# Lower Barataria Sediment Diversion

Restore Americas Estuary Conference

November 4, 2014

# The Project

- Diversion - 10% Design Analyses
- Civil, Geotechnical, Structural and Modeling
- Environmental, Social, or Economic Impacts Not Considered

# The Objective

- Identify the Most Cost Effective
- Most Environmentally Acceptable
- 50,000 cfs diversion when Mississippi River is at 1,000,000 cfs

# Project Team

- ARCADIS
- Coastal Protection and Restoration Authority
- The Water Institute of the Gulf
- LSU

# The Process

- 5 Sites Provided by TWI Through ongoing Hydrologic Modeling
- Key concept - Utilize Existing Data
- Minimal data collection

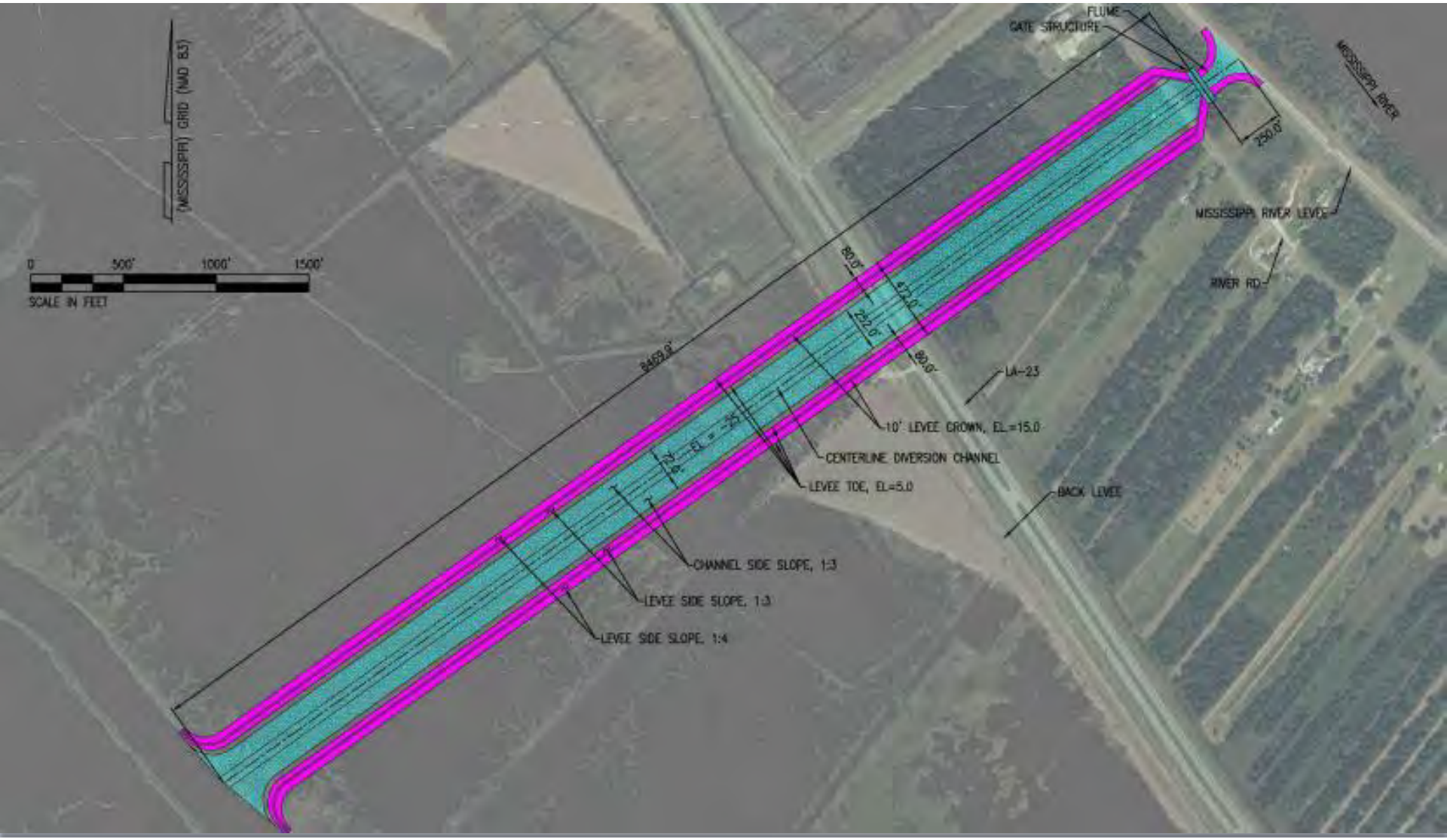
# Civil Engineering

- Initial Site Layouts
- General Area of Preliminary Modeling Results
- Set Marshland Elevation/Channel Width and Length/Invert at Entrance

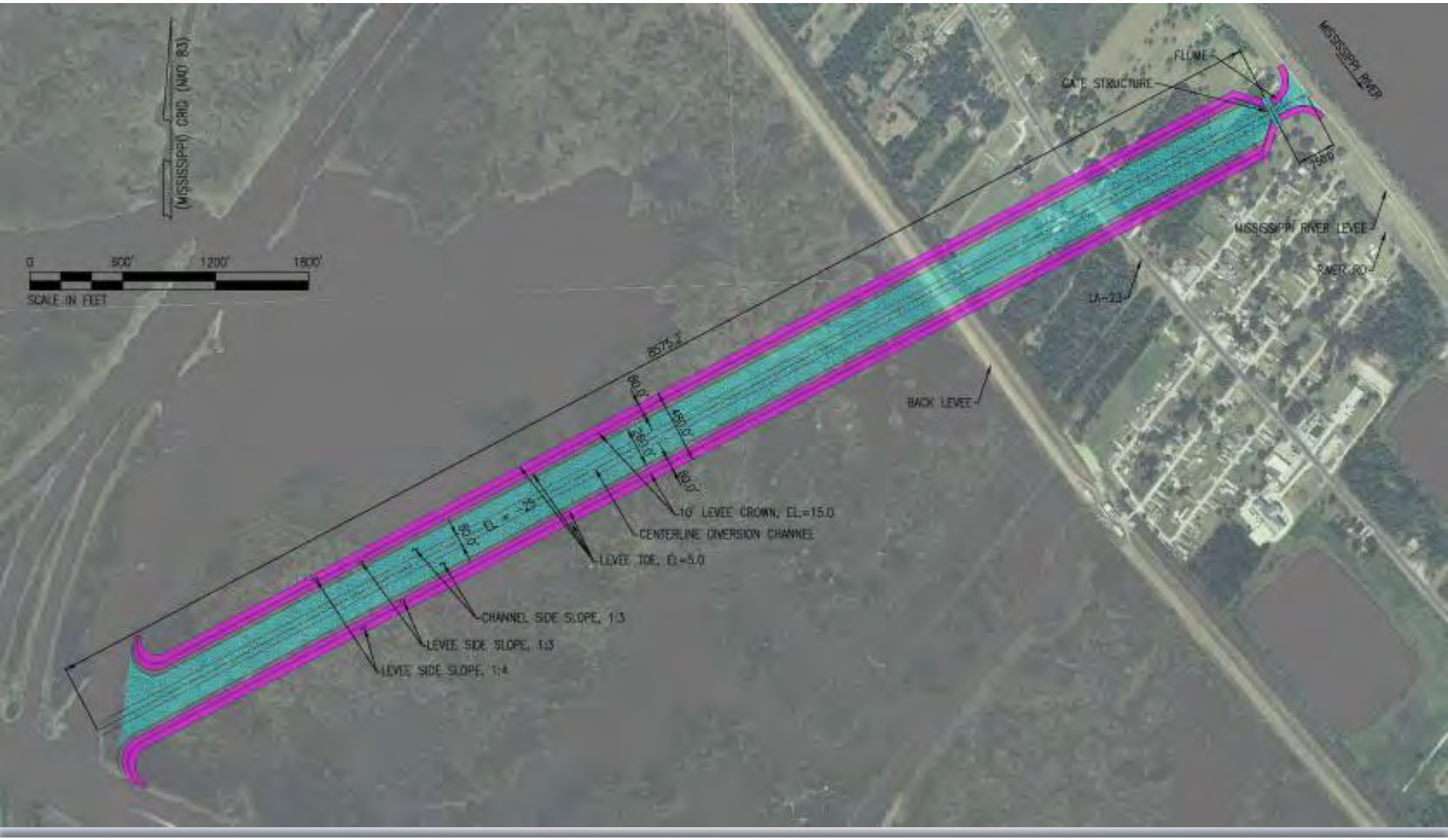
**Figure 1. Five Potential Lower Barataria Diversion Locations**


*Source: The Water Institute of the Gulf.*

# Magnolia Concept Plan



# Diamond Concept Plan



# Port Sulphur Concept Plan

# Empire Concept Plan

# Buras Concept Plan

# Location Summary

| Site | Length (miles) | SWR (Cumulative) | Anchorage | Revetment | River Power | Road Crossings | Lane Crossings | Structures on Land | Special Features |
|---|---|---|---|---|---|---|---|---|---|
| Magnolia | 1.46 | 1.11 | Neg. | Pos. | 1st | LA-23 (4 lanes) Diamond Rd (2 lanes) | 6 | none | |
| Diamond | 1.88 | 0.99 | Pos. | Neg. | 2nd | LA-23 (2 lanes) River Rd (2 lanes) | 4 | 3 mobile homes; 2 single family homes | |
| Port Sulphur | 0.89 | 0.46 | Pos. | Neg. | 3rd | LA-23 (4 lanes) | 4 | mobile office trailers, metal building | existing large MR dock |
| Empire | 0.83 | 0.71 | Pos. | Neg. | 4th | LA-23 (4 lanes) Frontages (4 lanes) Hwy 11 (2 lanes) | 10 | 1 mobile home | existing LA-23 bridge |
| Buras | 1.38 | 0.97 | Neg. | Pos. | 5th | LA-23 (4 lanes) Hwy 11 (2 lanes) River Rd (2 lanes) | 8 | 2 mobile homes; 1 single family home; abandon gas station and metal bldg | |

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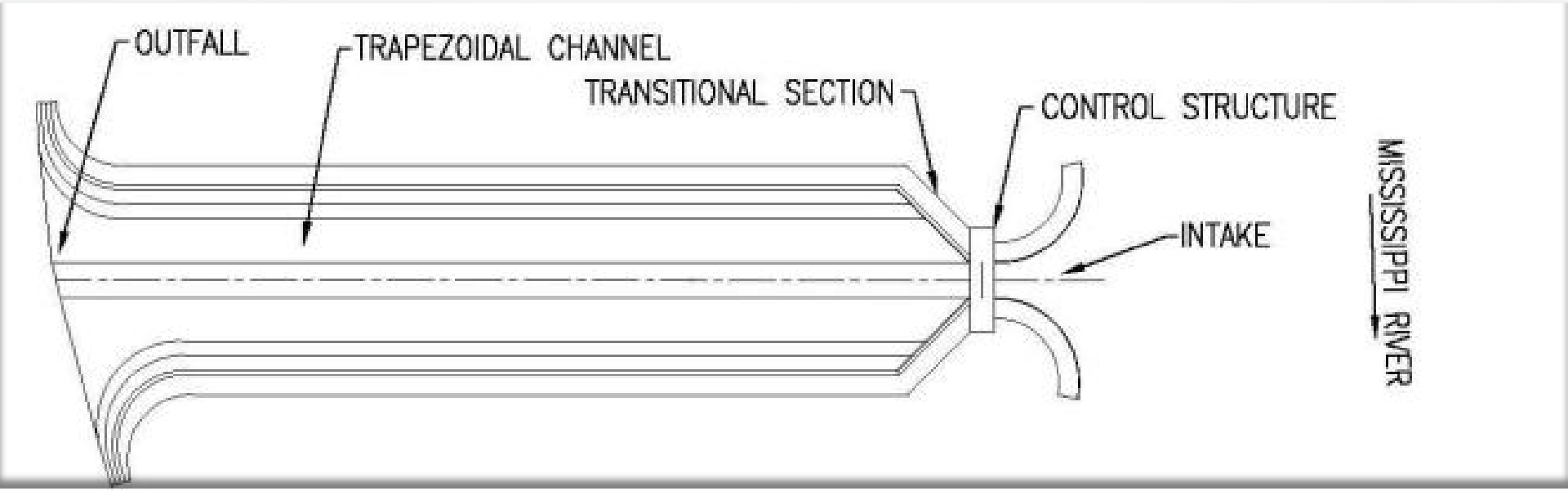
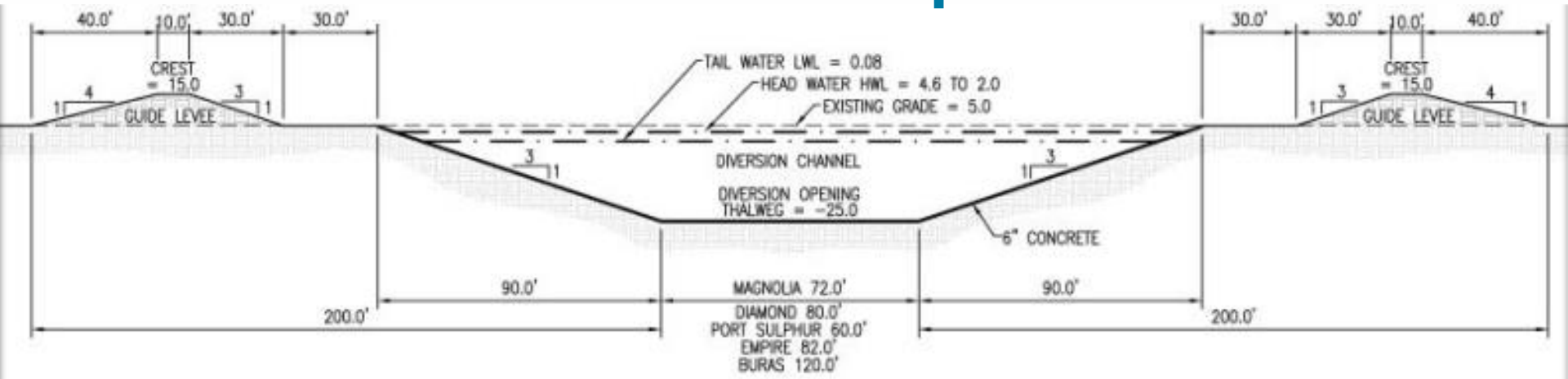
# Design Criteria

## Channel segments

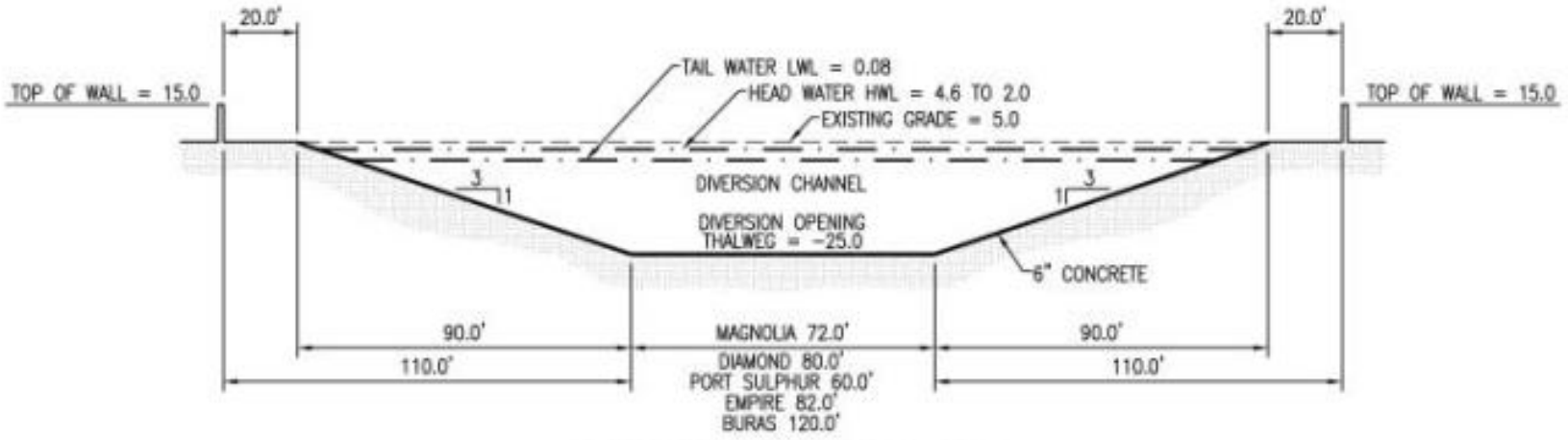
1. Intake connection to Mississippi River
2. Control structure
3. Transition to trapezoidal channel
4. Trapezoidal channel
5. Outfall



# Channel Cross Section Options




DIVERSION CHANNEL WITH GUIDE LEVEE




DIVERSION CHANNEL WITH WALLS

# Channel Dimensions

| Location | Invert | Width | Length | Upstream Water Surface Elevation | Downstream Water Surface Elevation | Average Water Surface Elevation |
|---|---|---|---|---|---|---|
| Magnolia | -25 | 72 | 7,700 | 4.6 | 0.08 | 2.4 |
| Diamond | -25 | 80 | 9,878 | 4.2 | 0.08 | 2.1 |
| Port Sulphur | -25 | 60 | 4,681 | 3.8 | 0.08 | 1.9 |
| Empire | -25 | 82 | 4,400 | 2.8 | 0.08 | 1.4 |
| Buras | -25 | 120 | 7,300 | 2.0 | 0.08 | 1.0 |

- Width is at bottom of channel
- Side slope = 3H : 1V
- Assume 2 feet head loss through control structure

# Outstanding Design Considerations

- Control structure at back levee?
- Bridges required at roads other than LA-23?
- Guide walls OR guide levees?
- Disposal of excavation materials?
- Work needed beyond back levee tie-in?
- Tainter gates (multiple bays) with stop log system for maintenance

# Design Assumptions

- Concrete channel lining
- Control structure with pile foundation
- Survey Data:  Bathymetric data from ACOE revetment surveys along with LIDAR and USGS information will be utilized
- Hydraulic Data:  Supplied by the WI.
- Guide Levee Elevation = 14.5

# Geotechnical Engineering

- Reviewed existing reports and data
- Preliminarily analyzed levee and excavation slope stability for the highlighted sites:

| Location | MRL | Back Levee |
|---|---|---|
| **Magnolia** | Nov. 9 | Nov. 5 |
| **Diamond** | Nov. 10 | No Info (Nov. 6) |
| **Port Sulphur** | Nov. 10 | No Info (Nov. 6) |
| **Empire** | Nov. 16 | Nov. 7 |
| **Buras** | Limited Info (Nov. 11) | Nov. 7 |

# Geotechnical Engineering (cont.)

- Coordinated with the New Orleans USACE's PM
- Field located, staked and submitted permit requests to Plaquemines Parish, USACE and CPRA of proposed CPT locations
- CPT's will not be needed for Magnolia due to NOV 5 borings and Empire due to LADOTD Bridges at Hwy 11 and Hwy 23

# Geotechnical Engineering (cont.)

- Slope Stability Analyses
- Pile Capacities
- Levee Sections/Wall Sections
- Cofferdams necessary for Construction

# Geotechnical Design Assumptions

| Material Unit Properties | | | | |
|---|---|---|---|---|
| **Material** | **Unit Weight** | **Short Term, Cohesion** | **Short Term, $\phi$** | **Long Term, $\phi$** |
| ▪ Water | 63 lb/ft$^3$ | 0 psf | 0° | 0° |
| ▪ Rip rap | 132 lb/ft$^3$ | 0 psf | 40° | 40° |
| ▪ Silt | 115 lb/ft$^3$ | 200 psf | 15° | 28° |
| ▪ Silty Sand | 122 lb/ft$^3$ | 0 psf | 30° | 30° |
| ▪ Levee | 110 lb/ft$^3$ | 400 psf | 0° | 23° |
| **Pile Capacity Safety Factors** | | | | |
| ▪ Gate and Wall Structures | Preliminary and Final Analysis, FS = 2 (Assume Pile Load Tests) | | | |
| ▪ Bridge Structure | Preliminary, FS = 2 | | Final, LRFD analysis | |
| **Slope Stability Safety Factors** | | | | |
| ▪ Top of Levee | Preliminary and Final Analysis, Spencer's Method FS = 1.4 (Short-term strengths only) | | | |
| ▪ Excavation | Preliminary and Final, Spencer FS = 1.4 (Short-term strengths only) | | Additional Final, Spencer FS =1.4 & MOP= 1.3 (Long-term strengths) | |
| ▪ Still Water Level (SWL) | Final Only, Spencer's Method FS = 1.5 (Short-term strengths), Spencer FS =1.4 & MOP= 1.3 (Long-term strengths) | | | |

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# Geotechnical Design Assumptions (Cont.)

| Design References |
| --- |
| ▪ *HSDRRSDG – Hurricane and Storm Damage Risk Reduction System Design Guidelines, USACE MVN |
| ▪ EM 1110-2-1913, Design and Construction of Levees |
| ▪ EM 1110-2-1902, Slope Stability |
| ▪ EM 1110-2-2105, Design of Hydraulic Steel Structures |
| ▪ EM 1110-2-2502, Retaining and Flood Walls |
| ▪ EM 1110-2-2906, Design of Pile Foundations |
| ▪ EM 1110-2-2504, Design of Sheet Pile Walls |
| ▪ Engineering Circular (EC) 1110-2-6066, Design of I-walls |
| ▪ EM 1110-2-1901, Seepage Analysis and Control for Dams |
| ▪ Engineering Technical Letter (ETL) 1110-2-569, Design Guidance for Levee Underseepage |
| ▪ Division Regulation (DIVR) 1110-1-400, Soil Mechanic Data |
| ▪ AASHTO LRFD Bridge Design Specifications |

# Structural Engineering

- Obtained structural design information for similar projects: White Ditch, Myrtle Grove/Mid Barataria diversion

- Reviewed proposed gate types and proportions based on USACE guidelines

# Structural Engineering

- Control Structure
- Back Levee Structure
- Bridge

# Structural Design Assumptions

| Material Unit Weights | |
|---|---|
| ▪ Water | 63 lb/ft$^3$ |
| ▪ Reinforced Concrete | 150 lb/ft$^3$ |
| ▪ Steel | 490 lb/ft$^3$ |
| ▪ Rip rap | 132 lb/ft$^3$ |
| ▪ Soil (dry, all type) | 120 lb/ft$^3$ |
| **Material Specifications** | |
| ▪ Structural Steel (Rolled Shapes) | ASTM A709, Grade 50 (50 ksi yield stress) |
| ▪ Structural Steel (Channels, plates & others) | ASTM A36 (36 ksi yield stress) |
| ▪ Steel Reinforcement | ASTM A615 Gr. 60 (60 ksi yield stress) |
| ▪ Superstructure Concrete | 4,000 psi at 28 days |
| ▪ Pre-stressed Concrete | 5,000 psi minimum |
| ▪ Welding | As per AWS D1.1 and D1.5 |
| ▪ Anchor Bolts | ASTM A325 Type 1 for non-weathering steel and Type 3 for weathering steel |

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# Structural Design Assumptions (Cont.)

| Design Loads | |
|---|---|
| ▪ Structural Loading | As per USACE MVN HSDRRSDG* Section 5.7 |
| ▪ Wind | 150 mph |
| ▪ Seismic Loading | Not considered |
| ▪ Impact Load | Corresponding to Zone #1B and Zone #3, as per HSDRRSDG, Section 5.2.1 |
| ▪ Bridge Load | LADOTD Louisiana Design Vehicle Live Load 2011 (LADV-11), Lane Load |
| **Design References** | |
| ▪ *HSDRRSDG – Hurricane and Storm Damage Risk Reduction System Design Guidelines, USACE MVN | |
| ▪ EM 1110-2-2104, Strength Design for Reinforced Concrete Hydraulic Structures | |
| ▪ EM 1110-2-2105, Design of Hydraulic Steel Structures | |
| ▪ EM 1110-2-2502, Retaining and Flood Walls | |
| ▪ EM 1110-2-2610, Lock and Dam Gate Operating and Control Systems | |
| ▪ American Concrete Institute, Building Code and Commentary, ACI 318-08 | |
| ▪ American Institute of Steel construction, Manual of Steel Construction (9th Ed.) | |
| ▪ ASCE/SEI 7-10, Including Supplement No. 1, Minimum Design Loads for Buildings and Other Structures | |

# Tainter Gates

# Cost Estimating

- Determined preliminary project material and labor costs
- Divided project components and quantities
- Investigated real estate parcel boundaries and appraised values
- Contingency = 30%

# Construction Cost Estimate - Schedule of Values

| Item | Unit | Cost |
|---|---|---|
| Asphalt | Ton | $55 |
| Road Base | S.F. | $15 |
| Bridge | S.F. | $130 |
| 30-inch Pipe Piles | L.F. | $150 |
| Reinforced Concrete | C.Y. | $1,100 |
| Steel | Ton | $8,000 |
| Excavation | C.Y. | $60 |
| Fill (guide levee, coffer dam, etc.) | C.Y. | $35 |
| Steel Sheet Pile | S.F. | $35 |
| Soilcrete | C.Y. | $25 |

# Real Estate Cost Estimate – Land Value Matrix

| Category | Unit | Unit Value |
|---|---|---|
| Unimproved Acreage | Acre | $8,000 |
| Established Agricultural Acreage | Acre | $15,000 |
| Acreage with Structures/Homes | Acre | $20,000 |
| Previous Industrial Site | Acre | $20,000 |
| Structures Above Flood Level | S.F. | $105 |
| Structures Below Flood Level | S.F. | $35 |
| Single Family Homes Below Flood Level | S.F. | $70 |
| Outbuildings | S.F. | $15 |

- Based on research of local land values
- No public GIS database available for Plaquemines Parish

# Construction Cost Estimate – Site Summary

| Site | Cost | Contingency | Total |
|---|---|---|---|
| Magnolia | $679,370,285 | $203,811,086 | $883,181,371 |
| Diamond | $760,606,748 | $228,182,024 | $988,788,772 |
| Port Sulphur | $614,291,835 | $184,287,551 | $798,579,386 |
| Empire | $776,284,353 | $232,885,306 | $1,009,169,659 |
| Buras | $837,974,496 | $251,392,349 | $1,089,366,845 |

# Overall Site Ranking

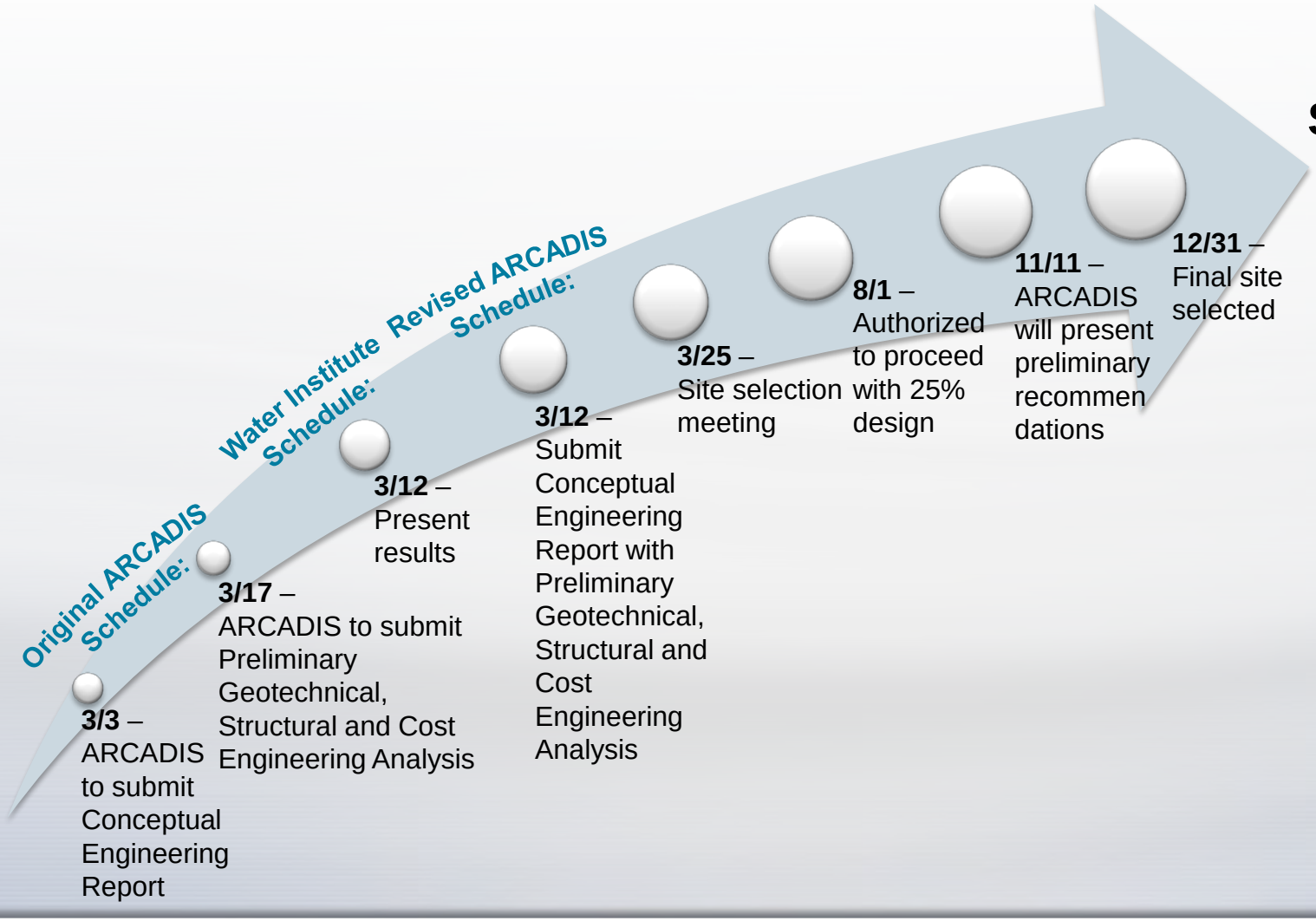
| Category | Wtg Fac | Magnolia | | Diamond | | Port Sulphur | | Empire | | Buras | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Rank | Score | Rank | Score | Rank | Score | Rank | Score | Rank | Score |
| Land Use Impacts | 1.5 | 4 | 6 | 3 | 4.5 | 5 | 7.5 | 2 | 3 | 1 | 1.5 |
| Channel Length | 1 | 2 | 2 | 1 | 1 | 4 | 4 | 5 | 5 | 3 | 3 |
| SWR | 3 | 5 | 15 | 4 | 12 | 1 | 3 | 2 | 6 | 3 | 9 |
| River Power | 1 | 5 | 5 | 4 | 4 | 3 | 3 | 2 | 2 | 1 | 1 |
| Bridges/ Structures | 1 | 3 | 3 | 4 | 4 | 5 | 5 | 1 | 1 | 2 | 2 |
| Soil Composition | 2 | 5 | 10 | 4 | 8 | 2 | 4 | 1 | 2 | 3 | 6 |
| Logistics | 0.5 | 5 | 2.5 | 4 | 2 | 3 | 1.5 | 2 | 1 | 1 | 0.5 |
| LA-23 Bypass Lane | 1 | 4 | 4 | 3 | 3 | 5 | 5 | 1 | 1 | 2 | 2 |
| Cost | 2 | 4 | 8 | 3 | 6 | 5 | 10 | 2 | 4 | 1 | 2 |
| Total Score | | | **55.5** | | **44.5** | | **43** | | **25** | | **27** |

# Reduced Sites to 2 Locations

# Where Are We Now??

- 25% Design Effort – 2 Sites
- Flow 3D and HEC –RAS Modeling
- Refining Channel Components
- Refining Cost Estimating

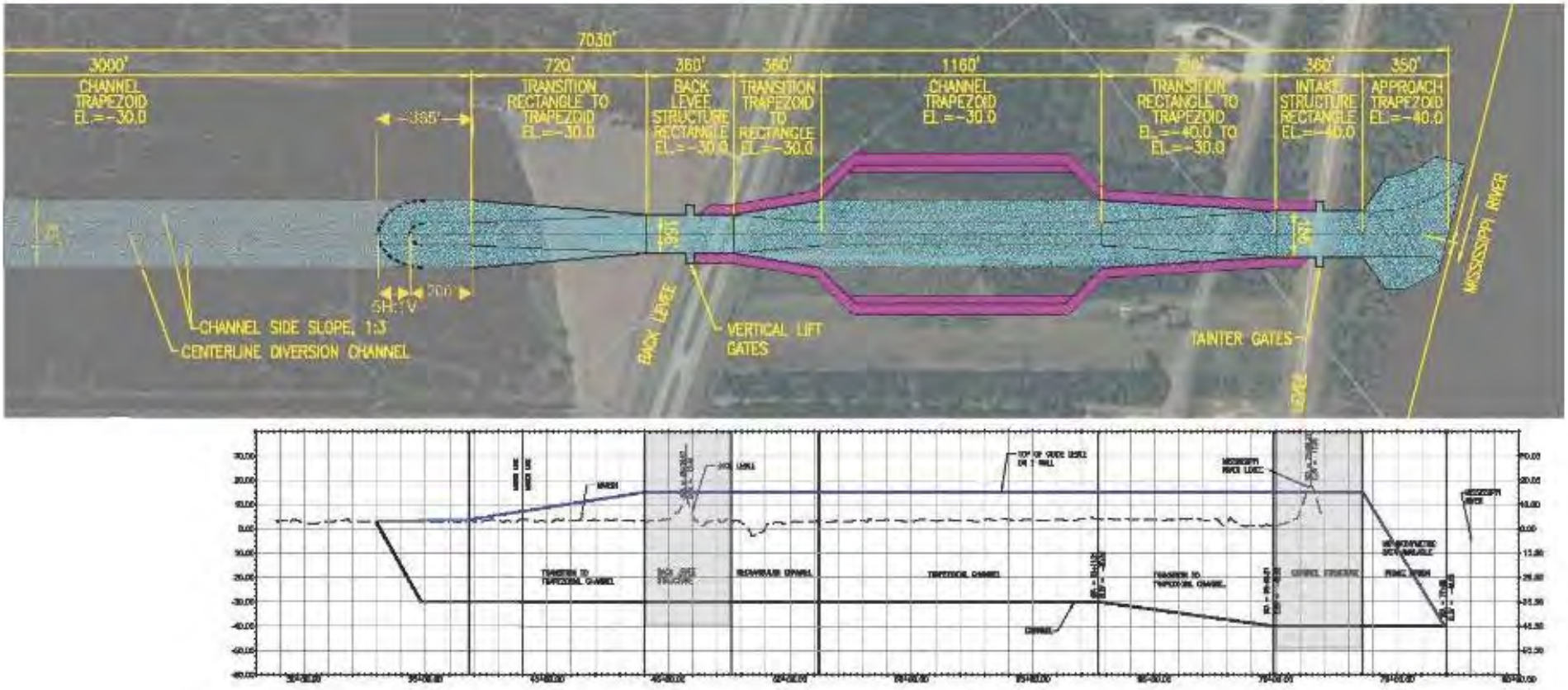
# Schedule Milestones



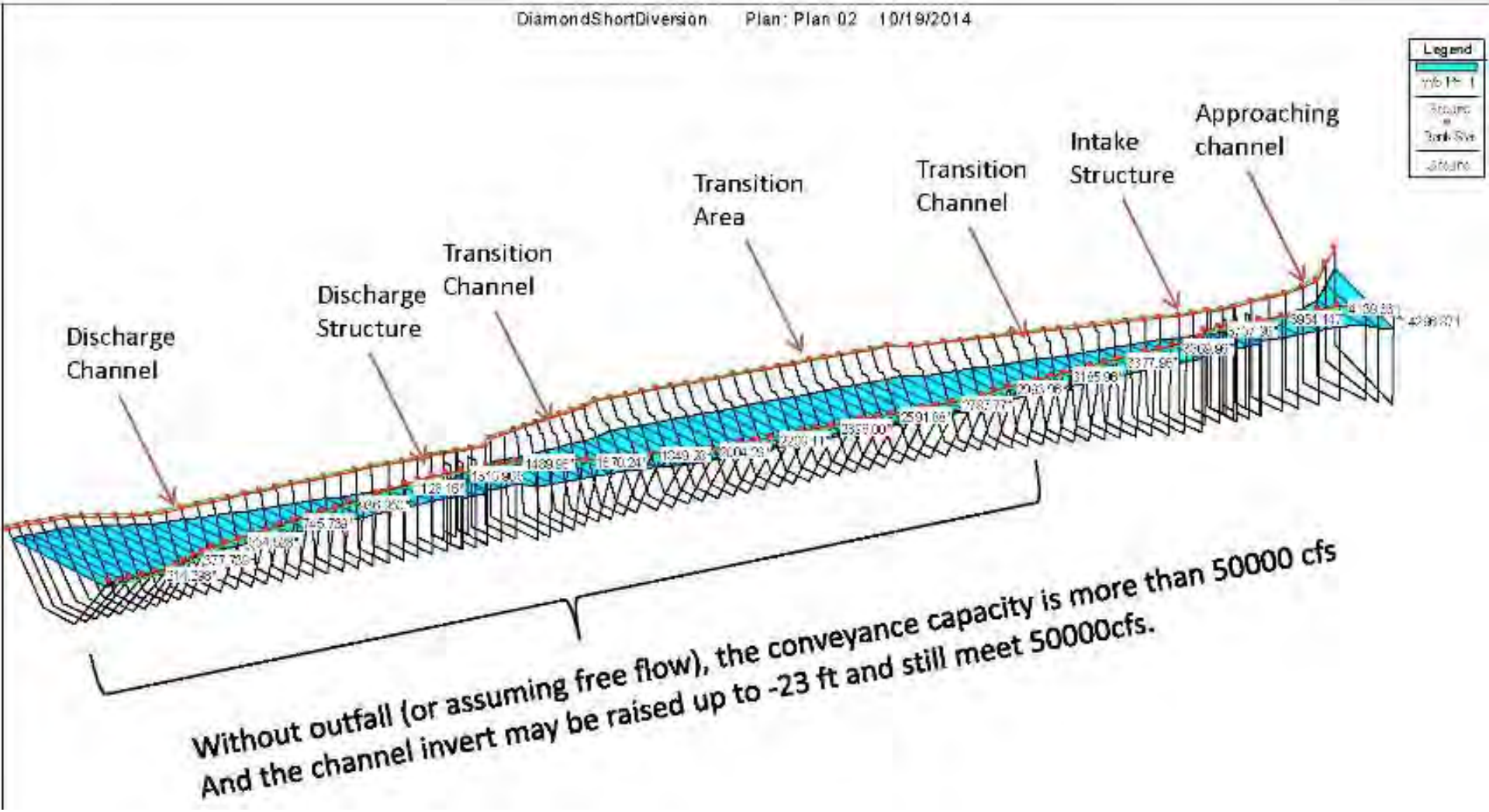
Imagine the result

# Questions/Comments

# Refined Location – 25%



# Diamond Short Channel – *without outfall*



# Revised Cost Considerations

## *Cost Estimating*

- 50% Concrete, 28% Earthwork, 12% Steel (Piles)
- Re-evaluating 5 unit prices (90% of construction costs)

<u>First Priority (70%)</u>

- Concrete (50%)
  - ✓ Intake Structure (12%)
  - ✓ T-Walls (12%)
  - ✓ Channel Lining (10%)
  - ✓ Outfall Structure (8%)
  - ✓ Stabilization Slabs (8%)
- Excavation (20%)

<u>Second Priority (20%)</u>

- Pipe Piles (7%)
- Sheet Pile (5%)
- Fill (5%)
- Dewatering (3%)