MILLONES DE m³									
NIVEL	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
190.00	2965.00	2965.74	2966.48	2967.21	2967.95	2968.69	2969.43	2970.16	2970.90	2971.64
190.10	2972.38	2973.11	2973.85	2974.59	2975.33	2976.06	2976.80	2977.54	2978.28	2979.01
190.20	2979.75	2980.49	2981.23	2981.96	2982.70	2983.44	2984.18	2984.91	2985.65	2986.39
190.30	2987.13	2987.86	2988.60	2989.34	2990.08	2990.81	2991.55	2992.29	2993.03	2993.76
190.40	2994.50	2995.24	2995.98	2996.71	2997.45	2998.19	2998.93	2999.66	3000.40	3001.14
190.50	3001.88	3002.61	3003.35	3004.09	3004.83	3005.56	3006.30	3007.04	3007.78	3008.51
190.60	3009.25	3009.99	3010.73	3011.46	3012.20	3012.94	3013.68	3014.41	3015.15	3015.89
190.70	3016.63	3017.36	3018.10	3018.84	3019.58	3020.31	3021.05	3021.79	3022.53	3023.26
190.80	3024.00	3024.74	3025.48	3026.21	3026.95	3027.69	3028.43	3029.16	3029.90	3030.64
190.90	3031.38	3032.11	3032.85	3033.59	3034.33	3035.06	3035.80	3036.54	3037.28	3038.01
191.00	3038.75	3039.49	3040.23	3040.96	3041.70	3042.44	3043.18	3043.91	3044.65	3045.39
191.10	3046.13	3046.86	3047.60	3048.34	3049.08	3049.81	3050.55	3051.29	3052.03	3052.76
191.20	3053.50	3054.24	3054.98	3055.71	3056.45	3057.19	3057.93	3058.66	3059.40	3060.14
191.30	3060.88	3061.61	3062.35	3063.09	3063.83	3064.56	3065.30	3066.04	3066.78	3067.51
191.40	3068.25	3068.99	3069.73	3070.46	3071.20	3071.94	3072.68	3073.41	3074.15	3074.89
191.50	3075.63	3076.36	3077.10	3077.84	3078.58	3079.31	3080.05	3080.79	3081.53	3082.26
191.60	3083.00	3083.74	3084.48	3085.21	3085.95	3086.69	3087.43	3088.16	3088.90	3089.64
191.70	3090.38	3091.11	3091.85	3092.59	3093.33	3094.06	3094.80	3095.54	3096.28	3097.01
191.80	3097.75	3098.49	3099.23	3099.96	3100.70	3101.44	3102.18	3102.91	3103.65	3104.39
191.90	3105.13	3105.86	3106.60	3107.34	3108.08	3108.81	3109.55	3110.29	3111.03	3111.76
192.00	3112.50	3113.24	3113.98	3114.71	3115.45	3116.19	3116.93	3117.66	3118.40	3119.14
192.10	3119.88	3120.61	3121.35	3122.09	3122.83	3123.56	3124.30	3125.04	3125.78	3126.51
192.20	3127.25	3127.99	3128.73	3129.46	3130.20	3130.94	3131.68	3132.41	3133.15	3133.89
192.30	3134.63	3135.36	3136.10	3136.84	3137.58	3138.31	3139.05	3139.79	3140.53	3141.26
192.40	3142.00	3142.74	3143.48	3144.21	3144.95	3145.69	3146.43	3147.16	3147.90	3148.64
192.50	3149.38	3150.11	3150.85	3151.59	3152.33	3153.06	3153.80	3154.54	3155.28	3156.01
192.60	3156.75	3157.49	3158.23	3158.96	3159.70	3160.44	3161.18	3161.91	3162.65	3163.39
192.70	3164.13	3164.86	3165.60	3166.34	3167.08	3167.81	3168.55	3169.29	3170.03	3170.76
192.80	3171.50	3172.24	3172.98	3173.71	3174.45	3175.19	3175.93	3176.66	3177.40	3178.14
192.90	3178.88	3179.61	3180.35	3181.09	3181.83	3182.56	3183.30	3184.04	3184.78	3185.51
193.00	3186.25	3186.99	3187.73	3188.46	3189.20	3189.94	3190.68	3191.41	3192.15	3192.89
193.10	3193.63	3194.36	3195.10	3195.84	3196.58	3197.31	3198.05	3198.79	3199.53	3200.26
193.20	3201.00	3201.74	3202.48	3203.21	3203.95	3204.69	3205.43	3206.16	3206.90	3207.64
193.30	3208.38	3209.11	3209.85	3210.59	3211.33	3212.06	3212.80	3213.54	3214.28	3215.01
193.40	3215.75	3216.49	3217.23	3217.96	3218.70	3219.44	3220.18	3220.91	3221.65	3222.39
193.50	3223.13	3223.86	3224.60	3225.34	3226.08	3226.81	3227.55	3228.29	3229.03	3229.76
193.60	3230.50	3231.24	3231.98	3232.71	3233.45	3234.19	3234.93	3235.66	3236.40	3237.14
193.70	3237.88	3238.61	3239.35	3240.09	3240.83	3241.56	3242.30	3243.04	3243.78	3244.51
193.80	3245.25	3245.99	3246.73	3247.46	3248.20	3248.94	3249.68	3250.41	3251.15	3251.89
193.90	3252.63	3253.36	3254.10	3254.84	3255.58	3256.31	3257.05	3257.79	3258.53	3259.26
194.00	3260.00	3260.74	3261.48	3262.21	3262.95	3263.69	3264.43	3265.16	3265.90	3266.64
194.10	3267.38	3268.11	3268.85	3269.59	3270.33	3271.06	3271.80	3272.54	3273.28	3274.01
194.20	3274.75	3275.49	3276.23	3276.96	3277.70	3278.44	3279.18	3279.91	3280.65	3281.39
194.30	3282.13	3282.86	3283.60	3284.34	3285.08	3285.81	3286.55	3287.29	3288.03	3288.76
194.40	3289.50	3290.24	3290.98	3291.71	3292.45	3293.19	3293.93	3294.66	3295.40	3296.14
194.50	3296.88	3297.61	3298.35	3299.09	3299.83	3300.56	3301.30	3302.04	3302.78	3303.51
194.60	3304.25	3304.99	3305.73	3306.46	3307.20	3307.94	3308.68	3309.41	3310.15	3310.89
194.70	3311.63	3312.36	3313.10	3313.84	3314.58	3315.31	3316.05	3316.79	3317.53	3318.26
194.80	3319.00	3319.74	3320.48	3321.21	3321.95	3322.69	3323.43	3324.16	3324.90	3325.64
194.90	3326.38	3327.11	3327.85	3328.59	3329.33	3330.06	3330.80	3331.54	3332.28	3333.01

NOTA: ESTAS TABLAS FUERON ELABORADAS EN BASE A LOS DATOS ORIGINALES DE PROYECTO, CON INTERPOLACION LINEAL A CADA METRO.

UNIDAD DE INGENIERIA Y CONSTRUCCION

DEPTO. DE HIDROMETEOROLOGIA

Reference for Meteorological File for Aguamilpa Reservoir.

COMISIÓN FEDERAL DE ELECTRICIDAD

SUBDIRECCIÓN DE GENERACIÓN
GERENCIA REGIONAL DE PRODUCCIÓN OCCIDENTE
SUBGERENCIA REGIONAL DE GENERACIÓN HIDROELÉCTRICA BALSAS - SANTIAGO
DIVISIÓN HIDROMÉTRICA MICHOACÁN

CLIMATOLÓGICA: AGUAMILPA ESTADO: JALISCO MUNICIPALIDAD: GUADALAJARA MES DE: NOVIEMBRE DE: 1995
ALTURA DE LA ESTACIÓN SOBRE EL NIVEL DEL MAR 1083 LOCALIZACIÓN EN COORDENADAS Latitud Norte 20° 47' 39' Longitud Oeste 103° 19' 24'

REGISTRO DE OBSERVACIONES HECHAS A LAS 8:00 HORAS

FECHAS	TERMÓMETRO AL ABRIGO				LLUVIA	MICRÓMETRO		EVAPORACIÓN EN 24 HORAS	A LA HORA DE LA OBSERVACIÓN					HELADAS	EN LAS 24 HORAS ANTERIORES A LA OBSERVACIÓN			
	AMBIENTE	MÁXIMA	MÍNIMA	OSCILACIÓN	EN mm DE ALTURA	LECTURAS			VIENTO DIR.	VIENTO VEL.	ESTADO DEL CIELO	ESTADO DEL TIEMPO (NOTAS)	VISIBILIDAD		ESTADO DEL CIELO	FENÓMENOS DIVERSOS	VIENTO DIRECCIÓN	VIENTO VELOCIDAD
1	21.0		20.0	12.5		112.69		5.92	NW	1	○	FRESCO	5 T	NO				
2	22.5	32.5	21.0	13.5	0.0	106.77		2	NW	2	○	FRESCO ≡	5 T	NO	○	CALUROSO	SE	2
3	23.5	34.5	22.0	12.5	0.0	100.94		5.97	SW	2	○	FRESCO ≡	5 T	NO	○	CALUROSO	SE	1
4	24.5	34.5	22.5	11.5	0.0	94.97		5.57	NW	2	○	FRESCO	4 T	NO	○	CALUROSO	SE	2
5	26.0	34.0	24.0	11.0	INAP	89.40		6.71	NE	2	●	FRESCO	3 T	NO	●	CALUROSO	SE	2
6	25.0	35.0	24.0	10.5	0.0	82.69		5.82	SW	2	●	TEMPLADO	4 T	NO	●	CALUROSO	SE	2
7	24.5	34.5	24.0	10.0	0.0	76.87		3.96	SW	1	◐	TEMPLADO	4 T	NO	◑	CALUROSO	SE	2
8	23.5	34.0	22.5	12.0	0.0	72.91		4.23	SW	3	○	TEMPLADO	4 T	NO	○	CALUROSO	SE	2
9	26.0	34.5	23.0	10.5	0.0	68.68		6.19	SW	3	◐	FRESCO	4 T	NO	◑	CALUROSO	SE	2
10	23.0	33.5	22.0	10.0	0.0	62.49		5.12	NW	1	◐	FRESCO	4 T	NO	◑	CALUROSO	SE	2
11	24.5	32.0	23.0	11.5	0.0	57.37		4.33	SW	2	◐	FRESCO	5 T	NO	◑	CALUROSO	SE	2
12	25.5	34.5	24.0	9.5	0.0	53.04		4.96	SW	2	◐	FRESCO	5 T	NO	◑	CALUROSO	SE	2
13	25.0	33.5	24.0	10.0	0.0	48.08		6.47	SW	1	○	FRESCO ≡	4 T	NO	○	CALUROSO	SE	2
14	25.0	34.0	24.0	9.5	0.0	41.61		5.34	SW	1	○	FRESCO ≡	4 T	NO	○	CALUROSO	SE	2
15	24.0	33.5	23.5	10.0	0.0	36.27		4.36	NE	2	○	FRESCO ≡	5 T	NO	○	CALUROSO	SE	2
16	24.0	33.5	23.5	8.5	0.0	31.91		5.58	NE	2	◐	FRESCO	5 T	NO	○	CALUROSO	SE	2
17	24.0	32.0	23.0	9.0	0.0	26.33		4.47	NW	1	◐	FRESCO ≡	4 T	NO	◑	CALUROSO	SE	2
18	23.5	32.0	22.5	10.0	0.0	21.86	149.90	4.33	NW	1	◐	FRESCO	5 T	NO	◑	CALUROSO	SE	2
19	23.0	32.5	21.5	12.5	0.0		145.57	6.17	SW	1	◐	FRESCO	4 T	NO	◑	CALUROSO	SE	2
20	23.0	34.0	22.0	8.5	0.0		139.40	4.74	SW	3	○	FRESCO	4 T	NO	◑	CALUROSO	SE	2
21	24.0	30.5	22.5	8.5	0.0		134.66	4.87	NW	2	●	FRESCO	4 T	NO	●	CALUROSO	SE	2
22	22.5	31.0	22.0	13.5	0.0		129.79	5.01	SW	1	○	FRESCO	5 T	NO	○	TEMPLADO	SE	2
23	23.5	35.5	22.5	11.5	0.0		124.78	6.59	SW	3	○	FRESCO	4 T	NO	○	CALUROSO	SE	2
24	24.5	34.0	23.0	14.0	0.0		118.19	6.56	SW	2	○	FRESCO	5 T	NO	○	CALUROSO	SE	2
25	25.0	37.0	22.5	14.5	0.0		109.63	8.73	SE	2	○	TEMPLADO	5 T	NO	○	CALUROSO	SE	2
26	21.5	37.0	21.0	14.0	0.0		100.90	9.07	SW	2	○	FRESCO	5 T	NO	○	CALUROSO	SE	2
27	20.5	35.0	20.0	12.5	0.0		91.83	8.47	SW	2	○	FRESCO	5 T	NO	○	CALUROSO	SE	2
28	22.0	32.5	20.0	10.5	0.0		83.36	8.85	SE	2	◐	FRESCO	5 T	NO	○	CALUROSO	SE	2
29	22.0	30.5	21.0	11.5	0.0		74.51	8.76	NW	1	◐	FRESCO	5 T	NO	◑	CALUROSO	SE	2
30	21.0	32.5	20.5	11.5	0.0		65.75	4.21	SW	1	○	FRESCO	5 T	NO	○	CALUROSO	SE	2
1		32.0			0.0		61.54								○	CALUROSO	SE	2
SUMA	707.5	1006.0	671.0	335.0	0.0			175.36										
MEDIA	23.6	33.5	22.4	11.2	0.0			5.85										

RESUMEN MENSUAL

Temperatura máxima en el mes	37.0	día: 24 y 25	Número de días con lluvia de 0.1 mm en adelante	0		
Temperatura mínima en el mes	20.0	día: Varios	Número de días con lluvia inapreciable	1		
Temperatura media en el mes	28.0		Lluvia máxima en 24 horas en milímetros	0	día: ---	
Número de días con helada	0		Total de lluvia en el mes en milímetros de altura	0		
Número de días con nevada	0		Evaporación total del mes en milímetros	175.36		
Número de días con granizo	0		Evaporación media diaria en milímetros	5.85		
Número de días nublados	3		Número de días con tempestad eléctrica	0		
Número de días despejados	17		Número de días con niebla	6		
Viento dominante	SE		Número de días con rocío	0		
Fecha de la primera y última helada	---		Visibilidad dominante	5 T		
Oscilación máxima	14.5					

NOTAS:

OBSERVADOR: #N/A CAPTURÓ: #N/A REVISÓ: #N/A