# BAYOU COCODRIE TMDL FOR DISSOLVED COPPER

SUBSEGMENTS 060201

Louisiana Department of Environmental Quality
Office of Environmental Assessment
Water Quality Assessment Division

December 22, 1999

First Revision 02/02/2000

Second Revision 10/13/2006

Third Revision 03/26/2007

Fourth Revision 12/06/2007

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# EXECUTIVE SUMMARY

Section 303(d) of the Federal Clean Water Act requires states to identify waterbodies that are not meeting water quality standards and to develop total maximum daily pollutant loads for those waterbodies. A total maximum daily load (TMDL) is the amount of a pollutant that a waterbody can assimilate without exceeding the established water quality standard for that pollutant. Through a TMDL, pollutant loads can be distributed or allocated to point sources and nonpoint sources discharging to the waterbody.

Bayou Cocodrie flows from its headwaters, at the outlet of Cocodrie Lake in South Central Louisiana, to its confluence with the Bayou Boeuf / Cocodrie Diversion Canal. The Bayou Cocodrie subsegment 060201 is listed on the 1998 Section 303(d) List as not fully supporting the water quality standard for dissolved copper and dissolved lead. These parameters were assessed to be above the water quality standard, based on sampling and lab techniques that did not adhere to the “Clean Methods” guidelines. It was decided to retest the water body using the “Clean Method” procedures. Between the months of July and October in 1999, five metals samples were taken. The sample results showed that the dissolved copper exceeded the subsegment’s water quality criterion based on the equation then in effect. The dissolved lead was meeting the water quality criterion. Thus a TMDL was developed for dissolved copper in Bayou Cocodrie. Since publication of the final TMDL in 2000, revisions have been made in the regulations to the equation used to determine the copper criterion and the stream has been reassessed as meeting the criterion. The revisions meet the Federal regulatory requirements for determining copper criterion.

For the purpose of TMDL development in 2006, the dissolved copper numerical criterion was calculated based on the freshwater chronic value for aquatic life protection using the minimum hardness of 25 from the LPDES Implementation Procedures and the equations and factors presented in the regulations. The dissolved copper numerical criterion value was determined to be 3.76 ug/l. The facility is planning a Water Effect Ratio study to verify that the criterion is appropriate for the stream.

A mass balance model was developed which addresses the headwater conditions, the CLECO outfalls from Mountain Bayou Lake and the CLECO cooling water intake on Bayou Cocodrie. The model was based on maintaining the copper criterion at the downstream from the cooling water intake. Since the CLECO plant is a merchant peak power plant with a wide variety of flows, an effluent discharge flow-based equation was developed to determine the permissible loading from CLECO.

CLECO Effluent Load in lbs/day = 0.0158*(CLECO flow in MGD) + 0.5108

**Table 1. Total Maximum Daily Load of Dissolved Copper at CLECO Total Discharge Flow = 350 MGD**

| **ALLOCATION** | % Reduction Required | TMDL lbs/day |
|---|---|---|
| Point Source WLA | 0 | 6.06 |
| Point Source Reserve MOS =50% | | 6.06 |
| Nonpoint Source LA | 0 | 0.06 |
| Nonpoint Source Reserve MOS (not used) | | 0 |
| TMDL | | 12.18 |

## 1. Introduction

The Bayou Cocodrie subsegment 060201 was tested during July through October of 1999, for metals using the "Clean Metals" techniques. The sample results showed an exceedance with dissolved copper thus requiring a TMDL for this parameter. A TMDL for dissolved copper was developed in accordance with the requirements of Section 303 of the federal Clean Water Act.

## 2. Study Area Description

### 2.1 Bayou Cocodrie, Subsegment 060201

Bayou Cocodrie flows from its headwaters at Cocodrie Lake through the town of St. Landry to the Bayou Bouef / Cocodrie Diversion Canal thence to Bayou Courtableau thence to Bayou Teche. A location map is shown as Attachment A.

Bayou Cocodrie is part of the Vermilion-Teche River Basin and lies in the Western Gulf Coastal Plain ecoregion. The Basin is characterized as plains/prairie, and the land is generally flat with a very gradual slope toward the Gulf of Mexico. The predominant land use in the Basin is agricultural.

Land use in Subsegment 060201, is shown in Table 2 and presented in a map in Attachment B. (LDEQ, GAP June 2000) Average annual rainfall in the Vermilion-Teche River Basin is near 60 inches, and average annual temperature is 68$^{o}$F.

Table 2. Land use in Subsegment 060201

| *Land Use* | *Area (Acres)* | *% Land Use* |
|---|---|---|
| Upland Forest Mixed | 16120.20 | 15.48 |
| Agriculture/Cropland/Grassland | 14629.78 | 14.05 |
| Wetland Forest Deciduous | 13729.52 | 13.19 |
| Upland Forest Evergreen | 9644.14 | 9.26 |
| Upland S/S Mixed | 8449.17 | 8.11 |
| Upland Forest Evergreen | 7989.40 | 7.67 |
| Wetland Forest Deciduous | 7255.85 | 6.97 |
| Upland Forest Deciduous | 6354.26 | 6.10 |
| Upland Forest Deciduous | 6109.50 | 5.87 |
| Upland Forest Mixed | 3642.15 | 3.50 |
| Upland S/S Mixed | 2892.24 | 2.78 |
| Agriculture/Cropland/Grassland | 2308.83 | 2.22 |
| Upland S/S Evergreen | 1435.38 | 1.38 |
| Wetland Forest Mixed | 1023.48 | 0.98 |
| Water | 902.03 | 0.87 |
| Dense Pine Thicket | 639.03 | 0.61 |
| Water | 223.17 | 0.21 |
| Vegetated Urban | 197.62 | 0.19 |
| Dense Pine Thicket | 191.04 | 0.18 |
| Wetland S/S Mixed | 181.25 | 0.17 |

| *Land Use* | *Area (Acres)* | *% Land Use* |
|---|---|---|
| Wetland S/S Deciduous | 54.26 | 0.05 |
| Upland S/S Evergreen | 52.26 | 0.05 |
| Fresh Marsh | 50.71 | 0.05 |
| Wetland Barren | 31.23 | 0.03 |
| Upland Barren | 9.30 | 0.01 |

## 2.2 Water Quality Standards

The designated uses for Bayou Cocodrie include primary contact recreation, secondary contact recreation, propagation of fish and wildlife and outstanding natural resource water. From Louisiana's LPDES Implementation Plan: "Metals criterion for aquatic life protection are based on dissolved metals concentrations in ambient waters. They are a function of hardness ($CaCO_3$), which typically will be obtained from average two-year data compilations contained in the latest Louisiana Water Quality Data Summary (Units in mg/l). However, other comparable data compilations or reports or water body specific data provided by the applicant may be considered. The minimum hardness shall be 25 mg/l and the maximum hardness shall be 400 mg/l used in hardness dependent metal criterion calculations in accordance with 40 CFR 131.36 (c) (4) (i)." The hardness values from the ambient sampling record were less than 25 mg/l, so the minimum hardness of 25 mg/l was used. The criterion was calculated for both acute and chronic protection and the most stringent was established as the criterion. The resulting copper criterion is 3.76 ug/l and is applied as a daily maximum. The calculations are shown in Table 3.

**Table 3. Calculation of the WQ Criterion for Dissolved Copper in Subsegment 060201:**

**Calculation of the Chronic Water Quality Standard**
**<u>for Dissolved Copper in the 060201 subsegment:</u>**

Minimum Hardness per LPDES Permit Implementation Plan = 25 mg/l

The dissolved Copper LADEQ WQ criterion = Freshwater Chronic criterion = $e^{(0.8545*\ln(\text{avg. hardness}) - 1.3860)}$ X CF
CF = 0.960 for copper

The dissolved Chronic Copper LADEQ WQ criterion = 3.76 ug/l = 0.00376 mg/l

**Calculation of the Acute Water Quality Standard**
**<u>for Dissolved Copper in the 060201 subsegment:</u>**

Minimum Hardness per LPDES Permit Implementation Plan = 25 mg/l

The dissolved Copper LADEQ WQ criterion = Freshwater Acute criterion = $e^{(0.9422*\ln(\text{avg. hardness}) - 1.3844)}$ X CF
CF = 0.960 for copper

The dissolved Acute Copper LADEQ WQ criterion = 4.99 ug/l = 0.004991 mg/l

**WATER QUALITY CRITERION TO BE USED = 3.76 ug/l = 0.00376 mg/l**

## 2.3 Identification of Sources

The suspected major source is the CLECO Evangeline, LLC plant located near the town of St. Landry. The facility has multiple discharges associated with the operation of a steam electric generating plant. The facility has revamped their piping system to eliminate as many sources of copper as possible with today's technology. Other point and non-point sources could also be contributing to the problem but none were located at this time. The discharger in this case is unique. Once through non-contact cooling water is withdrawn from Bayou Cocodrie and then discharged to Mountain Bayou Lake. The water discharges from the Lake back to Bayou Cocodrie at two points as shown by the map. Both discharge points are upstream of the cooling water intake. The withdrawal is larger than the effluent discharge due to evaporative losses in the lakes. At critical conditions, this difference is 3.04MGD. CLECO has no control over rainfall runoff that flows to Mountain Bayou Lake from the Lake's watershed. The effluent discharge is therefore a combination of plant effluent and stormwater runoff at various times. The facility is planning to perform a Water Effects Ratio (WER) or similar sampling program to identify and quantify any remaining sources of copper in their effluent and measure the actual stream water quality. Current assessments show no copper problem in the stream.

# 3. **TMDL**

The dissolved copper TMDL is based on maintaining the water quality criterion downstream from the only known source of copper in the watershed. In accordance with current regulations, the criterion value is 3.76 ug/l. The WER will verify that the standard is appropriate for the stream.

The TMDL established in 2000 treated CLECO as a "black box" having a net effect on Bayou Cocodrie. This approach proved impractical for implementation purposes since there was actually a small distance along the Bayou where the flow was the total of the plant effluent flow, any stormwater flow to Mountain Bayou Lake, and the headwater flow. The resulting copper load was increased accordingly in this small reach.

For the purpose of TMDL development in 2006, a mass balance model was developed which addresses the headwater conditions, the CLECO outfalls from Mountain Bayou Lake and the CLECO cooling water intake on Bayou Cocodrie. The uncontrollable stormwater flow into Mountain Lake Bayou cannot be measured and is therefore not included in the TMDL, providing an implicit margin of safety. The model was based on maintaining the copper criterion downstream from the cooling water intake. Since the CLECO plant is a merchant peak power plant with a wide variety of flows, an effluent discharge flow-based equation was developed to determine the permissible loading from CLECO.

CLECO Effluent Load in lbs/day = 0.0158*(CLECO flow in MGD) + 0.5108

The TMDL shown in Table 4 is based on critical conditions in the bayou and peak flow from the plant. The headwater concentration of 0.02 ug/l dissolved Cu is identical to the Cu concentration out of Bayou Chicot and was thus assumed to be the natural background nonpoint source loading. There are no other man-made sources known to exist. A margin of safety of 50% was used in this case.

**Table 4. Total Maximum Daily Load of Dissolved Copper at CLECO Total Discharge Flow = 350 MGD**

| ALLOCATION | | |
|---|---|---|
| | % Reduction Required | TMDL lbs/day |
| Point Source WLA | 0 | 6.06 |
| Point Source Reserve MOS =50% | | 6.06 |
| Natural Nonpoint Source LA | 0 | 0.06 |
| Natural Nonpoint Source Reserve MOS (not used) | | 0 |
| TMDL | | 12.18 |

### 3.1 Seasonal Variability

The water quality criterion for dissolved copper is a year-round value thus the TMDL is applicable year round. No seasonal variability is expected or observed for copper concentrations in ambient waters.

### 3.2 Margin of Safety (MOS)

The Clean Water Act requires that TMDLs take into consideration a margin of safety. EPA guidance allows for the use of implicit or explicit expressions of the margin of safety or both. When conservative assumptions are used in the development of the TMDL or conservative factors are used in the calculations, the margin of safety is implicit. In this TMDL for dissolved copper, there is an explicit margin of safety of 50%.

## 4. **Monitoring Plan**

LDEQ has developed this TMDL to be consistent with the state antidegradation policy (LAC 33:IX.1109.A).

LDEQ will work with other agencies such as local Soil Conservation Districts to implement agricultural best management practices in the watershed through the 319 programs. LDEQ will also continue to monitor the waters to determine whether standards are being attained.

In accordance with Section 106 of the federal Clean Water Act and under the authority of the Louisiana Environmental Quality Act, the LDEQ has established a comprehensive program for monitoring the quality of the state's surface waters. The LDEQ Surveillance Section collects surface water samples at various locations, utilizing appropriate sampling methods and procedures for ensuring the quality of the data collected. The objectives of the surface water monitoring program are to determine the quality of the state's surface waters, to develop a long-term database for water quality trend analysis, and to monitor the effectiveness of pollution controls. The data obtained through the surface water monitoring program is used to develop the state's biennial 305(b) report (*Water Quality Inventory*) and the 303(d) list of impaired waters. This information is also utilized in establishing priorities for the LDEQ nonpoint source program.

The LDEQ is continuing to implement a watershed approach to surface water quality monitoring. In 2004 a four year sampling cycle replaces the previous five year cycle. Approximately one quarter of the states watersheds will be sampled each year so that all of the state's watersheds will be sampled within the four year cycle. This will allow LDEQ to determine whether there has been any improvement in water quality following implementation of the TMDLs. As the monitoring results are evaluated at the end of each year, waterbodies may be added to or removed from the 303(d) list.

# REFERENCES

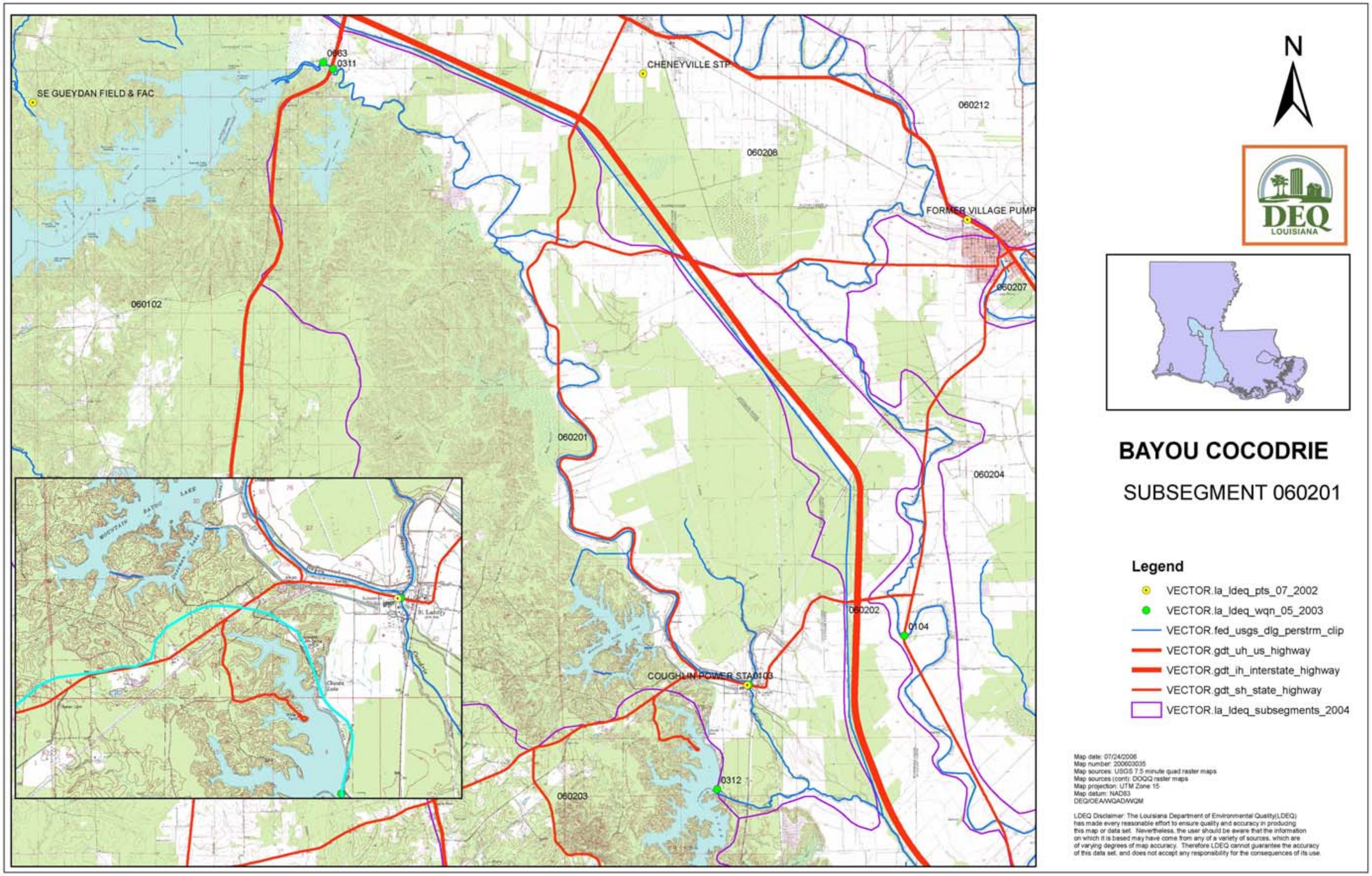
Louisiana Department of Environmental Quality. *Permitting Guidance Document For Implementing Louisiana Surface Water Quality Standards Water Quality Management Plan Volume 3*. Louisiana Department of Environmental Quality, Office of Environmental Services, Baton Rouge, 2001.

Louisiana Department of Environmental Quality. *Environmental Regulatory Code, Part IX. Water Quality Regulations*. Louisiana Department of Environmental Quality, 2005

*Lowflow on Streams in Louisiana*. Fred N. Lee. Louisiana Department of Environmental Quality, Water Quality Assessment Division, WQ Modeling Section, 2000.

*Bayou Cocodrie Watershed TMDL Report.* ftn Associates, Ltd., December 22, 1999.

ATTACHMENT A


SE GUEYDAN FIELD & FAC
0083
0311
CHENEYVILLE STP
060212
060208
FORMER VILLAGE PUMP
060207
060102
060201
060204
060202
0104
COUGHLIN POWER STA
0103
0312
060203
N
DEQ
LOUISIANA
BAYOU COCODRIE
SUBSEGMENT 060201
Legend
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VECTOR.la_ldeq_wqn_05_2003
VECTOR.fed_usgs_dlg_perstrm_clip
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VECTOR.gdt_ih_interstate_highway
VECTOR.gdt_sh_state_highway
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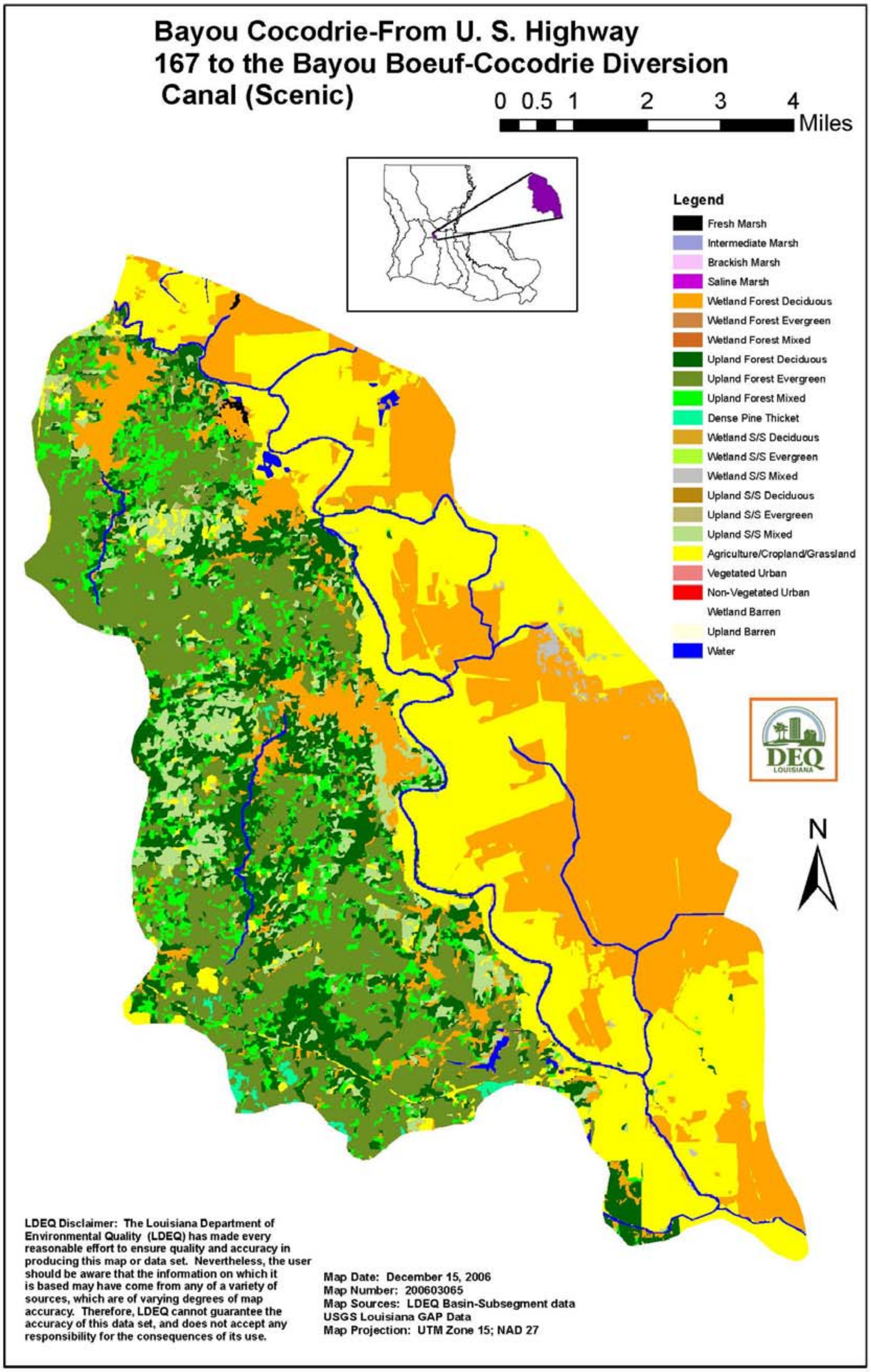
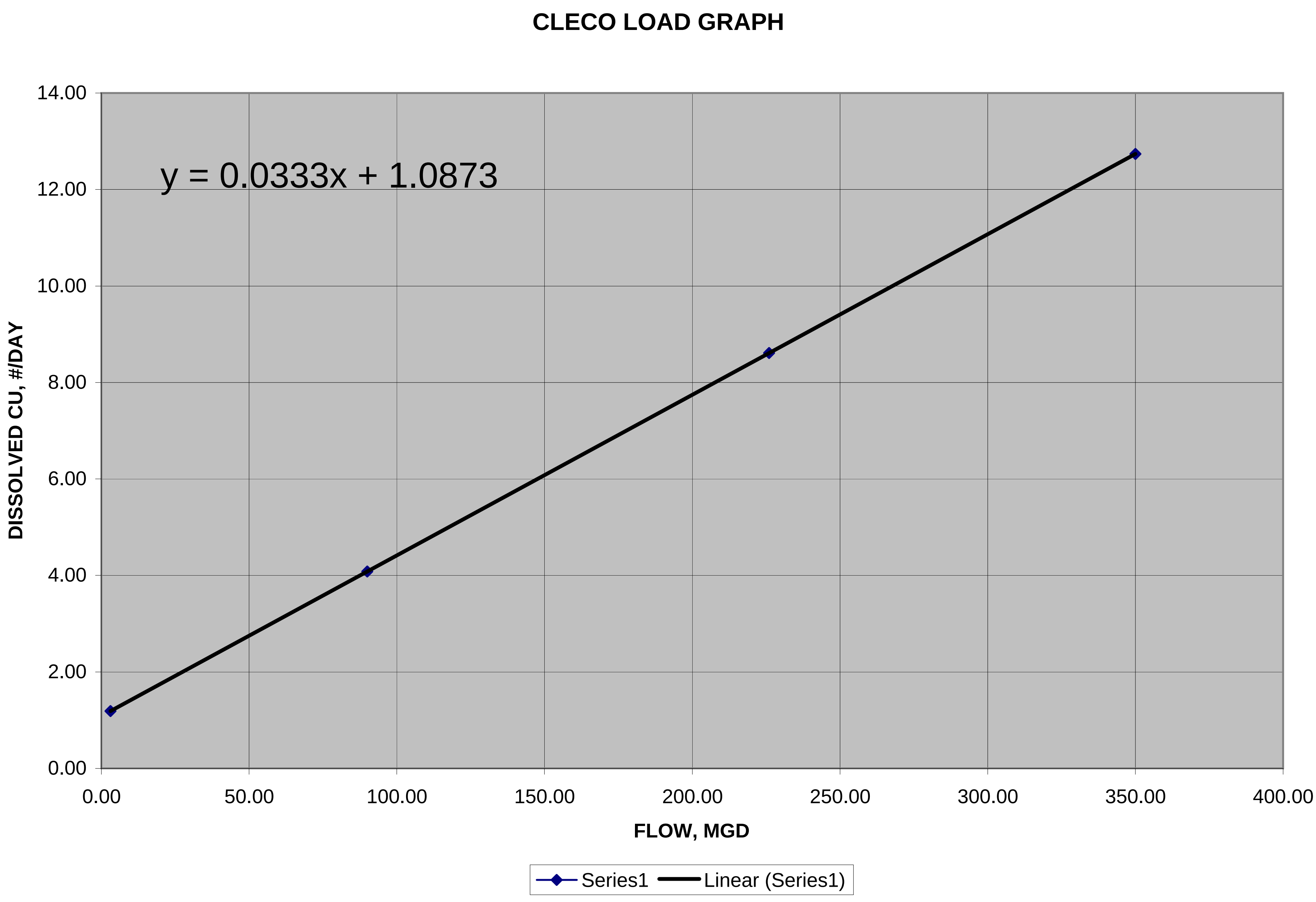
Map number: 200603035
Map sources: USGS 7.5 minute quad raster maps
Map sources (cont): DOQQ raster maps
Map projection: UTM Zone 15
Map datum: NAD83
DEQ/OEA/WQAD/WQM
LDEQ Disclaimer: The Louisiana Department of Environmental Quality(LDEQ) has made every reasonable effort to ensure quality and accuracy in producing this map or data set. Nevertheless, the user should be aware that the information on which it is based may have come from any of a variety of sources, which are of varying degrees of map accuracy. Therefore LDEQ cannot guarantee the accuracy of this data set, and does not accept any responsibility for the consequences of its use.

# ATTACHMENT B


Bayou Cocodrie-From U. S. Highway 167 to the Bayou Boeuf-Cocodrie Diversion Canal (Scenic)
0 0.5 1 2 3 4 Miles
Legend
Fresh Marsh
Intermediate Marsh
Brackish Marsh
Saline Marsh
Wetland Forest Deciduous
Wetland Forest Evergreen
Wetland Forest Mixed
Upland Forest Deciduous
Upland Forest Evergreen
Upland Forest Mixed
Dense Pine Thicket
Wetland S/S Deciduous
Wetland S/S Evergreen
Wetland S/S Mixed
Upland S/S Deciduous
Upland S/S Evergreen
Upland S/S Mixed
Agriculture/Cropland/Grassland
Vegetated Urban
Non-Vegetated Urban
Wetland Barren
Upland Barren
Water
DEQ LOUISIANA
N
LDEQ Disclaimer: The Louisiana Department of Environmental Quality (LDEQ) has made every reasonable effort to ensure quality and accuracy in producing this map or data set. Nevertheless, the user should be aware that the information on which it is based may have come from any of a variety of sources, which are of varying degrees of map accuracy. Therefore, LDEQ cannot guarantee the accuracy of this data set, and does not accept any responsibility for the consequences of its use.
Map Date: December 15, 2006
Map Number: 200603065
Map Sources: LDEQ Basin-Subsegment data
USGS Louisiana GAP Data
Map Projection: UTM Zone 15; NAD 27

ATTACHMENT C


CLECO LOAD GRAPH
y = 0.0333x + 1.0873
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
DISSOLVED CU, #/DAY
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
400.00
FLOW, MGD
Series1
Linear (Series1)

MASS BALANCE MODEL FOR CLECO ALLOCATIONS

X = CLECO monthly average discharge concentration which causes the downstream concentration to equal the criteria (mg/l)
L = CLECO monthly average concentration limitation (mg/l)
M = CLECO monthly average mass limitation (lb/d)
Q1 = Bayou Cocodrie upstream critical flow (mgd)
Q2 = CLECO discharge rate from Mountain Bayou Lake to Bayou Cocodrie (mgd)
(Total for Outfalls???, 002 and 003)(Equivalent to Q3 less 4.7 cfs in evaporative losses)
Q3 = CLECO intake rate from Bayou Cocodrie (mgd)
Y = Bayou Cocodrie upstream Cu concentration (mg/l)
C = Cu criteria (mg/l)
MOS = % Margin of safety

A mass balance at any point in Bayou Cocodrie between the CLECO discharge and the CLECO intake should yield the same mg/l allocation as a mass balance in Bayou Cocodrie below the CLECO intake. The latter implements a net CLECO discharge of copper. The former takes advantage of the fact that the in-stream concentration of copper will be the same above and below the CLECO withdrawal.

1. Mass balance downstream of CLECO intake:

C*(Q1+Q2-Q3)*8.32 = (Y*Q1*8.34) + (X*Q2*8.34) - Q3*8.34*(Y*Q1+X*Q2)/(Q1+Q2)

C*(Q1+Q2-Q3) = Y*Q1 + X*Q2 - Y*Q1*Q3/(Q1+Q2) + X*Q2*Q3/(Q1+Q2)

$$\boxed{X = \frac{C*(Q1+Q2-Q3) - Y*Q1 + \frac{Y*Q1*Q3}{(Q1+Q2)}}{Q2 - \frac{Q2*Q3}{Q1+Q2}}}$$

2. Mass balance between CLECO discharge and intake:

C*(Q1+Q2)*8.32 = (Y*Q1*8.34) + (X*Q2*8.34)

$$\boxed{X = \frac{C*(Q1+Q2) - Y*Q1}{Q2}}$$

3. CLECO mass limitation:

M = X*Q2*8.34

| | | cfs | mgd | Mass Balance 1 | Mass Balance 2 | Units |
|---|---|---|---|---|---|---|
| Q1 = | | 52.60 | 34.00 | 0.06 | | lbs/d |
| Q2 = | | | 350.00 | | | |
| Q3 = | | | 353.04 | | | |
| Y (mg/l) = | 0.0002 | | | | | |
| C (mg/l) = | 0.0050 | | | | | |
| % MOS = | 20 | | | 3.1848 | | |
| L = X - MOS | | | | 0.0044 | 0.0044 | mg/l |
| M | | | | 12.7393 | 12.7393 | lbs/d |

Provide input to the light gray cells. Allocations in white type in the dark gray cells.

MASS BALANCE MODEL FOR CLECO ALLOCATIONS

X = CLECO monthly average discharge concentration which causes the downstream concentration to equal the criteria (mg/l)
L = CLECO monthly average concentration limitation (mg/l)
M = CLECO monthly average mass limitation (lb/d)
Q1 = Bayou Cocodrie upstream critical flow (mgd)
Q2 = CLECO discharge rate from Mountain Bayou Lake to Bayou Cocodrie (mgd)
(Total for Outfalls???, 002 and 003)(Equivalent to Q3 less 4.7 cfs in evaporative losses)
Q3 = CLECO intake rate from Bayou Cocodrie (mgd)
Y = Bayou Cocodrie upstream Cu concentration (mg/l)
C = Cu criteria (mg/l)
MOS = % Margin of safety

A mass balance at any point in Bayou Cocodrie between the CLECO discharge and the CLECO intake should yield the same mg/l allocation as a mass balance in Bayou Cocodrie below the CLECO intake. The latter implements a net CLECO discharge of copper. The former takes advantage of the fact that the in-stream concentration of copper will be the same above and below the CLECO withdrawal.

1. Mass balance downstream of CLECO intake:

C*(Q1+Q2-Q3)*8.32 = (Y*Q1*8.34) + (X*Q2*8.34) - Q3*8.34*(Y*Q1+X*Q2)/(Q1+Q2)

C*(Q1+Q2-Q3) = Y*Q1 + X*Q2 - Y*Q1*Q3/(Q1+Q2) + X*Q2*Q3/(Q1+Q2)

$$\boxed{X = \frac{C*(Q1+Q2-Q3) - Y*Q1 + \dfrac{Y*Q1*Q3}{(Q1+Q2)}}{Q2 - \dfrac{Q2*Q3}{Q1+Q2}}}$$

2. Mass balance between CLECO discharge and intake:

C*(Q1+Q2)*8.32 = (Y*Q1*8.34) + (X*Q2*8.34)

$$\boxed{X = \frac{C*(Q1+Q2) - Y*Q1}{Q2}}$$

3. CLECO mass limitation:

M = X*Q2*8.34

| | | cfs | mgd | Mass Balance 1 | Mass Balance 2 | Units |
|---|---|---|---|---|---|---|
| Q1 = | | 52.64 | 34.03 | 0.06 | | lbs/d |
| Q2 = | | | 226.00 | | | |
| Q3 = | | | 229.04 | | | |
| Y (mg/l) = | 0.0002 | | | | | |
| C (mg/l) = | 0.0050 | | | | | |
| % MOS = | 20 | | | 2.1529 | | |
| L = X - MOS | | | | 0.0046 | 0.0046 | mg/l |
| M | | | | 8.6118 | 8.6118 | lbs/d |

Provide input to the light gray cells. Allocations in white type in the dark gray cells.

MASS BALANCE MODEL FOR CLECO ALLOCATIONS

X = CLECO monthly average discharge concentration which causes the downstream concentration to equal the criteria (mg/l)
L = CLECO monthly average concentration limitation (mg/l)
M = CLECO monthly average mass limitation (lb/d)
Q1 = Bayou Cocodrie upstream critical flow (mgd)
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(Total for Outfalls???, 002 and 003)(Equivalent to Q3 less 4.7 cfs in evaporative losses)
Q3 = CLECO intake rate from Bayou Cocodrie (mgd)
Y = Bayou Cocodrie upstream Cu concentration (mg/l)
C = Cu criteria (mg/l)
MOS = % Margin of safety

A mass balance at any point in Bayou Cocodrie between the CLECO discharge and the CLECO intake should yield the same mg/l allocation as a mass balance in Bayou Cocodrie below the CLECO intake. The latter implements a net CLECO discharge of copper. The former takes advantage of the fact that the in-stream concentration of copper will be the same above and below the CLECO withdrawal.

1. Mass balance downstream of CLECO intake:
C*(Q1+Q2-Q3)*8.32 = (Y*Q1*8.34) + (X*Q2*8.34) - Q3*8.34*(Y*Q1+X*Q2)/(Q1+Q2)
C*(Q1+Q2-Q3) = Y*Q1 + X*Q2 - Y*Q1*Q3/(Q1+Q2) + X*Q2*Q3/(Q1+Q2)

$$\boxed{X = \frac{C*(Q1+Q2-Q3) - Y*Q1 + \frac{Y*Q1*Q3}{(Q1+Q2)}}{Q2 - \frac{Q2*Q3}{Q1+Q2}}}$$

2. Mass balance between CLECO discharge and intake:
C*(Q1+Q2)*8.32 = (Y*Q1*8.34) + (X*Q2*8.34)

$$\boxed{X = \frac{C*(Q1+Q2) - Y*Q1}{Q2}}$$

3. CLECO mass limitation:
M = X*Q2*8.34

| | | cfs | mgd | Mass Balance 1 | Mass Balance 2 | Units |
|---|---|---|---|---|---|---|
| Q1 = | | 52.60 | 34.00 | 0.06 | | lbs/d |
| Q2 = | | | 90.00 | | | |
| Q3 = | | | 93.04 | | | |
| Y (mg/l) = | 0.0002 | | | | | |
| C (mg/l) = | 0.0050 | | | | | |
| % MOS = | 20 | | | 1.0208 | | |
| L = X - MOS | | | | 0.0054 | 0.0054 | mg/l |
| M | | | | 4.0830 | 4.0830 | lbs/d |

Provide input to the light gray cells. Allocations in white type in the dark gray cells.

MASS BALANCE MODEL FOR CLECO ALLOCATIONS

X = CLECO monthly average discharge concentration which causes the downstream concentration to equal the criteria (mg/l)
L = CLECO monthly average concentration limitation (mg/l)
M = CLECO monthly average mass limitation (lb/d)
Q1 = Bayou Cocodrie upstream critical flow (mgd)
Q2 = CLECO discharge rate from Mountain Bayou Lake to Bayou Cocodrie (mgd)
(Total for Outfalls???, 002 and 003)(Equivalent to Q3 less 4.7 cfs in evaporative losses)
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A mass balance at any point in Bayou Cocodrie between the CLECO discharge and the CLECO intake should yield the same mg/l allocation as a mass balance in Bayou Cocodrie below the CLECO intake. The latter implements a net CLECO discharge of copper. The former takes advantage of the fact that the in-stream concentration of copper will be the same above and below the CLECO withdrawal.

1. Mass balance downstream of CLECO intake:

C*(Q1+Q2-Q3)*8.34 = (Y*Q1*8.34) + (X*Q2*8.34) - Q3*8.34*(Y*Q1+X*Q2)/(Q1+Q2)

C*(Q1+Q2-Q3) = Y*Q1 + X*Q2 - Y*Q1*Q3/(Q1+Q2) + X*Q2*Q3/(Q1+Q2)

$$\boxed{X = \frac{C*(Q1+Q2-Q3) - Y*Q1 + \dfrac{Y*Q1*Q3}{(Q1+Q2)}}{Q2 - \dfrac{Q2*Q3}{Q1+Q2}}}$$

2. Mass balance between CLECO discharge and intake:

C*(Q1+Q2)*8.34 = (Y*Q1*8.34) + (X*Q2*8.34)

$$\boxed{X = \frac{C*(Q1+Q2) - Y*Q1}{Q2}}$$

3. CLECO mass limitation:

M = X*Q2*8.34

| | | cfs | mgd | Mass Balance 1 | Mass Balance 2 | Units |
|---|---|---|---|---|---|---|
| Q1 = | | 52.64 | 34.03 | 0.06 | | lbs/d |
| Q2 = | | | 3.10 | | | |
| Q3 = | | | 6.14 | | | |
| Y (mg/l) = | 0.0002 | | | | | |
| C (mg/l) = | 0.0050 | | | | | |
| % MOS = | 20 | | | 0.2977 | | lbs/d |
| L = X - MOS | | | | 0.0461 | 0.0461 | mg/l |
| M | | | | 1.1907 | 1.1907 | lbs/d |

Provide input to the light gray cells. Allocations in white type in the dark gray cells.

MEMORANDUM

TO: Melanie Connor

FROM: Brian Baker

DATE: August 22, 2006

RE: Stream Flow and Water Quality Characteristics for Bayou Cocodrie, receiving water for CLECO Power Evangeline Plant (Permit No. LA0002879, AI: 1906)

Determinations of water quality characteristics for the outfalls were taken from ambient monitoring station No. 103 on Bayou Cocodrie at a bridge on Hwy 106 in St. Landry about 8 miles southwest of Bunkie, LA.

The following results were obtained:

| | | |
|---|---|---|
| Average hardness | = | 18.0 mg/l |
| $15^{th}$ percentile TSS | = | 6 mg/l |

The critical (7Q10) and harmonic mean flow of Bayou Cocodrie was obtained from a USGS Station number 07382000 near Clearwater, Louisiana. The calculations yielded the following information;

| | |
|---|---|
| Critical Flow (7Q10) | = 52.6 CFS |
| Harmonic Mean Flow | = 191.0 CFS |

If you have additional questions or comments, please contact me at 2-3466.

BMB:bb

## Flow determinations for the dissolved Copper TMDL on Bayou Cocodrie (Subsegment 060201):

| Flow description | Flow value (cfs) | Justification |
|---|---|---|
| Headwater | 52.872 | Note 1 |
| Incremental (nonpoint) | 0 | Note 2 |
| Flow Losses | -4.7 | Note 3 |
| **Total Flow for system** | **48.2** | |

Note 1 - Headwater to system is outflow from Cocodrie Lake. This was determined from the published "Lowflow Statistics from USGS Database Through 1993". This excerpt from the attached document calculates a 7Q10 on Bayou Cocodrie near Clearwater, LA(USGS station 07382000).

Note 2 - This value was taken from the summer projection of the Bayou Cocodrie water quality model for dissolved oxygen. This model was performed by ftn Associates, Ltd. in December, 1999.

Note 3 - This value was taken from the summer projection of the Bayou Cocodrie water quality model for dissolved oxygen. This model was performed by ftn Associates, Ltd. in December, 1999. This accounts for the evaporative losses from CLECO operations and is based on the surface area of cooling lake and Aug-Sep evaporation.

07382000 BAYOU COCODRIE NEAR CLEARWATER

Analysis for -- 12 month period
starting April 1
ending March 31
1940-1999

Parameter is 7-day low value.

0 zero values in data

59 non-zero values in data

| | | | | |
|---|---|---|---|---|
| 65.571 | 84.714 | 129.143 | 77.286 | 76.857 |
| 85.000 | 93.571 | 92.000 | 76.571 | 60.000 |
| 82.286 | 84.571 | 64.000 | 52.000 | 82.000 |
| 58.286 | 75.000 | 60.000 | 82.143 | 31.429 |
| 81.429 | 52.857 | 98.571 | 84.857 | 55.143 |
| 64.286 | 64.286 | 83.714 | 78.714 | 91.286 |
| 78.857 | 56.857 | 71.000 | 78.571 | 139.143 |
| 95.857 | 102.714 | 76.571 | 72.286 | 46.429 |
| 131.000 | 61.000 | 58.571 | 72.571 | 105.143 |
| 132.429 | 128.429 | 102.000 | 43.143 | 68.571 |
| 80.000 | 73.571 | 94.143 | 109.286 | 97.857 |
| 117.714 | 113.714 | 57.000 | 53.143 | |

The following 7 statistics are based on non-zero values.

| | |
|---|---|
| Mean (logs) | 1.891 |
| Variance (logs) | 0.017 |
| Standard Deviation (logs) | 0.129 |
| Skewness (logs) | -0.300 |
| Standard Error of Skewness (logs) | 0.311 |
| Serial Correlation Coefficient (logs) | 0.149 |
| Coefficient of Variation (logs) | 0.068 |

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07382000 BAYOU COCODRIE NEAR CLEARWATER

| Non-exceedance Probability | Recurrence Interval | Parameter Value |
|---|---|---|
| 0.0100 | 100.00 | 36.449 |
| 0.0200 | 50.00 | 40.252 |
| 0.0500 | 20.00 | 46.507 |
| 0.1000 | 10.00 | 52.643 |
| 0.2000 | 5.00 | 60.831 |
| 0.5000 | 2.00 | 78.902 |
| 0.8000 | 1.25 | 100.207 |
| 0.9000 | 1.11 | 112.621 |
| 0.9600 | 1.04 | 126.792 |
| 0.9800 | 1.02 | 136.438 |
| 0.9900 | 1.01 | 145.428 |

| | | | | | | | | | | Sum of Absolute value Diff. | Sum of Diff. squared |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 3.02 | 3.16 |
| | | | | | | [Cu] ug/l=AQ$^B$ + C | | | | | |
| TOTAL CLECO DISCHARGE MGD | CONCENTRATION TOTAL COPPER mg/l | CONCENTRATION TOTAL COPPER ug/l | LOAD TOTAL COPPER #/day | | | | | | | ABSOLUTE VALUE OF DIFFERENCE | ABSOLUTE VALUE OF DIFFERENCE SQUARED |
| | | | | A | B | C | Q, MGD | CALC [Cu] ug/l | [Cu] ug/l | delta | delta |
| 3.10 | 0.0575 | 57.55 | 1.49 | | | | | | | | |
| 30.00 | 0.0105 | 10.47 | 2.62 | 21 | -0.30000 | 1.4 | 30 | 8.97 | 10.47 | 1.50 | 2.26 |
| 40.00 | 0.0091 | 9.12 | 3.04 | 21 | -0.30000 | 1.4 | 40 | 8.34 | 9.12 | 0.77 | 0.60 |
| 90.00 | 0.0069 | 6.86 | 5.15 | 21 | -0.30000 | 1.4 | 90 | 6.84 | 6.86 | 0.01 | 0.00 |
| 226.00 | 0.0058 | 5.77 | 10.87 | 21 | -0.30000 | 1.4 | 226 | 5.53 | 5.77 | 0.24 | 0.06 |
| 350.00 | 0.0055 | 5.51 | 16.09 | 21 | -0.30000 | 1.4 | 350 | 5.02 | 5.51 | 0.49 | 0.24 |

**TOTAL CU CONCENTRATION EQUATION FOR Q≥30 MGD**

WHERE Q IS THE COMBINED FLOWS FROM OUTFALLS 002 AND 003

[Cu] ug/l = 21 Q $^{-0.30}$ + 1.4

**TOTAL CU MASS EQUATION FOR ALL FLOWS**

[Cu] LB/DAY = 0.0421Q + 1.3574

Q IN MGD

| | | |
|---|---|---|
| | | permit |
| FLOW | DISSOLVED | TOTAL |
| | CU | CU |
| MGD | mg/l | mg/L |
| 3.10 | 0.021659 | 0.057550 |
| 30.00 | 0.003942 | 0.010474 |
| 40.00 | 0.003431 | 0.009117 |
| 90.00 | 0.002581 | 0.006857 |
| 226.00 | 0.002171 | 0.005769 |
| 350.00 | 0.002075 | 0.005514 |
| | | |
| | | permit |
| FLOW | | TOTAL |
| | | CU |
| MGD | | ug/l |
| 3.10 | | 57.550 |
| 30.00 | | 10.474 |
| 40.00 | | 9.117 |
| 90.00 | | 6.857 |
| 226.00 | | 5.769 |
| 350.00 | | 5.514 |
| | | |
| | | permit |
| FLOW | | TOTAL |
| | | CU |
| MGD | | LB/DAY |
| 3.10 | | 1.488 |
| 30.00 | | 2.621 |
| 40.00 | | 3.042 |
| 90.00 | | 5.147 |
| 226.00 | | 10.873 |
| 350.00 | | 16.094 |

CONVERT DISSOLVED METALS TO TOTAL METALS: (FROM IMPLEMENTATION PLAN)

The formula for streams and lakes is as follows:

$$K_p = K_{po} \times TSS^a$$

$K_p$ = Linear partition coefficient

TSS = Suspended solids concentration receiving stream, units in mg/l

$K_{po}$ = found from Table 1 - Implementation Plan

a = found from Table 1 - Implementation Plan

$$\frac{C_D}{C_T} = \frac{1}{1 + (K_p)\,(\,TSS\,)\,(\,10^{-6})}$$

$C_D/C_T$ = Fraction of metal dissolved

$C_r$ = Dissolved Criteria Value = 0.003757 mg/l

$$\text{Total Metal Criteria} = C_r / (C_D/C_T)$$

From Table 1 for streams:

| Metal | | $K_{po}$ | | a |
|---|---|---|---|---|
| | | | | |
| Copper | | $1.04 \times 10^{6}$ | | -0.74 |

From Data: PERMITS CALC

15th Percentile TSS 6

$K_p$ = 276185.8

$\frac{C_D}{C_T}$ = 0.376348

**Total Metal Criteria =** 0.009983 mg/l

| Sum of Absolute value Diff. | Sum of Diff. squared |
|---|---|
| 0.97 | 0.26 |

$[Cu]\ ug/l = AQ^{B} + C$

| TOTAL CLECO DISCHARGE MGD | CONCENTRATION DISSOLVED COPPER mg/l | CONCENTRATION DISSOLVED COPPER ug/l | LOAD DISSOLVED COPPER #/day | | A | B | C | | Q, MGD | CALC [Cu] ug/l | [Cu] ug/l | ABSOLUTE VALUE OF DIFFERENCE delta | ABSOLUTE VALUE OF DIFFERENCE SQUARED delta |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.10 | 0.0217 | 21.66 | 0.56 | | | | | | | | | | |
| 30.00 | 0.0039 | 3.94 | 0.99 | | 9.3 | -0.29000 | 0.1 | | 30 | 3.57 | 3.94 | 0.37 | 0.14 |
| 40.00 | 0.0034 | 3.43 | 1.14 | | 9.3 | -0.29000 | 0.1 | | 40 | 3.29 | 3.43 | 0.14 | 0.02 |
| 90.00 | 0.0026 | 2.58 | 1.94 | | 9.3 | -0.29000 | 0.1 | | 90 | 2.62 | 2.58 | 0.04 | 0.00 |
| 226.00 | 0.0022 | 2.17 | 4.09 | | 9.3 | -0.29000 | 0.1 | | 226 | 2.03 | 2.17 | 0.14 | 0.02 |
| 350.00 | 0.0021 | 2.08 | 6.06 | | 9.3 | -0.29000 | 0.1 | | 350 | 1.80 | 2.08 | 0.27 | 0.08 |

**DISSOLVED CU CONCENTRATION EQUATION FOR Q≥30 MGD**

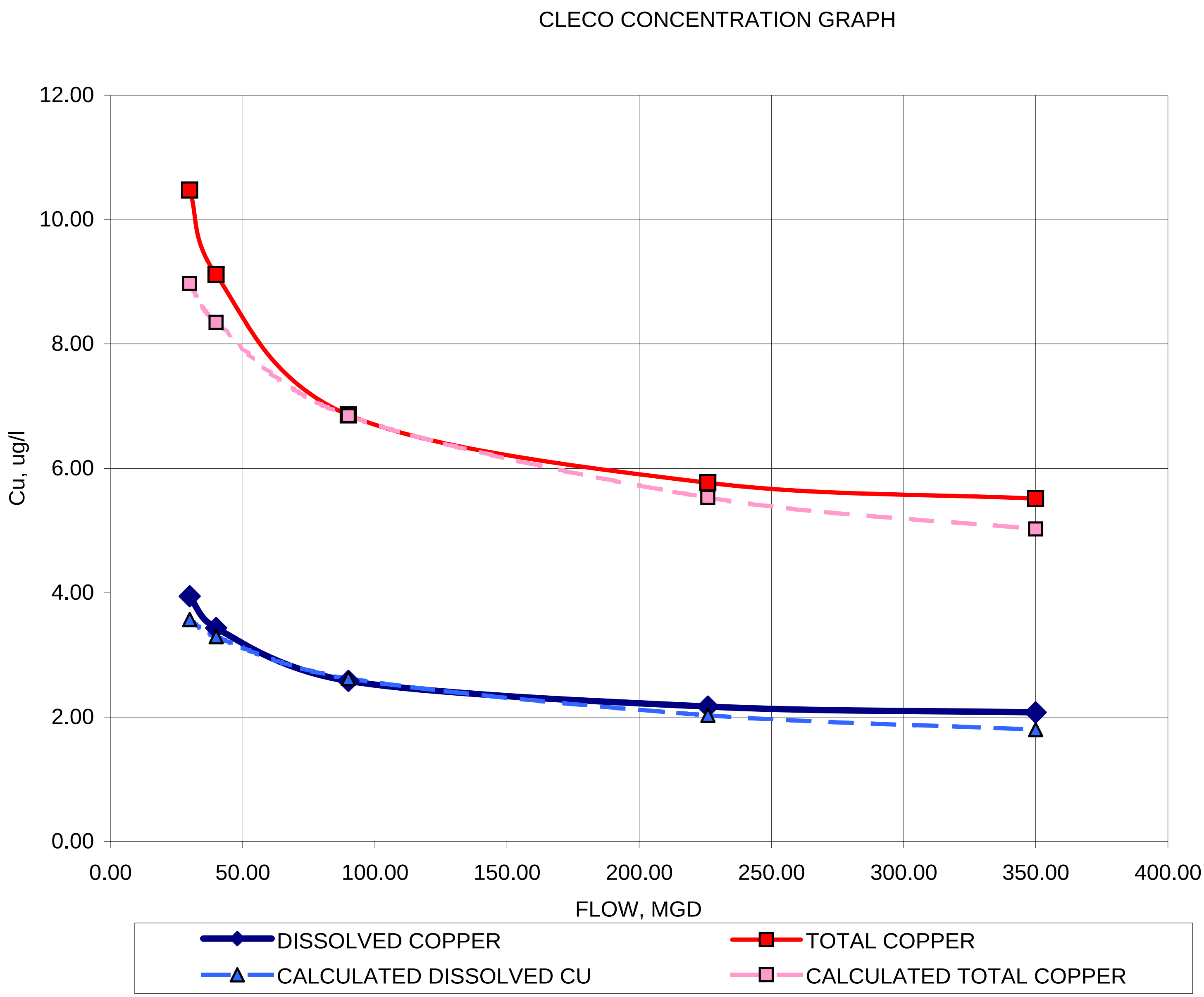
WHERE Q IS THE COMBINED FLOWS FROM OUTFALLS 002 AND 003

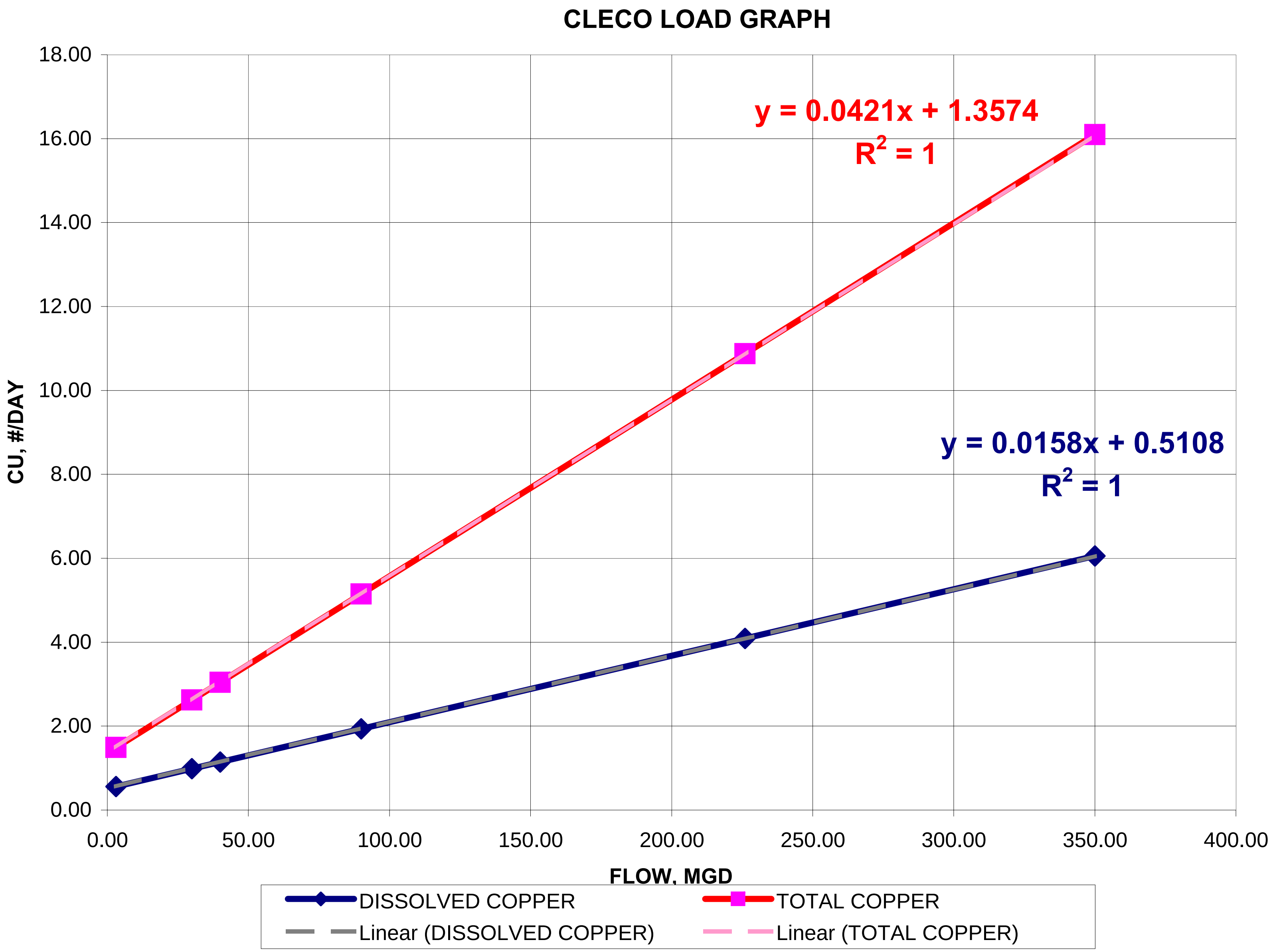
$[Cu]\ ug/l = 9.3\ Q^{-0.29} + 0.1$

**DISSOLVED CU MASS EQUATION FOR ALL FLOWS**

$[Cu]\ LB/DAY = 0.0158Q + 0.5108$

Q IN MGD


CLECO CONCENTRATION GRAPH
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Cu, ug/l
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
400.00
FLOW, MGD
DISSOLVED COPPER
TOTAL COPPER
CALCULATED DISSOLVED CU
CALCULATED TOTAL COPPER



CLECO LOAD GRAPH
y = 0.0421x + 1.3574
$R^2$ = 1
y = 0.0158x + 0.5108
$R^2$ = 1
CU, #/DAY
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
400.00
FLOW, MGD
DISSOLVED COPPER
TOTAL COPPER
Linear (DISSOLVED COPPER)
Linear (TOTAL COPPER)

MASS BALANCE MODEL FOR CLECO ALLOCATIONS

X = CLECO monthly average discharge concentration which causes the downstream concentration to equal the criteria (mg/l)
L = CLECO monthly average concentration limitation (mg/l)
M = CLECO monthly average mass limitation (lb/d)
Q1 = Bayou Cocodrie upstream critical flow (mgd)
Q2 = CLECO discharge rate from Mountain Bayou Lake to Bayou Cocodrie (mgd)
(Total for Outfalls 002 and 003)(Equivalent to Q3 less 4.7 cfs in evaporative losses)
Q3 = CLECO intake rate from Bayou Cocodrie (mgd)
Y = Bayou Cocodrie upstream Cu concentration (mg/l)
C = Cu criteria (mg/l)
MOS = % Margin of safety

A mass balance at any point in Bayou Cocodrie between the CLECO discharge and the CLECO intake should yield the same mg/l allocation as a mass balance in Bayou Cocodrie below the CLECO intake. The latter implements a net CLECO discharge of copper. The former takes advantage of the fact that the in-stream concentration of copper will be the same above and below the CLECO withdrawal.

1. Mass balance downstream of CLECO intake:

C*(Q1+Q2-Q3)*8.32 = (Y*Q1*8.34) + (X*Q2*8.34) - Q3*8.34*(Y*Q1+X*Q2)/(Q1+Q2)

C*(Q1+Q2-Q3) = Y*Q1 + X*Q2 - Y*Q1*Q3/(Q1+Q2) - X*Q2*Q3/(Q1+Q2)

$$\boxed{X = \frac{C*(Q1+Q2-Q3) - Y*Q1 + \dfrac{Y*Q1*Q3}{(Q1+Q2)}}{Q2 - \dfrac{Q2*Q3}{Q1+Q2}}}$$

2. Mass balance between CLECO discharge and intake:

C*(Q1+Q2)*8.32 = (Y*Q1*8.34) + (X*Q2*8.34)

$$\boxed{X = \frac{C*(Q1+Q2) - Y*Q1}{Q2}}$$

3. CLECO mass limitation:

M = X*Q2*8.34

| | | cfs | mgd | Mass Balance 1 | Mass Balance 2 | Units |
|---|---|---|---|---|---|---|
| Q1 = | | 52.64 | 34.03 | 0.06 | | lbs/d |
| Q2 = | | | 350.00 | | | |
| Q3 = | | | 353.04 | | | |
| Y (mg/l) = | 0.0002 | | | | | |
| C (mg/l) = | 0.0038 | | | | | |
| % MOS = | 50 | | | 6.0569 | | |
| L = X - MOS | | | | 0.0021 | 0.0021 | mg/l |
| M | | | | 6.0569 | 6.0569 | lbs/d |

Provide input to the light gray cells. Allocations in white type in the dark gray cells.

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C*(Q1+Q2-Q3) = Y*Q1 + X*Q2 - Y*Q1*Q3/(Q1+Q2) - X*Q2*Q3/(Q1+Q2)

$$\boxed{X = \frac{C*(Q1+Q2-Q3)-Y*Q1+\dfrac{Y*Q1*Q3}{(Q1+Q2)}}{Q2-\dfrac{Q2*Q3}{Q1+Q2}}}$$

2. Mass balance between CLECO discharge and intake:
C*(Q1+Q2)*8.32 = (Y*Q1*8.34) + (X*Q2*8.34)

$$\boxed{X = \frac{C*(Q1+Q2)-Y*Q1}{Q2}}$$

3. CLECO mass limitation:
M = X*Q2*8.34

| | | cfs | mgd | Mass Balance 1 | Mass Balance 2 | Units |
|---|---|---|---|---|---|---|
| Q1 = | | 52.64 | 34.03 | 0.06 | | lbs/d |
| Q2 = | | | 226.00 | | | |
| Q3 = | | | 229.04 | | | |
| Y (mg/l) = | 0.0002 | | | | | |
| C (mg/l) = | 0.0038 | | | | | |
| % MOS = | 50 | | | 4.0920 | | |
| L = X - MOS | | | | 0.0022 | 0.0022 | mg/l |
| M | | | | 4.0920 | 4.0920 | lbs/d |

Provide input to the light gray cells. Allocations in white type in the dark gray cells.

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1. Mass balance downstream of CLECO intake:

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C*(Q1+Q2-Q3) = Y*Q1 + X*Q2 - Y*Q1*Q3/(Q1+Q2) - X*Q2*Q3/(Q1+Q2)

$$\boxed{X = \frac{C*(Q1+Q2-Q3) - Y*Q1 + \dfrac{Y*Q1*Q3}{(Q1+Q2)}}{Q2 - \dfrac{Q2*Q3}{Q1+Q2}}}$$

2. Mass balance between CLECO discharge and intake:

C*(Q1+Q2)*8.32 = (Y*Q1*8.34) + (X*Q2*8.34)

$$\boxed{X = \frac{C*(Q1+Q2) - Y*Q1}{Q2}}$$

3. CLECO mass limitation:

M = X*Q2*8.34

| | | cfs | mgd | Mass Balance 1 | Mass Balance 2 | Units |
|---|---|---|---|---|---|---|
| Q1 = | | 52.64 | 34.03 | 0.06 | | lbs/d |
| Q2 = | | | 90.00 | | | |
| Q3 = | | | 93.04 | | | |
| Y (mg/l) = | 0.0002 | | | | | |
| C (mg/l) = | 0.0038 | | | | | |
| % MOS = | 50 | | | 1.9370 | | |
| L = X - MOS | | | | 0.0026 | 0.0026 | mg/l |
| M | | | | 1.9370 | 1.9370 | lbs/d |

Provide input to the light gray cells. Allocations in white type in the dark gray cells.

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$$\boxed{X = \frac{C*(Q1+Q2-Q3) - Y*Q1 + \dfrac{Y*Q1*Q3}{(Q1+Q2)}}{Q2 - \dfrac{Q2*Q3}{Q1+Q2}}}$$

2. Mass balance between CLECO discharge and intake:

C*(Q1+Q2)*8.34 = (Y*Q1*8.34) + (X*Q2*8.34)

$$\boxed{X = \frac{C*(Q1+Q2) - Y*Q1}{Q2}}$$

3. CLECO mass limitation:

M = X*Q2*8.34

| | | cfs | mgd | Mass Balance 1 | Mass Balance 2 | Units |
|---|---|---|---|---|---|---|
| Q1 = | | 52.64 | 34.03 | **0.06** | | lbs/d |
| Q2 = | | | 40.00 | | | |
| Q3 = | | | 43.04 | | | |
| Y (mg/l) = | 0.0002 | | | | | |
| C (mg/l) = | 0.0038 | | | | | |
| % MOS = | 50 | | | **1.1447** | | lbs/d |
| L = X - MOS | | | | **0.0034** | **0.0034** | mg/l |
| M | | | | **1.1447** | **1.1447** | lbs/d |

Provide input to the light gray cells. Allocations in white type in the dark gray cells.

MASS BALANCE MODEL FOR CLECO ALLOCATIONS

X = CLECO monthly average discharge concentration which causes the downstream concentration to equal the criteria (mg/l)
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C*(Q1+Q2-Q3) = Y*Q1 + X*Q2 - Y*Q1*Q3/(Q1+Q2) - X*Q2*Q3/(Q1+Q2)

$$\boxed{X = \frac{C*(Q1+Q2-Q3) - Y*Q1 + \dfrac{Y*Q1*Q3}{(Q1+Q2)}}{Q2 - \dfrac{Q2*Q3}{Q1+Q2}}}$$

2. Mass balance between CLECO discharge and intake:

C*(Q1+Q2)*8.34 = (Y*Q1*8.34) + (X*Q2*8.34)

$$\boxed{X = \frac{C*(Q1+Q2) - Y*Q1}{Q2}}$$

3. CLECO mass limitation:

M = X*Q2*8.34

| | | cfs | mgd | Mass Balance 1 | Mass Balance 2 | Units |
|---|---|---|---|---|---|---|
| Q1 = | | 52.64 | 34.03 | 0.06 | | lbs/d |
| Q2 = | | | 30.00 | | | |
| Q3 = | | | 33.04 | | | |
| Y (mg/l) = | 0.0002 | | | | | |
| C (mg/l) = | 0.0038 | | | | | |
| % MOS = | 50 | | | 0.9862 | | lbs/d |
| L = X - MOS | | | | 0.0039 | 0.0039 | mg/l |
| M | | | | 0.9862 | 0.9862 | lbs/d |

Provide input to the light gray cells. Allocations in white type in the dark gray cells.

MASS BALANCE MODEL FOR CLECO ALLOCATIONS

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$$\boxed{X = \frac{C*(Q1+Q2-Q3) - Y*Q1 + \dfrac{Y*Q1*Q3}{(Q1+Q2)}}{Q2 - \dfrac{Q2*Q3}{Q1+Q2}}}$$

2. Mass balance between CLECO discharge and intake:

C*(Q1+Q2)*8.34 = (Y*Q1*8.34) + (X*Q2*8.34)

$$\boxed{X = \frac{C*(Q1+Q2) - Y*Q1}{Q2}}$$

3. CLECO mass limitation:

M = X*Q2*8.34

| | | cfs | mgd | Mass Balance 1 | Mass Balance 2 | Units |
|---|---|---|---|---|---|---|
| Q1 = | | 52.64 | 34.03 | 0.06 | | lbs/d |
| Q2 = | | | 3.10 | | | |
| Q3 = | | | 6.14 | | | |
| Y (mg/l) = | 0.0002 | | | | | |
| C (mg/l) = | 0.0038 | | | | | |
| % MOS = | 50 | | | 0.5600 | | lbs/d |
| L = X - MOS | | | | 0.0217 | 0.0217 | mg/l |
| M | | | | 0.5600 | 0.5600 | lbs/d |

Provide input to the light gray cells. Allocations in white type in the dark gray cells.

| | TOTAL | | CONCENTRATION | CONCENTRATION | LOAD | |
|---|---|---|---|---|---|---|
| | CLECO | | DISSOLVED | DISSOLVED | DISSOLVED | |
| | DISCHARGE | | COPPER | COPPER | COPPER | |
| | MGD | | mg/l | ug/l | #/day | |
| | | | | | | |
| | 3.10 | | 0.0461 | 46.05 | 1.19 | |
| | 90.00 | | 0.0054 | 5.44 | 4.08 | |
| | 226.00 | | 0.0046 | 4.57 | 8.61 | |
| | 350.00 | | 0.0044 | 4.36 | 12.74 | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | The acute is still less stringent than chronic, so chronic applies. | | | | | |