2019

Lake Pontchartrain & Vicinity GRR Appendix B – Geotechnical Engineering

U.S. Army Corps of Engineers,
New Orleans District

Non-Federal Sponsor: Coastal Protection and Restoration Authority Board

11/22/2019

LAKE PONTCHARTRAIN & VICINITY GRR

APPENDIX B – GEOTECHNICAL ENGINEERING

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1 INTRODUCTION

1.1 OVERVIEW

The appendix documents geotechnical analyses for levee lifts for future conditions of 2073 intermediate and high project grades.

1.2 SCOPE

The scope was to project lift schedules to the year 2073 based on lift schedules which were previously developed to the year 2057. Settlement-induced bending moment caused by levee lifts on adjacent T-wall transition was not included in the analyses.

1.2.1 STUDY AREA

The study area is Lake Pontchartrain and Vicinity, which borders Lake Pontchartrain to the north, Lake Borgne to the east, and the Mississippi River to the south.

2 FUTURE WITH PROJECT/ACTION CONDITION

2.1 PRIOR ANALYSIS

“Previously developed lift schedules” or “prior lift schedules” were last prepared in 2014 to estimate levee lifts needed to ensure that previously established design grades were maintained from settlement over time. Consolidation settlement of the foundation was caused by the volume change in saturated cohesive soils due to expulsion of the water that occupies the void spaces. The volume change was induced by the levee load that compresses the soil layers.

The process involved creating consolidation parameters from subsurface exploration and testing, estimating stress increase from levee load, and using Settle3D computer program.

Shrinkage and consolidation of levee fill were also considered in development of lift schedules.

Due to the non-uniform nature of soil’s physical structure and substance, settlement was estimated and lift schedules were developed for planning purposes only.

2.2 ANALYSIS

Survey of levee elevations was performed in November and December 2018. Since survey was performed in 8 reaches which consist of different levee segments, settlement was also estimated for these 8 reaches and lift schedules were developed.

First, lift schedules previously developed to 2057 for segments of each reach were compared to each other and the control segment with the highest rate of settlement was selected. It should be noted that in some cases lift schedules for all levee segments of a certain reach were not previously developed.

Secondly, latest constructed lift was drawn with year and elevation. Thirdly, the November or December 2018 average survey values of the control segment were plotted. Since survey elevation included the 6-inch thick articulated concrete block if the levee was armored, the

survey was lowered 6 inches for the actual levee crown. A settlement curve was then drawn from the actual lift elevation to the survey elevation.

If this settlement curve intersected the new design grade, another levee lift was drawn. The new settlement curve was then estimated by using a curvature of the curve to 2057.

Experience has shown that a settlement value of 6 inches from 2023 to 2073 can be used for the co-located LPV-MRL levees which are without previously developed lift schedules. These areas are expected to experience little settlement.

2.3 ASSUMPTIONS AND RISK

Most settlement curves were developed from actual settlement of levee lifts – from latest lift year and elevation to November or December 2018 survey data. In lieu of sufficient data (latest lift occurred after survey), settlement curve was assumed to follow prior lift schedule. To be conservative, the same assumption also applies to subsequent lift schedules following a first lift with a small amount of settlement.

3 LEVEE COMPOSITION

A typical levee is constructed of fat clay or lean clay with less than 35% sand and 9% organic material. The clay is compacted to at least 90% maximum dry density at a moisture content of within +5% to -3% optimum moisture content.

4 GEOLOGY

4.1 GENERAL GEOLOGY AND TOPOGRAPHY

LPV is situated in St. Charles, Jefferson, and Orleans Parishes along the eastern edge of the Mississippi River's deltaic plan. Broad natural levees associated with the Mississippi River, Bayou des Familles, and Bayou Metairie are the most prominent physiographic features in the area (Figure 1). Surface elevations are generally near sea level and range from approximately 15 feet above sea level along the crests of the Mississippi River levees to below sea level over much of the area north of the river. Increased urban reclamation of low-lying areas occurred after World War II by draining the cypress swamps that were present north of the city to meet the demands for expansion and population growth. Continuous pumping of ground water drainage since then has contributed to the desiccation of these swamp and marsh soils and has lowered the ground surface to below sea level for a significant portion of the city. Levees that encircle the city and continuous pumping of ground water are required to keep the surround water bodies from entering the Metropolitan area south of Lake Pontchartrain (Dunbar, Britsch, 2008).

4.2 REGIONAL GEOLOGY

4.2.1 BEDROCK GEOLOGY

The bedrock in the New Orleans are greater than 14,000 feet below sea level (Figure 2).

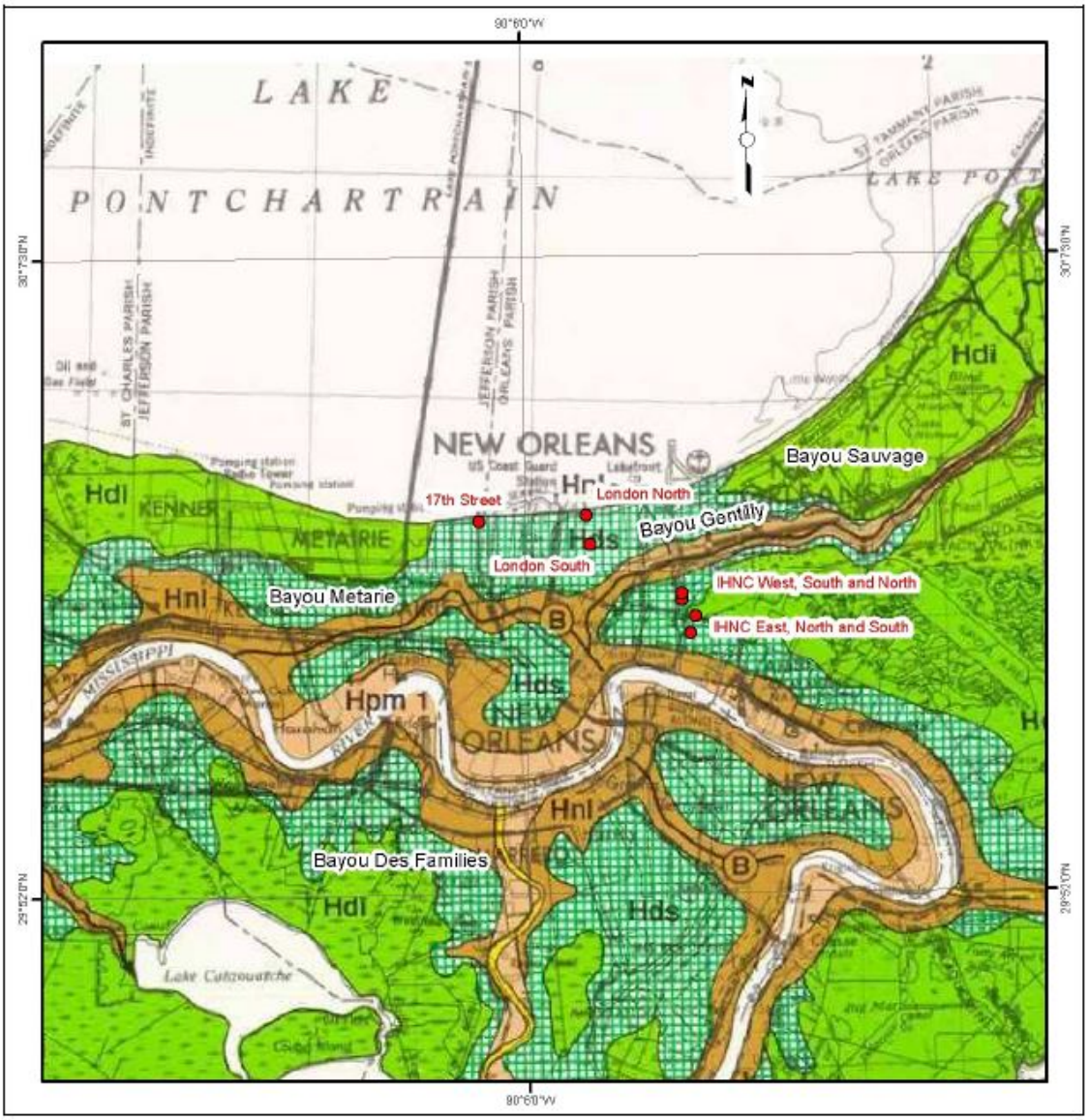


FIG. 1. General geology map of the New Orleans area showing the limits of the different surface depositional environments (Saucier 1994). Map symbols are as follows: H = Holocene, d = deltaic, i = interdistributary, s = inland swamp, nl = natural levee, pm1 = point bar (most recent meander belt), B=St. Bernard distributary channel

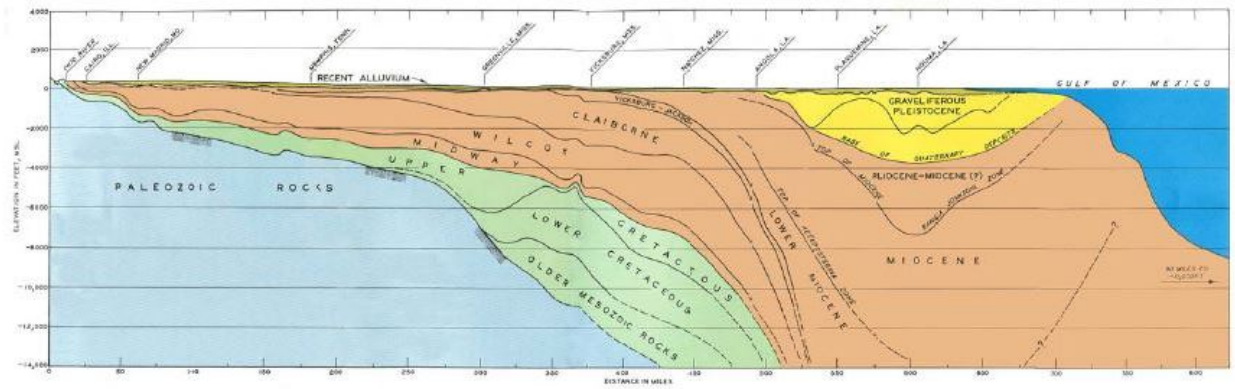


FIG. 2. North – south geologic cross section through the central Gulf of Mexico Coastal Plain, along the Mississippi River Embayment (from Moore, 1972). Note the axis of the Gulf Coast Geosyncline beneath Houma, LA, southwest of New Orleans. In this area, the Quaternary age deposits reach a thickness of 3600 ft.

4.2.2 GEOMORPHOLOGY

The Pleistocene Prairie Complex was deposited in a coastal-plain setting approximately 135,000 to 150,000 years before present (Saucier, 1994). The Pleistocene sand channel deposit represents the course of a large river channel in this area. During the late-Pleistocene (Wisconsin Stage) glaciation between 120,000 and approximately 10,000 years before present (b.p.), the Prairie Complex was exposed to weathering and erosion due to the low stand of sea level that accompanied glaciation. During the low-stand period, the Prairie Complex sediments were oxidized and desiccated resulting in over-consolidation of the soil and the development of soil-weathering features such as iron oxidation and precipitation of calcium carbonate nodules. The erosion surface of the Pleistocene sediments is a distinct contact that generally can be recognized by the contrast between the Holocene and Pleistocene sediments in color, soil consistency and strength, and water content. The overlying Holocene sediments typically are dark gray or blue gray in color. The upper portion of the Pleistocene generally is tan, reddish brown, or brown in color as a result of the soil oxidation accompanying weathering during the sea-level low stand. Where the Pleistocene contact is deeper than 50 feet below sea level, the color of the Pleistocene sediment can be mottled tan, orange, and greenish gray and have a smaller contrast with the Holocene sediments. In addition, at locations where Holocene sand deposits directly overlie sand units of Pleistocene age, the stratigraphic boundary can be difficult to identify. The soil cohesive strengths in the upper portion of the Pleistocene clay range from 0.5 to more than 2.0 tons per square foot (tsf). The immediately overlying Holocene near-shore and estuarine clays have much lower cohesive strengths. The high soil strengths of the majority of the Pleistocene soils are due to cementation by hydrous iron oxides, calcium carbonate, siderite, and manganese carbonate (Kolb and others, 1975) resulting from the exposure and weathering that took place during the glacial low stand of sea level. The water content of the overlying Holocene sediments is generally much higher than the Pleistocene sediments, which have water contents less than 50 percent.

The Holocene transgression (rise) of sea level started approximately 18,000 years b.p. and was at an elevation of approximately -140 feet msl by 12,000 years ago. The shoreline was located in the investigation area by approximately 6,000 to 4,500 years b.p. (Saucier, 1994; Kindinger, 2002). Approximately 6,000 years ago, the elevation of sea level was approximately 10 to 15 feet below its present level. The rise in sea level deposited fine sand derived from the Pearl River to the east in a beach environment extending east to west through the area of LPV 105 and LPV 106, in the area south of LPV 108, and across the area of LPV 109 during the period from approximately 6,000 to 4,500 years b.p. This beach trend is the Pine Island Barrier or Pine Island Beach Trend (Saucier, 1994; Kindinger, 2002). The thickness of the main trend of the Pine Island beach deposit generally ranges from 15 to 25 feet. The Pine Island beach deposit is displayed extensively in the soil boring logs and CPTs from Levee Reaches LPV 105 and LPV 106. As sea level continued to rise, the Pine Island beach deposit continued to be deposited in portions of LPV 108 to the north (inland) of the main trend of the Pine Island Barrier. The beach deposit occurs in portions of LPV 108 as discontinuous lenses of silty and clayey sand with thicknesses ranging from 5 to 10 feet that are intercalated with lacustrine and interdistributary deposits. The beach deposit occurs in portions of LPV 109 as discontinuous lenses of silty and clayey sand with thicknesses ranging from 5 to 15 feet that are intercalated with interdistributary deposits.

As sea level continued to rise, clay was deposited across the area in an estuarine lacustrine environment north of the Pine Island Beach Trend and in interdistributary shallow bays. Between approximately 3,000 and 1,000 years ago, the Mississippi River deltaic plain was being deposited to the southeast of LPV 108 and across LPV 109 by the St. Bernard lobe of the Mississippi River delta. The main channel of the Mississippi River was located along the Bayou Sauvage Distributary during this time period. The sediment deposited in the deltaic plain in the New Orleans East area included clay, silt, and sand deposited in interdistributary bays and marshes and in intradelta lobes. In the LPV 108 and LPV 109 area, several small distributary channels derived from the Bayou Sauvage Distributary flowed northward across the LPV 108 area and eastward across the LPV 109 area. Minor natural levee deposition occurred along the channel banks and filling of the channels occurred primarily by fine-grained deposition. The Bayou Sauvage distributaries continued to be active as recently as 700 years b.p. As the areas of lacustrine and interdistributary deposition across the area became shallower, coastal marsh deposits formed.

The Mississippi River established its present course approximately 600 years ago and has deposited clay, silty clay, and silt in natural-levee deposits adjacent to the river during periods of river flooding. The natural-levee deposits range from approximately 5 to 15 feet in thickness and generally become thinner or absent away from the river. These most-recent alluvial deposits related to the present course of the Mississippi River are not encountered in the project area. In the project area, the upper 10 to 15 feet of the Holocene sediments can consist of soft to very soft clays deposited in brackish and salt-water marshes.

4.2.3 SURFICIAL GEOLOGY

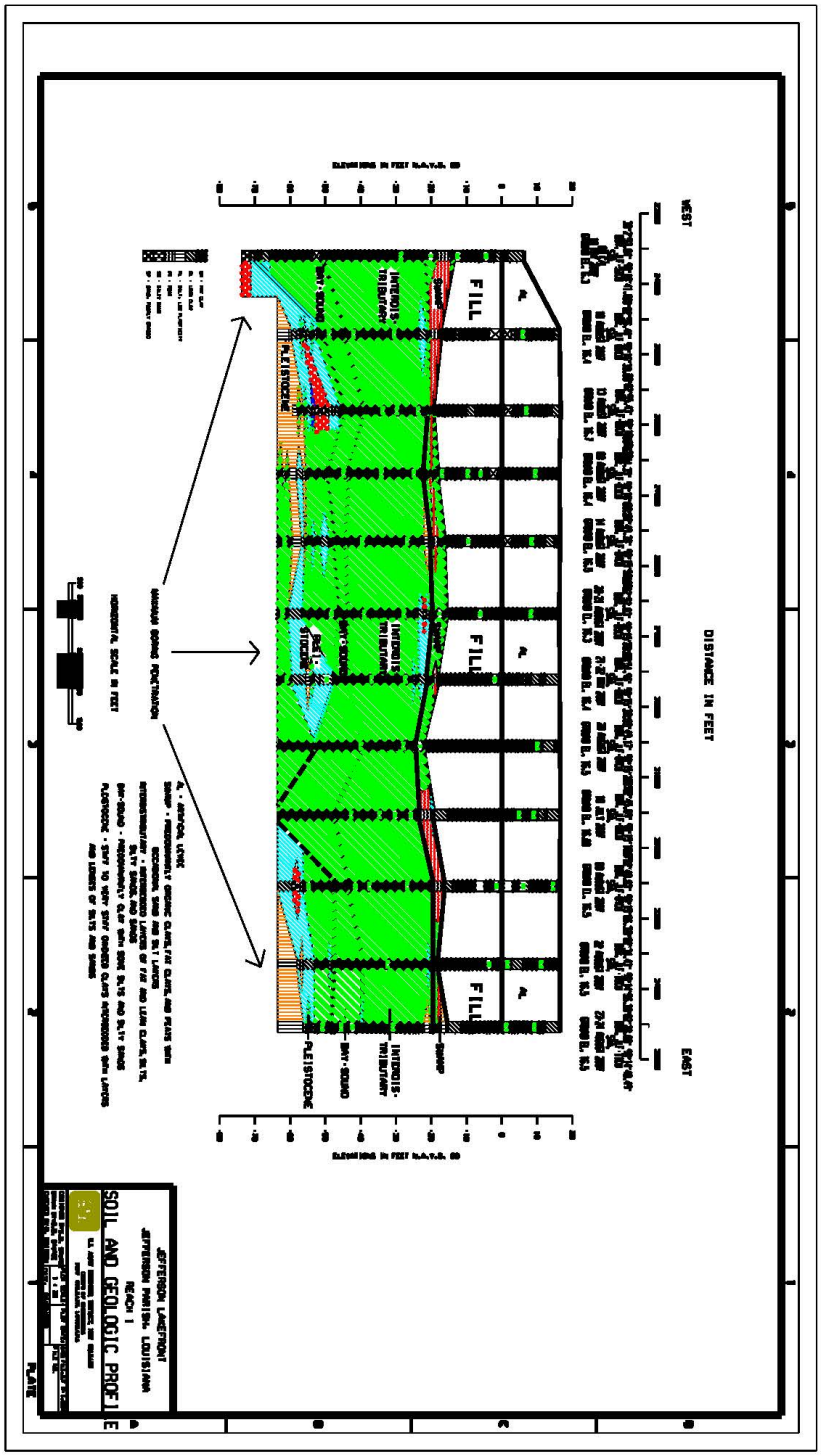
The major stratigraphic units corresponding to depositional environments of the deltaic plain and alluvial plain were identified from the soil boring logs and CPTs. The principal characteristics of the stratigraphic units are summarized in the following table prepared by Mr. Burton Kemp.

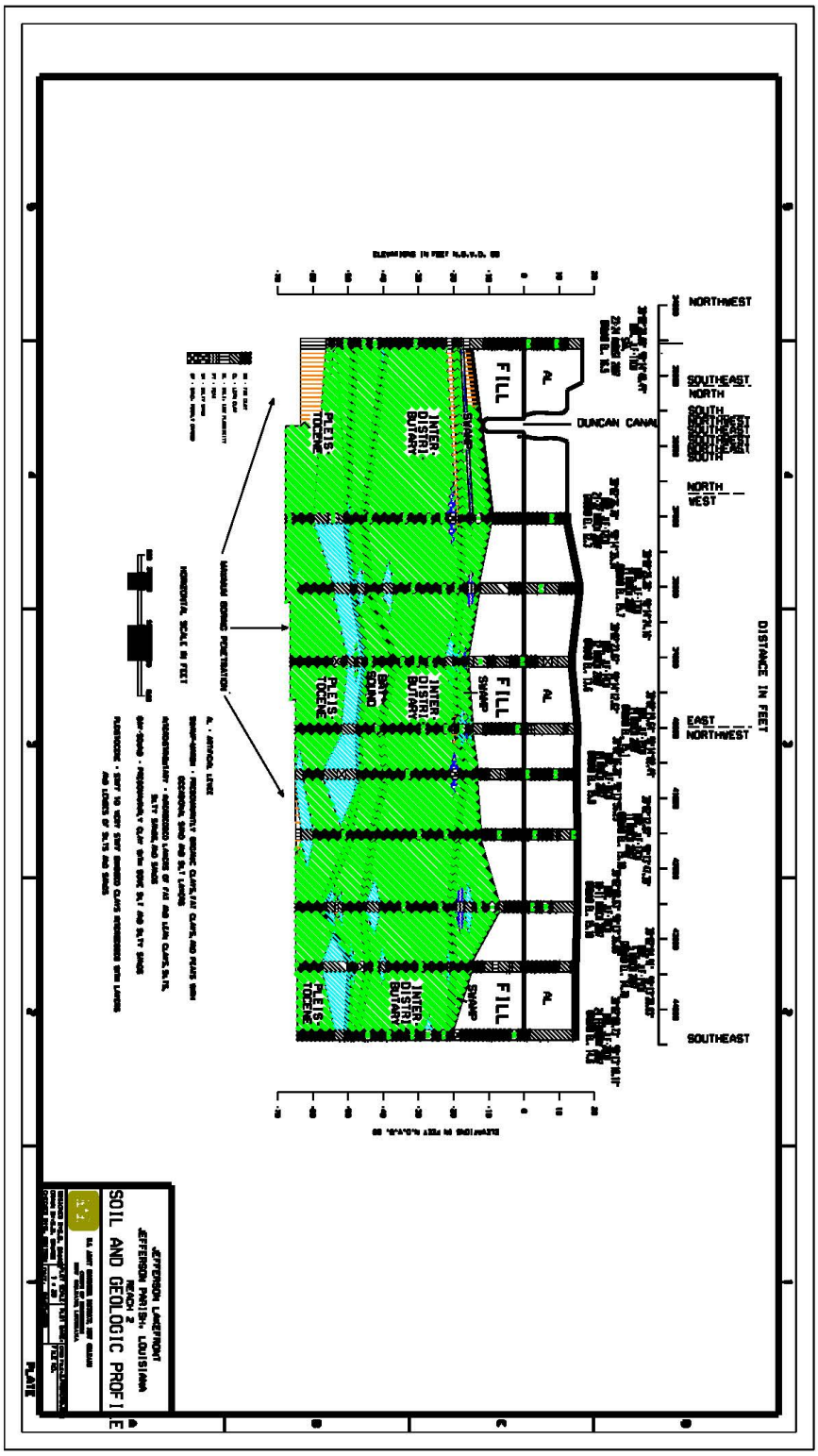
Stratigraphic (Depositional) Unit	General Description and Geotechnical Parameters
Natural Levee (NL)	Generally found adjacent to streams; limited desiccation and oxidation. Consists of brown, light gray and gray thin alternating layers of fat clay (CH), lean clay (CL), and silt, very fine sand, or silty sand (ML). Moisture content (MC) varies from 25 to 40% in CH to 20 to 35 % in CL. Densities range from 105 to 120 pounds per cubic foot (lb/cu ft)in CH to 95 to 105 lb/cu ft in CL. Strengths from 300 to 700 pounds per square foot (lb/sq ft) in CH to up to 1000 lb/sq ft in CL.
Point Bar (PB)	Generally found along convex bend area of streams, immediately adjacent to stream. Consist of light brown and gray thin bedded topstratum of ML, silty sand (SM), and poorly graded sand (SP), coarsening with depth.
Backswamp (BS)	Generally found in the alluvial valley section. Consists of massive dark gray CH with occasional thin lenses of ML. MC almost constant between 45 and 50 percent. Densities are in the 105 to 115 lb/cu ft range. Strengths vary from 500 to 1000 lb/sq ft.
Inland Swamp (IS)	Confined to the deltaic plain area in low areas within interdistributary deposits. Consists of gray and dark gray clays with varying amounts of organic matter. MC highly variable between 100 and 120 %. Densities 70 to 90 lb/ cu ft; and strengths around 250 lb/ sq ft.
Beach	These deposits are generally composed of fine sand and silty sand with shells and shell fragments. Minor amounts of silt and clay may also be present. In the study area, beach deposits are related to the Pine Island trend and generally parallel the shoreline of Lake Pontchartrain.
Bay-sound	Characteristically are non-cohesive, consisting of soft to medium gray silt (ML), silty sand (SM), or fine sand (SP). All three (ML, SM, SP) are very fossiliferous with shell fragments and occasionally whole shells generally scattered throughout, but occasionally concentrated into thin layers.

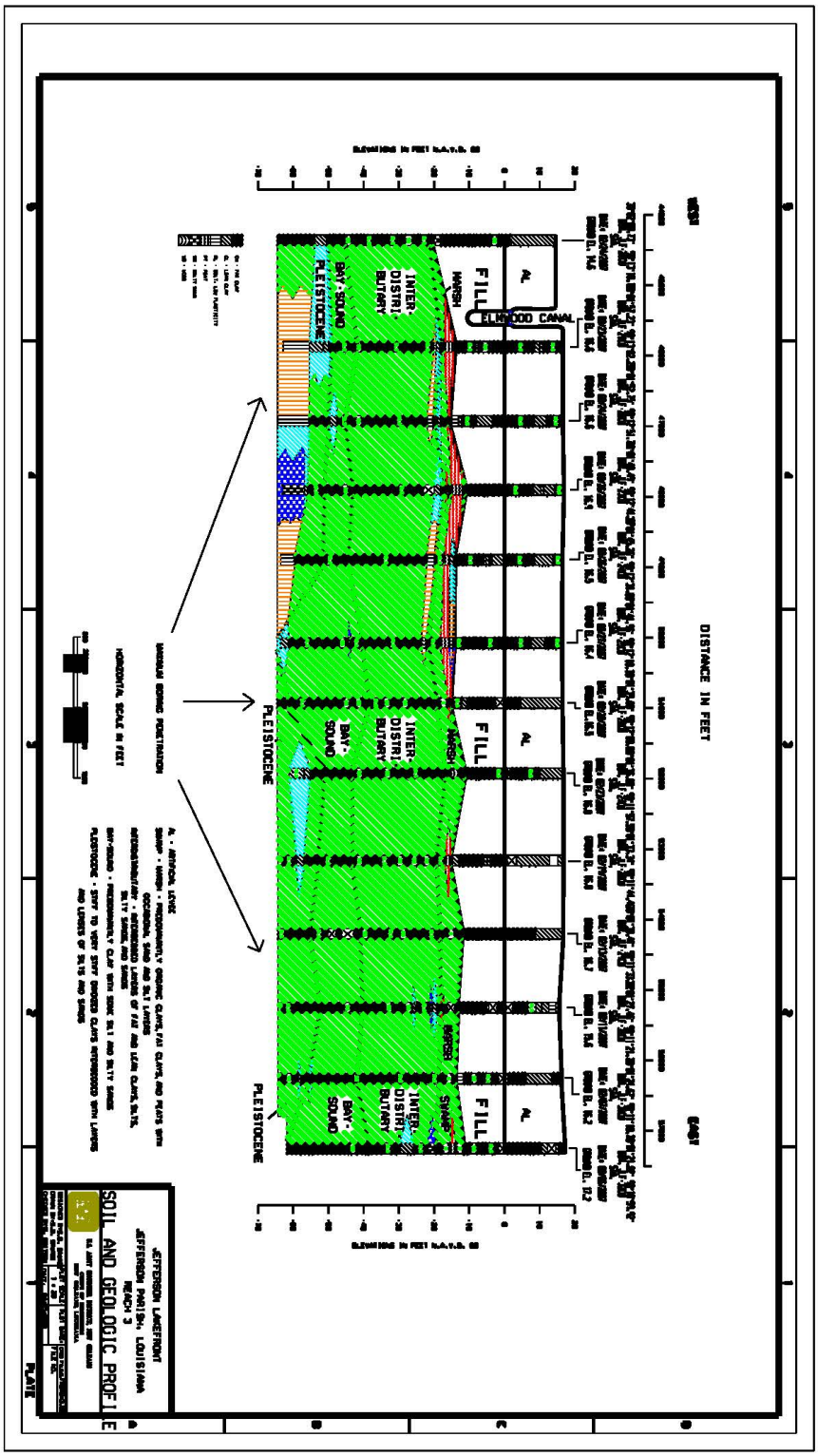
Stratigraphic (Depositional) Unit	General Description and Geotechnical Parameters
Nearshore Gulf	These deposits are characterized by sand, silty sand, silt, and clay with shell fragments. They represent reworked Pleistocene deposits under marine influence and are found directly above the Pleistocene surface when present. They are considered “dirty sands” due to the heterogeneous nature of these deposits. These deposits are usually less than 10 feet thick.
Intradelta	Intradelta deposits consist of fine sand and silty sand with some silt. Shells are usually absent. Intradelta deposits are associated with prograding distributaries, and as such, are found adjacent to the Bayou Savage distributary channel in the study area.
Interdistributary (INTD)	Generally located between the distributaries. Consists of gray dark gray clay sequences with interbedded ML/SM resulting in a laminated or varved appearance. MC varies between 60 and 80 %. Densities constant between 95 and 98 lb/cu ft; and strengths between 200 and 300 lb/sq ft.
Lacustrine (L)	Generally massive, soft to medium clays interbedded with occasional lenses of silt and silty sand. Lacustrine deposits formed by clays settling out of suspension in protected lake areas. Shell fragments can be common, but restricted lacustrine environments can be devoid of shells. Lacustrine deposits are often difficult to differentiate from interdistributary deposits; but generally contain more massive clays and have a lower fraction of interbedded silt and sand than the interdistributary deposits. MC between 50 and 75%, densities in the 95 to 115 lb/cu ft range; and strengths between 250 and 500 lb/sq ft are common.
Abandoned Distributary (AD)	Generally located throughout the area, but increase in frequency in the lower reaches of the coastal plain. The deposits generally consist of shallow dark gray and gray, very soft to medium Ch and CL w/varying amounts of SM and ML. MC is highly variable, Densities in the clays range from between 90 and 100 lb/cu ft and strengths are between 300 and 400 lb/ sq ft.
Marsh (M)	Consist generally of surficial deposits up to 10 ft thick of dark gray and black watery ooze and very soft organic clays and ML. MC varies greatly between 100 and over 350 %. Densities also vary

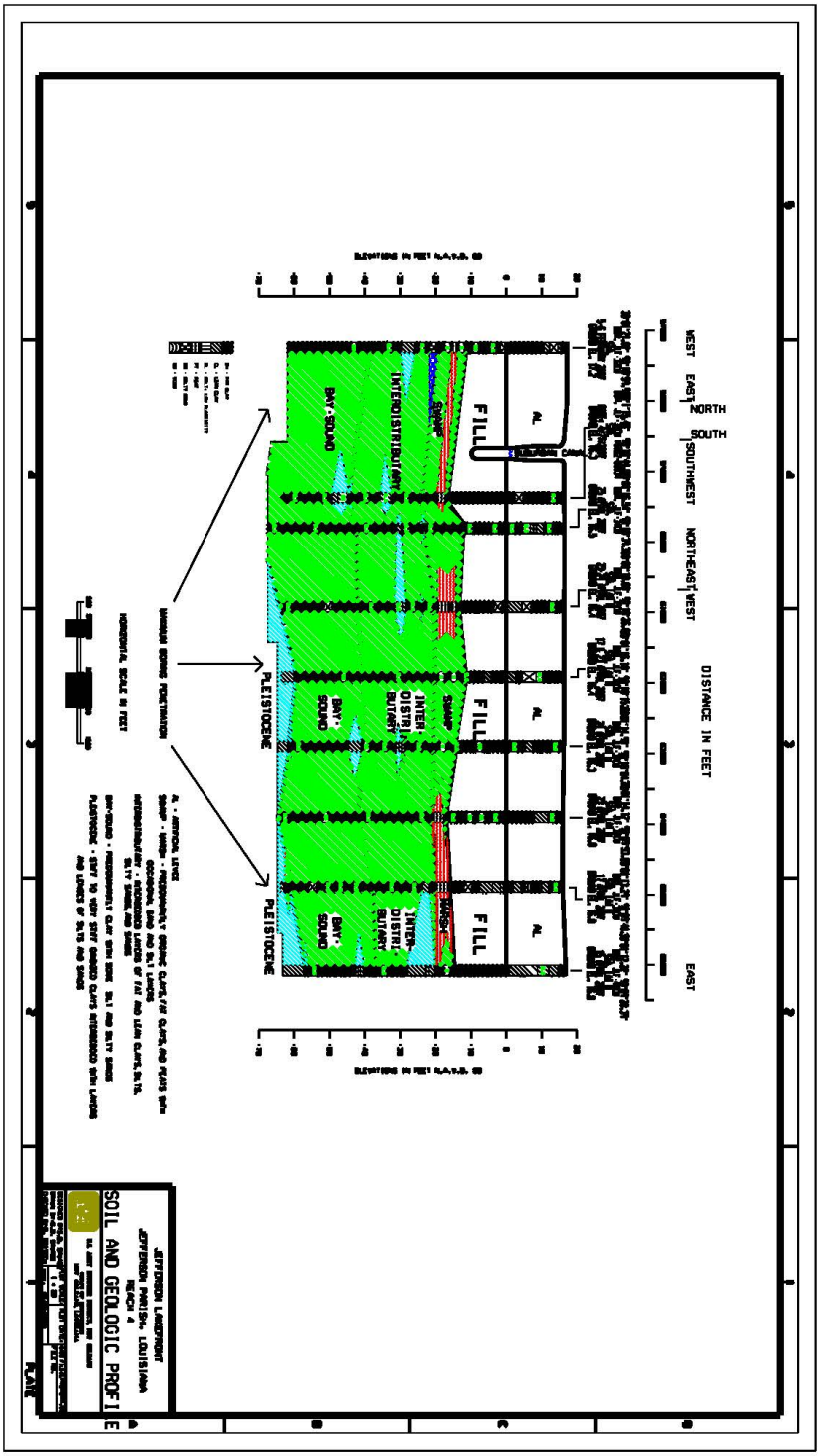
Stratigraphic (Depositional) Unit	General Description and Geotechnical Parameters
	greatly between less than 60 to about 95 % and strengths range from less than 100 to about 250 lb/sq ft.
Pleistocene (P) Prairie Complex (alluvial deposits)	Found in the subsurface throughout the area. These deposits consist of clays, interbedded with silts, silty sands, and sands. Within the Pleistocene, sand bodies varying greatly in thickness can be found. The top surface of the Pleistocene fine-grained units normally forms a distinctive formational interface, easily identified from the overlying deposits. However, in the marginal coastal area of southeast Louisiana, oxidized shell-free sand deposits may be found at the top of the Pleistocene and can be difficult to identify. MC vary from 25 to 45 % in the CH to 22 to 40 % in the CL. Densities from 107 to 125 lb/cu ft in the CH to 116 to 125 lb/cu ft in the CL and strengths range from 900 to 2100 lb/sq ft in the CH to 500 to 1300 lb/sq ft in the CL. The Pleistocene sands are generally oxidized, fine to medium sand and silty sand. Clay interbeds and strata may be present. Shells usually are absent because of the alluvial origin of the sand bodies. The thicknesses of the Pleistocene sands generally are on the order of 5 to 10 feet, but in the investigation area, the thicknesses of the Pleistocene are on the order of 100 feet.

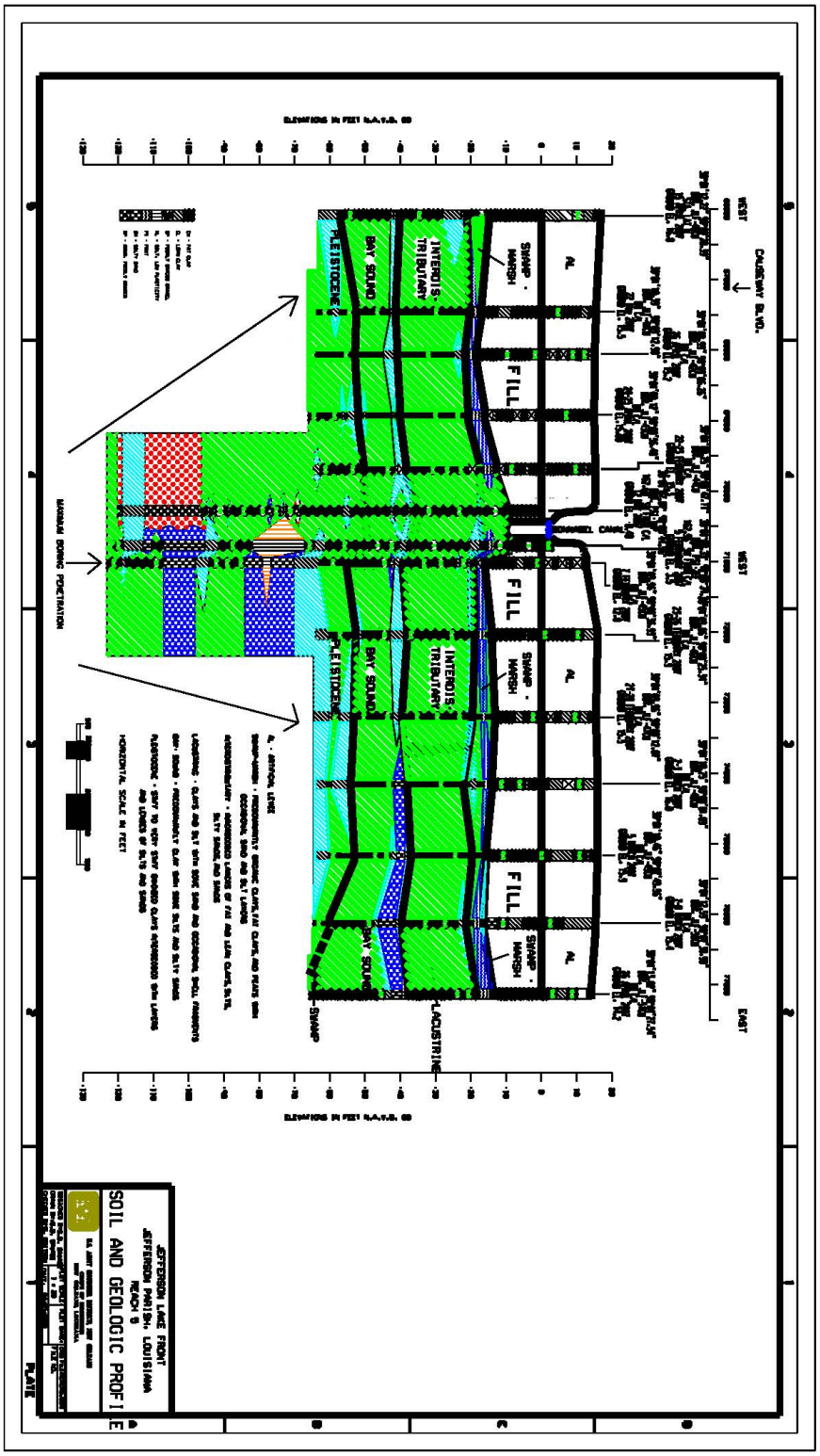
The point bar and backswamp environments are alluvial environments and were not identified in the subsurface of the project area. The point-bar environment, however, could occur along the traces of the distributary channels in the area. The backswamp environment related to the deltaic distributaries also could be gradational with inland swamp and marsh environments.

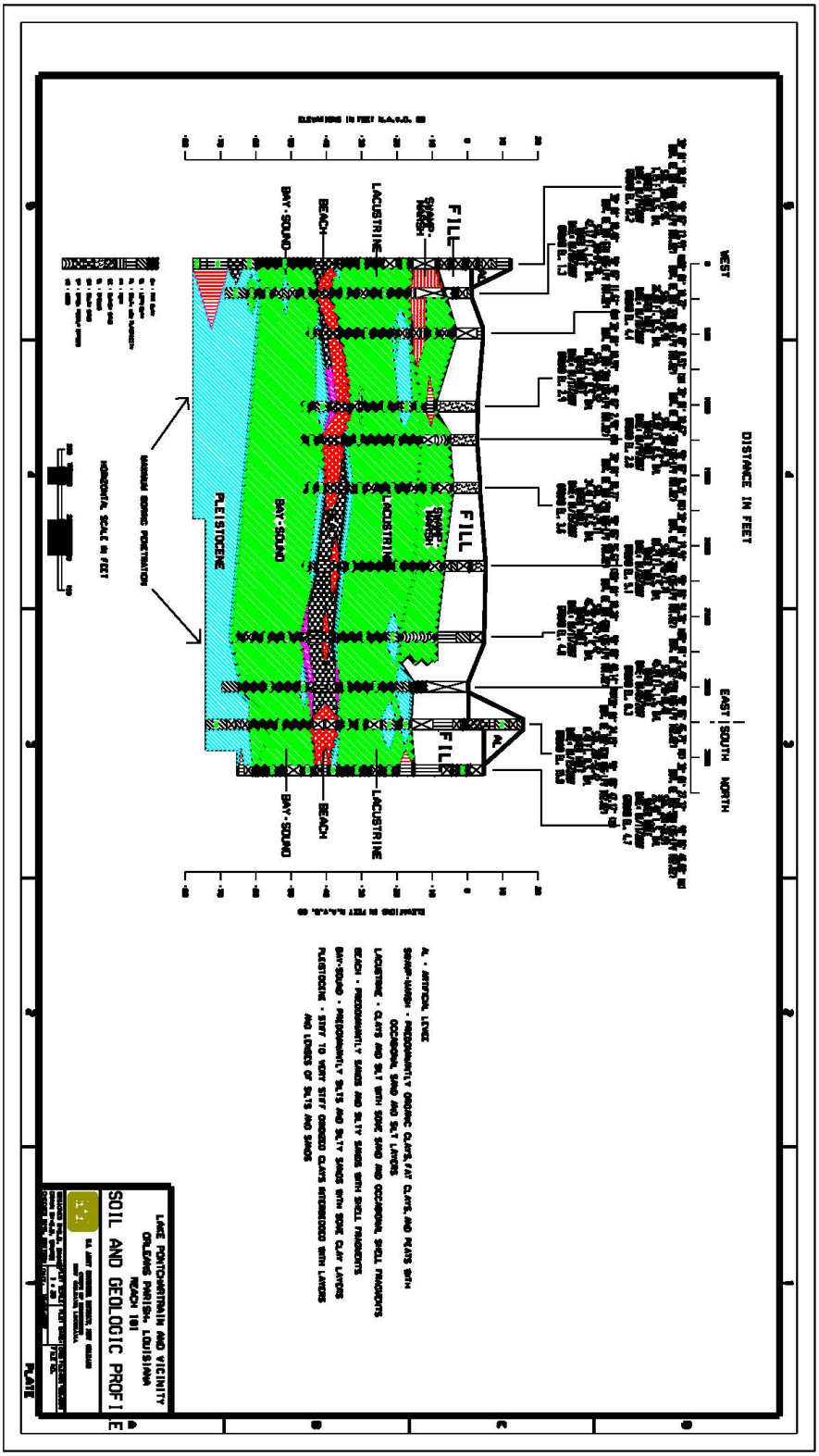

WEST
EAST
DISTANCE IN FEET
FILL
FILL
FILL
INTERDIS-TRIBUTARY
BAY-SOUND
PLEISTOCENE
SWAMP
JEFFERSON LAKEFRONT
JEFFERSON PARISH, LOUISIANA
REACH 1
SOIL AND GEOLOGIC PROFILE
PLATE

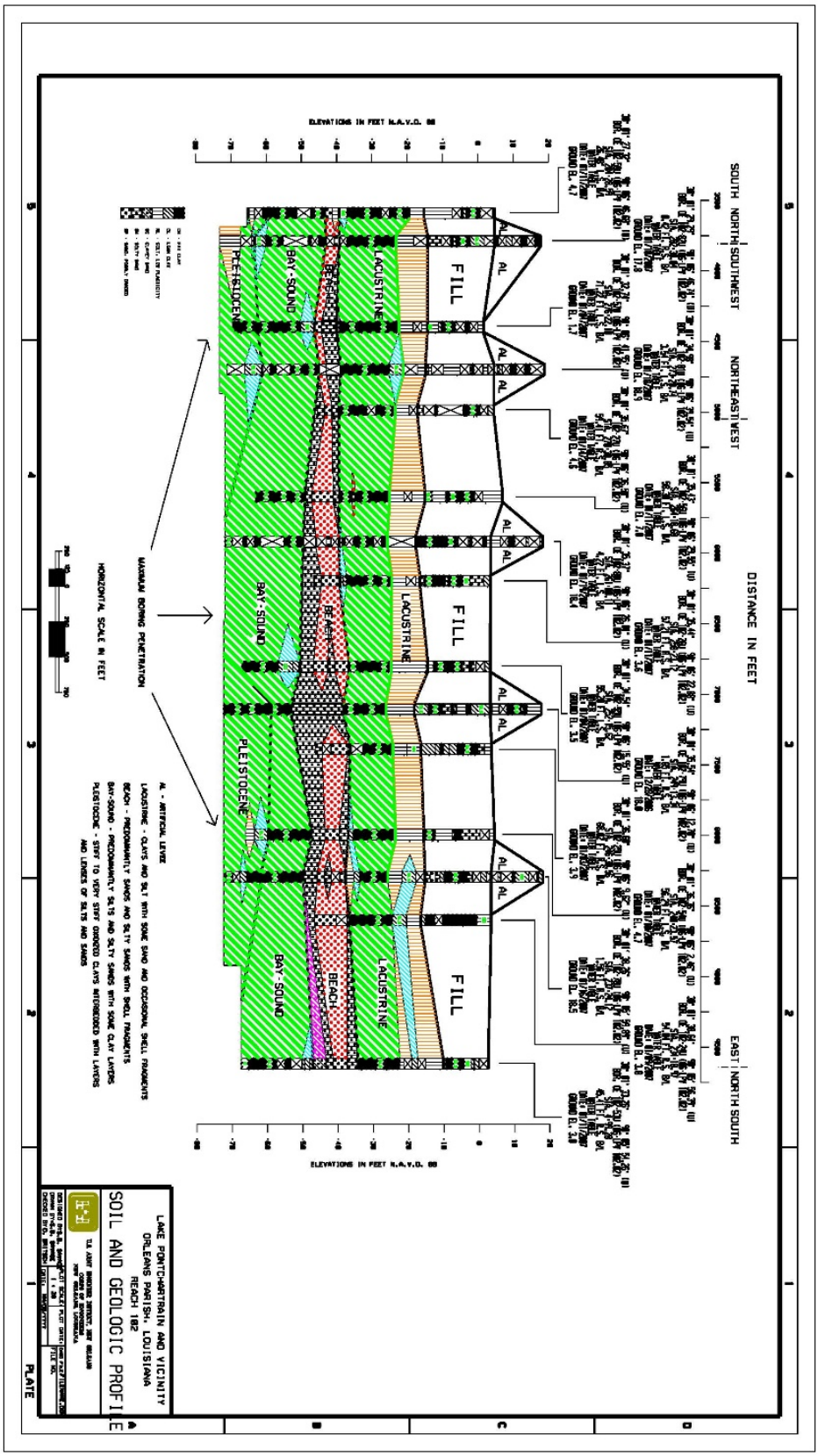

NORTHWEST
SOUTHEAST
NORTH
SOUTH
NORTHWEST
SOUTHEAST
SOUTHWEST
NORTHEAST
SOUTH
NORTH
WEST
EAST
NORTHWEST
SOUTHEAST
DISTANCE IN FEET
DUNCAN CANAL
FILL
SWAMP
INTER-DISTRI-BUTARY
PLEIS-TOCENE
BAY-SOUND
AL
MAXIMUM BORING PENETRATION
HORIZONTAL SCALE IN FEET
JEFFERSON LAKEFRONT
JEFFERSON PARISH, LOUISIANA
REACH 2
SOIL AND GEOLOGIC PROFILE
PLATE

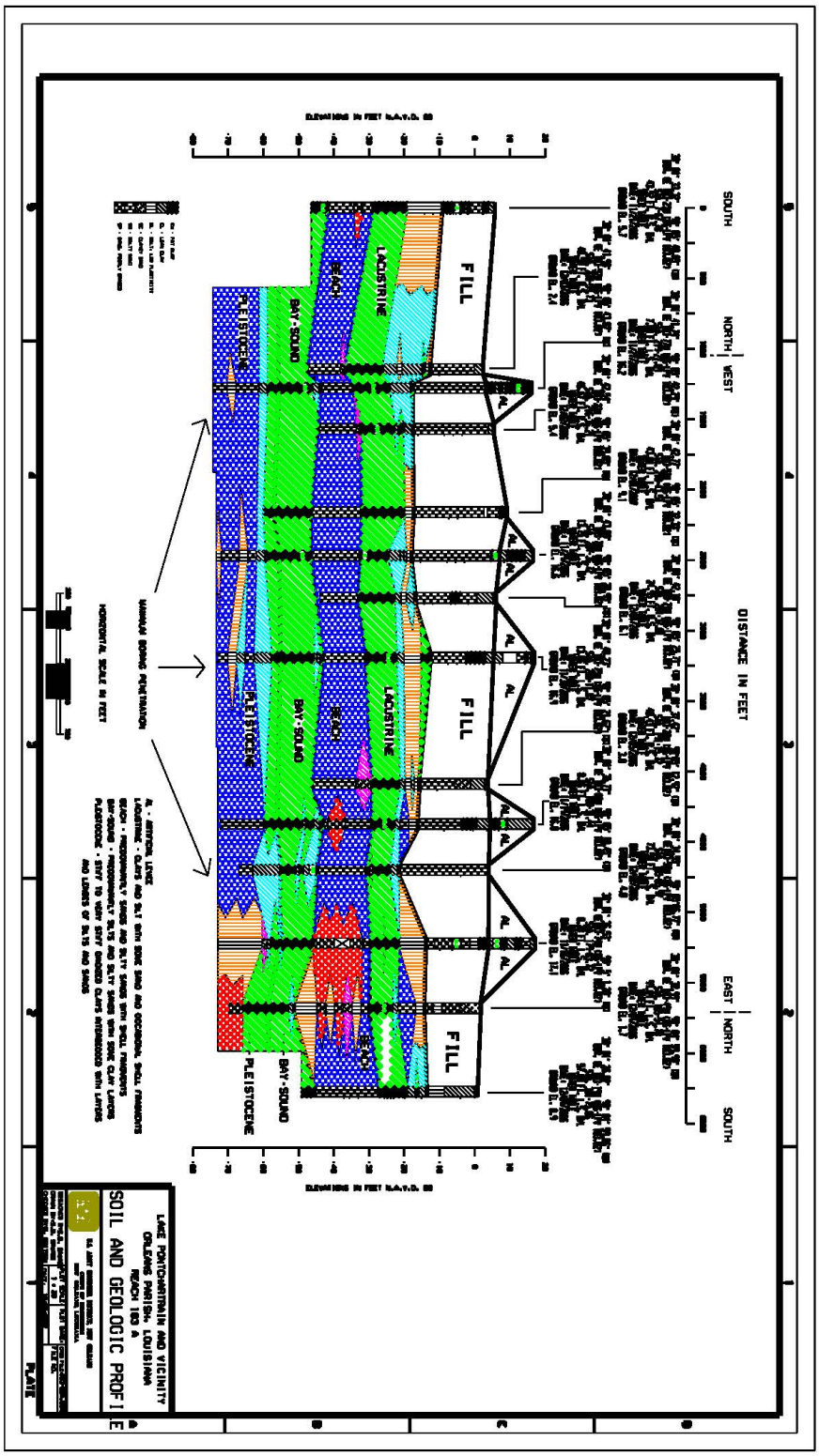

DISTANCE IN FEET
EAST
FILL
AL
ELMWOOD CANAL
MARSH
INTER-DISTRI-BUTARY
BAY-SOUND
PLEISTOCENE
SWAMP
ELEVATIONS IN FEET N.A.V.D. 88
MAXIMUM BORING PENETRATION
HORIZONTAL SCALE IN FEET
JEFFERSON LAKEFRONT
JEFFERSON PARISH, LOUISIANA
REACH 3
SOIL AND GEOLOGIC PROFILE
PLATE

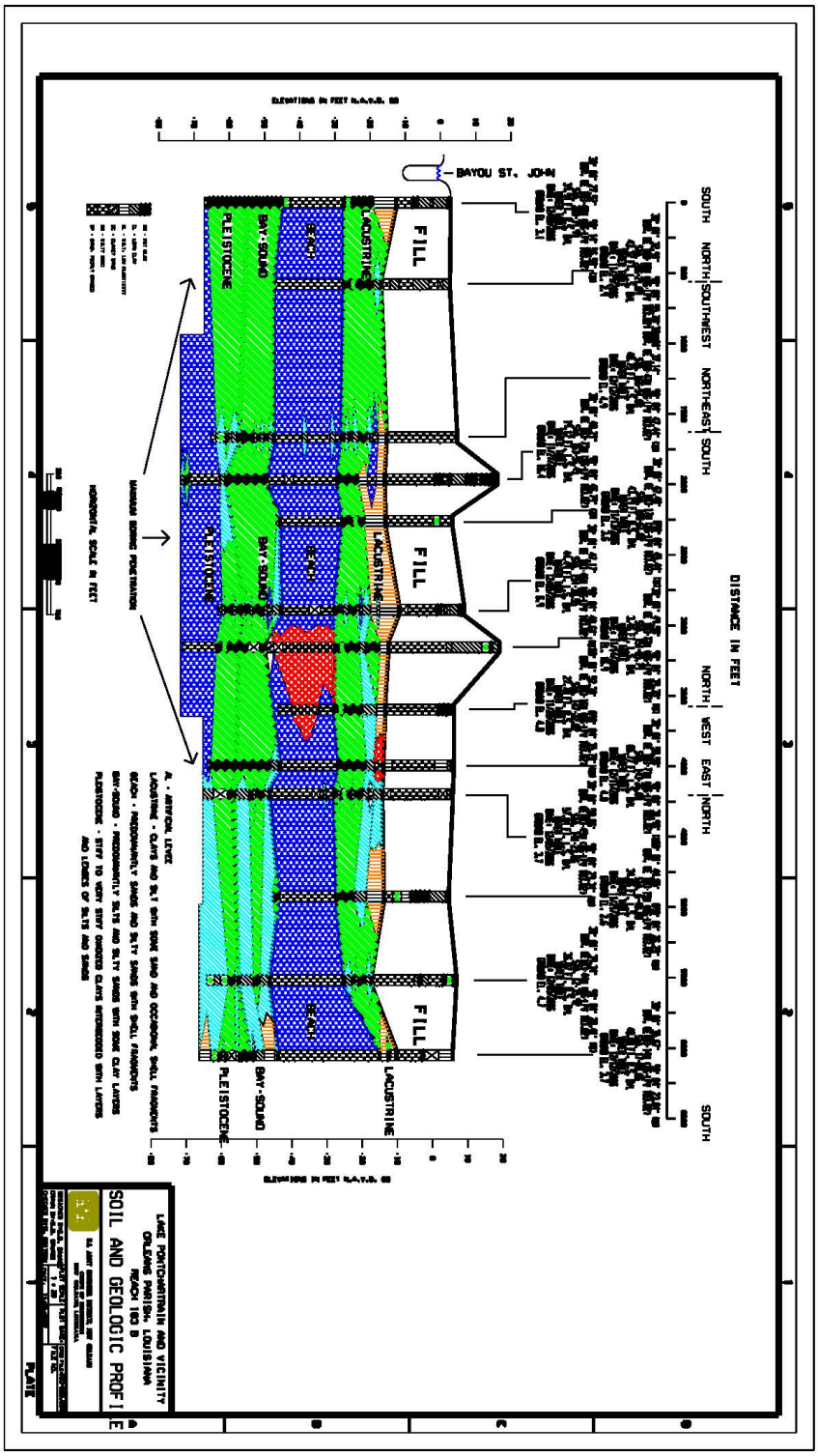

WEST
EAST
NORTH
SOUTH
SOUTHWEST
NORTHEAST
WEST
DISTANCE IN FEET
EAST
FILL
FILL
FILL
AL
AL
AL
SWAMP
SWAMP
SWAMP
INTERDISTRIBUTARY
INTER-DISTRI-BUTARY
INTER-DISTRI-BUTARY
BAY-SOUND
BAY-SOUND
BAY-SOUND
PLEISTOCENE
PLEISTOCENE
ELEVATIONS IN FEET N.A.V.D. 88
JEFFERSON LAKEFRONT
JEFFERSON PARISH, LOUISIANA
REACH 4
SOIL AND GEOLOGIC PROFILE
PLATE

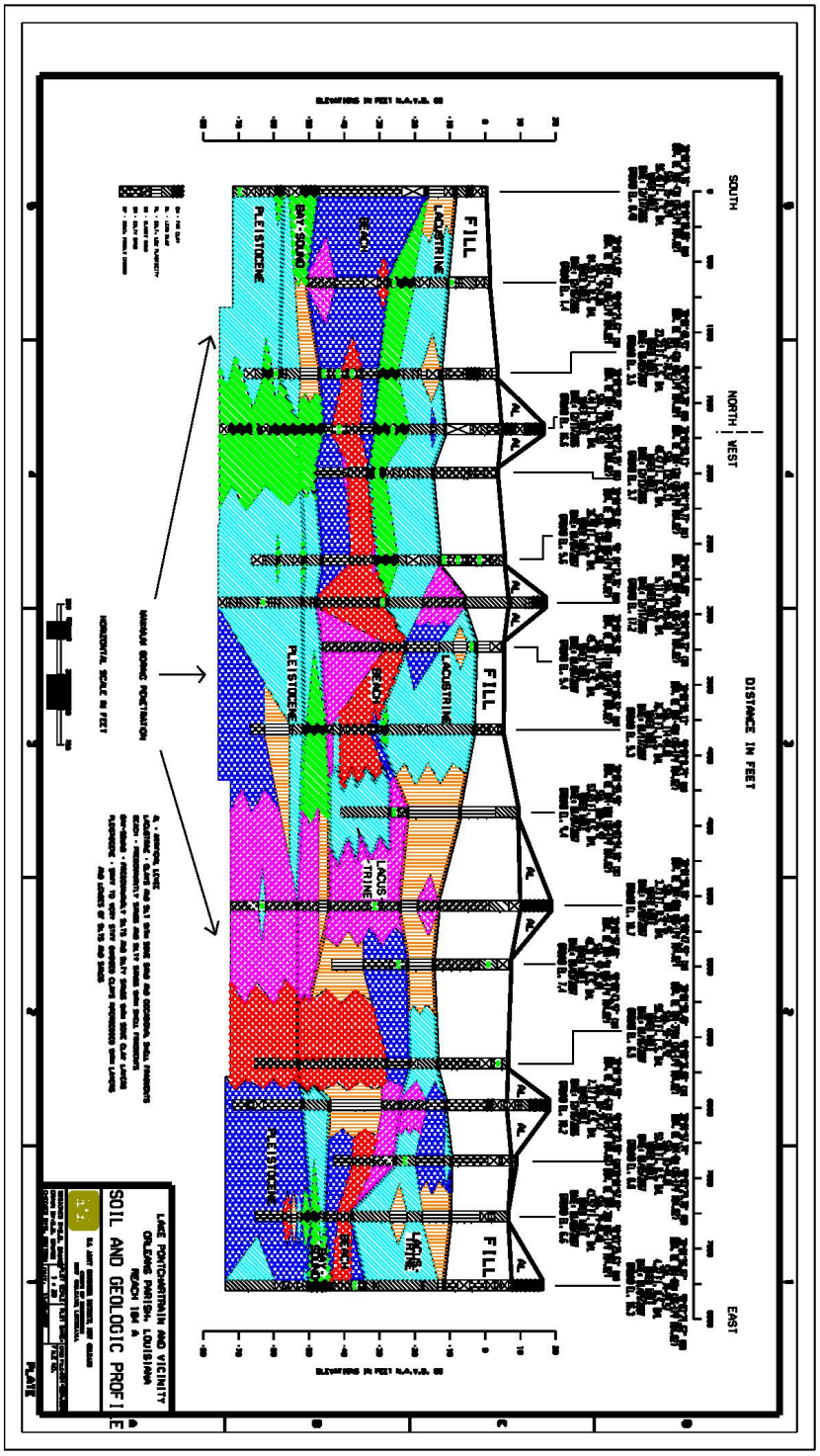

CAUSEWAY BLVD.
WEST
EAST
ELEVATIONS IN FEET N.A.V.D. 88
SWAMP - MARSH
FILL
AL
INTERDIS. TRIBUTARY
BAY SOUND
PLEISTOCENE
LACUSTRINE
SWAMP
MAXIMUM BORING PENETRATION
AL - VERTICAL LINE
SWAMP-MARSH - PREDOMINATELY ORGANIC CLAYS,FAT CLAYS,AND PEATS WITH OCCASIONAL SAND AND SILT LAYERS
INTERDISTRIBUTARY - INTERBEDDED LAYERS OF FAT AND LEAN CLAYS,SILTS, SILTY SANDS AND SANDS
LACUSTRINE - CLAYS AND SILT WITH SOME SAND AND OCCASIONAL SHELL FRAGMENTS
BAY SOUND - PREDOMINATELY CLAY WITH SOME SILTS AND SILTY SANDS
PLEISTOCENE - GRAY TO VERY STIFF BANDED CLAYS INTERBEDDED WITH LAYERS AND LENSES OF SILTS AND SANDS
HORIZONTAL SCALE IN FEET
JEFFERSON LAKE FRONT
JEFFERSON PARISH, LOUISIANA
REACH 9
SOIL AND GEOLOGIC PROFILE
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
NEW ORLEANS, LOUISIANA
PLATE

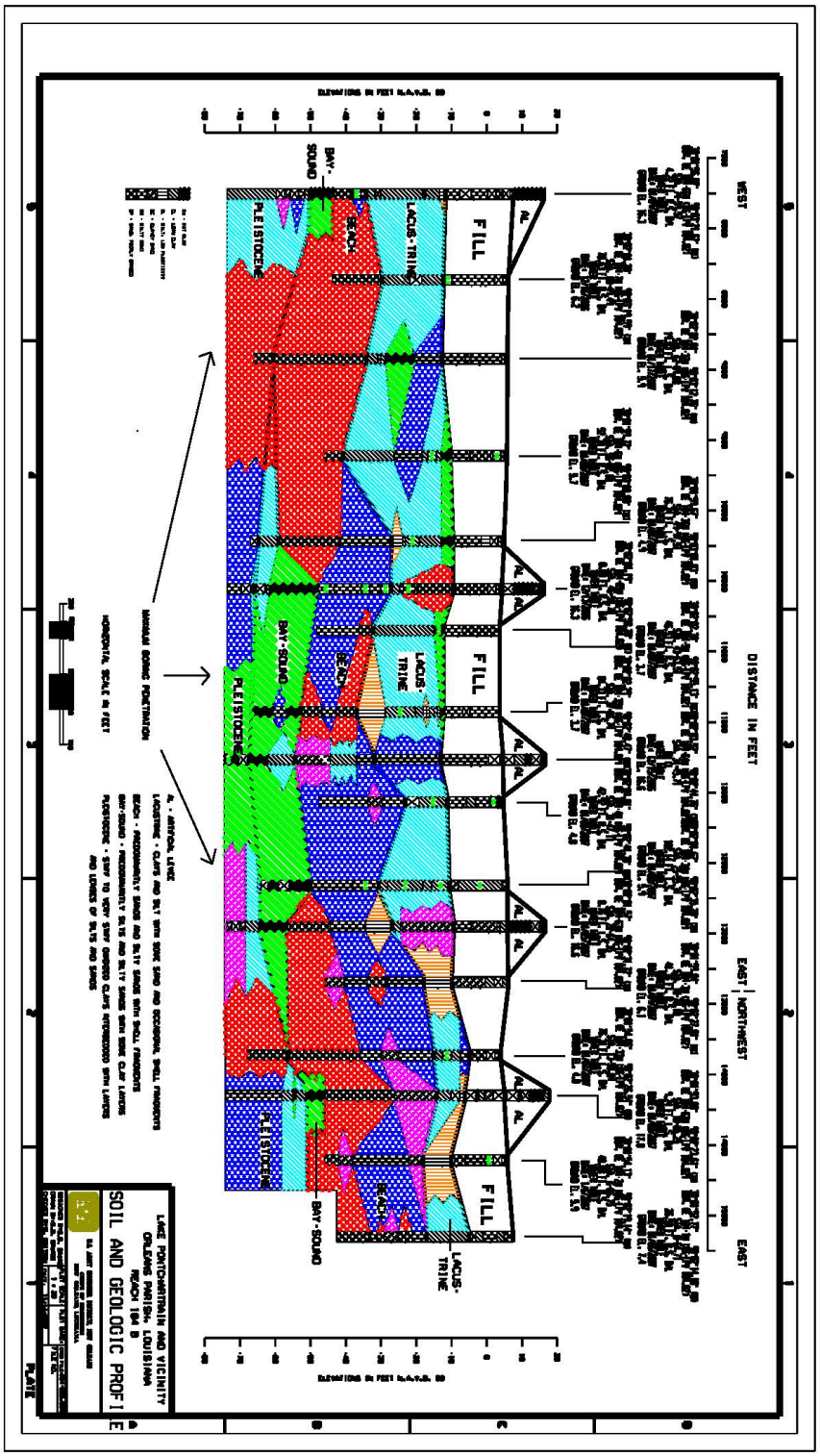

DISTANCE IN FEET
WEST
EAST
SOUTH
NORTH
FILL
SWAMP-MARSH
LACUSTRINE
BEACH
BAY-SOUND
PLEISTOCENE
AL - ARTIFICIAL LEVEE
SWAMP-MARSH - PREDOMINANTLY ORGANIC CLAYS/FAT CLAYS AND PEATS WITH OCCASIONAL SAND AND SILT LAYERS
LACUSTRINE - CLAYS AND SILT WITH SOME SAND AND OCCASIONAL SHELL FRAGMENTS
BEACH - PREDOMINANTLY SANDS AND SILTY SANDS WITH SHELL FRAGMENTS
BAY-SOUND - PREDOMINANTLY SILTS AND SILTY SANDS WITH SOME CLAY LAYERS
PLEISTOCENE - STIFF TO VERY STIFF CRACKED CLAYS INTERBEDDED WITH LAYERS AND LENSES OF SILTS AND SANDS
LAKE PONTCHARTRAIN AND VICINITY
ORLEANS PARISH, LOUISIANA
REACH 101
SOIL AND GEOLOGIC PROFILE
PLATE


DISTANCE IN FEET
SOUTH NORTH SOUTHWEST
NORTHEAST WEST
EAST NORTH SOUTH
ELEVATIONS IN FEET N.A.V.D. 88
FILL
AL
LACUSTRINE
BEACH
BAY-SOUND
PLEISTOCENE
MAXIMUM BORING PENETRATION
HORIZONTAL SCALE IN FEET
AL - ARTIFICIAL LEVEE
LACUSTRINE - CLAYS AND SILT WITH SOME SAND AND OCCASIONAL SHELL FRAGMENTS
BEACH - PREDOMINANTLY SANDS AND SILTY SANDS WITH SHELL FRAGMENTS
BAY-SOUND - PREDOMINANTLY SILTS AND SILTY SANDS WITH SOME CLAY LAYERS
PLEISTOCENE - STIFF TO VERY STIFF OVERCOMPACTED CLAYS INTERBEDDED WITH LAYERS AND LENSES OF SILTS AND SANDS
LAKE PONTCHARTRAIN AND VICINITY
ORLEANS PARISH, LOUISIANA
REACH 1B2
SOIL AND GEOLOGIC PROFILE
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
PLATE


SOUTH
NORTH
WEST
DISTANCE IN FEET
EAST
NORTH
SOUTH
FILL
FILL
FILL
LACUSTRINE
LACUSTRINE
BAY-SOUND
BAY-SOUND
BAY-SOUND
PLEISTOCENE
PLEISTOCENE
PLEISTOCENE
MINIMUM BORING PENETRATION
HORIZONTAL SCALE IN FEET
LAKE PONTCHARTRAIN AND VICINITY
ORLEANS PARISH, LOUISIANA
REACH 1&3 A
SOIL AND GEOLOGIC PROFILE
PLATE


DISTANCE IN FEET
SOUTH
NORTH
SOUTH-WEST
NORTH-EAST
SOUTH
NORTH
WEST
EAST
NORTH
SOUTH
BAYOU ST. JOHN
FILL
FILL
FILL
LACUSTRINE
LACUSTRINE
LACUSTRINE
BEACH
BEACH
BEACH
BAY-SOUND
BAY-SOUND
BAY-SOUND
PLEISTOCENE
PLEISTOCENE
PLEISTOCENE
HORIZONTAL SCALE IN FEET
LAKE PONTCHARTRAIN AND VICINITY
ORLEANS PARISH, LOUISIANA
REACH 1&3 B
SOIL AND GEOLOGIC PROFILE
PLATE


SOUTH
NORTH
WEST
DISTANCE IN FEET
EAST
FILL
LACUSTRINE
BEACH
BAY-SOUND
PLEISTOCENE
MINIMUM BORING PENETRATION
HORIZONTAL SCALE IN FEET
LAKE PONTCHARTRAIN AND VICINITY
ORLEANS PARISH, LOUISIANA
REACH 1BM A
SOIL AND GEOLOGIC PROFILE
PLATE

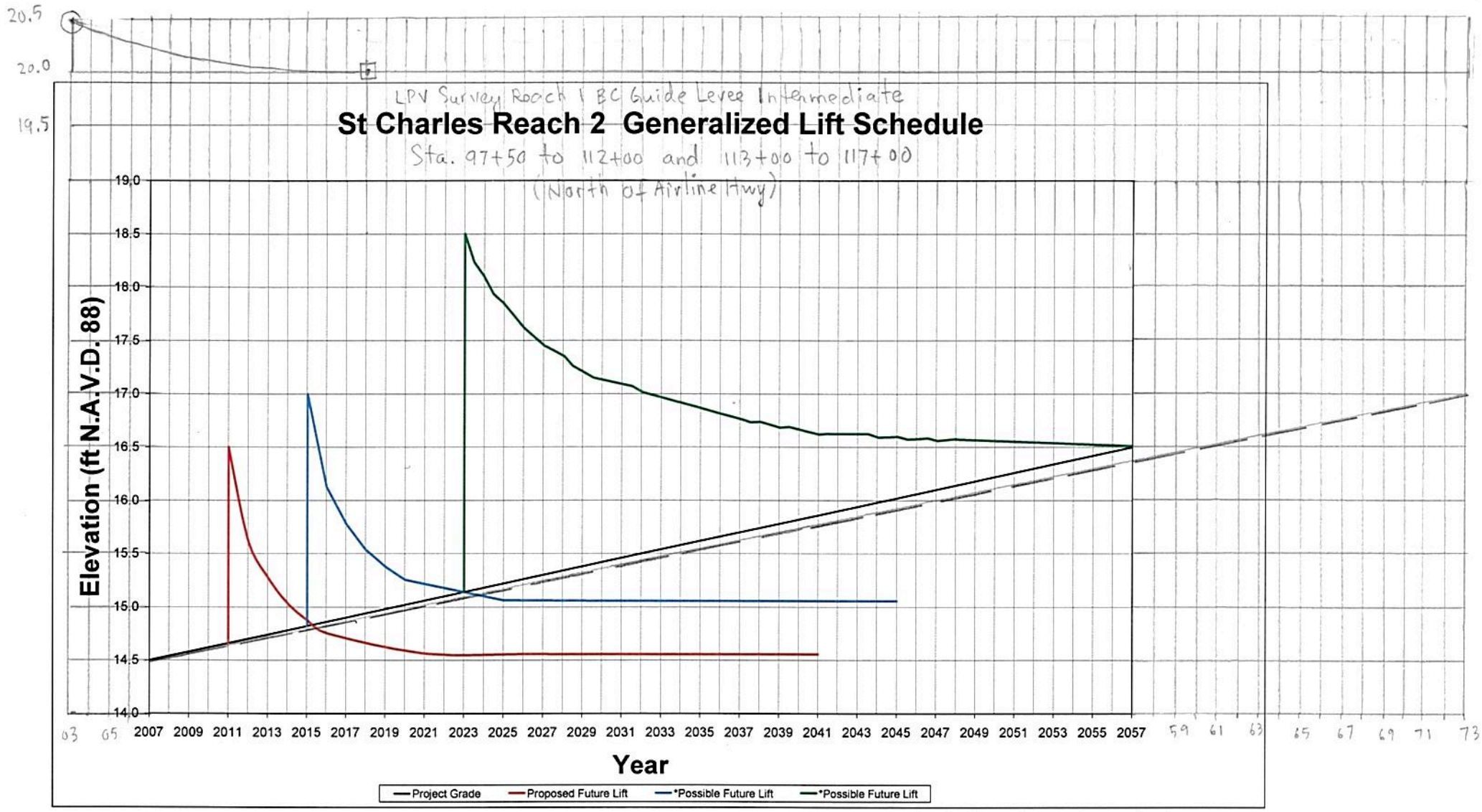

DISTANCE IN FEET
WEST
EAST NORTHWEST
EAST
FILL
FILL
FILL
AL
LACUS-TRINE
BEACH
BAY-SOUND
PLEISTOCENE
MAXIMUM BORING PENETRATION
HORIZONTAL SCALE IN FEET
AL - ARTIFICIAL LEVEE
LACUSTRINE - CLAYS AND SILT WITH SOME SAND AND OCCASIONAL SHELL FRAGMENTS
BEACH - PREDOMINANTLY SAND AND SILTY SAND WITH SHELL FRAGMENTS
BAY-SOUND - PREDOMINANTLY SILTS AND SILTY SANDS WITH SOME CLAY LAYERS
PLEISTOCENE - STIFF TO VERY STIFF OVERCONSOLIDATED CLAYS INTERBEDDED WITH LAYERS AND LENSES OF SILTS AND SANDS
LAKE PONTCHARTRAIN AND VICINITY
ORLEANS PARISH, LOUISIANA
REACH IBA B
SOIL AND GEOLOGIC PROFILE
PLATE

5 CONCLUSION

LPV levee segments can require a number of lifts to maintain the 1% of 2073 intermediate and high project grades.

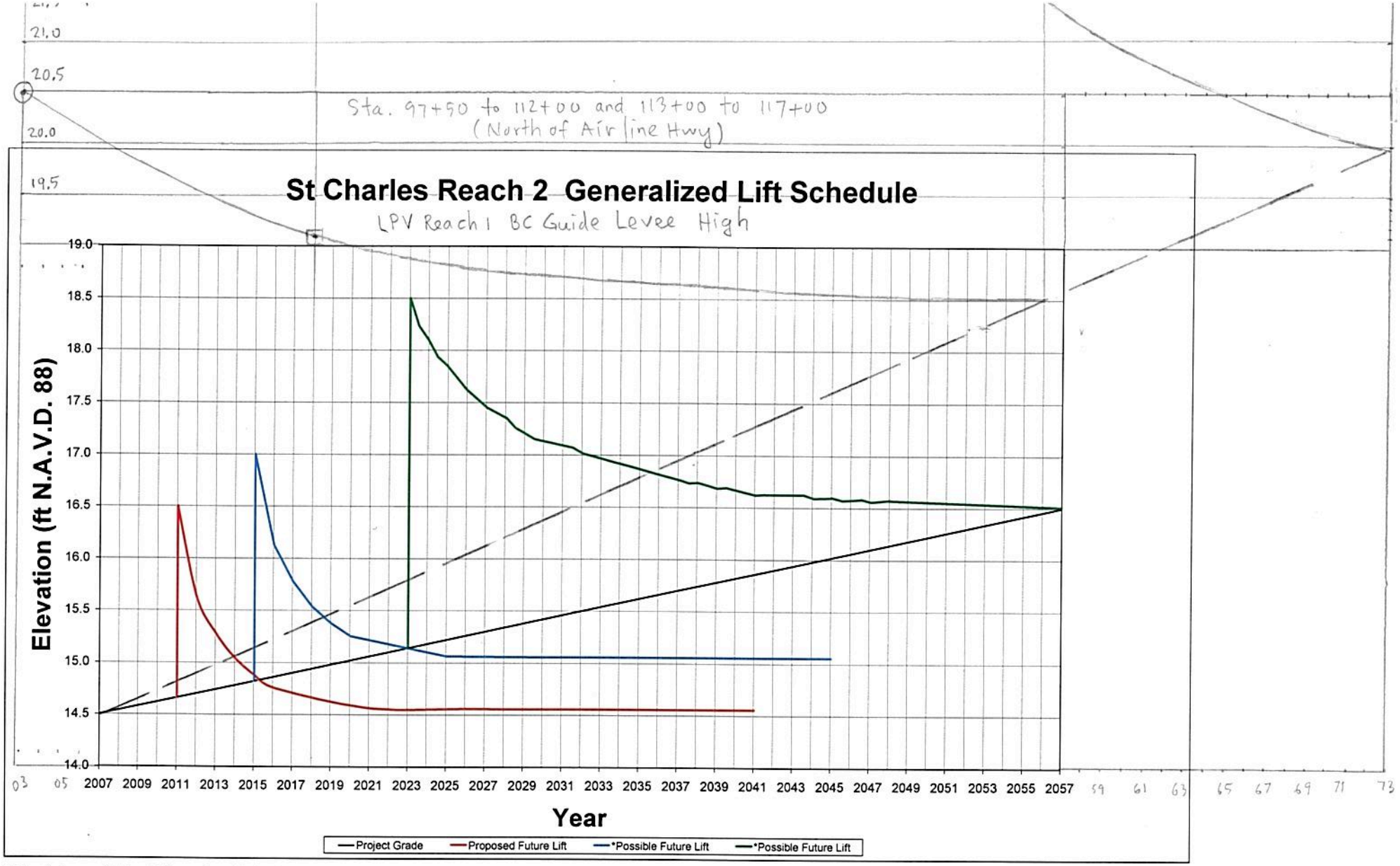
LPV-WBV GRR Levee Lifts, Summary Table
LPV

Survey Reach	Levee Segment	Control Levee Segment (Highest Amount and Rate of Setlement)	Year Levee Was Lifted	Elevation Levee Was Lifted	Year Levee Was Armored	Note
Reach 1	Bonnet Carre lower guide		2003	20.5		No armoring assumed
Reach 2	St Charles Parish (LPV-03d.2,04.2a, 04.2b, 05.2a, 05.2b)	04.2a (Cross Bayou to I-310)	2017	17	2017	
Reach 3	Jefferson Lakefront (LPV-00.2, 01.1, 02.2, 19.2, 20.1)	00.2 Reach 1 Lakefront Levee	2017	17	2018	
Reach 4	Orleans Parish Lakefront (LPV-102, 103, 104))	103 (Orleans to London Ave canal)	2008	19.5	2015	
Reach 5	Orleans East (LPV-106, 108, 109.02a, 111.01)	109	2011	18.5	2018	
Reach 6	Chalmette (LPV-141, 142, 143)					No prior lift schedules
Reach 7	MRL Orleans Levee District					No prior lift schedules
Reach 8	MRL Lake Borgne Levee District					No prior lift schedules



*Note: Subsequent Lifts shall be evaluated in the future for final levee design

— — Project grade intermediate
——— Settlement curve
⊙ Last levee lift (2003 to 20.5 NGVD)
⊡ Avg survey (Nov'18) NAVD 88 (2009.55)
Assume no armoring



*Note: Subsequent Lifts shall be evaluated in the future for final levee design

Project Grade High

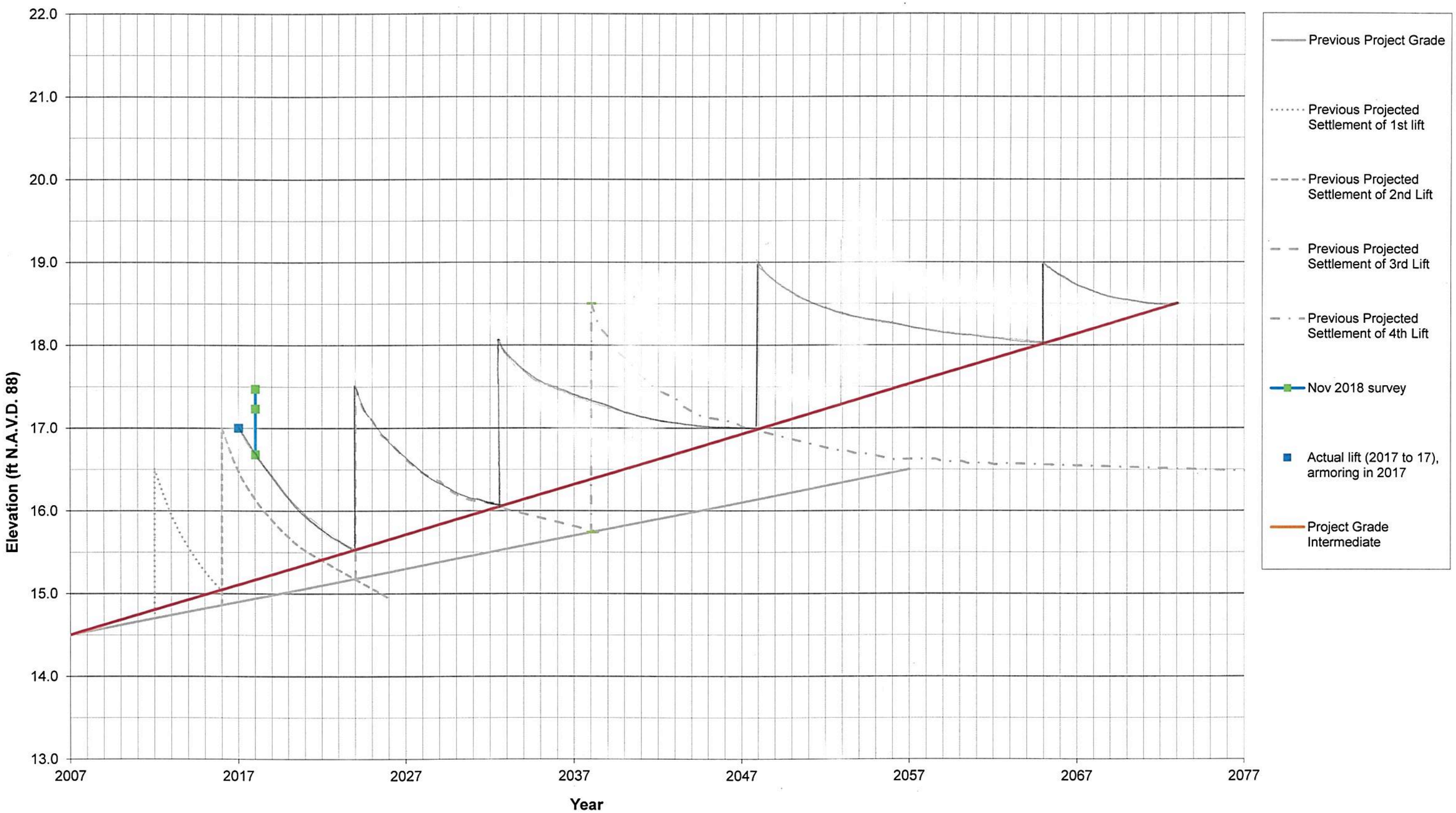
Settlement Curve

Last levee lift (2003 to 20.5 NGVD)

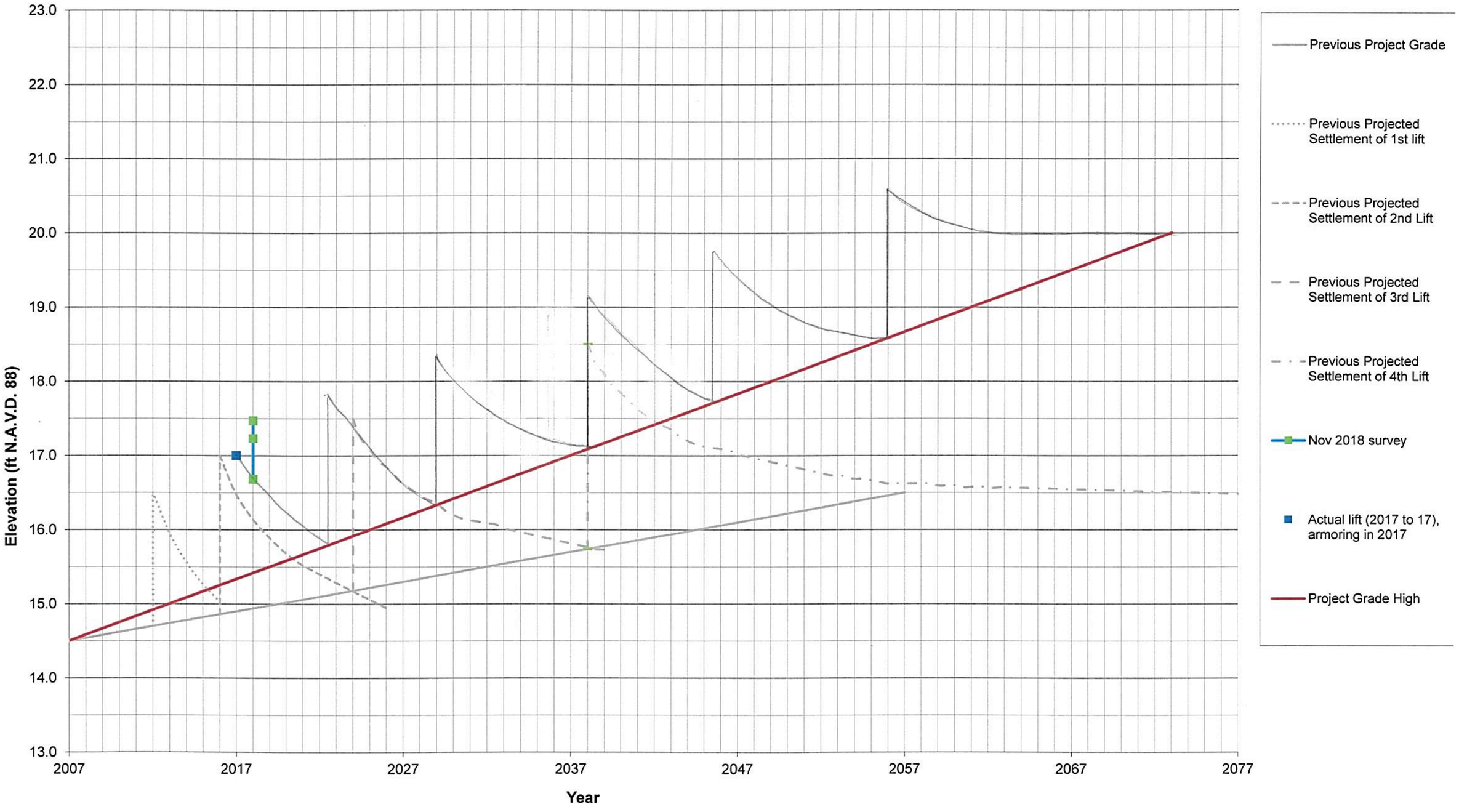
Mode Survey (Nov '18) NAVD 88 (2009.55)

Assume no armoring

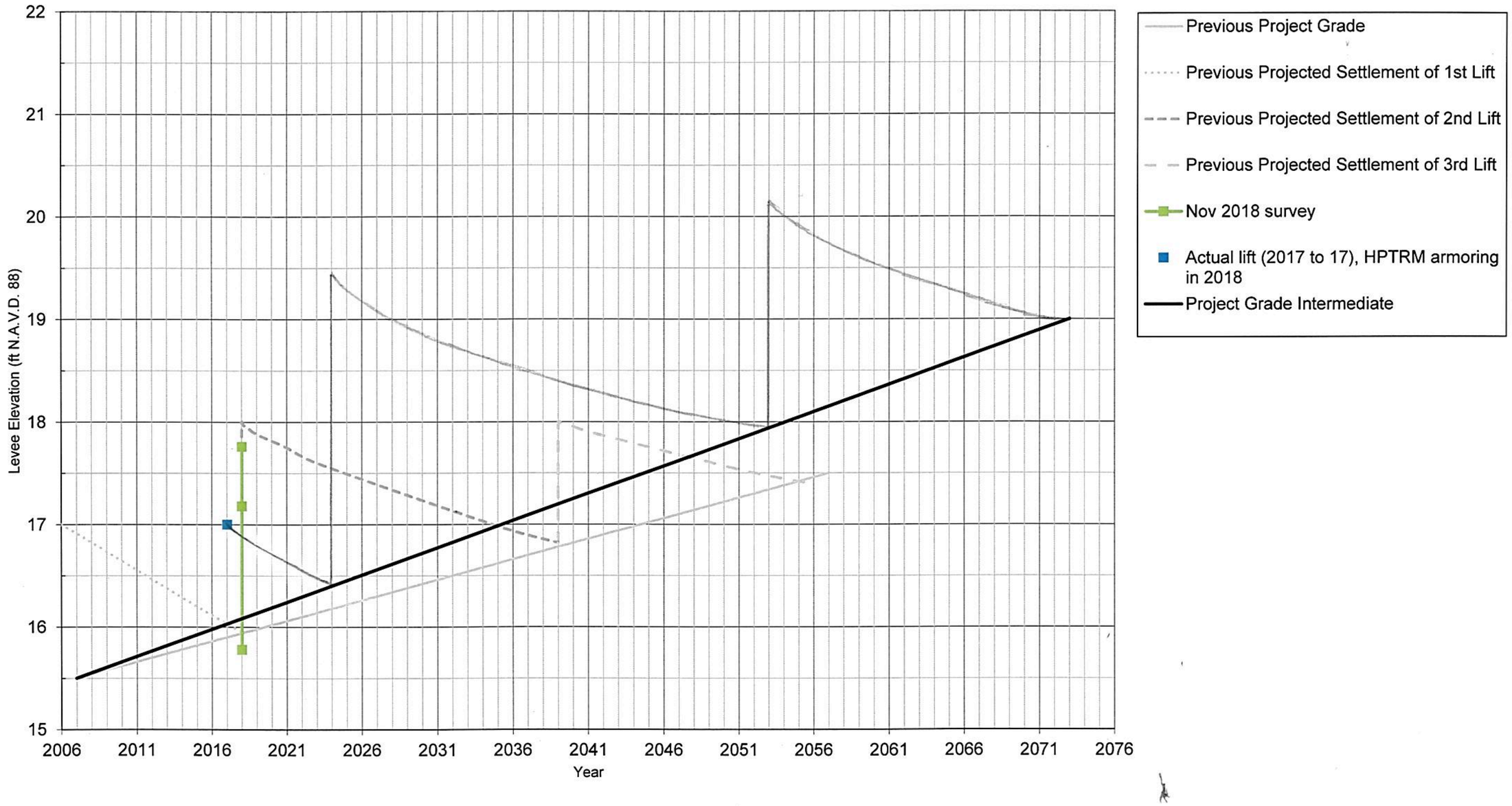
LPV Survey Reach 2
LPV 4.2A Lift Schedules Projections Intermediate Design Elevations

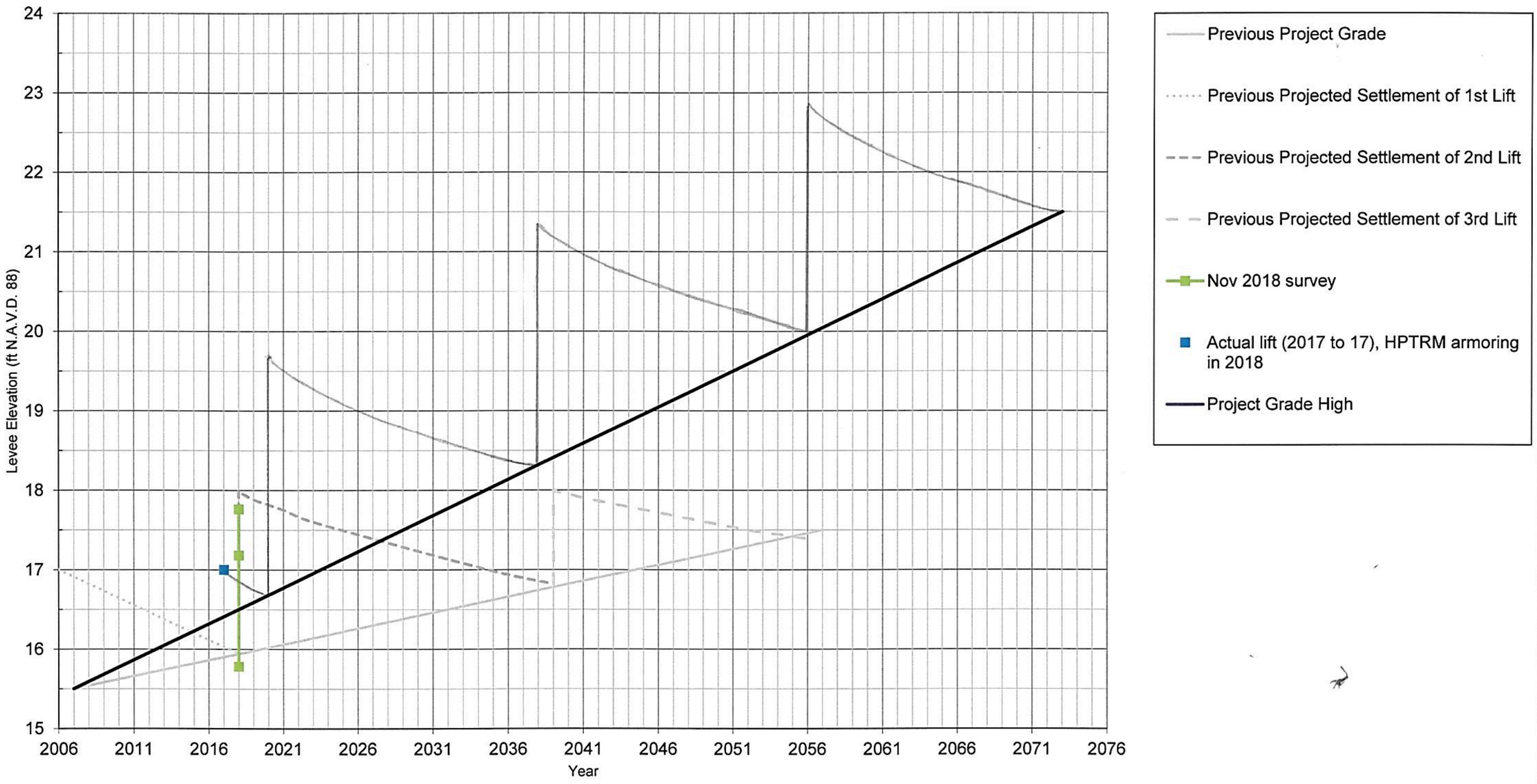


LPV Survey Reach 2
LPV 4.2A Lift Schedules Projections High Design Elevations



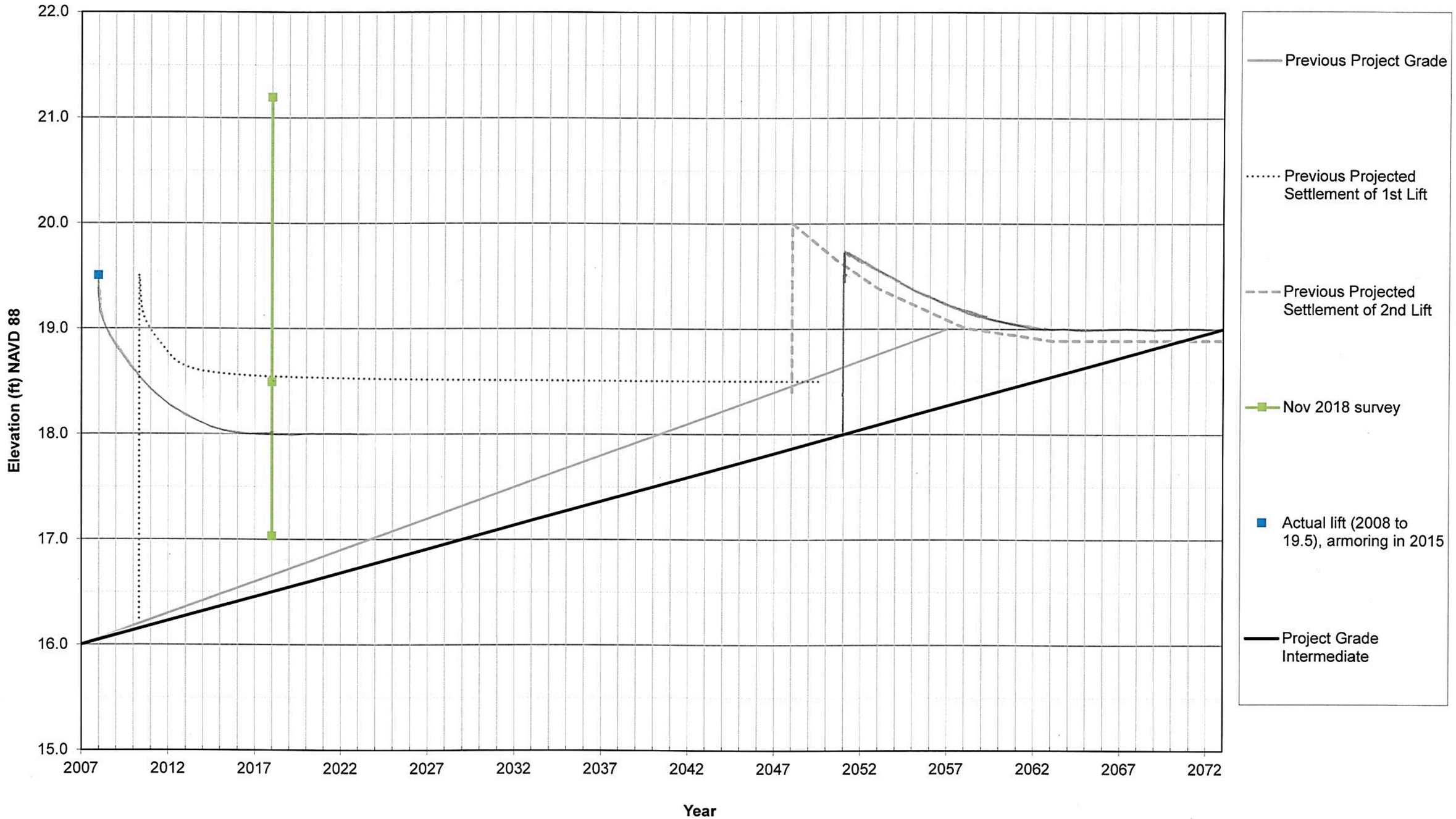
LPV Survey Reach 3
LPV 00.2 Lift Schedules Projections
Intermediate Design Elevations




LPV Survey Reach 3
LPV 00.2 Lift Schedules Projections
High Design Elevations
Levee Elevation (ft N.A.V.D. 88)
24
23
22
21
20
19
18
17
16
15
2006
2011
2016
2021
2026
2031
2036
2041
2046
2051
2056
2061
2066
2071
2076
Year
Previous Project Grade
Previous Projected Settlement of 1st Lift
Previous Projected Settlement of 2nd Lift
Previous Projected Settlement of 3rd Lift
Nov 2018 survey
Actual lift (2017 to 17), HPTRM armoring in 2018
Project Grade High

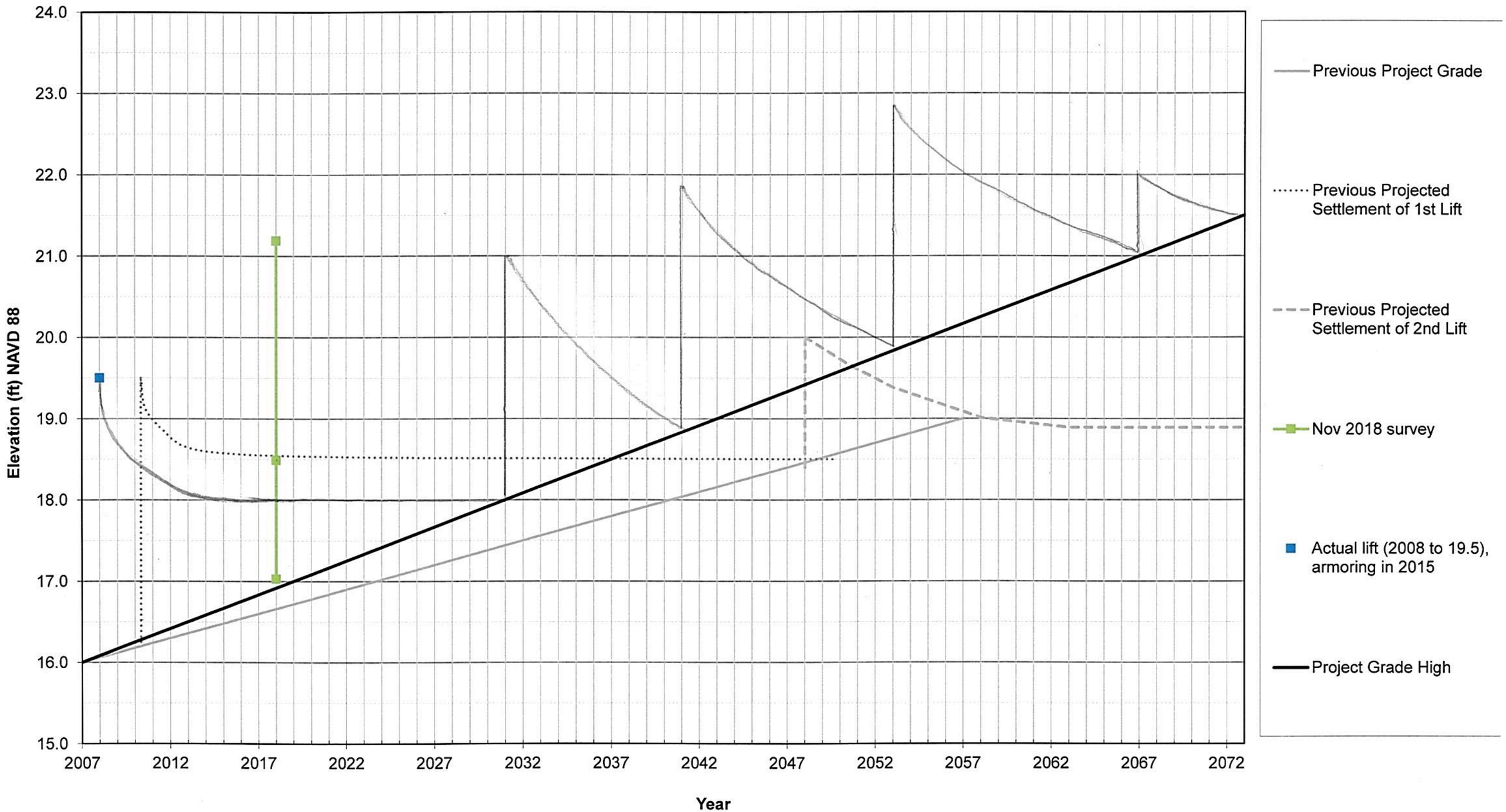
LPV Survey Reach 4

LPV-103 Lift Schedules Projections Intermediate Design Elevations



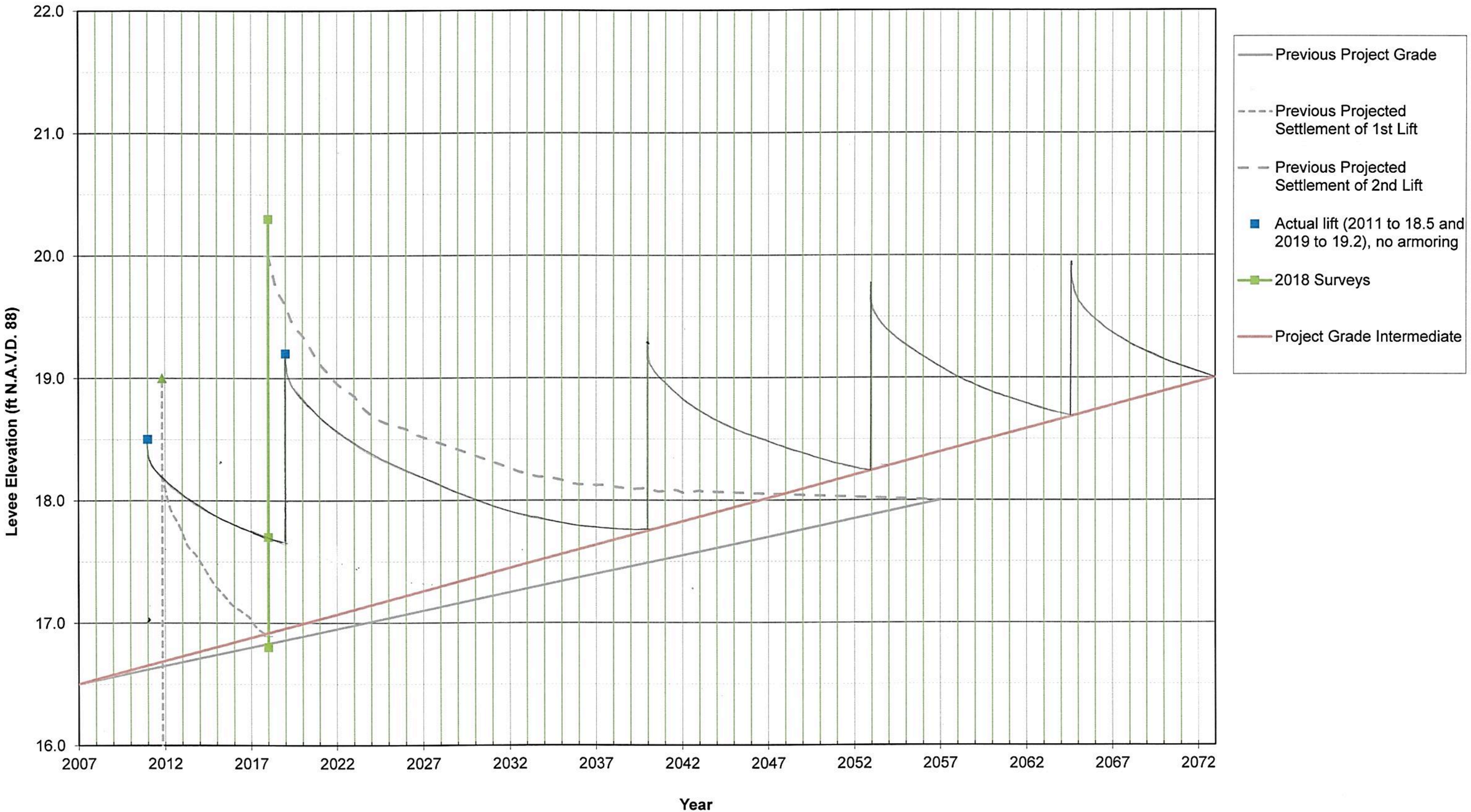
LPV Survey Reach 4

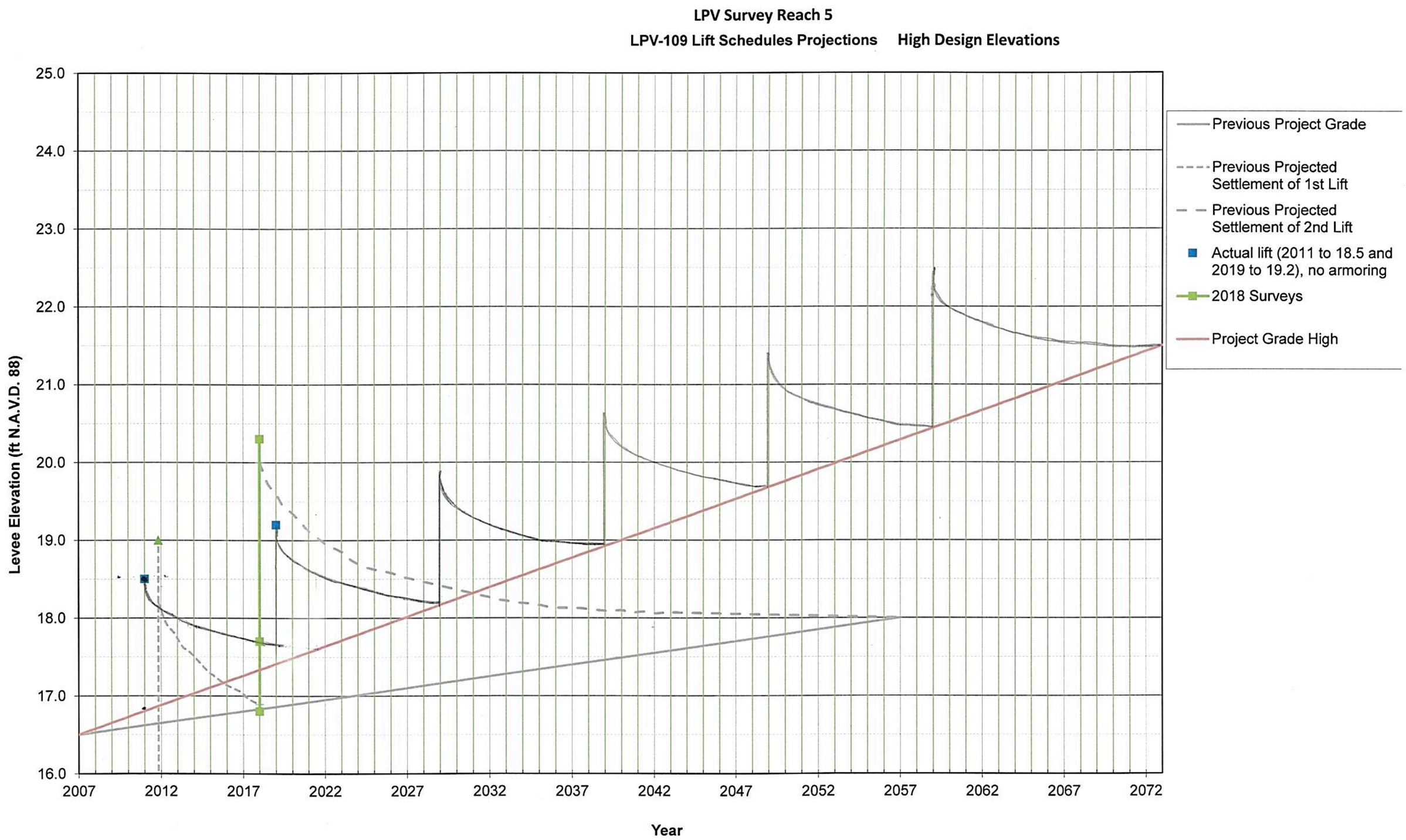
LPV-103 Lift Schedules Projections High Design Elevations



LPV Survey Reach 5

LPV-109 Lift Schedules Projections Intermediate Design Elevations




LPV Survey Reach 5
LPV-109 Lift Schedules Projections High Design Elevations
Levee Elevation (ft N.A.V.D. 88)
25.0
24.0
23.0
22.0
21.0
20.0
19.0
18.0
17.0
16.0
2007
2012
2017
2022
2027
2032
2037
2042
2047
2052
2057
2062
2067
2072
Year
Previous Project Grade
Previous Projected Settlement of 1st Lift
Previous Projected Settlement of 2nd Lift
Actual lift (2011 to 18.5 and 2019 to 19.2), no armoring
2018 Surveys
Project Grade High