LDEQ, Environmental Regulatory Code, Part IX. Water Quality Regulations, February 1997.

C2.4 Hydraulic Design.

C2.4.1 General. Much of the design of this lock was based on the design of the Leland Bowman Lock; however, the Leland Bowman Lock has an earthen chamber and the selected plan for this lock has a concrete chamber with vertical walls. The selected plan has a usable length of 1,200 feet, a width of 75 feet and a sill elevation of -15 feet NGVD. Except where noted, all of the information shown below applies to the selected plan as well as to all of the alternatives that were studied.

C2.4.2 Design Stages And Design Heads. The proposed lock will be impacted on the flood side (south) by water levels in the Atchafalaya Floodway and will be impacted on the protected side (north) by water levels in the backwater area east of the Atchafalaya Floodway. Under existing conditions, stages in the backwater area east of the Atchafalaya Floodway are increased significantly during occurrences of high flows in the Atchafalaya Floodway and can also be affected significantly by tidal influences. Construction of a barrier levee and pumping station at Amelia, LA is a flood control alternative that is being evaluated in connection with another study. Should this alternative (which is not authorized at this time) be constructed, both of these influences (i.e., the tidal influences and the backwater influences from high flows in the Atchafalaya Floodway) on stages in the backwater area would be eliminated and stages as low as about 0 foot NGVD could occur during extended dry periods.

C2.4.2.1 Incorporation of Lock into Line of Protection. The proposed lock will be incorporated into the line of protection afforded to the backwater area by the East Atchafalaya Basin Protection Levee. The MR&T Project Flood flow line for the proposed lock is 28.7 ft. NGVD (DM No. 1, Hydraulic Design, Atchafalaya Basin, LA, Project Flood Flow Line dated January 1987). This stage incorporates the impacts of projected changes in topography and hydrography (deposition of sediments in the delta and the floodway, as well as decreased capacity of the floodway outlets) through Year 2030. The authorized freeboard at this location is 2 feet (as shown in House Document No. 308). The lock must therefore provide protection up to a net grade of 30.7 ft NGVD.

C2.4.2.2 Design Stages and Design Heads for Various Loading Cases. Records at New Orleans District gaging stations at the existing Bayou Sorrel Lock for the period of record of 1956 to 1995 were used to develop the design stages shown below. Design stages on the flood side were derived from gage data for the EABPL Borrow Pit (FWS) at Bayou Sorrel Lock (#49630) gaging station. Design stages on the protected side were derived from gage data for the Lower Grand River at Bayou Sorrel Lock (#52560) gaging station. All elevations are in feet NGVD.

a. Maximum stages of record:
   Flood Side = 18.1 (May 73)
   Protected Side = 7.9 (Apr 80, Jan 93)

b. Project flood condition:
   Flood Side = 28.7
   Protected Side = 8.0 maximum (assumes barrier levee alternative is not constructed)
   0.0 minimum (assumes barrier levee alternative is constructed)

c. Maximum reverse head (design) = 7.9 feet:
   Flood Side = 0.0 (minimum of record, Jan 64, Oct 76)
   Protected Side = 7.9

d. Maximum reverse head (observed) = 3.0 feet: (occurred 7-10 Mar 66) –
   Flood Side = 3.0 (7 Mar 66) - 2.2 (10 Mar 66)
   Protected Side = 6.0 (7 Mar 66) - 5.2 (10 Mar 66)

e. Dewatered condition:
   Flood Side = 5.7 (5% exceedence during low water, Aug-Oct 56-95)
   Protected Side = -0.3 (minimum of record, Oct 52)

f. Dewatered condition, reverse head:
   Flood Side = 0.0 (minimum of record during low water, Aug-Oct 56-95-occurred Oct 76)
   Protected Side = 6.6 (maximum of record during low water, Aug-Oct 56-95 – occurred Oct 64)

C2.4.2.3 Stage Duration and Head Duration Curves. Stage duration curves for the floodside and protected side of the lock are shown on Figures 1 and 2 in Annex 2, respectively. A differential head duration curve (flood side stage vs. protected side stage) is shown on Figure 3 in Annex 2.

C2.4.3 Filling and Emptying Computations. Four 70-degree sector gates will be installed, one pair at each end of the lock. Each of the gates will have an ear gate configuration, similar to those in use at Algiers Lock. This configuration allows flow to pass around the outside of each gate as well as through the opening between the gates. Filling and emptying of the chamber will be accomplished by opening the appropriate set of gates at controlled angular velocities and permitting flow to enter or exit the chamber as necessary. The Sector-Gated Lock Filling and Emptying Program, developed by the New Orleans District, was used to compute the filling and emptying times for the selected plan. This program determines a mode of operation for each lift by optimizing the times that the gate is opened at various angular speeds. Both the times of opening at each speed and the total opening time are governed by setting an upper limit on turbulence. Turbulence represents the total energy, in lbs/sec, developed by the water passing through the gates divided by the depth of water in the chamber. From experience in operating other sector-gated locks in the New Orleans District, a maximum allowable turbulence value of 33,000 lbs/sec was used in these computations. A plot of filling and emptying times (which are the same for a given lift for a sector-gated lock) vs. lift (differential head) is shown on Figure 4 in Annex 2. This plot covers most of the lifts experienced at this location, extending from 1 foot (equaled or exceeded 57% of the time) to 14 feet (equaled or exceeded 0.01% of the time). Examples of filling/emptying times for the selected plan for the more frequently occurring lifts at this location are shown below:

TABLE C19 - EXAMPLES OF FILLING AND EMPTYING TIMES – SELECTED PLAN

Lift, feet	Percent of Time Equalled or Exceeded	Filling/Emptying Time, minutes
1	57	0.8
2	43	2.0
3	30	3.0
4	19	3.6
5	10	4.5

Examples of filling/emptying times for the other alternatives that were studied for these same lifts are shown below:

TABLE C19A - EXAMPLES OF FILLING AND EMPTYING TIMES – OTHER ALTERNATIVES

	Filling and emptying times in minutes				
Lift, feet	110' X 900' Concrete	110' X 900' Earthen	110' X 1,200' Concrete	110' X 1,200' Earthen	75' X 1,200' Earthen
1	1.0	0.6	1.2	0.9	0.9
2	2.6	1.9	2.7	2.3	2.1
3	3.1	4.0	3.4	4.6	3.8
4	4.0	5.6	4.6	6.8	5.7
5	5.0	7.6	6.0	9.4	7.9

The filling/emptying times that will actually occur after the lock is placed in operation will likely be somewhat longer than the computed filling/emptying times shown above and on Figure 4 in Annex 2. This is expected to occur because the New Orleans District lock operators have tended to operate the gates using a 2-speed mode of operation (with the gates held at a small opening, after opening at the slow speed, until the stages on both sides of the gate are almost equalized). No program currently in use at the New Orleans District can accurately simulate this mode of operation. The same is true regarding simulation of the impact of the ear gate configuration on filling/emptying times. An estimate was obtained from ERDC (formerly WES) based on their experience with physically modeling both ear gate and conventional configurations of sector gates; ERDC estimates that the use of the ear gate configuration will reduce filling/emptying times by at least 15%.

C2.4.4 Sill and Floor Elevations; Analysis of Variation in Sill Depth. As stated in the GIWW Locks Reconnaissance Study, the sill and floor elevation for the selected plan, -15 ft NGVD, essentially provides the same vertical clearance for the design vessel (which has a design draft of 9 ft) as the existing lock. Use of sill (and floor) elevations lower than -15 ft NGVD would provide more clearance below the design vessel and would therefore enable the lock to be filled and emptied in somewhat less time. The sensitivity of the economic analysis to variation in sill depth was investigated for the selected plan and for the 1,200-ft by 110-ft lock alternative with a concrete chamber and vertical walls. Examples of computed filling / emptying times that were used for the economic analysis for the selected plan are shown below:

TABLE C20 – EXAMPLES OF FILLING/EMPTYING TIMES FOR VARIOUS SILL ELEVATIONS – SELECTED PLAN

Lift, feet	Filling / Emptying Times in Minutes				
	Sill Elevation, ft. NGVD				
	-15	-17	-19	-21	-23
1	0.8	0.8	0.7	0.7	0.7
2	2	2	1.9	1.9	1.9
3	3	3	2.9	2.9	2.9
4	3.6	3.4	3.2	3.1	3
5	4.5	4.2	3.9	3.6	3.5

The computed filling /emptying times vary in the same manner for the 1,200-ft by 110-ft lock alternative with a concrete chamber and vertical walls.

C2.4.5 Other Statistical Information Provided for Use in the Economic Analyses. The average lift by month (which varies from 0.3 ft in September to 4.0 ft in April) was determined and tabulated. An analysis was also done to determine the effects of projected increases in flood flow lines within the Atchafalaya Floodway on lifts during the various seasons of the year. Due to the projections for considerable deposition of sediments in both the delta in Atchafalaya Bay (effectively resulting in elongation of the Atchafalaya Floodway outlets (Lower Atchafalaya River and Wax Lake Outlet)) and within the Atchafalaya Floodway, as well as the projections for decreases in the combined capacity of the outlets, the Atchafalaya Floodway stage at the lock for any given flow will increase significantly over time. From information available from another ongoing project (Lower Atchafalaya Basin Reevaluation Study), tabulations showing how much the lifts will increase by Year 2045 were generated. The increases in stages over time on the protected side of the lock for any given Atchafalaya Floodway flow (for flows high enough to produce backwater flooding east of the Floodway) were determined and used in this analysis. Tabulations showing how much the lifts will increase by Year 2045 were also generated assuming that the barrier levee and pumping station at Amelia, LA are in place (see paragraph C2.4.2 above).

C2.4.6 Navigation During High Heads; Analysis Of Need For Sidewall Culvert Filling System. As shown in paragraph C2.4.2.2 above, extremely high lifts would occur during an occurrence of the MR&T Project Flood, possibly as high as 28.7 feet. As this is a sector-gated lock with no sidewall culverts (meaning that water can enter or exit the lock only at the sector gates), filling and emptying times for high lifts are prohibitively long. For example, the filling and emptying time computed for filling/emptying using sector gates on another project (IHNC Lock Replacement) for a lift of 11 feet is about twice as long as that computed for a lock the same size that fills and empties using sidewall culverts. The differences in filling/emptying times between these two filling methods increases significantly with corresponding increases in lifts. It was therefore necessary to determine whether or not navigation must be maintained through this lock during extremely severe flood events, including the Project Flood (which could possibly indicate that a miter-gated lock with sidewall culverts would be required to achieve acceptable filling and emptying times during high lifts). The Coast Guard Marine Safety Office in Morgan City noted that navigation is completely shut down along the Lower Atchafalaya River through Morgan City when the stage at the Morgan City gage reaches about 10 feet NGVD (which corresponds to a lift of about 15.5 ft at this lock under existing conditions and about 15.8 feet for Year 2045 conditions). The occurrences of these lifts, which are higher than the record high lift of 14.1 feet, would be extremely rare. If navigation is shut down through Morgan City, the only navigation that would be able to reach Bayou Sorrel Lock would be tows coming southbound in the Atchafalaya River from Krotz Springs and turning northward into the Morgan City – Port Allen Alternate Route at Stout's Pass just above Morgan City (or going the same route in the reverse direction). These tows constitute only about 1% - 2% of the traffic that passes through Bayou Sorrel Lock. Provision of a miter-gated lock with sidewall culverts to decrease the filling/emptying times for the approximately 1% - 2% of navigation that would still be using it after the stage exceeds 10 feet NGVD at Morgan City is not economically justified.

C2.4.7 Erosion Protection. The three possible causes of erosion at the lock will be waves from propeller action, flow diversion (velocity of flow during diversion is limited to 3 feet/second) and filling and emptying of the lock chamber. Waves from propeller action will be the most severe cause of erosion and will therefore govern the design of the erosion protection. The design of the erosion protection was based on the methodology shown in the Shore Protection Manual, Volume II, 1984 version, published by the Coastal Engineering Research Center (the same methodology used for design of erosion protection at the Leland Bowman Lock – see Vermilion Lock, LA – Replacement, Design Memorandum No. 2, Detail Design, 1977). The required riprap gradation is shown in the following table:

TABLE C21 – RIPRAP GRADATION

Percent Lighter by Weight	Limits of Stone Weight in Pounds
100	1500 - 600
50	650 - 300
15	330 - 100

This riprap gradation was specified for repair of erosion protection within the chamber of the existing lock (completed in 1988) and is essentially the same as that used at Leland Bowman Lock. The erosion protection at Leland Bowman Lock, which was placed 13 years ago, has held up exceptionally well. The layer thicknesses that will be required at the new Bayou Sorrel Lock are 32 inches for dry placement and 48 inches for wet placement. The riprap will be placed along permitting flow to enter or exit the chamber as necessary. The Sector-Gated Lock Filling and Emptying Program, developed by the New Orleans District, was used to compute the filling and emptying times for the selected plan. This program determines a mode of operation for each lift by optimizing the times that the gate is opened at various angular speeds. Both the times of opening at each speed and the total opening time are governed by setting an upper limit on turbulence. Turbulence represents the total energy, in lbs/sec, developed by the water passing through the gates divided by the depth of water in the chamber. From experience in operating other sector-gated locks in the New Orleans District, a maximum allowable turbulence value of 33,000 lbs/sec was used in these computations. A plot of filling and emptying times (which are the same for a given lift for a sector-gated lock) vs. lift (differential head) is shown on Figure 4 in Annex 2. This plot covers most of the lifts experienced at this location, extending from 1 foot (equaled or exceeded 57% of the time) to 14 feet (equaled or exceeded 0.01% of the time). Examples of filling/emptying times for the selected plan for the more frequently occurring lifts at this location are shown below:

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4	3.6	3.4	3.2	3.1	3
5	4.5	4.2	3.9	3.6	3.5