2016 UMRR HREP WORKSHOP
PUMP STATION CONSTRUCTION
ELECTRICAL & MECHANICAL CONSIDERATIONS

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Presenter Title: Mechanical Engineer

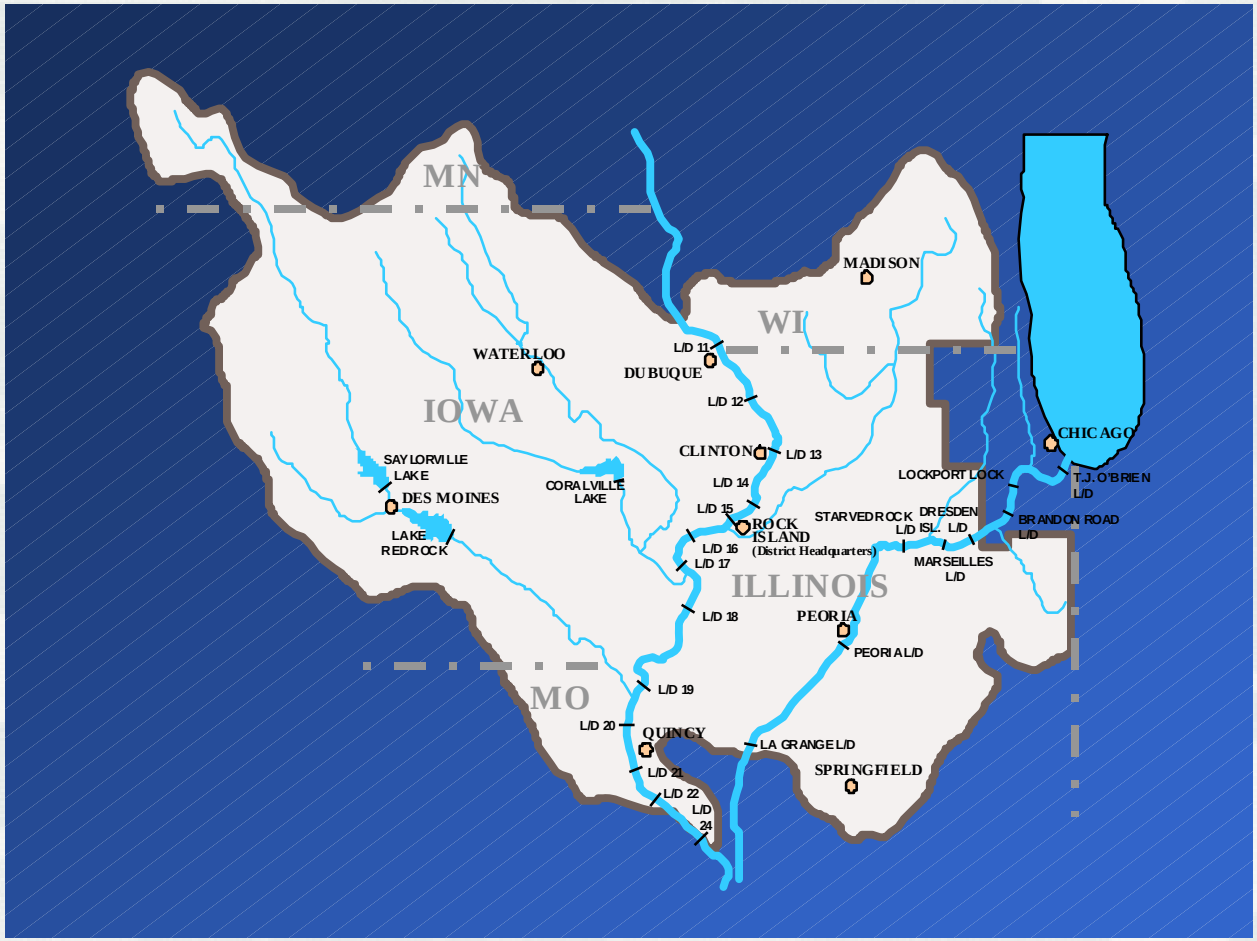
Duty Location: USACE Rock Island District, CEMVR-EC-DG

Date: September 28, 2016

U.S.ARMY

US Army Corps of Engineers
BUILDING STRONG®

Rock Island District Boundaries



District Pump Stations By State

Iowa = >90
Illinois = >75
Missouri = >8
Minnesota = 0
Wisconsin = 0

TOTAL = > 173 in MVR

Federal vs. Non-Federal
163 vs.10

UMRR (HREP)
>=10

Pump Station Projects in MVR

- PL84-99 Flood Recovery Projects
  - Drainage and Levee District Pump Station Repair
  - Local Flood Protection Project Repair
  - Emergency Pumping Contracts
- New UMRR (EMP) & Section 206 Projects
  - National Fish & Wildlife Service
  - State Department of Natural Resources
- New Local Flood Protection Projects
  - Municipality Sponsor
- Federally Owned Pump Station Projects
- HSDRRS Pump Stations

PL84-99 Flood Response & Recovery

Lima Lake Pump Station 2008

Indian Grave Levee &
Drainage District
Emergency Pumping

Henderson Pump Station 2008

Pump Station Projects in MVR

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  - Local Flood Protection Project Repair
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  - State Department of Natural Resources
- New Local Flood Protection Projects
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- Federally Owned Pump Station Projects
- HSDRRS Pump Stations

UMRR (HREP) & Section 206

Ventura Marsh Pump Station
Section 206

Rice Lake Pump Station

Henderson Pump Station 2008

Pump Station Projects in MVR

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- HSDRRS Pump Stations

Local Flood Protection Projects

Dubuque Bee Branch Pump Station

Hannibal Pump Station

Henderson Pump Station 2008

Pump Station Projects in MVR

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Federally Owned Pump Stations

Big Creek Pump Station

Southeast Des Moines Pump Station

Pump Stations Designed in MVR

- PL84-99 Flood Recovery Projects
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- HSDRRS Pump Stations

HSDRRS Pump Stations

Wilkinson Canal Pump Station
Plaquemines Parish, LA

Belle Chase II Pump Station,
Plaquemines Parish, Belle Chase, LA

Pump Station Construction Challenges

- Prime Contractors May Lack Structural, Mechanical, Electrical Experience
- Coordination Through Prime to Subcontractors Completing the Work
- Pump Stations may be a Small Portion of a Larger Project
- Pump Station Construction Typically Towards Middle or End of Project Causing Schedule Pressure, Transmittal Delays, and Funding Scrutiny
- Lack of Thorough Understanding of Contract Plans & Specifications by Prime Contractor and Subcontractors
- Site Access and Unique Conditions

Pump Station Construction Challenges (Continued)

- Contract Durations Sometimes Cause Difficulties in Staying Engaged with the Project Details.
- Construction Challenges with Dewatering and Flooding
- Understanding Design Intent, Vulnerabilities, and High Risk Features
- Contractor Workmanship to Ensure Survivability of Pump Station Features
- Availability of Electrical Power
- Building a Structure on Poor Foundation Materials

Pump Station Construction Challenges (Continued)

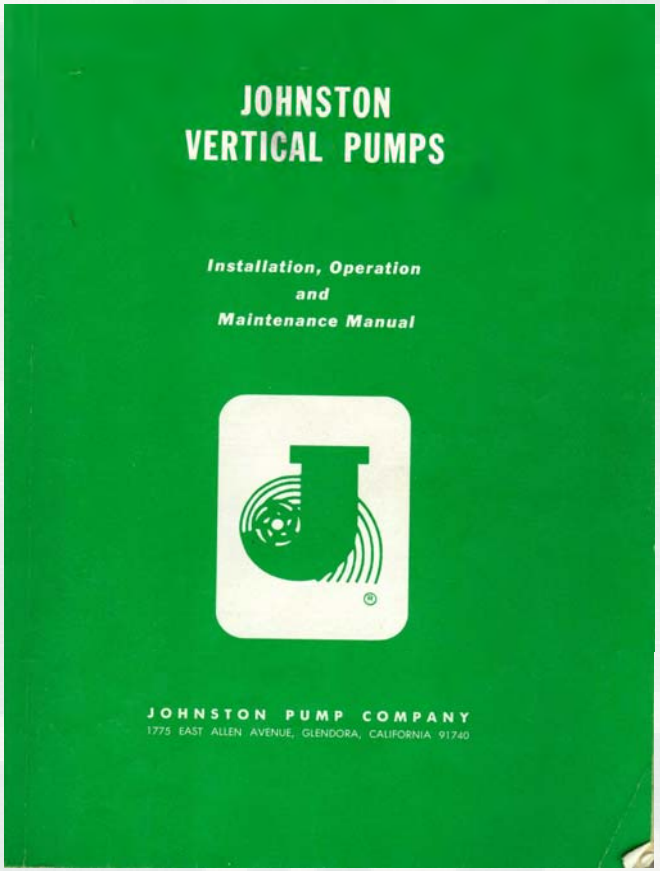
- Floodproofing the Structure
- Discharge Pipe Fit-up, Installation, & Coating
- Paint Coating Systems
- Factory and Field Testing
- Debris & Ice

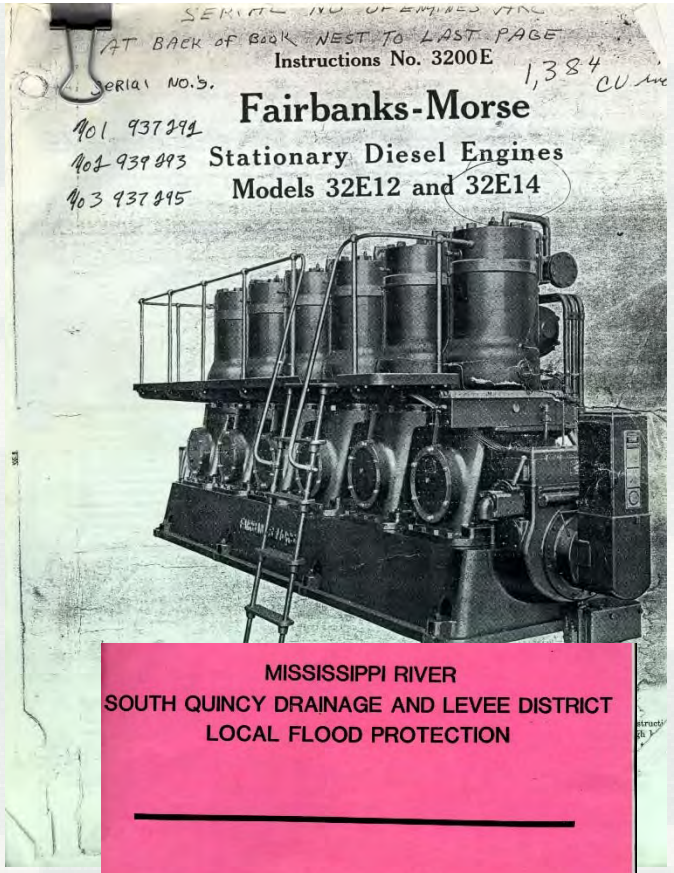
Pump Station Features & Inspection

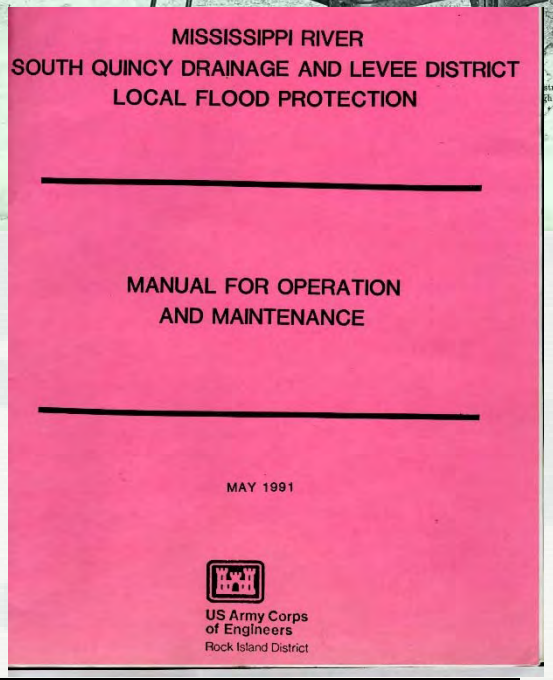
- Operations & Maintenance Manuals with Installation Instructions
- Plant Building
- Pumps
- Motors/Engines/Gear Reducers
- Sumps/Trash Racks
- Other Metallic Items
- Ancillary Equipment
- Backup Ancillary Equipment
- Pump Control System
- Intake and Discharge Outlets
- Electrical Power Distribution & Controls
- Pump Factory & Field Testing
- Electrical Megger Testing

O&M Manuals

- Corps O&M
- Pumps
- Motor/Engines
- Gear Drives
- Ancillary Equip.
  - Compressed Air
  - Vacuum
  - Siphon Breaks
  - Heating/Vent.
- Backup Equip.



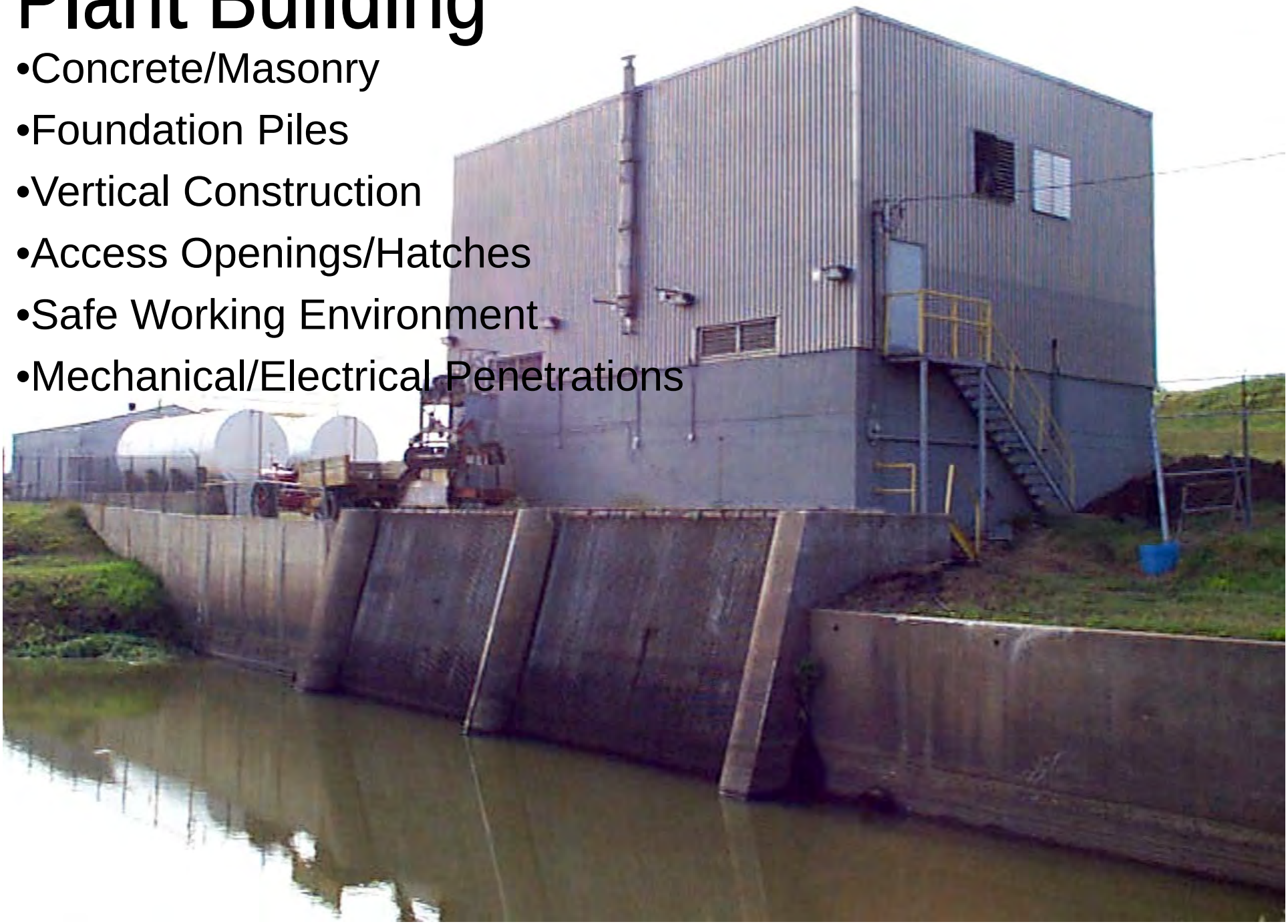




Pump, Engine and Corps O&M

Plant Building

- Concrete/Masonry
- Foundation Piles
- Vertical Construction
- Access Openings/Hatches
- Safe Working Environment
- Mechanical/Electrical Penetrations



Pumps

- Installation Procedure
- Temporary Storage
- Lubrication System
  - Pre-Charge
  - Bearings
  - Grease Lines
- Factory & Field Testing
- Cavitation/Noise
- Vibration
- Alignment/Levelness
- Impeller Balancing

Submersible Centrifugal

Horizontal

Submersible Axial

Vertical Turbine

BUILDING STRONG®

Pumps

Portable Trailer Centrifugal
(PTO, Diesel, Electric)

Floating Pump Solutions
(Diesel or Electric)

Pump Types and Capacity

Pump Type	Power Type	Applications	Sizes	Pump Head FT TDH	Capacity Range GPM
Centrifugal Trash	Gas or Diesel Trailer/Skid Mounted	Manholes/Storm Sewers/Rentention Basins Low or High Head	3”-24”	15-200	450-20,000
Tractor or Engine PTO Trailer Pump (Crissafulli)	Tractor PTO or Integral Diesel Engine	Drainage Ditches Ponding Areas Shallow Submergence Low Head	4-24”	0-30	1150-17,000
Submersible Centrifugal	Electric or Engine Driven Hydraulic	Manholes/Storm Sewers Sumps/Gatewells	3”-10”	0-200	300-5,000
Submersible Axial Flow	Electric or Engine Driven Hydraulic	Large Unwatering Projects Drainage Districts	8”-60” 12”-42”	0-25 25-50	3,000-110,000 4,000-24,000

Motor/Engines/Gear Reducers

- Installation Procedure
- Lubrication
- Instrumentation
- Alignment
- Electrical Connections
- Functional
  - Alarms & Shutdowns
  - Field Testing

Diesel Engine

Vertical Motors

Right Angle Gear and Horizontal Motor or Engine

Sumps/Trash Racks

- Foundation/Piles/Sheetpile
- Temporary Pumping
- Confined Space
- Concrete Formwork/Placement
- Corrosion Protection Items
- Floating/Sunken Debris
- Silt Removal
- Pump Clearances
- Vortex Prevention

Other Metallic Items

- Steel Corrosion
- Anchors and Installation Methods
- Grout Placement/Consolidation
- Pipe Alignment

Ancillary Equipment

- Installation Procedures
- Bubbler Systems
- Lubrication Systems
- Siphon Breakers
- Fuel Supply

Compressed Air

Vacuum Pump

Fuel Supply

Siphon Break

Pump Control System

- Installation Procedures
- Corrosion Protection
- Debris Protection
- Rodent Protection
- Operational Testing
- Alarms vs. Shutdowns

(Float level controls are shown, but there are other level sensors such as pressure type level sensor)

Float Tape & Controls

Float Well w/ Encapsulated Floats

Intake/Discharge Outlets

- Flap Gates
- Sluice Gates
- Erosion Protection
- Pipe Integrity/Compaction
- Outfall Structure
- Backflow Prevention
- Backfill Compaction

Sluice Gates

Discharge Pipe w/ Erosion

Flap Gates

Gate Valve

Discharge Outlet

Electrical Power Distribution & Controls

POWER SERVICE:

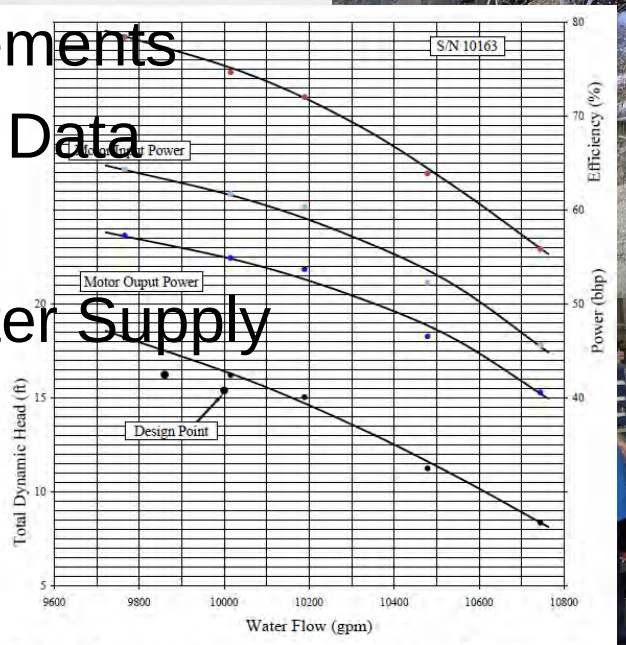
- High Voltage Provided by Electric Power Company
- Low Voltage Provided by Construction Contractor
- Design Coordination with Utility by Design PDT
- Installation Coordination with Utility by Contractor
- Service Entrance Size and Location are Important Considerations
  - Overhead
  - Underground
  - Redundant
  - Standby Power (Genset)

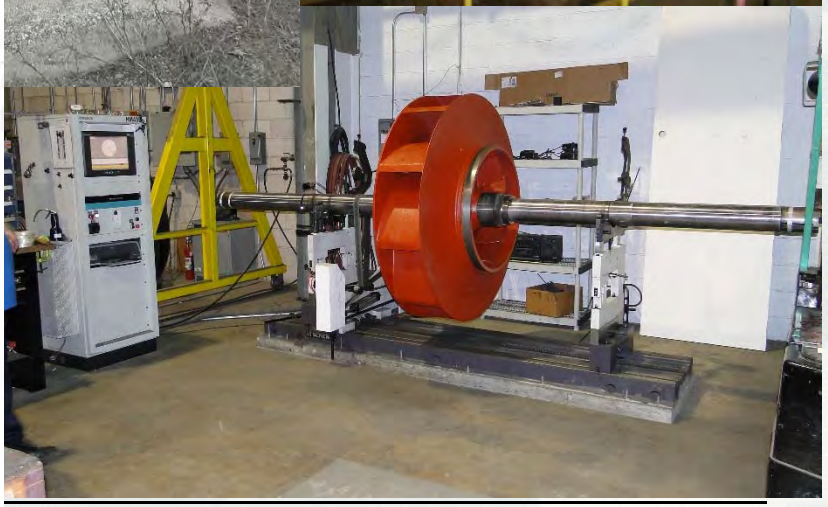
CONTROL SYSTEMS:

- Pump Controls
  - Automatic or Manual Motor Starting
  - Water Level Controls
  - Pump Bearing Temperature
  - Pump Seal Leak Detection

Pump Factory & Field Testing

- Pump Curve
- Design Points
- Sump Conditions
- Dynamic Balance Criteria
- Field Measurements
- Electric Motor Data
- Flow Testing
- Adequate Water Supply





MWI CORPORATION ESTABLISHED 1926

PUMP BOWL PERFORMANCE CURVE

Project: Iowa River Basin

TYPE: AXIAL FLOW	PROPELLER DIA: 16"
MODEL NO: SEA316	SPEED: 1150 RPM
INTAKE DIA: 24"	DISCHARGE DIA: 30"

Electric motor: 60 Hp, 1150 rpm

SINGLE STAGE PERFORMANCE

FOR TWO STAGES MULTIPLY HEAD AND HORSEPOWER BY 2.0 AND EFFICIENCY BY 1.0

PERFORMANCE IS BASED ON PUMPING CLEAR, NON-AERATED WATER, WITH A SPECIFIC GRAVITY OF 1.0, TEMPERATURE 85 DEG F OR LESS AND AT SEA LEVEL. PUMP PERFORMANCE MAY BE AFFECTED BY HIGHER TEMPERATURES, SPECIFIC GRAVITY, ALTITUDES AND SUMP CONDITIONS.

IT IS HEREBY CERTIFIED THAT THIS CURVE REPRESENTS THE TRUE PERFORMANCE CHARACTERISTICS OF THE MWI PUMP MODEL SHOWN AND WAS OBTAINED BY SCALE MODEL TEST AND CALCULATIONS IN ACCORDANCE WITH STANDARDS OF THE HYDRAULIC INSTITUTE.

MWI CORPORATION CERTIFIED BY

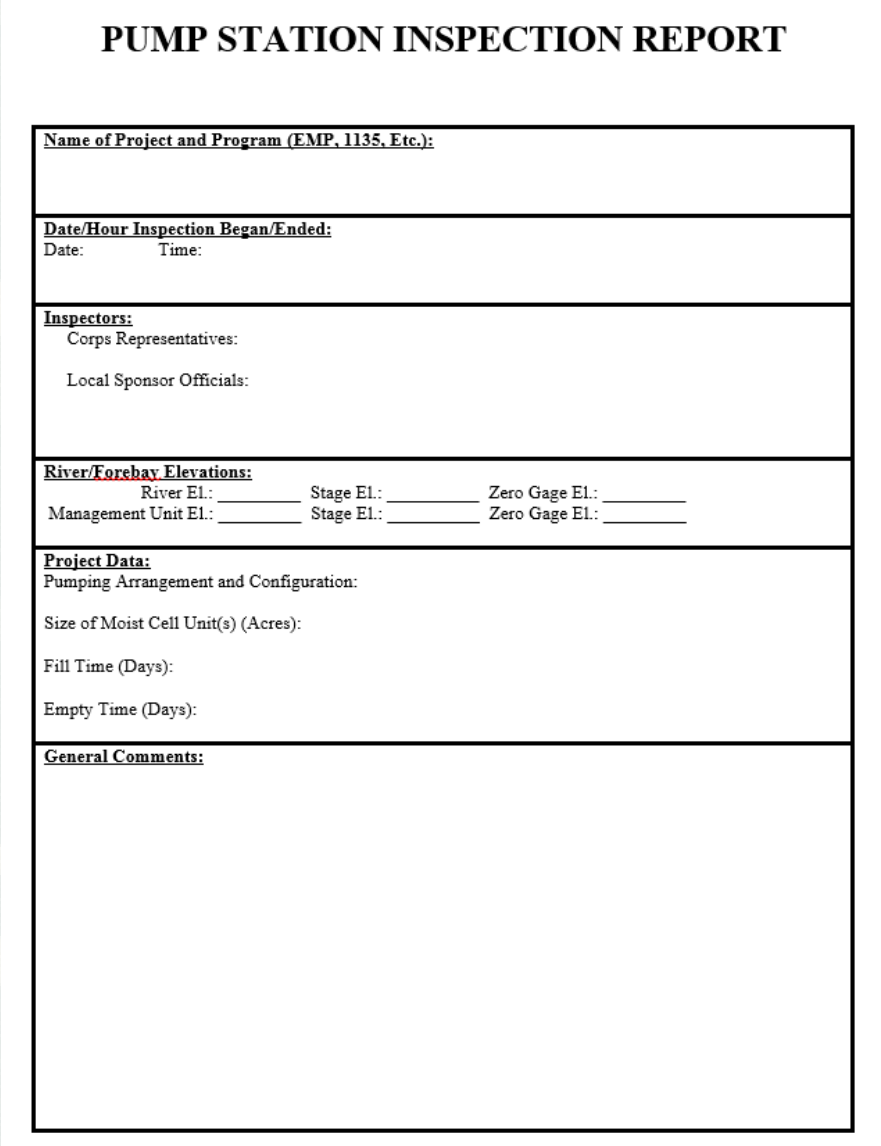
MWI CORPORATION Deerfield Beach, Florida

Megger Testing

- Necessary for Larger Electric Motors Only
- Measurement of Insulation Resistance Integrity Between Conductors
- Monitored Over Time for Decreasing Trend
- Maintenance Indication Tool

Pump Station Inspection Guide

- Record of Performance Data
- Water Stages River/MSU
- Monitoring for Trends
- Maintenance Indication Tool
- Metrics to Track Success & Failures
- Record of Significant Events & Maintenance



PUMP STATION INSPECTION REPORT

Name of Project and Program (EMP, 1135, Etc.):

Date/Hour Inspection Began/Ended:
Date: Time:

Inspectors:
Corps Representatives:

Local Sponsor Officials:

River/Forebay Elevations:
River El.: _____ Stage El.: _____ Zero Gage El.: _____
Management Unit El.: _____ Stage El.: _____ Zero Gage El.: _____

Project Data:
Pumping Arrangement and Configuration:

Size of Moist Cell Unit(s) (Acres):

Fill Time (Days):

Empty Time (Days):

General Comments:

Pump Station Inspection Guide

PUMP STATION MAINTENANCE INSPECTION GUIDE

RATED ITEM	A	M	U	EVALUATION	REMARKS
SECTION I				***FOR INTERNAL USE AND EVALUATION***	
1. Pump Station Size				Pump station has adequate capacity (considering pumping capacity, ponding areas, Compare Fill/Empty times with Design, etc.). (A or U.)	
SECTION II				***FOR LOCAL SPONSOR USE***	
2. O&M Manual				O&M Manual is present and adequately covers all pertinent areas. (A or U.)	
3. Operating Log				Pump Station Operating Log is present and being used. (A or U.)	
4. Annual Inspection				Annual inspection is being performed by the local sponsor. (A or U.)	
5. Plant Building				A Plant building is in good structural condition. No apparent major cracks in concrete, no subsidence, roof is not leaking, etc. Intake louvers clean, clear of debris. Exhaust fans operational and Maintained. Safe working environment. M Spalling and cracking are present, or minimal subsidence is evident, or roof leaks, or other conditions are present that need repair but do not threaten the structural integrity or stability of the building. U Any condition that does not meet at least Minimum Acceptable standard.	

Pump Station Inspection Guide

PUMP STATION MAINTENANCE INSPECTION GUIDE

RATED ITEM	A	M	U	EVALUATION	REMARKS
6. Pumps				A All pumps are operational. Preventive maintenance and lubrication are being performed. System is periodically subjected to Performance testing. No evidence of unusual sounds, cavitation, or vibration. M All pumps are operational and deficiencies/minor discrepancies are such that pumps could be expected to perform through the next period of usage. U One or more primary pumps are not operational, or noted discrepancies have not been corrected.	
7. Motors, Engines and Gear Reducers				A All items are operational. Preventive maintenance and lubrication being performed. Systems are periodically subjected to performance testing. Instrumentation, alarms, and auto shutdowns operational. M All systems are operational and deficiencies/minor discrepancies are such that pumps could be expected to perform through the next Expected period of usage. U One or more primary motors are not operational, or noted discrepancies have period of usage.	
8. Sumps/Trash Racks				**SPECIAL INSTRUCTIONS:** *Measure silt accumulation in sumps and trash racks. Measure water depth at inlet and outlet.* A Sumps/Trash Racks are free of concrete deterioration, protected from Permanent damage by corrosion and free of floating and sunken debris. Sumps are clear of Accumulated silt. Passing debris is minimized by spacing of trash rack bars. Periodic maintenance performed on trash racks and removal of accumulated silt in sumps is performed. M Trash racks and sumps have some accumulated silt or debris but are not currently inhibiting the pump(s) performance. No periodic maintenance has been performed. Present condition could be expected to perform through the next expected period of usage provided removal of floating debris is accomplished. U Proper operation can not be ensured through the next period of usage. Possible damage could result to the pumping equipment with continued operation.	

Pump Station Inspection Guide

PUMP STATION MAINTENANCE INSPECTION GUIDE

RATED ITEM	A	M	U	EVALUATION	REMARKS
9. Other Metallic Items				A All metal parts in plant/building are protected from permanent damage by corrosion. Equipment anchors and grout pads show no rust or deterioration. M Corrosion on metallic parts (except equipment anchors) and deterioration period of usage. U Any condition that does not meet at least Minimum Acceptable standards.	
10. Ancillary Equipment i.e. Compressed Air Siphon Breakers Fuel Supply Vacuum Priming Pump Lubrication Heating/Ventilation Engine Cooling Engine Oil Filtering				A All equipment operational. Preventive and annual maintenance being performed. Equipment operation understood and followed by pump station operators. M Ancillary equipment is operational and deficiencies/minor discrepancies are such that equipment could be expected to perform through the next period of usage. U One or more of the equipment systems is inoperable. The present condition of the inoperable equipment could reduce the efficiency of the pump station or jeopardize the pump station's role in flood protection.	
11. Backup Ancillary Equipment				A Adequate, reliable, and enough capacity to meet demands. Backup units/equipment are properly sized, operational, periodically exercised, and in an overall well maintained condition. M Backup ancillary equipment is operational and deficiencies/minor discrepancies are such that equipment could be expected to perform through the next period of usage. U Backup ancillary equipment not considered reliable to sustain operations during flooding conditions.	

Pump Station Inspection Guide

PUMP STATION MAINTENANCE INSPECTION GUIDE

RATED ITEM	A	M	U	EVALUATION	REMARKS
12. Pump Control System				A Operational and maintained free of damage, corrosion, or other debris. M Operational with minor discrepancies. U Not operational, or uncorrected discrepancies noted from previous inspections.	
13. Intake and Discharge Outlets				Functional. No damaging erosion evident. Opening/closing devices for vertical gates, flap gates, etc. are functional in a well-maintained condition. (A or U.)	
14. Insulation Megger Testing (For pump stations with Electric pumps only)				A Megger test has been performed within the last 36 months. Results of megger test show that insulation of primary conductors and electric motor meet manufacturer's or industry standard. M Results of megger test show that insulation resistance is lower than manufacturer's or industry standard, but can be expected to perform satisfactorily until next testing or can be corrected. U Insulation resistance is low enough to cause the equipment to not be able to meet its design standard of operation.	
15. Final Remarks					

USACE/Sponsor Project Quality Enhancement

- USACE - Understand the Customer's needs and operational & maintenance capabilities
- USACE/Sponsor - Seek to get simplicity of design and function
- USACE/Sponsor - Identify vulnerabilities and critical features early in design/construction
- USACE - Troubleshoot the design in review for pitfalls
- USACE - Ensure Operating Controls are easy to understand
- USACE/Sponsor - Anticipate future maintenance issues
- USACE/Sponsor - Ensure design review comments are fully addressed
- USACE - Identify critical path transmittals

USACE/Sponsor Project Quality Enhancement

- USACE - Provide quality specifications and transmittal register for proper review
- USACE - Prepare useful engineering considerations for construction
- USACE - Communicate specialized skill sets necessary for construction to the Contractor
- USACE - Encourage Contractors to communicate with subcontractors and submit transmittals
- USACE/Sponsor - Participation in Pre-construction meetings for critical phases of work

USACE/Sponsor Project Quality Enhancement

- USACE/Sponsor - Work together as team
- USACE/Sponsor - Participate in routine site visits during construction to head off issues
- USACE – Engage with appropriate disciplines
- USACE - Ensure that transmittal review comments are fully addressed prior to installation.

USACE/Sponsor Project Quality Enhancement

- USACE - PDT & Sponsor Meetings prior to and during construction
- USACE - Develop risk matrix/register during design
- USACE - Conduct mock PA prior to solicitation for identification of Potential Failure Modes
- USACE - Know flood elevations for design superiority
- USACE - Develop checklists for phases of work
- USACE/Sponsor -Receive well written O&M manuals

Pump Station Construction & Mechanical Equipment

Ventura Marsh Deep Foundation Piles

Rice Lake Flooding, Debris, Ice

Unique Construction Challenges

Big Creek Helicopter Lift

Pump Station Construction & Mechanical Equipment

Big Creek Helicopter Lift

Ventura Marsh Dredge

Unique Construction Challenges

Pump Station Construction & Mechanical Equipment

Banner Marsh Before

Banner Marsh During

Banner Marsh After

Unique Construction Challenges

Big Creek Helicopter Lift

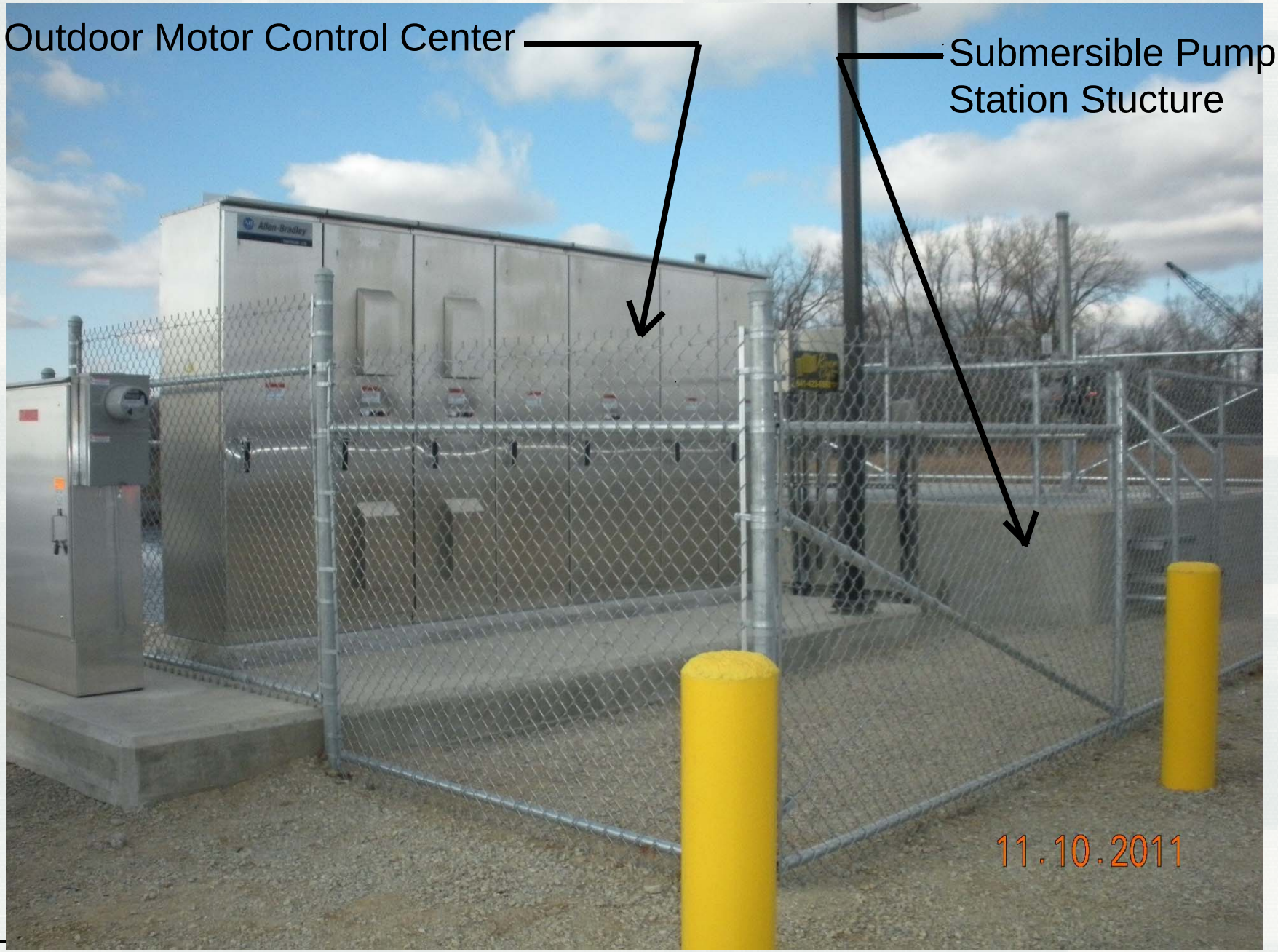
Ventura Marsh

Pump Station Arrangement

- Bi-Direction Pumping
- Submersible Pump Installation
- Outdoor Motor Controller Center/Operating Platform
- Concrete Sump and RCP Discharge Conduit
- 20,000 GPM Total Capacity

Project Challanges

- Deep Pile Foundation
- Fish Exclusion
- RCP Joints, Sinkholes, Remediation
- Nuisance Pump Faults/Shutdowns
- Cold Weather Operation
- Floating Cattail Bogs



Ventura Marsh Pump Station

Sinkhole

Conduit Joint Repair

Conduit Joint Repair

Joint Inspection

Ventura Marsh Pump Station

BUILDING STRONG®

Carp

Battered Pile Installation

Conduit Installation

Conduit w/ Spiral Sleeve

Bay Island/Peoria Lake

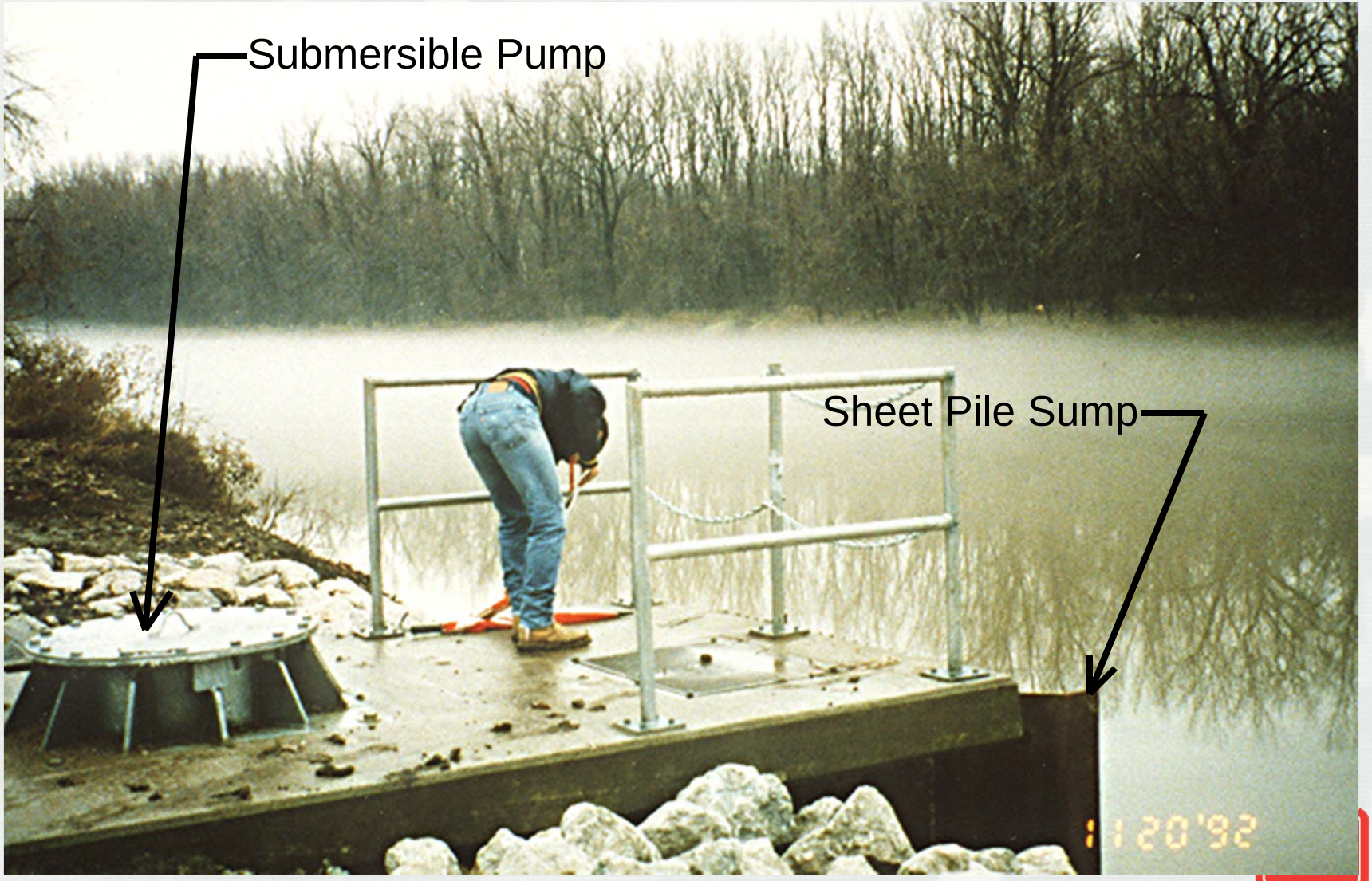
Pump Station Arrangement

- One Direction Pumping
- Submersible Pump Installation
- Open Controller/Operating Platform
- Sheet Pile Sump Configuration
- 6000 GPM Total Capacity

Project Challanges

- Power Availability/Remoteness
- Phase Converter Operation
- Sump Sedimentation
- Flood Potential

Bay Island Pump Station



Bay Island Pump Station

Princeton Wildlife Management Area

Pump Station Arrangement

- One Direction Pumping
- Submersible Hydrualic Pump Installation
- Concrete Structure w/ Diesel Drive Unit
- 14,000 GPM Total Capacity

Project Challanges

- Remoteness/Access
- Vandal/Bullet Proof Design
- Low Sump Configuration
- Reuse of Existing Mechanical Equipment
- Future Dewatering

Vandal Resistant Structure

Cross Levee

Princeton Wildlife Management Area

Outlet Structure

Diesel Power Unit

Submersible Hydraulic Pump

Princeton Wildlife Management Area

Intake Structure

BUILDING STRONG®

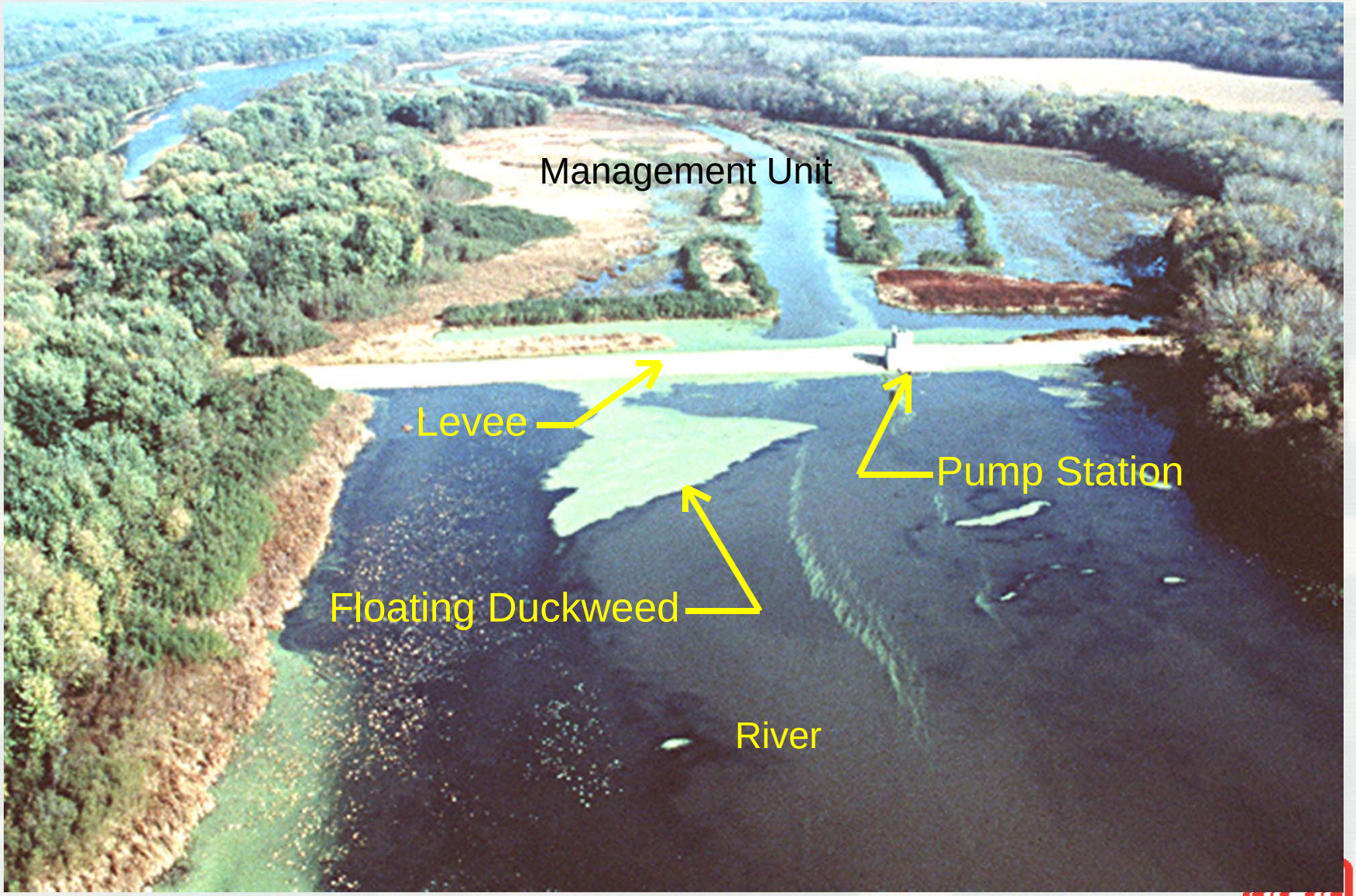
Andalusia Refuge/Spring Lake

Pump Station Arrangement

- Bidirectional Pumping
- Submersible Pump Installation
- Concrete Pump Station Structure
- 6,800 GPM Total Capacity

Project Challanges

- Bidirectional Pumping
- Float Wiring and Float Well Design
- Duckweed
- Building Humidity/ Ventilation
- “Turn-The-Key” Operation
- Sump Dewatering
- Stop Log Ergonomics
- Power Availability/ Remoteness

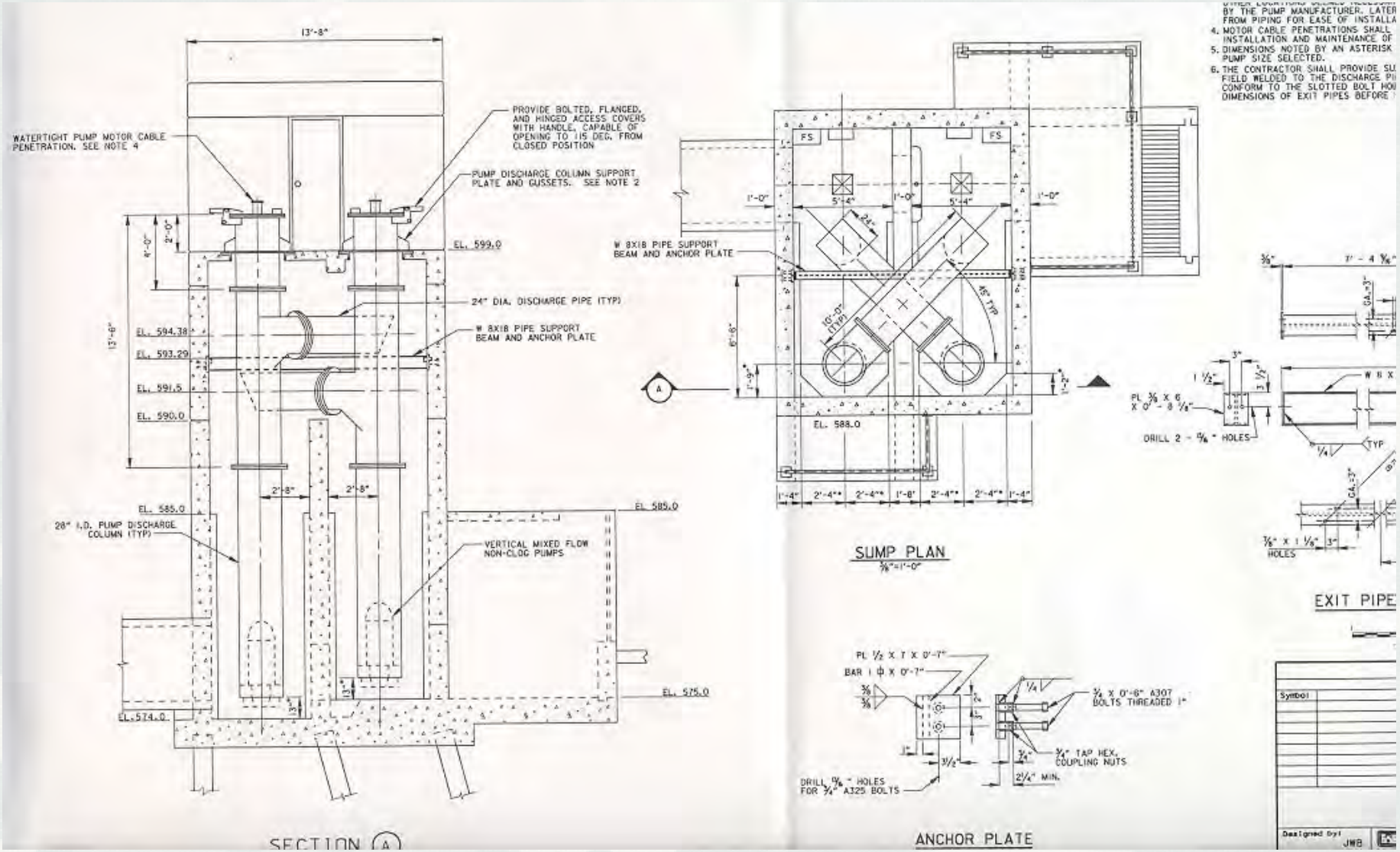


Andalusia Refuge

BUILDING STRONG®

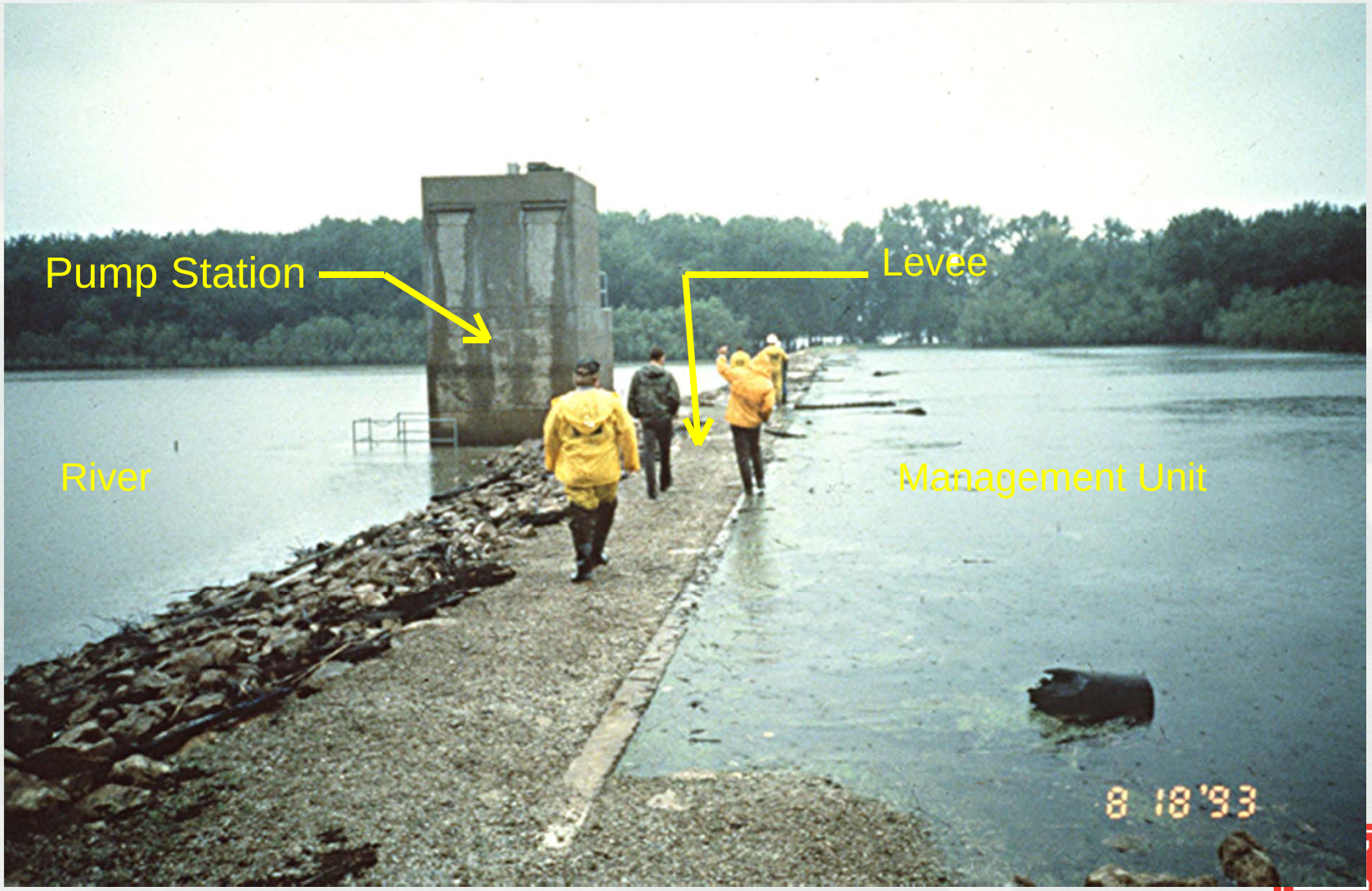
Andalusia Refuge
Pump Station
Structure

Spring Lake Pump
Station Structure



Andalusia Refuge/ Spring Lake Pump Station Layout Drawing

BUILDING STRONG®


Pump Station
Levee
River
Management Unit
8 18'93

Lake Chautuaqua

Pump Station Arrangement

- Multidirectional Pumping
- Submersible Pump Installation
- Concrete Pump and Gatewell Structure
- 41,000 GPM Total Capacity

Project Challanges

- Multidirectional Pumping
- Clear Operating and Maintenance Instructions
- Flooding During Construction
- Improper Pump Storage
- Incorrect Sluice Gate Installation
- Floatwell Operation

Lake Chautuaqua
Conduit Construction

BUILDING STRONG®

Sluice Gate Operators

Improper Pump Storage

Pump Station Structure

Lake Chautuaqua

Lake Chautuaqua
Pump Station Structure

Pump Station Electrical Equipment

Concrete-Embedded PVC Conduits in Floors & Walls

- Communication & Coordination With Other Trades And Construction Features is Required

Liquidtight Flexible Metal Conduit (Sealtight)

- Vibrating Loads
  - Motors
  - Generators
  - Actuators
  - Switches

Pump Station Electrical Equipment

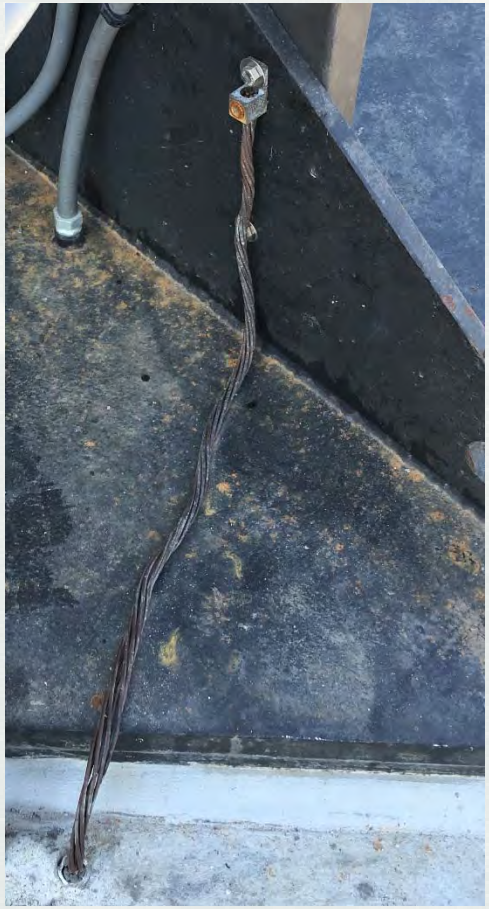
PVC-Coated Or PVC Tape-Wrapped RGS At Concrete & Air Interface

- Helps Prevent Corrosion Otherwise Typical at This Interface Location

Conduits To Be Installed Parallel And Perpendicular To Building Lines And Other Equipment

- Good Workmanship

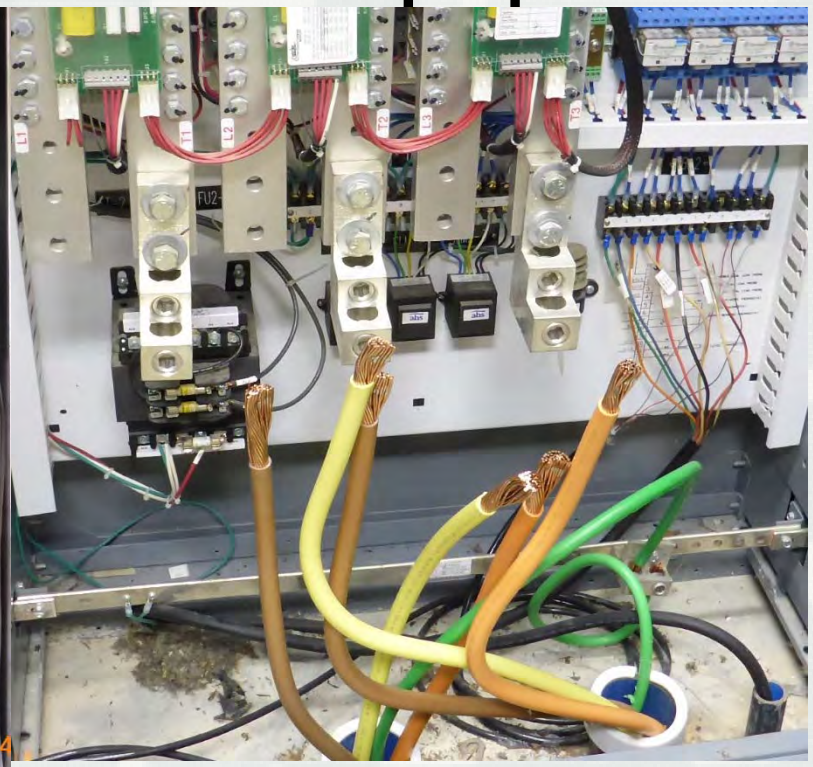
Pump Station Electrical Equipment



Equipment Grounding Wire

Outdoor Pump Alarm Panel

Pump Station Electrical Equipment



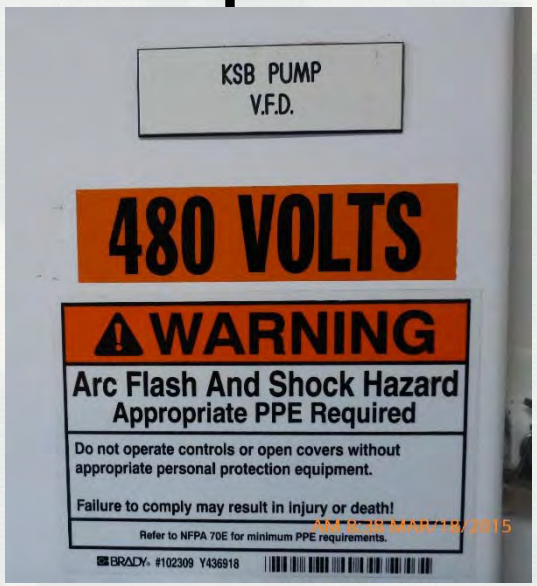
Electrical Relay-Based Controller

- Enclosure is Full; No Spare Space

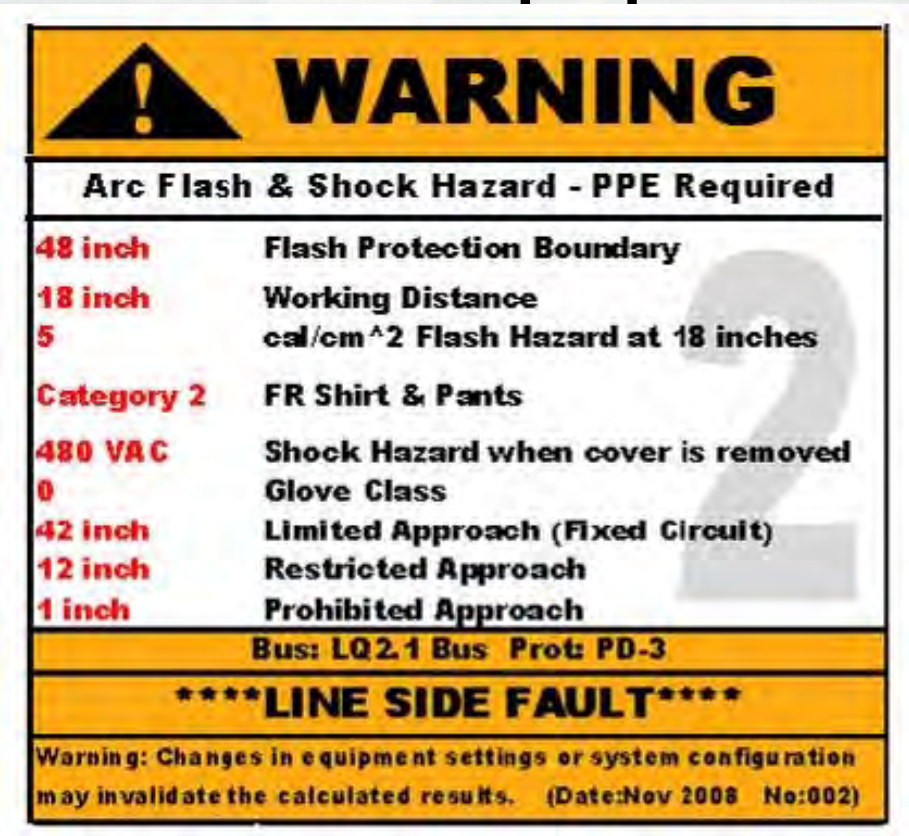
Motor Control Center (MCC) Parallel Pump Cables

- These Cables Were Removed To facilitate Megger Test.

Pump Station Electrical Equipment



Early Version of Arc Flash Hazard (AFH) Label
(This label exists on Non-USACE equipment)



Arc Flash Hazard (AFH) Warning Label – USACE Format Required by ER and EP 385-1-100

Pump Station Electrical Equipment

One Unique Method of Flood Proofing – Steel Bell Installed Over the Top of Electrical Equipment to Provide Air Pocket

Steel Bell Removed Reveals The Pump Electrical Equipment

?? Questions ??

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MAR 30 2001

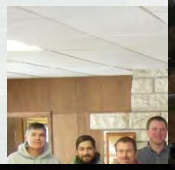

CAT
MAR 30 2001

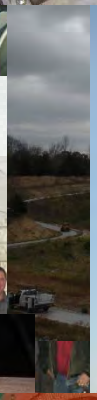

11/18/1999


11/18/1999

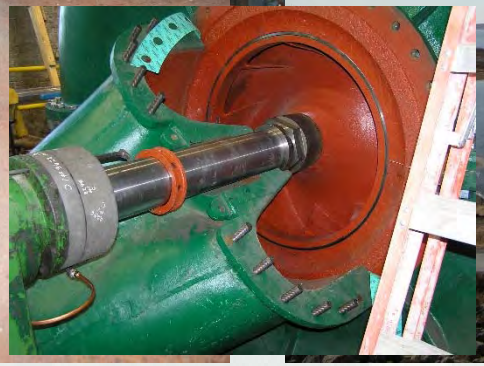

FEB 19 2009

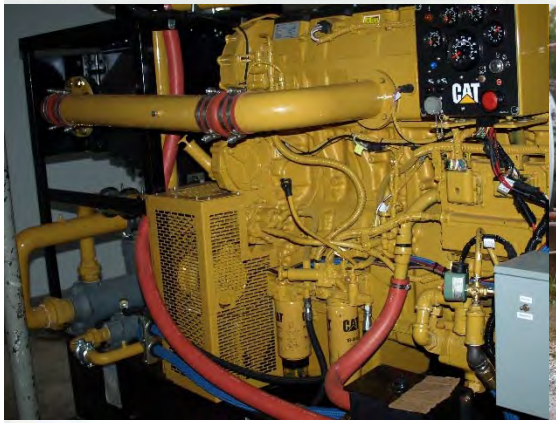

11/18/1999






11.17.2



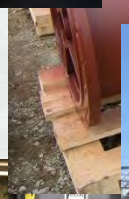

CAT


07.24.2013 12:22


06.18.20


09.19.2014


05.13.2014 05:10



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