DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
CIVIL WORKS
108 ARMY PENTAGON
WASHINGTON DC 20310-0108

FEB 2 6 2009

The Honorable Peter J. Visclosky
Chairman
Subcommittee on Energy and Water Development
Committee on Appropriations
United States House of Representatives
Washington, D.C. 20510

Dear Mr. Chairman:

In fulfillment of requirements contained in Title III, Chapter 3, of Public Law 110-252, "Flood Control and Costal Emergencies", I am transmitting to the House and Senate Committees on Appropriations the Army Corps of Engineers report providing cost estimates for pump station Options 1, 2, and 2a, described in the Report to Congress dated 30 August 2007, which was provided in response to the requirements of Chapter 3, section 4303 of Public Law 110-28.

The cost comparisons in the enclosed report are based upon design scope that is considered pre-feasibility level (less than 10% design) and rely on conceptual designs and engineering judgment to establish details of the features included in the cost estimates. The cost estimating process considered the results of numerous engineering concept reports, Interagency Performance Evaluation Task Force reports, canal inspection reports, and other local technical evaluations as referenced in the Report. The Corps' Cost Engineering Center of Expertise provided an agency independent technical review of the cost estimates and schedules and a risk analysis study to establish the contingencies and escalation associated with each of the three options. Local stakeholders have not had the opportunity to review in detail the information contained in this report.

The most useful presentation of the comparative cost data would include annual operations and maintenance (O&M) costs as well as all project feature construction costs, contingencies and escalation. However, projected O&M costs are too preliminary for any reasonable evaluation or comparison. Consequently, the cost estimates presented herein only include projected "delivery costs" for each of the options.

The three options and their estimated costs are summarized below:

Option 1: "Operating the new pumping stations at the mouths of the 17th Street, Orleans Avenue and London Avenue canals in the New Orleans area concurrently or in series with existing pumping stations serving these canals."

Option 1 provides storm surge protection in a way that does not appreciably modify the design of the interior drainage and pumping system that exists today. The existing floodwalls along the outfall canals would remain as a secondary or redundant line of defense against storm surge while the perimeter protection provides the risk reduction. Option 1 simply replaces the temporary closure structures and pump stations that were installed after Katrina with similar, but more robustly-designed and optimized permanent features. These closure structures and pumps operate only during hurricanes when storm surge (seawater) from Lake Pontchartrain threatens to enter the drainage canals requiring the gates to be closed. When the gates are closed the rainwater that is being pumped into the canals by the city's interior pump stations can no longer flow freely out into the lake, and must be pumped past the closure structures. The cost estimate for Option 1 is within the authorized and appropriated programmatic cost estimate of $804 million.

Option 2: "Removing the existing [interior] pumping stations and configuring the new [outfall] pumping stations and associated canals to handle all needed discharges to the lakefront."

Option 2 provides the same level of storm surge protection as Option 1 but significantly modifies the design of the city's interior drainage system that handles rainfall. By deepening the interior drainage canals, rainwater falling in the city could gravity-flow to the lakefront before being pumped out into the lake, eliminating the need for the pump stations that currently exist at the interior ends of the canals. However, deepening the canals would require that they be lined to isolate them from the groundwater, and would require their outfall ends to be permanently closed in order to keep lake water out of the canals, even at normal lake levels. The lowered canal elevations would require the pumps to be larger and more powerful than the Option 1 pumps and would require several bridge structures to be modified or replaced, but there would be no need for the closure structures to be operable since they would always be closed. The technical feasibility of lowering the canals has not been established. The cost estimate is based on a design that envisions trapezoidal shaped canals utilizing deep soil mixing/jet grouting and grout-filled fabric forms with bottom and side slopes to reduce uplift pressure on the canal lining. The cost estimate for Option 2 is approximately $3.4 billion.

Option 2a: "Removing the existing pumping stations and configuring the new pumping stations and associated canals to handle all needed discharges to the lakefront [as in Option 2] or in a combination with discharges directly into the Mississippi River in Jefferson Parish".

> Option 2a provides the same level of storm surge protection as Options 1 and 2 but adds an interior pumping station in Jefferson Parish to intercept and divert Jefferson Parish (Hoey's Basin) rain water from the 17th Street canal and instead pump it directly into the Mississippi River. The cost estimate for Option 2a is approximately $3.5 billion.

Both Options 2 and 2a would require a complete engineering feasibility study to inform a full design and constructability determination. If feasible, these options offer simplified operation of the rainwater drainage system because they eliminate the interior pump stations. Fewer "moving parts" generally also translates to increased reliability. Operation and maintenance and interior drainage issues, traditionally a municipal responsibility, are especially important to the non-Federal sponsor. Stakeholders such as the Sewage and Water Board, the President of the Jefferson Parish Council, and the Mayor of the City of New Orleans have expressed strong preferences for Options 2 and 2a. They believe that Option 1, the solution currently being employed by the Corps, "requires too much coordination during the chaos of a storm", and that "the complexity of operating major and powerful pump stations in tandem . . . is fraught with unacceptable risk". Further, they believe that Option 1 is "bad from a technical perspective because it ignores the storm-weakened levees and flood walls on the outfall canals and would cause undue pressure on the 17th Street canal flood walls".

These stakeholders also have expressed dismay with the cost estimates contained in this report, and have questioned their validity. While local stakeholders were briefed by senior leaders as this report was being developed, they did not have the opportunity to participate directly in the preparation of the cost estimates. Their recent feedback reflects a belief that the cost estimate for Option 1 is understated because the Corps does not, but should, plan to replace the existing floodwalls along the outfall canals. Also, they believe the cost estimates for the concrete linings for the canals are far more than what is required, while costs of unnecessary floodwalls and levees are inappropriately included. The magnitude of the resulting estimated costs leads them to fear that undue "concern for cost may take precedence over concerns for long-term safety of the residents".

The Corps, however, is confident of the technical feasibility and operational effectiveness of Option 1, as was demonstrated during Hurricanes Gustav and Ike when the temporary pumps and the gates at the outfall ends of the canals were successfully operated in concert with the city's pumps at the interior ends of the canals. Also, while the cost estimates contained in this report are not presented as definitive, Option 1 is clearly the least costly approach to meet the demand of the Federal system. Option 1

was the approach that was the basis for the authorization contained in supplemental appropriation Public Law 109-234, and planning for the installation of the permanent pump stations and closure structures is already well underway. Options 2 and 2a would not provide any additional storm surge protection and would require many years to plan and construct. Of the three options considered, Option 1 is the only option that can be implemented within the near future.

The enclosed constitutes my report in response to Title III, Chapter 3, of Public Law 110-252.

Very truly yours,

John Paul Woodley, Jr.

John Paul Woodley, Jr.
Assistant Secretary of the Army
(Civil Works)

Enclosure

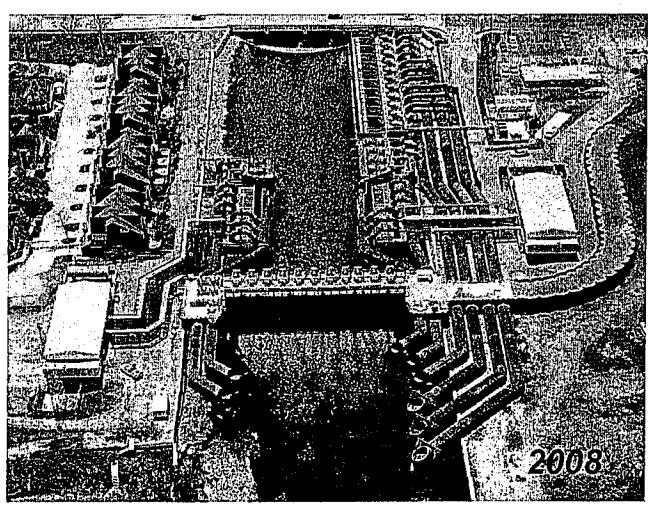
REPORT TO CONGRESS

Hurricane Protection System

New Orleans, Louisiana

By:

U.S. Army Corps of Engineers



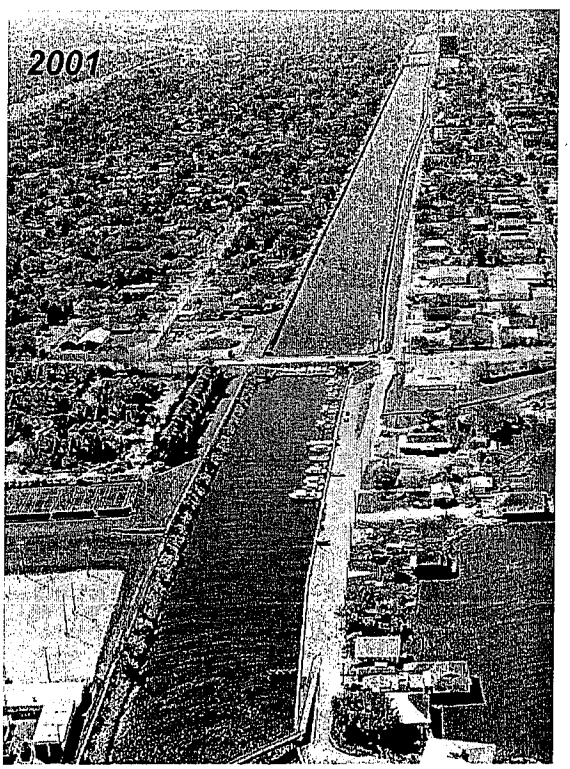
For

P.L. 110-252

17th Street, Orleans Avenue

and London Avenue Canals

Permanent Protection System



September 26, 2008

(Revised: December 2008)

US Army Corps
of Engineers

ENCL 2

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1.0 EXECUTIVE SUMMARY

The purpose of this Report is to provide information to Congress as required in Title III, Chapter 3, of Public Law 110-252, "Flood Control and Coastal Emergencies". This Section states:

> "... the Secretary of the Army, within available funds, is directed to continue the NEPA alternative evaluation of all options with particular attention to Options 1, 2 and 2a of the Report to Congress, dated August 30, 2007, provided in response to the requirements of Chapter 3, section 4303 of Public Law 110-28, and within 90 days of enactment of this Act, provide the House and Senate Committees on Appropriations cost estimates to implement Options 1, 2, and 2a of the above cited report..."

Option 1, Option 2, and Option 2a were described in the Report to Congress dated August 30, 2007. In brief, the Options are defined as follows:

- **Option 1** includes the construction of new gated pumping stations at or near the mouths of the 17th Street, Orleans Avenue, and London Avenue Canals in the New Orleans area as directed in PL 109-124. The pumping stations will be designed to operate concurrently and in series with the existing pumping stations serving these canals. In order to provide the best engineering solution, this option could be designed and constructed with features such as deeper foundations and sills or formed suction inlets on the pumps. For the purposes of this report, deeper foundations and sills at the pump stations were used in the estimate. This is the least cost of the three options and is within the authorized and appropriated programmatic cost of $804,000,000.
- **Option 2** includes construction of new pumping stations at or near the mouths of the canals on 17th Street, Orleans Avenue, and London Avenue, deepening of the existing canals and removal of the existing pumping stations, allowing the water to flow by gravity from the existing interior

drainage elements to the new pumping stations at the Lake. Option 2 takes advantage of any diversions which are cost effective. The cost estimate is a pre-feasibility level estimate (less than 10% design effort). This is a significantly higher cost than Option 1, and slightly lower cost than Option 2a. The approximate program cost is $3.4B and it exceeds the authorized and appropriated amount.

- **Option 2a** is the same as Option 2 with the addition of a new pumping station in Jefferson Parish to intercept flow from the 17th Street Canal and discharge directly to the Mississippi River. The cost estimate is a pre-feasibility level estimate (less than 10% design effort). The approximate program cost is $3.5B, which exceeds the cost of both Option 1, and 2, and exceeds the authorized and appropriated amount.

Table 1-1 Approximate Program Cost

(in millions of dollars)

Feature	Option 1 a/	Option 2	Option 2a
LANDS AND DAMAGES	2	2	3
RELOCATIONS	7	29	30
CHANNELS & CANALS	10	1,495	1,508
LEVEES & FLOODWALLS	-0-	89	90
PUMPING PLANT	708	1,468	1,553
PLANNING, ENGINEERING & DESIGN	34	167	173
CONSTRUCTION MANAGEMENT	36	154	159
TOTAL COST COMPARISON	**797**	**3,404**	**3,516**
Schedule Completion with Contingency	**Feb 2014**	**Apr 2023**	**Apr 2023**

a/ Within the authorized and appropriated programmatic cost of $804,000,000.

Notes:
1) Costs include all contingencies and escalation, supported by a risk analysis
2) Costs exclude O&M and Life Cycle Cost estimates

Each of these options would provide hurricane storm surge protection for the three outfall canals: 17th Street, Orleans Avenue and London Avenue. The technical advantages, disadvantages, and operational effectiveness of the three options were evaluated and described in the 2007 Report to Congress (REFERENCE 1).

Environmental impacts and alternatives as required by the National Environmental Policy Act of 1969 (Public Law 91-190, 83 Statute 852) are currently being evaluated, and will be presented in an Individual Engineering Report #5, which considers system-wide environmental impacts.

2.0 INVESTIGATIVE ANALYSIS

2.1 Background Information

Much of the storm water from the New Orleans Metro Area is pumped into three outfall canals at 17th Street, Orleans Avenue, and London Avenue. Figure 2-1 indicates the various drainage basins within New Orleans Metro Area. The outfall canals connect pumping stations located on the interior of the City to Lake Pontchartrain, where the storm water is discharged. Public Law 109-234 provides both authority and funding, based on preliminary Corps analysis, to "modify the 17th Street, Orleans Avenue, and London Avenue drainage canals and install pumps and closure structures at or near the lakefront."

The new closure structures, as authorized, will provide permanent storm surge protection by preventing hurricane storm surge from Lake Pontchartrain from entering the canals. The pumps will take storm water from the canals around the closure structures so that the interior drainage system can continue to function when the closure structures prevent direct discharge to Lake Pontchartrain.

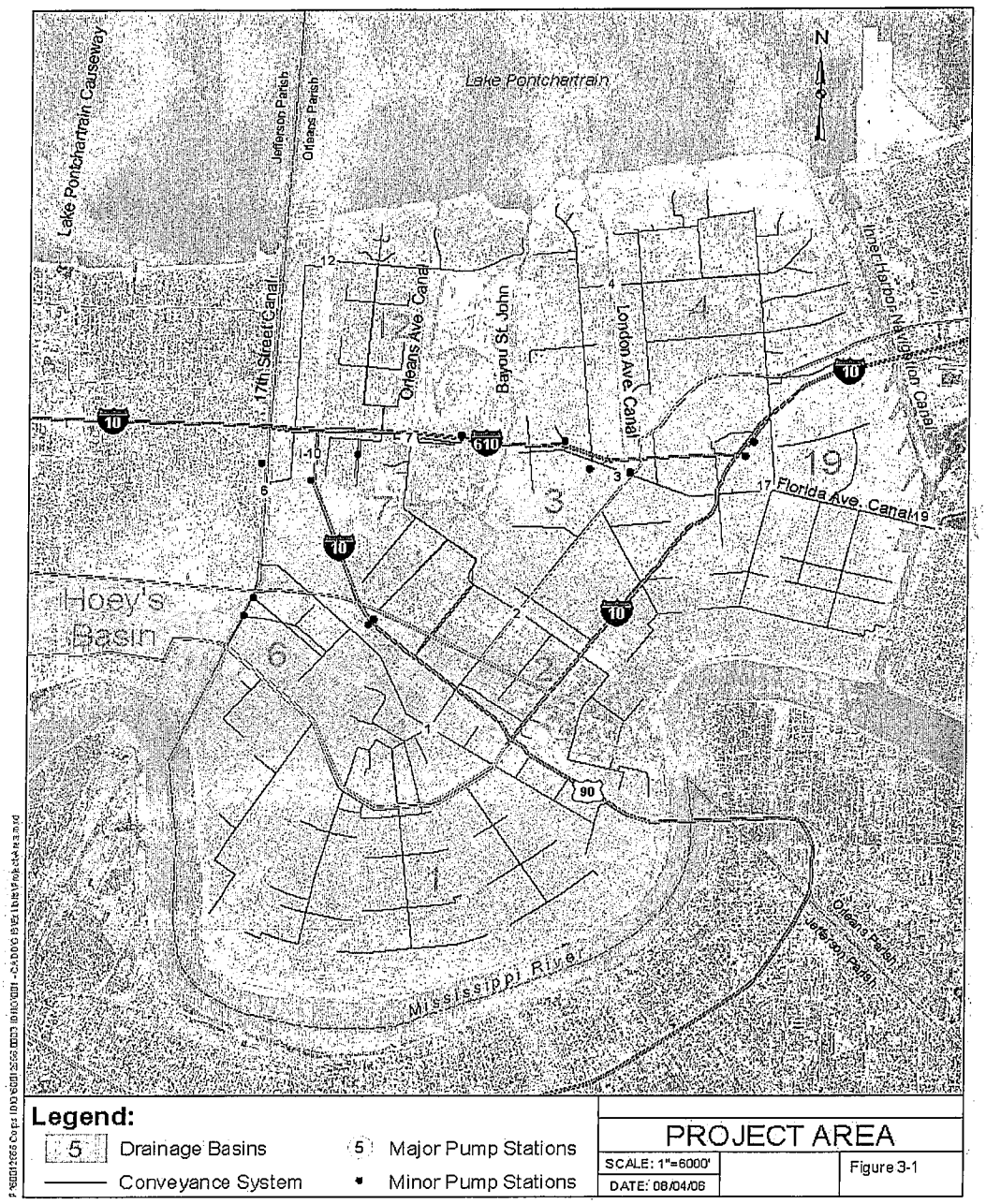

Figure 2-1 Area Under Consideration

2.2 Evaluation Process

In the aftermath of Hurricane Katrina, the Army Corps of Engineers, in concert with local stakeholders began to explore options to address the hurricane storm surge and evacuation of water in the area. Immediately after Congressional authorization (P.L. 109-234) to design and construct permanent pumping stations for 17th Street, Orleans Avenue and London Avenue Canals, the Corps of Engineers entered into a collaborative process with the local stakeholders to evaluate different options. To support the collaborative process the Corps of Engineers consulted existing reports, and initiated new reports to further investigate the options.

The Corps of Engineers utilized as input to the process the results of numerous engineering concept reports, Interagency Performance Evaluation Task Force (IPET) reports, canal inspection reports, and other technical evaluation. A list of the reports consulted throughout the process is contained in Section 4.0 REFERENCES. The evaluation and report process was integrated into the ongoing collaborative process of stakeholder involvement through partnering, consultation with experts through a Senior Review Panel, and additional engineering studies.

Ongoing stakeholder participation has included bi-weekly progress meetings, various USACE senior leadership board meeting presentations and assistance with the development of the analysis of technical advantages and disadvantages presented in REFERENCE 1. Throughout the development of this Report to Congress, in-depth coordination with the project sponsors has been an ongoing and iterative process. This collaborative process has been further strengthened through frequent interface with the stakeholders'. In May, 2008, Corps leadership engaged the local sponsors in discussions on a phased approach to implementation. In July 2008, the local sponsors provided input into the initiation of the Report to Congress. The Corps contractor also solicited and obtained technical input from the local Sewerage and Water Board while formulating their technical input to the Report to Congress. As the report was being finalized, in October, 2008, the local sponsors were updated on the status of the Report to Congress. As a result from the local sponsor's request to be engaged in further coordination efforts, the Corps conducted meetings in November 2008 with Jefferson Parish and the Orleans

Sewage and Water Board to provide releasable technical and operational information from the finalized Report to Congress.

Cost estimates have been developed for the pumping stations and their associated features based on conceptual studies for the various features required for the project. Since the project is in the pre-feasibility stage, conceptual designs and engineering judgment have been used to establish details of the features included in the cost estimates. This report includes information on the cost basis used for the cost estimates for each of the Options 1, 2 and 2a.

As a part of this effort, the USACE Cost Engineering Directory of Expertise for Civil Works (Cost Engineering Dx) provided an independent technical review (ITR) of the cost estimates and schedules for the three pump stations, all three represented in each of the three options. That effort also included providing a risk analysis study of the three options to establish the resulting contingencies. In conjunction with this requirement, it was determined that the most useful conveyance of the established cost data would be to present a cost comparison of the three options that reflect all project feature costs, contingencies and escalation, but exclude operations and maintenance (O&M) costs. The O&M costs are too preliminary for any reasonable evaluation or comparison. The cost estimates included herein include the total cost estimate of all expected delivery costs for each of the options.

Environmental impacts and alternatives as required by the National Environmental Policy Act of 1969 (Public Law 91-190, 83 Statute 852) are currently being evaluated and will be presented in an Individual Environmental Report #5, which considers system-wide environmental impacts. IER #5 has incorporated the previous studies, input from stake-holders, and other sources to formulate viable alternatives. The alternatives have been evaluated through multiple engineering studies, environmental impacts analyses, and team evaluation sessions utilizing Alternatives Evaluation Process meetings. Team evaluation sessions included specialists in environmental, technical, real estate, and legal issues evaluating the various advantages, disadvantages, and impacts of the different alternatives and site locations.

IER #5 considers those alternatives which meet the purpose and need of the project, i.e. to protect the City of New Orleans and Jefferson Parish from storm surge-induced flooding through the 17th Street, Orleans Avenue, and London Avenue Canals, while not impeding the ability of the area's internal drainage system to function. Several alternatives did not receive further consideration when it was determined that they would not satisfy the purpose and need of the project or were deemed infeasible or unreasonable. The alternatives carried through the impact analysis included No-Action (NEPA mandated), canal closures pumping stations, and parallel protection. Variations of these alternatives in both feature and location were evaluated as described above.

Draft IER #5 which will disclose the environmental impacts of all reasonable alternatives and the proposed action will be released in January 09 for a 30-day public review and comment period. At the conclusion of the 30-day review and comment period, if no substantive public comments are received, the CEMVN District Commander will make a decision on the proposed action, documented in an IER Decision Record. If substantive comments are received, Addendum to IER #5 will be prepared and released for an additional 30-day review and comment period. After this subsequent public comment period, the Commander would make a final decision.

3.0 OPTIONS UNDER CONSIDERATION

The Options required for consideration in this Report were described in some detail in the 2007 Report to Congress (REFERENCE 1). In brief, these Options are defined as:

- **Option 1:** New pumping stations and closure structures at or near the mouths of 17th Street, Orleans Avenue, and London Avenue Canals operating concurrently and in series with the existing pumping stations serving these canals. Decommission and remove the Interim Control Structure (ICS).
- **Option 2:** New pumping stations at or near the lake with deepened canals to carry gravity flow to the new pumping stations including any diversions which are cost effective. Decommission and remove the ICS. Decommission, remove and by-pass existing pumping stations.
- **Option 2a:** New pumping stations at or near the lake with deepened canals to carry gravity flows to the new pumping stations. Reduce flow in 17th Street Canal by diversion of flow from Jefferson Parish. Diverted flow from Jefferson Parish to be collected and pumped directly to the Mississippi River. Decommission and remove the ICS. Decommission, remove and by-pass existing pumping stations.

These Options are described in greater detail below. Cost estimates included herein were developed on the basis that an Option would be implemented as a separate, stand-alone, complete project. This approach allows direct comparison of the total estimated program cost of each of the Options.

This section provides background information on the features that are included in the cost estimates for each of the Options under consideration. Much of the criteria used to provide reasonable bounds on the project costs are based on engineering judgment regarding the types of features and equipment that are included in the project. Key engineering criteria applicable to all three Options and all three canals are as follows:

1. Pumping stations could be equipped with a mix of diesel driven pumps and electric motor driven pumps. For the purpose of this report, electric motor driven pumps were used.
2. Pumping stations require back-up power generation on site, including generators for any electric driven pumps, controls, auxiliary systems, and building power
3. Fuel storage on site is for four days at full capacity.
4. Pumps could discharge maximum flow during a storm surge on Lake Pontchartrain.
5. Vertical pumps are assumed to estimate the size of the building required to house pumps and their auxiliary systems.

In addition to the above considerations, several different potential site locations were evaluated. The following site locations were chosen for the purposes of cost estimates contained in this Report, and are based on the sites considered during the ongoing NEPA process. All Options utilize the same site locations for each canal.

Figure 3-1 17th Street Canal – Maximum Footprint

The location on the 17th Street Canal is just downstream of the existing Interim Closure Structure. Any ancillary facilities would be located on the east side of the new Pumping Station (toward the bottom of Figure 3-1).

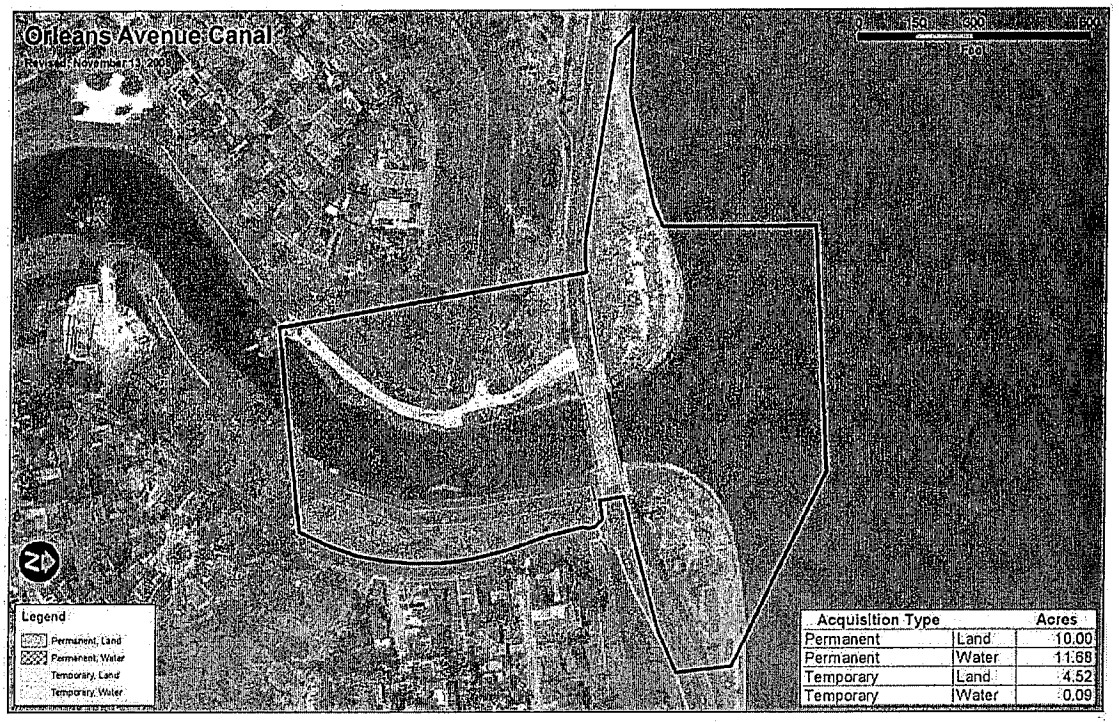

Figure 3-2 Orleans Avenue Canal – Maximum Footprint

On Orleans Avenue Canal, the location of the new Pumping Station is just upstream of Lakeshore Drive. Any ancillary facilities are on the west side of the Pumping Station (toward the top of Figure 3-2), and accessible from Lakeshore Drive.

Figure 3-3 London Avenue Canal – Maximum Footprint

On London Avenue Canal, the proposed location is approximately several hundred feet upstream of the bridge on Lakeshore Drive. Any ancillary facilities will be on the east side of the new pumping station (toward the bottom of Figure 3-3).

3.1 Option 1: New Pumping Stations Operating in Series with Existing Pumping Stations

3.1.1 Option 1: Brief Description

This Option was part of a previous engineering concept analysis described in a *Conceptual Report for Permanent Flood Gates and Pump Stations* (REFERENCE 2) dated July 31, 2006. This Option consists of construction of new permanent pumping stations with closure structures at or near the mouths of the three outfall canals. The existing Sewerage & Water Board of New Orleans (S&WBNO) pumping stations that discharge into the canals would remain in service. The canals would continue to convey storm water from the existing pumping stations to the new pumping stations and closure structures.

The new pumping stations would operate only during storm surge on Lake Pontchartrain. During normal conditions the flow from the canals would discharge through gates directly into Lake Pontchartrain without having to operate the pumping station. When a combination of lake stage and discharge flow from the existing pumping stations creates a condition where the water in the canals would exceed the safe water elevation in the canals, the gates could be closed, and the new pumping stations would operate.

Figure 3-4 shows the centerline profile of 17th Street Canal. Other canal profiles are similar. This Figure shows the centerline profile from the existing pumping station through the drainage canal and through the new pumping station to Lake Pontchartrain. This demonstrates the relative elevation of the intake of the new pumping station in comparison to the current elevation of the bottom of the canal and the existing pumping station.

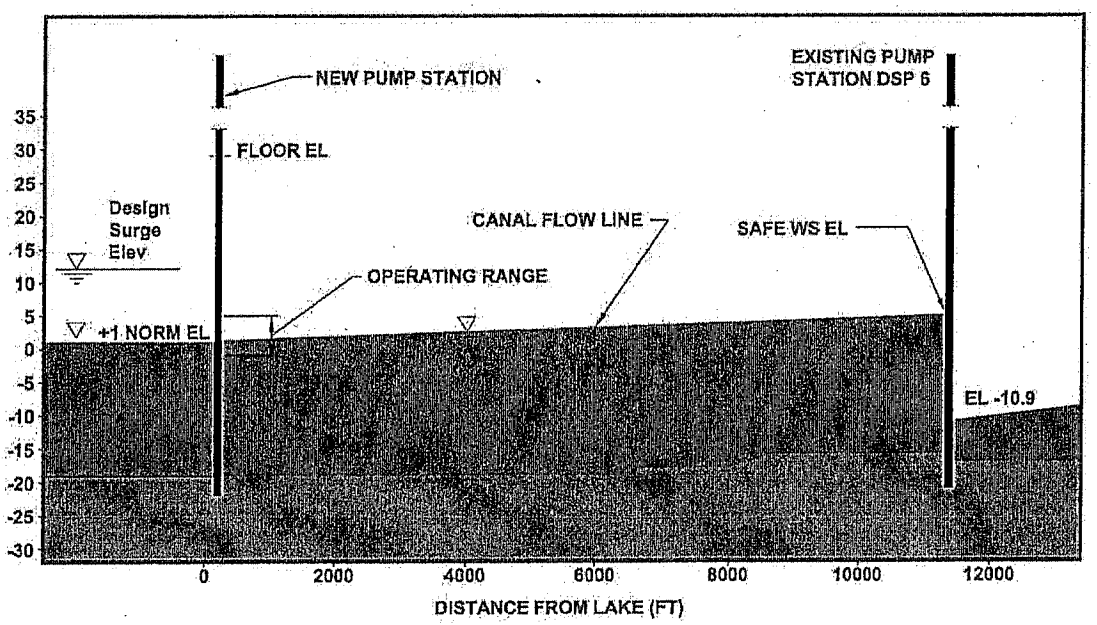

Figure 3-4 Option 1, 17th Street Canal Profile

Option 1 canals are considered "above-grade" canals because canal water levels are higher than the adjacent protected properties. This is shown schematically in Figure 3-5.

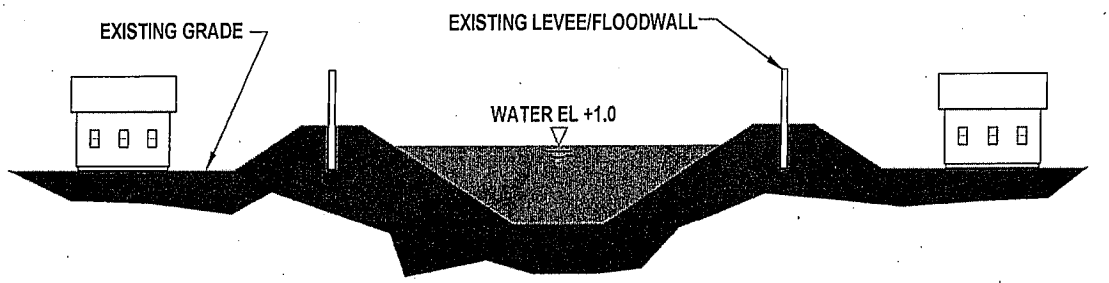

Figure 3-5 Option 1 – Typical Canal Cross Section

The Option 1 project could be designed and constructed with deeper foundations and sills to ensure operability over the life of the project due to future expansion. The proposed equipment of the Option 1 estimate does not include the larger power supplies, larger back-up power supplies or tank farms, larger pump motors, larger real estate requirements, etc. that might be required for operability due to future expansion. The equipment in this option is sized to meet the following existing capacities; 10,500 cfs at 17th Street Canal, 2,690 cfs at Orleans Canal and 7,980 cfs at London Ave. Canal.

3.2.1 Option 1: Basis of Cost

Additional considerations related specifically to Option 1 are discussed in this Section.

Pumping Plant – The pumping stations include the pumping station building and equipment, intake wet well, discharge section, canal transitions, generators with enclosures, a tank farm, and all the ancillary systems required for a fully functional facility. A cofferdam is required for the construction of the pumping station. A temporary bypass may also be required to route canal flows around the cofferdam during construction.

17th Street Canal Pumping Station: The pumping station on the 17th Street Canal includes a pile foundation, substructure, wet well inlets for each pump bay, a pumping station building, fully enclosed generators, and a tank farm for fuel.

The pumping station on the 17th Street Canal would be designed to match the current capacity of the existing pump stations discharging into this canal. The pumps could include a combination of diesel and electric driven pumps from 1,000 cfs down to 250 cfs, however for the cost basis of this report, all electric driven pumps were selected. The variety of pump sizes will provide better control to match the inflow into the canal produced by DPS 6 and the smaller pumping stations which discharge into the canal. Electric pumps are costed with diesel generator backup in the event of power loss at the station. Additional generating capacity is provided for station lighting, controls and instrumentation, and ancillary systems required for a fully operational system. The tank farm is sized for storage of sufficient fuel for four days of continuous operation at maximum capacity.

Orleans Avenue Pumping Station: The pumping station on the Orleans Avenue Canal includes a pile foundation, substructure, wet well inlets for each pump bay, a pumping station building, fully enclosed generators, and a tank farm for fuel.

The pumping station on Orleans Avenue canal would be designed to match the current capacity of the existing pump station discharging into this canal. The installed pumps could include a combination of diesel and electric driven pumps from 1,000 cfs down to 150 cfs, and for this cost basis all electric driven pumps were selected. Electric pumps will have back-up power generation capability. Additional generating capacity for station lighting and auxiliary systems will also be provided. The tank farm is sized for storage of sufficient fuel for four days of continuous operation at maximum capacity.

London Avenue Pumping Station: The London Avenue pumping station includes a pile foundation, substructure, wet well inlets for each pump bay, a pumping station building, fully enclosed generators, and a tank farm for fuel tanks.

The pumping station on London Avenue canal would be designed to match the current capacity of the existing pump stations discharging into this canal. The installed pumps could include a combination of diesel and electric driven pumps from 1,000 cfs

down to 250 cfs, and for this cost basis all electric driven pumps were selected. Electric pumps will have back-up power generation capability. Additional generating capacity for station lighting and auxiliary systems will also be provided. The tank farm is sized for storage of sufficient fuel for four days of continuous operation at maximum capacity.

Channels & Canals – The cost associated with canal work for Option 1 is primarily the canal work in and around the pumping stations and work associated with the Interim Control Structures (ICS) Decommissioning and Removal. At the completion of the project the ICS will be decommissioned and removed.

Levee and Floodwalls – There is no cost associated with Option 1 as the levees and floodwalls remain as an integral component of the protection system.

Lands and Damages – The majority of the lands associated with Option 1 for the Pump Station sites are currently publicly held properties, requiring only limited acquisition of private lands. The methodology of how the costs were developed included use of the maximum footprints, calculate the areas for various types of land use, estimate the value of the land type and calculate a total cost for each location. Lands and Damages included an estimated acreage for each appropriate Land Use type such as:

Existing Canal Right-of-Way
Existing Street Right-of-Way
Perpetual Drainage Easement Potential Residential/Commercial
Perpetual Drainage Easement Existing Levee and Canal ROW
Perpetual Drainage Easement Existing Drainage Canal
Temporary Work Area Easement
Perpetual Flood Protection Levee Easement Levee District Owned ROW

In addition, other associated real estate costs included:

Existing Improvements
P.L. 91-646, Title II
Acquisition Costs (Private Owners)
Acquisition Costs (Local/State Owners)

Relocations – Relocations includes all costs associated with relocating existing utilities and improvements within lands and properties required for the project. The methodology of costs for Relocations was calculated as a direct percentage (1%) of the estimated construction costs.

Planning, Engineering & Design (PED) – PED includes all costs associated with the Corps activities to develop this design-build project to a biddable level, through procurement and finally to contract award. The methodology of costs for PED was calculated as a direct percentage (6%) of the estimated construction costs.

Construction Management (CM) – CM includes all costs associated with the Corps activities to monitor and administer the execution of the design-build project through design, construction, operation testing and project close-out. The methodology of costs for CM was calculated as a direct percentage (5%) of the estimated construction costs.

3.2 Option 2: New Pumping Stations at or Near the Lakefront with Deepened Canals and Removal of Existing Pumping Stations

3.2.1 Option 2: Brief Description

This option includes constructing new pumping stations at or near the lakefront and necessary canal modifications that allow gravity flow of storm water to the pumping station. Canal modifications may include deepening, widening, lining, etc. In this scenario, the existing S&WBNO pumping stations would no longer be required. The deepened canals would allow the water that is currently pumped by the existing pumping stations to flow by gravity all the way to the new, pumping stations at the lakefront. With the canals deepened the need for levees and floodwalls along the existing canals from the existing pumping stations to the lake could be eliminated. The canal would no longer be elevated above the surrounding ground level, but would be a normal, below-grade canal.

The pumping station effectively becomes the closure structure. Gates for bypassing flow are not required for this Option, and the new pumping stations would operate anytime storm water flows in the canals. This would be expected to occur for most rain events.

The primary difference in operation between Option 2 and Option 1 is depicted in Figure 3-6. This Figure shows the water level in the canal at a much lower elevation than

shown in Figure 3-4 and shows existing Drainage Pumping station (DPS) 6 bypassed. This Option, therefore, eliminates the need to double pump the water. However, the water would have to be lifted higher from the deepened canal into the lake. This would have a significant impact on the type and size of pumps to be used. Modifications to pump components and larger motors would be required to provide for the additional lift. Required pump capacity remains the same as Option 1 for 17th Street Canal, and Orleans Canal, however the required pump capacity is 6,880 cfs at London Ave. Canal due to the diversion at Florida Ave. . .

Option 2 provides the opportunity for making improvements and/or modifications to the major components of the drainage system. For example, some of the water that currently has to be pumped into the canals could be configured to flow by gravity into the new deepened canals.

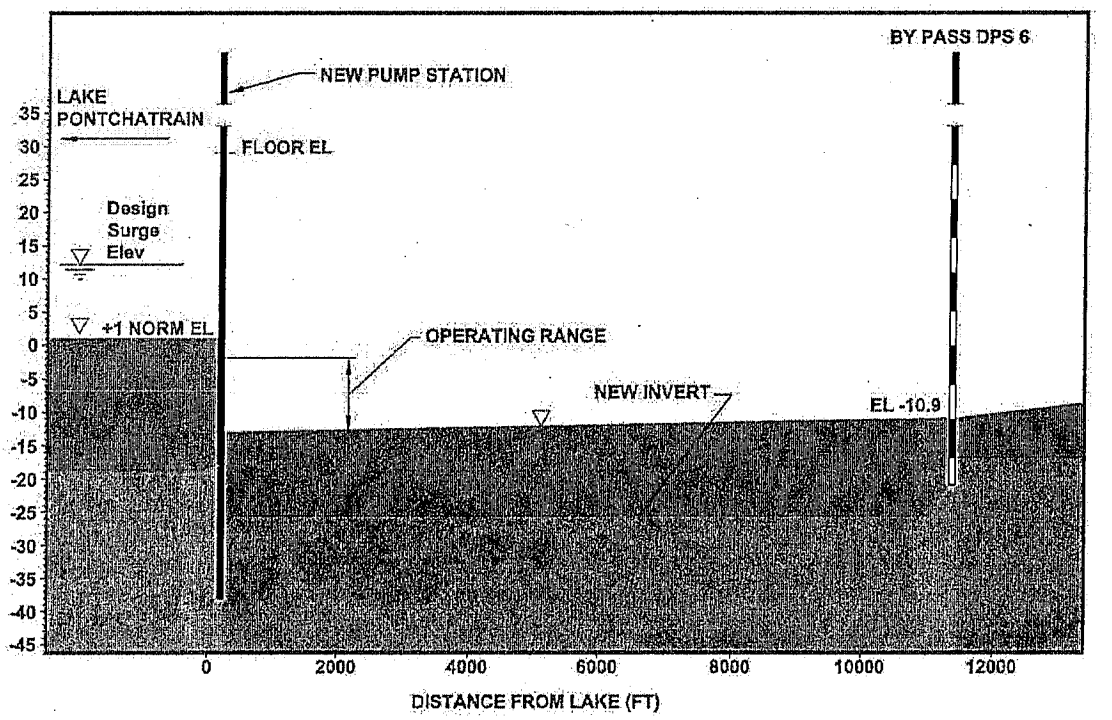

Figure 3-6 Option 2, 17th Street Canal Profile

The sill elevation and foundation of the new pumping station would be the same for both the Option 1 and Option 2. The pumping station is required to be designed for the additional depth and future water level difference between the Lake and the canal.

The significance of the below-grade canal can be seen by comparing Figure 3-5 and Figure 3-7. Comparison shows that Option 2 results in a water surface elevation lower than the adjacent developed areas, where in Option 1, the water surface elevation is still above the adjacent ground elevation.

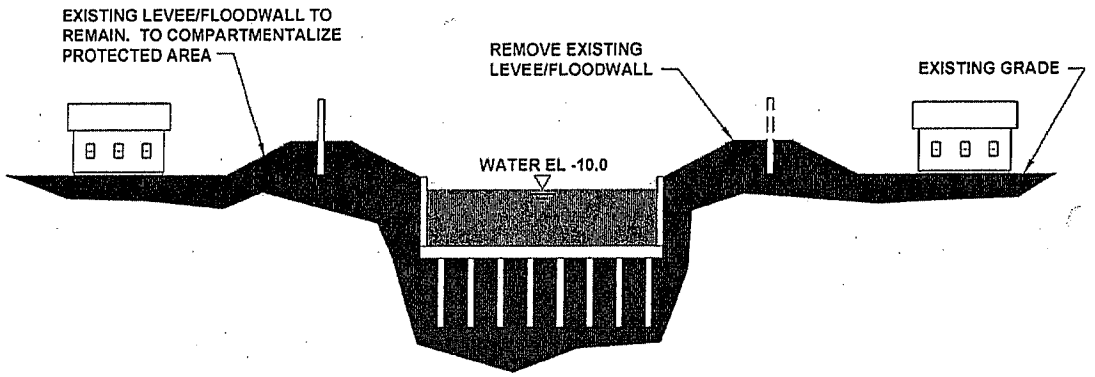

Figure 3-7 Option 2 – Typical Canal Cross Section

The locations of the new pumping stations at or near the lakefront are the same as the locations considered for Option 1. Since the motors for the pumps are larger, the standby power requirements may also be greater. The greater power requirements would require a larger tank farm for fuel. Overall, more real estate is required for the Option 2 solution because of the larger tank farm requirements.

3.2.2 Option 2: Cost Basis

Additional considerations related specifically to Option 2 are discussed in this Section. The Option 2 pumping station provides for future flow capacity, a deepened canal for gravity flow to the new pumping stations, an optimized diversion thru Florida Avenue, and the removal of existing pump stations.

Pumping Plant – The pumping stations include the pumping station building and equipment, intake and discharge sections, canal transitions, generator building and

equipment, a tank farm, and all the ancillary systems required for a fully functional facility. For construction, a cofferdam is required for the construction of the pumping station. A temporary bypass may also be required to route canal flows around the cofferdam during construction. The pumping stations are of sufficient size to accommodate the future expected increases in flow. The total lift for the Option 2 pumping stations are about twice the height of the lift for the Option 1 pumping stations, which essentially doubles the power requirements. The tank farms are sized for storage of sufficient fuel for four days of continuous operation at maximum capacity.

The new pumping stations will be constructed with bypasses around the construction sites so that the existing systems can continue to function. The timing of the closure of each bypass will have to be coordinated with the lowering of the water level in the canal, bypass of the existing Interim Control Structure, and bypass of the existing pumping stations.

17th Street Canal Pumping Station: The pumping station on the 17th Street Canal includes a pile foundation, substructure, formed suction inlets for each pump bay with a lowered invert elevation, a pumping station building, a generator building, and tank farm for fuel. A gated section is not required. The intake basin (forebay) is formed by transitioning from the canal cross section to the intake section of the pumping station at an angle of approximately 10 degrees from the canal edge line. The transition is required to produce good flow characteristics across the entire width of the pumping station intakes. A similar transition is required on the discharge side of the pumping station (tailrace), but can be formed with a much steeper angle of about 30 degrees. Concrete training walls are used to form the transitions. .

The pumping station structure on the 17th Street Canal is costed to accommodate additional pumps and equipment for a potential future flow of 12,500 cfs. The installed pumps could include a combination of diesel and electric driven pumps from 1,000 cfs down to 250 cfs, but for the purpose of this report electric pumps were used. The variety of pump sizes will provide control to match the inflow into the canal produced varied rain events. Any electric pumps are provided with diesel generator backup in the event of power loss at the station. Additional generating capacity is provided for station lighting,

controls and instrumentation, and ancillary systems required for a fully operational system.

Orleans Avenue Pumping Station: The pumping station on the Orleans Avenue Canal includes a pile foundation, substructure, formed suction inlets for each pump bay, a pumping station building, a generator building, and tank farm for fuel. The forebay and tailrace and transitions for the pumping station are similar to the description above for the 17th Street pumping station.

The pumping station structure on Orleans Avenue canal is costed to accommodate a future flow of 3,390 cfs. The installed pumps could include a combination of diesel and electric driven pumps from 1,000 cfs down to 250 cfs, but for the purpose of this report electric pumps were used. Electric pumps will have back-up power generation capability. Additional generating capacity for station lighting and auxiliary systems will also be provided. The tank farm is sized for storage of sufficient fuel for four days of continuous operation at maximum capacity.

London Avenue Pumping Station: The London Avenue pumping station includes a pile foundation, substructure, formed suction inlets for each pump bay, a pumping station building, a generator building, and tank farm. No gated section is needed or provided. The forebay and tailrace and transitions for the pumping station are similar to the description above for the 17th Street pumping station.

The pumping station structure on London Avenue canal is costed to accommodate a potential future total flow of 7,880 cfs. The installed pumps could include a combination of diesel and electric driven pumps from 1,000 cfs down to 250 cfs, but for the purpose of this report electric pumps were used. Electric pumps will have back-up power generation capability. Additional generating capacity for station lighting and auxiliary systems will also be provided. The tank farm is sized for storage of sufficient fuel for four days of continuous operation at maximum capacity.

Channels & Canals – Option 2 requires several miles of drainage canal to be deepened to permit gravity flow from the existing interior drainage system to the new pumping station at or near the lake. Bypass and demolition of the existing pumping stations, and the levees and flood walls on both sides of the canals is also included.

Canal deepening has to occur with the canal remaining in service. Alternatives have been considered which allow the work to be accomplished without taking the canals out of service during the construction. Methods include improving the foundation soils utilizing deep soil mixing and jet grouting with either tremie concrete or grout filled fabric forms for bottom and side slopes. The cost estimate includes a trapezoidal shaped canal with deep soil mixing/jet grouting and the grout filled fabric forms bottom and side slopes. This was the least cost of several methods reviewed.

Bridge Modifications – The deepening of the canals will result in some excavation near or adjacent to bridges. To ensure the continued stability of these structures, these structures will be modified in a conservative manner, or in a few cases replaced, as follows:

- 17th Street - Hammond Highway, Veterans Blvd, Interstate 10, and replacement of the Southern Railroad Bridge

- Orleans Avenue - Lakeshore Drive, Robert E. Lee, Filmore Avenue, and Harrison Avenue

- London Avenue - Leon C. Simon Blvd., Filmore Ave., Mirabeau Ave., Gentilly Blvd., and the replacement of Robert E. Lee and Southern Railroad bridges. ...

Florida Avenue Diversion – A diversion project which is cost effective is the diversion of 1,100 cfs from DPS 3 through the Florida Avenue Canal to DPS 19 and into the Inner Harbor Navigation Canal. To accomplish this diversion requires that 1,100 cfs pumping capacity remain at DPS 3. The system currently allows all flow from DPS 3 to be pumped into the London Avenue Canal or through the use of gated structures allows 1,100 cfs to be pumped into the Florida Avenue Canal. Implementing this diversion allows the new London Avenue Pumping station structure to be designed for 7,880 cfs with an installed pumping capacity of 6,880 cfs.

Bypass/Demolition of Existing Pumping Stations – Once the canal deepening is completed, the water level in the canal is lowered allowing for bypass of the existing S&WBNO pumping station. The bypass has to be constructed to maintain the water surface differential across the existing pumping station until all systems and features are in place to allow for a fully functional system at the new lowered canal water surface

elevation. When all systems are ready and the water surface elevation of the canal has been lowered, the bypass is completely opened. Once the bypass is opened, the existing pumping stations could be demolished and the cross section at those locations restored to a typical canal cross section.

Interim Control Structures (ICS) Decommissioning and Removal – At the completion of the project the Interim Control Structure (ICS) will be decommissioned and removed.

Levee and Floodwalls - Once the water level in the canal is lowered, the existing levees and floodwalls lining both sides of the canals can also be removed down to existing grade.

Lands and Damages – The majority of the lands associated with Option 2 for the Pump Station sites, canals and diversions are currently publicly held properties, requiring only limited acquisition of private lands. The methodology of how the costs were developed included use of the maximum footprints, calculate the areas for various types of land use, estimate the value of the land type and calculate a total cost for each location. Lands and Damages included an estimated acreage for each appropriate Land Use type such as:

Potential Industrial Use
Existing Canal Right-of-Way
Batture (Area between Levee and Mississippi River)
Existing Street Right-of-Way
Perpetual Drainage Easement Potential Residential/Commercial
Perpetual Drainage Easement Existing Levee and Canal ROW
Perpetual Drainage Easement Existing Drainage Canal
Temporary Work Area Easement
Perpetual Flood Protection Levee Easement Levee District Owned ROW

In addition, other associated real estate costs included:

Existing Improvements
P.L. 91-646, Title II
Acquisition Costs (Private Owners)
Acquisition Costs (Local/State Owners)

Relocations – Relocations includes all costs associated with relocating existing utilities and improvements within lands and properties required for the project. The

methodology of costs for Relocations was calculated as a direct percentage (1%) of the estimated construction costs.

Planning, Engineering & Design (PED) – PED includes all costs associated with the Corps activities to develop this design-build project to a biddable level, through procurement and to contract award. The methodology of costs for PED was calculated as a direct percentage (6%) of the estimated construction costs.

Construction Management (CM) – CM includes all costs associated with the Corps activities to monitor and administer the execution of the design-build project through design, construction, operation testing and project close-out. The methodology of costs for CM was calculated as a direct percentage (5%) of the estimated construction costs.

3.3 Option 2a: Option 2 in Combination with Discharges Directly to the Mississippi River in Jefferson Parish

3.3.1 Option 2a: Brief Description

Option 2a is similar to Option 2 but includes the addition of a storm water diversion from Jefferson Parish. A new pumping station in Jefferson Parish would be constructed to intercept flow from 17th Street Canal to discharge directly to the Mississippi River. Option 2a only impacts the 17th Street Canal and Pumping Station.

As required by Title III, Chapter 3 of Public Law 110-252 this diversion of flow from the 17th Street Canal was investigated. The diversion consists of collecting the flow from about 2,500 acres of Jefferson Parish, consisting primarily of an area known as Hoey's Basin, and directing that flow to the Mississippi River. This drainage basin currently gravity drains into the system served by existing drainage pumping station (DPS) 6, which discharges into the 17th Street Canal.

The diversion anticipated by Option 2a includes closing the existing gate which separates Jefferson Parish on Hoey's Canal from the 17th Street drainage system. The gate may be used in emergencies to allow flow from Hoey's Basin to discharge through

the 17th Street system, or could be used to allow flow from the 17th Street system to the new pumping station for Hoey's Basin.

The complete diversion system includes Hoey's Canal modifications for a new pumping station and equipment, a discharge pipeline from the new station to the Mississippi River and a diffuser box and protective cells for protection in the Mississippi River. The new pumping station capacity is 1,600 cfs, which is the reduction in flow to the 17th Street drainage system. The conceptual pumping station includes four 400 cfs diesel driven pumps. The 400 cfs pumps are the largest pumps that can be driven with a standard diesel engine. Larger pumps would require custom diesel engines. A small diesel generator set is installed in the new pumping station to power station lighting, controls and instrumentation, and ancillary systems in the event of a power outage.

The discharge pipeline is approximately 13 foot diameter, with a routing that generally follows an abandoned railroad right-of-way. It includes approximately 400 feet of direct buried pipeline and 3,500 feet of above grade piping, 750 feet of tunneling under railroads, and a pipe bridge to cross River Road. At the terminus, the pipeline extends over the Mississippi River levee to a diffuser structure in the river protected by dolphins. The Mississippi River levee is higher than the Lake Pontchartrain levee which requires more pump horsepower to lift the water to greater heights.

Several potential diversions were considered during engineering studies to support the estimated program cost of Option 2. The only diversion of flow considered cost effective from a solely engineering perspective was the London Avenue Diversion through Florida Avenue. This diversion was considered in the Option 2 cost estimate.

3.3.2 Option 2a: Cost Basis

The costs for Option 2a were based on Option 2. The savings from Option 2 includes: costs associate with reducing: the number of pumps at the 17th Street pumping station because of the 1,600 cfs that is diverted to the Hoey's Basin station, the extent of the canal deepening at 17th St is also reduced because of the 1600 cfs diverted to the Hoey's Basin station . Since the pumping station capacity is reduced, the fuel tank requirements are also reduced. The additional costs realized in this option are the new

pump station, the transition to the pump station, the discharge pipeline along with the ancillary systems required for a complete and functional system.

The total cost of Option 2a is derived by starting with Option 2, realizing the savings associated with the reductions in the 17th Street canal and pumping station as described above and adding the cost of the Hoey's Basin diversion system.

Interim Control Structures (ICS) Decommissioning and Removal – At the completion of the project the ICS will be decommissioned and removed.

Lands and Damages – The lands associated with Option 2a for the same as Option 2 with the addition of the real estate associated with Hoey's Basin (See Figure 3-8). The methodology of how the costs were developed included use of the aerial photograph for the Hoey's Basin, calculate the areas for various types of land use, estimate the value of the land type and calculate a total cost for each location. Hoey's Basin area included an estimated acreage for each appropriate Land Use type such as:

Potential Industrial Use
Existing Canal Right-of-Way
Batture (Area between Levee and Mississippi River)
Existing Street Right-of-Way
Temporary Work Area Easement

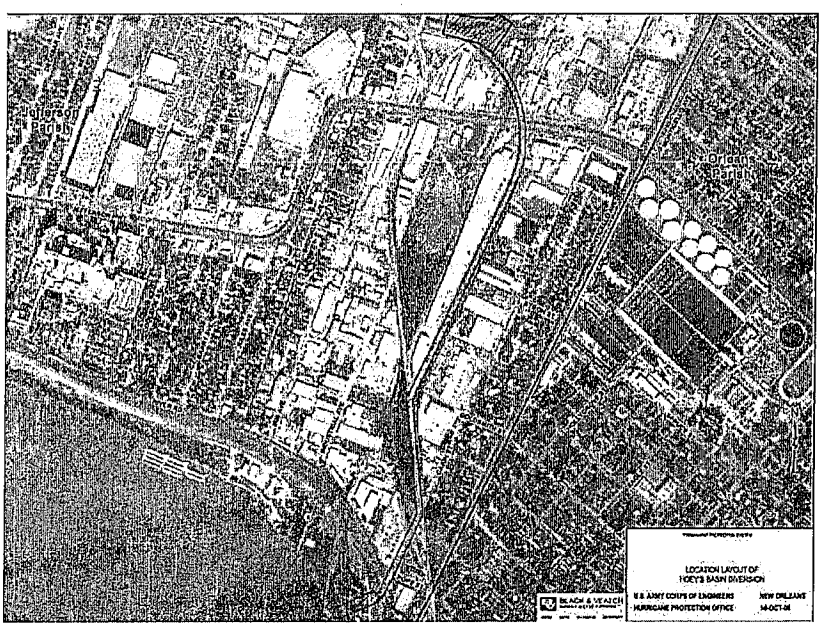

Figure 3-8 Option 2a – Hoey's Basin Layout

3.4 Construction Sequencing

One benefit of construction of this pumping station is the ability to transition from an Option 1 project to an Option 2 or 2a project at some time in the future. Additional studies have been performed to determine the features and sequencing required to accomplish the required transition. The construction phasing has been evaluated in four distinct phases as follows:

- **Construction Sequence No. 1** – Construct an Option 1 pumping station including demolition of the existing Interim Control Structure. The ICS pumping stations are decommissioned and removed.
- **Construction Sequence No. 2** – Construct cost effective diversion systems. This would authorize and fund viable diversions to reduce the required flow of the canals.
- **Construction Sequence No. 3** – Deepen the existing canals to permit gravity flow of storm water to the new pumping stations. Convert the pump components and motors to the larger sizes required for the increase in lift height.
- **Construction Sequence No. 4** – Using reconfigured pumping stations, pump the canals down to the new required water surface elevation. Construct bypass around existing pumping stations and demolish existing pumping stations, fill and re-grade site to new canal cross section.

After the Construction Sequence No. 1 is completed the pumping station would operate in series with the existing S&WBNO pumping stations. The pumps and ancillary equipment would be designed for the lower lift requirements for lifting the water from the current water surface elevation in the canal to the storm surge elevation in the Lake. Also included is the demolition of the existing Interim Control Structure.

Construction Sequence No. 2 includes the consideration of several diversion projects. If the flow in any of the canals can be reduced by diverting some of the flow to another location, the future cost of the deepening of the canal could be reduced because lower flow requires less excavation. In addition, the future cost of conversion of the pumps to the higher lift requirements could also be reduced.

Three possible diversions were considered: (1) London Avenue Canal diversion from DPS 3 to DPS 19 via Florida Avenue Canal to the Inner Harbor Navigation Canal (IHNC), (2) Option 2a Hoey's Basin diversion to the Mississippi River, (3) London Avenue Canal diversion from DPS 4 to a new pump station on Dwyer Avenue Canal to discharge to the IHNC. Only the first of these diversions was found to be cost effective from a solely engineering perspective. The third diversion was dropped from further consideration.

The costs were compared to the cost of Option 2 without diversions to determine whether the proposed diversions were cost effective in reducing the overall cost of Option 2.

Diversions could be constructed independent of any of the other Construction Sequence. If diversions are desired, the greatest benefit would be obtained by construction of the diversion project as early as possible. It is even possible to construct the diversion projects prior to construction of the Option 1 pumping station. This allows taking maximum advantage of the cost savings that can be produced by implementation of the diversion projects.

Construction Sequence No. 3 is the first step in converting the Option 1 pumping station into an Option 2 full project. This sequence includes deepening of the existing canals, upgrading the Option 1 pumps to Option 2 pumps, installation of additional fuel tanks. Deepening of the canal may include modification of bridge foundations and relocation of utilities. At this point, the existing pumping station will still operate in series with the new Option 2 pumping station. Once the Option 2 pumps are in service, the elevation of the water surface elevation in the canal will be lowered. The existing drainage pumping stations will discharge into the lowered canal with minimal differential between the intake and discharge sides of the pumping stations.

Construction Sequence No. 4 includes bypass and decommissioning of the existing pumping stations. Once the decommissioning is complete, the space occupied by the pumping station could be filled to the same canal cross section of the remainder of the drainage canal. A dry weather weir is constructed at the approximate location of the existing pumping stations. Small pumping stations could be constructed to pump the collected dry weather flows to the existing dry weather flow system which discharges to the Mississippi River.

It is possible to overlap portions of Construction Sequence No. 3 and No. 4. For example, the construction of the bypass could be in progress while completing the canal deepening. Once the canal deepening is completed and the water surface elevation is lowered, the bypass could be opened. As soon as the bypass is opened, the existing pumping stations are no longer required, and the system operates in the full Option 2 mode.

Drainage Pumping Stations 3, 6, and 7 are on the National Register of Historic Places. There may be consideration given to keeping at least the historic portion of the existing pumping station(s). Other potential uses for the existing historic pumping stations should be further investigated before a final decision is made. If the existing pumping stations are demolished, the requirements of the State Historic Preservation Office would need to be followed in terms of full documentation of each of the facilities. The cost estimates include the cost of demolition and restoration of the site to the required drainage canal cross section.

Once the water surface elevation of the canal is permanently lowered, the existing levees and walls which formed the parallel protection system are no longer required and could also be demolished. Since the new water surface elevation in the canal is lower than the existing grade surrounding the canal, the existing levees and flood walls could be demolished to approximately the level of the surrounding grade. In some cases, surrounding interior drainage may be reconfigured to drain through drainage swales and ditches into the lowered canals instead of being directed toward the location of the demolished pumping stations.

4.0 REFERENCES

In creating this Report, the United States Army Corps of Engineers (USACE) reviewed the following documents.

1. *Report to Congress for P.L. 110-28, Chapter 3, SEC 4303, 17th Street, Orleans Avenue, and London Avenue Canals, Permanent Protection System,* August 31, 2007, US Army Corps of Engineers
2. *Conceptual Design Report for Permanent Flood Gates and Pump Stations,* July 31, 2006, GEC and Black & Veatch
3. *Performance Evaluation of the New Orleans and Southeast Louisiana Hurricane Protection System, Final Report of the Interagency Performance Evaluation Task Force (IPET), Volume I – Executive Summary*, March 26, 2007, US Army Corps of Engineers
4. *Performance Evaluation of the New Orleans and Southeast Louisiana Hurricane Protection System, Final Report of the IPET, Volume II – Geodetic Vertical and Water Level Datums*, March 26, 2007, US Army Corps of Engineers
5. *Performance Evaluation of the New Orleans and Southeast Louisiana Hurricane Protection System, Final Report of IPET, Volume VI – The Performance – Interior Drainage and Pumping,* March 26, 2007, US Army Corps of Engineers
6. *Final Report of Alternatives Analysis of the Interim Drainage Maintenance Opportunities for the East Orleans Drainage Project,* August 18, 2006, DMJM Harris
7. *Project Information Report, Rehabilitation Hurricane or Shore Protection Projects Damaged by Hurricane Katrina, East Orleans Parish, Revision #2,* May 17, 2006, New Orleans District Corps of Engineers
8. *Application for Hurricane Flood Control Protection Program, Hoey's Basin, Pump to Mississippi River Plan,* October 2006, by Brown Cunningham Gannuch

9. *Report on Alternative Drainage Outlet to the Mississippi River for the Hoey's Basin for Jefferson Parish,* July 9, 2007, NY Associates, Inc.

10. *17th Street Outfall Canal Floodwall Inspection Report, New Orleans District, Engineering Division, May 25, 2006*

11. *Senior Review Panel Best Technical Solution Evaluation Final Report, ECM-GEC Joint Venture, July 25, 2007*