Appendix L
Mechanical Engineering

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1. EXISTING CONDITIONS

There are currently three diesel engine deep-well pumps, two diesel powered pump station, and several water control structures in Yorkinut Slough. Beginning in 1967, these structures were built for Moist Soil Units (MSUs) to create optimal conditions for the surrounding habitats. The existing well pumps and water control structures, built between 1990-early 2000's, have since been degraded and need replacement. The well pumps are hollow shafted pumps with mountable gearboxes and are driven by mobile engines. The existing well pumps pump water from the aquifers that are 75 – 110ft down into the surrounding wetlands ponding areas. Controlling the water levels of the MSUs creates the right conditions for local plants and animals to thrive. Several existing water control structures are used in Yorkinut Slough for gravity drainage into Swan Lake. Additionally, a 16-foot open channel controlled by stop logs is used to gravity drain the MSUs in Yorkinut Slough and Swan Lake and its upland tributary inputs when the Illinois River levels are lower than Swan Lake. There are a total of two pump stations in Swan Lake. The purpose of the pump stations is to pump water out of Swan Lake and into the Illinois River when the water level in Swan Lake is too high for gravity drainage. The easternmost pump in Swan Lake has a capacity of 48,000 gpm and is powered by a diesel-powered motor. The pump station has had numerous maintenance issues including catching on fire twice. The following proposed items are for the Tentatively Selected Plan (TSP), Alternative 3 Intermediate B.

2. POTENTIAL MEASURES

2.1. Pump Station

Pump stations are comprised of pumps, motors, gates, and control systems. They are set up to provide a certain flow of liquid at a specific pressure to deliver fluid to and from targeted areas. Typically pump stations can have various configurations that work effectively for the project. Two locations and types of pump stations were evaluated (fixed location and portable). A portable pump station was not retained because it was not acceptable to the project sponsor due to O&M concerns. A pump station located at Lower or Middle Swan Lake to drain into the Illinois River was retained. This new pump station along the Swan Lake riverside berm would increase capacity to drawdown water levels within the Swan Lake units and the Yorkinut Slough area and will be used in conjunction with the existing 48,000 gpm station. The total capacity of the pump station is proposed to be 23,300 gpm which will consist of two 11,500 gpm pumps. See Sub-Appendix G-2 in the Hydrologic and Hydraulic Engineering Appendix for calculations on how the pump station capacity was determined. The pumps will be powered by a diesel engine. Additional features such as sluice gates, flap gates, and check valves can be used to control water intake and prevent backflow into pumps respectively. The final configuration of the station will involve input from multiple disciplines, however a configuration similar to the existing Swan Lake Pump Station shown in Figure 1 will be considered.

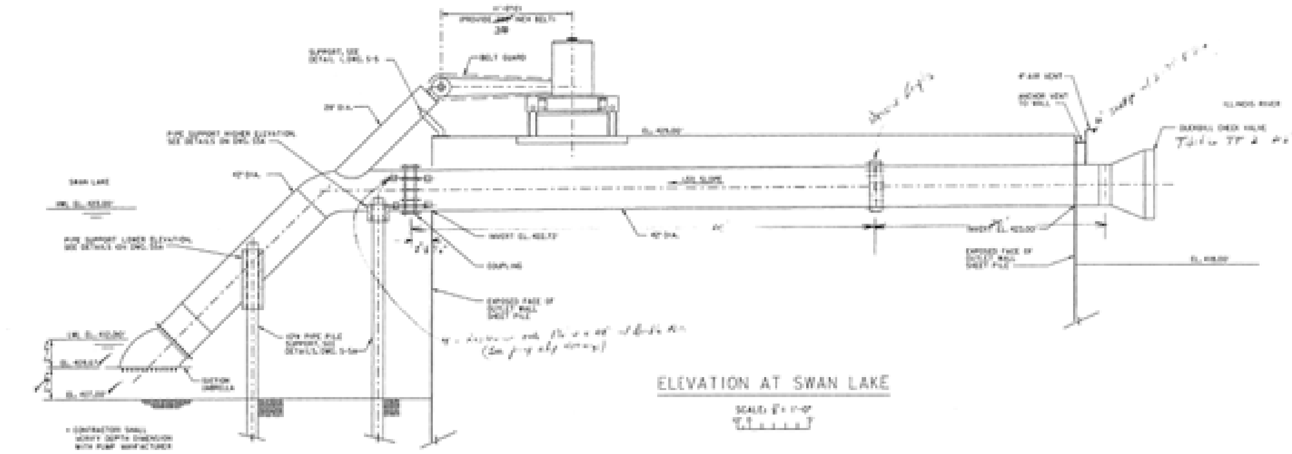

Figure 1. Lower Swan Lake Pump Station

2.1.1. Pumps

The type of pumps used for the pump station will be two axial or mixed flow, line shaft pumps (Figure 2). In case one of the pumps fails or requires maintenance, the inclusion of a second pump will ensure that the pump station can continue to operate at half capacity. The drive configuration will be a direct connection to the shaft as requested by the sponsor. The existing pump station features a belt connection that has caused issues with tension on the drum, causing the gear head to catch fire. The pumps will need to be lubricated regularly and will require maintenance to ensure they are running at maximum efficiency. A trash rack or screen will be included in the design of the station to ensure large debris will not clog or damage the pump.

Figure 2. Lineshaft pump.

2.1.2. Motors and Engines

2.1.2.1.Electric motors

To power the pumps, either electric motors or diesel engines could be used. Electric motors can provide power without the need of fuel storage or a heat exchanger. However, power lines must be able to reach the pump station and space on the power grid must be made. Electric motors can be less reliable as they are reliant are the power grid which could prioritize other destinations over the pump station, a problem that has occurred before with an electric motor in Yorkinut Slough.

2.1.2.2.Diesel engines

Diesel engine drives (Figure 3) can require more maintenance and be more complex to operate. A diesel engine system will also require additional equipment such as a radiator or heat exchanger for the cooling system and fuel tanks for storage. Diesel engines will be proposed for the pump station due to past issues with the power grid and the fact that electric motors will require the installation of power lines. These power lines would be an expensive addition due to the large amount of power that would be required by pumps of this size. The diesel engine and fuel tank can be trailer mounted (Figure 4) so it can be stored off-site when not in use.

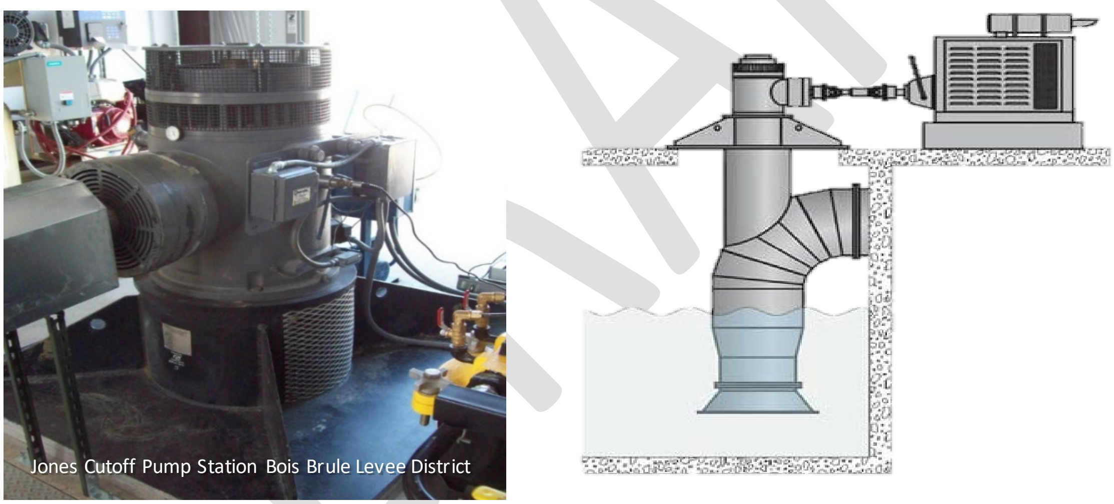

Figure 3. Diesel Engine Powered Pump

Figure 4. Trailer Mounted Fuel Tank

2.1.3 Controls

Float control devices can be included in the pump station for automatic start/stop of the pumps. The float switches are encapsulated in a polypropylene casing and are activated when the longitudinal axis of the float is horizontal and is de-activated when the water level falls one inch below the activation level. The float switch, located in the sump, serve as an interlock that will stop the pump and/or prevent the pumps from operating if the water level in the sump falls below the pump low water cut-off elevation. This device is shown in Figure 5.

Figure 5. Low Water Cutoff Float Switch

2.2. Water Control Structures

The proposed water control structures will consist of reinforced concrete pipe and flared end sections. In order to control water levels within the management units, gates or stop log structures will be installed. See the Structural Appendix for more detail on stop log structures.

2.2.1. Slide Gates

Slide gates are available in various sizes, materials, and operations (e.g., Figure 6 and Figure 7). Manually operated slide gates will be considered for the water control structures. Manual gates are considered over automatic gates to provide a less complex system that would not have to rely on electric power. The sluice gates will need to be maintained in a condition wherein the full range of operation is insured. Maintenance will include lubrication, cleaning procedures, and cycling to insure optimal operation.

Figure 6. Cast Iron Sluice Gate

Figure 7. Stainless Steel Sluice Gate

2.2.2. Flap Gates

Flap gates are attached to the end of discharge piping as a means of backflow prevention. No operation is required for flap gates, and maintenance will consist of ensuring the gates open without resistance through cleaning and lubrication.

Figure 8. Flap Gate

2.3. Well Pumps

Two new well pumps are proposed to be constructed within Yorkinut Slough (Figure 8). Ducks Unlimited have currently designed the Office and Deer Plain wells. USACE plans designing the pipework for these wells and building two additional well pumps with pipework at the Yorkinut Well and Calhoun Point Well locations. The well pumps for this project will be vertical turbine pumps that will be powered by electric motors. All four of the well pumps will have a capacity of 2500 gpm and a 14” discharge.

Figure 9. Example Well Pump and Locations of New Well Pumps

2.4 Gravity Drain Structure

An additional large gravity structure to control gravity water flow into the Illinois River will be constructed. This structure will be used to maintain a set water surface elevation as opposed to being used simply for drainage. Different design methods to gravity drain include the use of stop logs or a tilting weir/overshot gate (Figure 10 and Figure 11). A design using stoplog will be similar to the existing 16’ wide stoplog structure. Details of this structure can be found in the Structural Appendix. A design using tilting weir/overshot gates could be similar to the Clarence Cannon gravity drain. This design will use a manual hoist drum, manually operated, to lift a gate at an angle to control the incoming water level.

Figure 10. Gravity Drain at Clarence Cannon

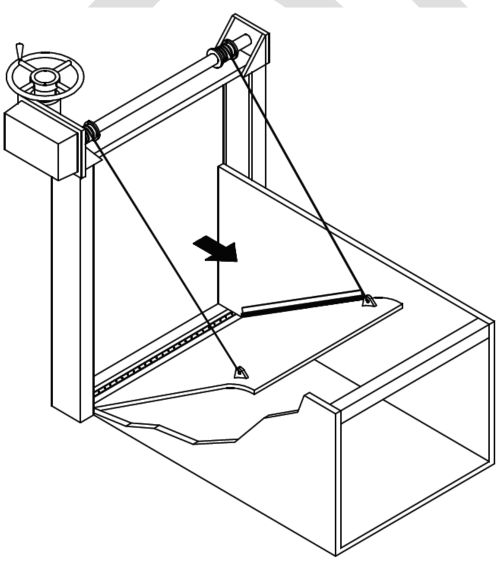

Figure 11. Typical Tilting Weir/Overshot Gate

REFERENCES

US Army Corps of Engineers. (2020, April). Engineer Manual 1110-2-3105. *Mechanical and Electrical Design of Pumping Station.*

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