UPPER DES PLAINES RIVER AND TRIBUTARIES, ILLINOIS AND WISCONSIN INTERGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

GEOTECHNICAL DESIGN - APPENDIX G

U.S. Army Corps of Engineers, Chicago District
Geotechnical & Survey Section

August 2013

GEOTECHNICAL DESIGN APPENDIX
APPENDIX G

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

PLATES

Plate 1: Lake Mary Anne Pump Station Soil Investigation

Plate 2: Bull Creek Reservoir Soil Investigation

Plate 3: Aptakisic Reservoir Soil Investigation

Plate 4: Campground Road Reservoir Map

Plate 5: DPLV09 Soil Investigation

Plate 5a: DPLV09 Profile

Plate 6: Groveland Floodwall Soil Investigation

Plate 6a: Groveland Floodwall Profile

Plate 7: Adler Park Levee Soil Investigation*

Plate 7a: Adler Park Profile*

Plate 8: DPLV04 Proposed Boring Map

Plate 9: DPLV05 Proposed Boring Map

**Removed from consideration*

ATTACHMENTS

Attachment 1: USDA Soil Survey Maps

Attachment 2: Two AECOM Des Plaines II Investigation Reports (Soil Boring Logs/Laboratory Data from reservoir and levee sites, Illinois State Water Survey Logs, Site Photographs)

Attachment 3: Previous Project Soil Boring Logs (North Libertyville Levee*, Levee 50, Section 14 Riverside)

Attachment 4: Design Analysis (Adler Park Levee*, Oakton-Everett Floodwall** and Levee, Bull Creek Reservoir, Groveland Floodwall)

**Removed from consideration*

***Portion of DPLV09*

GEOTECHNICAL DESIGN APPENDIX
APPENDIX G

INTRODUCTION

1. The study area encompasses the Upper Des Plaines River Basin and tributaries from the headwaters at the border of Racine and Kenosha Counties, Wisconsin to just north of I-55 and the confluence with Salt Creek in Cook County, Illinois. The purpose of this appendix is to evaluate subsurface soil information and provide generalized geotechnical design and related construction considerations for each project feature of the proposed flood risk management and ecosystem restoration project.

2. During the feasibility study formulation, the preliminary plan includes four levee sites, one reservoir site, one structure modification, one pump station, five dam removal sites, and thirteen restoration sites. Further details of all the sites are included in the Main Report while this appendix focuses on the levee, reservoir, pump station, and dam removal sites. This report mentions sites that were previously considered but for various reasons, have been eliminated from the proposed plan. The sites removed include one levee, two reservoirs, road raises, and a bridge modification. All sites within this Appendix are located in either Lake or Cook counties, Illinois.

Project Background

3. The Upper Des Plaines and Tributaries Feasibility Study (Des Plaines II) has been formulated to build on the benefits achieved by the Upper Des Plaines River Flood Damage Reduction Feasibility Study (Des Plaines I). Des Plaines II recommends a plan that further manages flood risk on the main stem in both Illinois and Wisconsin, manages tributary flood risk, and, in addition to flood risk management, restores and enhances degraded ecosystems within the study area.

4. The flood risk management projects are described below:

- Lake Mary Anne Pump Station (FPCI01) – Plate 1 – This site would connect Lake Mary Anne with Dude Ranch Pond by crossing underneath Golf Road between Reding Circle and Oak Lane in Des Plaines, IL. A pump station would pump water from one lake to the other to reduce flooding on the banks. The site is currently covered with landscaped lawn and trees.

- Bull Creek Reservoir (BCRS02) – Plate 2 – *This site was removed from the recommended plan.* This site is west of Lake Street/US 45 and south of Winchester Road in Mundelein, IL. It is currently an undeveloped grassy, marshy area with a few trees. The berm is anticipated to be at elevation 765 NAVD88, use a 10-foot wide crest, and hold up to around 175 acre-feet. The reservoir bottom would be at about 754 NAVD and the spoil would be stored on site. Structural elements would include separate inlet and outlet structures.

- Aptakisic Creek Reservoir (ACRS08) – Plate 3 – This site is at the northeast corner of Aptakisic Road and Buffalo Grove Road in Buffalo Grove, IL. It is currently farmland. The berm is anticipated to be at elevation 688 NAVD88, use a 10-foot wide crest, and hold up to around 400 acre-feet. The reservoir bottom would be at about 676 NAVD and the spoil would be stored on site. Structural elements would include separate inlet and outlet structures on an existing creek, as well as, a pump station.

- Campground Road Reservoir (DPRS15) – Plate 4 – *This site was removed from the recommended plan.* This site is near the east bank of the Des Plaines River in between Algonquin Road and Oakton Street in Des Plaines, Illinois. It is currently parkland covered mostly with trees. The berm is anticipated to be at elevation 635.6 NAVD88, use a 10-foot wide crest, and hold up to around 205 acre-feet. The reservoir bottom would be at about 622.7 NAVD and the spoil would be stored on site, likely to be reused in DPLV09 levee construction. Structural elements would include separate inlet and outlet structures.

- DPLV09 Levee/Floodwall – Plate 5 – This site runs in between River Road and the Des Plaines River south from Ashland Road to Fargo Avenue in Des Plaines, IL for approximately 2 miles. The alignment turns west at both ends to reach high ground. Currently, the site runs behind and in between areas with residential houses, condos, and commercial buildings. Portions of the site also extend through wooded areas. The levee height is anticipated to range from 635.7 to the north and 633.8 NAVD to the south.

- Groveland Avenue Levee (DPLV01) – Plate 6 – This site is located along the west side of Groveland Avenue in Riverside, IL. It extends between Park Place and the BNSF railroad behind residential lots next to the Des Plaines River. The proposed crest elevation of the sheet pile wall is anticipated to be about 618 NAVD. This project also includes raising Park Place road on the north end of the floodwall to the same elevation.

- Adler Park Levee (DPLV15) – Plate 7 – *This site was removed from the recommended plan.* It would have been south of Buckley Road, just west of Idlewood Lane, Birchwood Lane, and Sprucewood Lane in Libertyville, IL. It is generally wooded with limited grass areas. The proposed crest elevation of the clay levee was anticipated to be about 660 NAVD.

- DPLV04 Floodwall/Levee – Plate 8 – This site is located along the east side of Des Plaines River Road in River Grove, IL. It extends south from a railroad bridge over the Des Plaines River near Franklin St to North 5th Ave. At North 5th Ave, the proposed floodwall/levee would run to Palmer Street where it would turn west to high ground. This floodwall/levee would include two road closures and one road raise, with a crest height around 628 to 629 NAVD88.

- DPLV05 Floodwall/Levee – Plate 9 – This site is located along the east side of Des Plaines River Road in Schiller Park and Franklin Park, IL. It ties into high ground just north of Irving Park Road and extends south to tie into high ground at King Ave. This floodwall/levee would include three road closures, with a crest height at about 630 NAVD88.

- First Avenue Bridge (DPBM04) – First Avenue Bridge in River Grove, IL would be raised over the Des Plaines River for about 2,000 feet, raising River Road for about 600 feet, as well.

- BNSF Railroad Bridge (DPBM01) – *This site was removed from the recommended plan.* The BNSF Railroad Bridge is in Riverside, IL and the plan would have added a total of 264 feet of extensions to the piers and excavate the banks to improve flow of the Des Plaines River. This bridge is located near the southern end of the proposed Groveland Avenue Levee.

5. The following dams on the Des Plaines River are being proposed for removal. Removal of these low-head, run of the river dams will provide ecosystem restoration benefits, restoring riverine function and fish passage.

- Dam #1 – This dam is located east of Hintz Road and Milwaukee Avenue in Wheeling, IL at river mile 73.1.
- Dam #2 – This dam is located northeast of Kensington Road and River Road in Wheeling, IL at river mile 69.3.
- Dempster Avenue Dam – This dam is located south of the Miner Street and UP-NW Railroad bridges and east of River Road in Des Plaines, IL at river mile 64.75.
- Touhy Avenue Dam – This dam is located east of I-294 and about 0.3 miles north of Touhy Avenue Bridge in Park Ridge, IL at river mile 62.3.
- Dam #4 (Devon Ave Dam) – This dam is located east of River Road and about 0.2 miles south of Devon Avenue in Rosemont, IL at river mile 60.5.

REGIONAL GEOLOGY

Physiography

6. The Des Plaines River is located primarily within the Wheaton Morainal Country and secondly within the Chicago Lake and Kankakee Plains of the Central Lowland Province (Figure 1). This area is characterized by a series of broad parallel moronic ridges complicated by a variety of elongated hills, mounds, basins, sags, valleys, natural lakes, and swamps. Post-glacial erosion has been slight and restricted largely to youthful valleys along the Fox, Des Plaines, and Illinois Rivers.

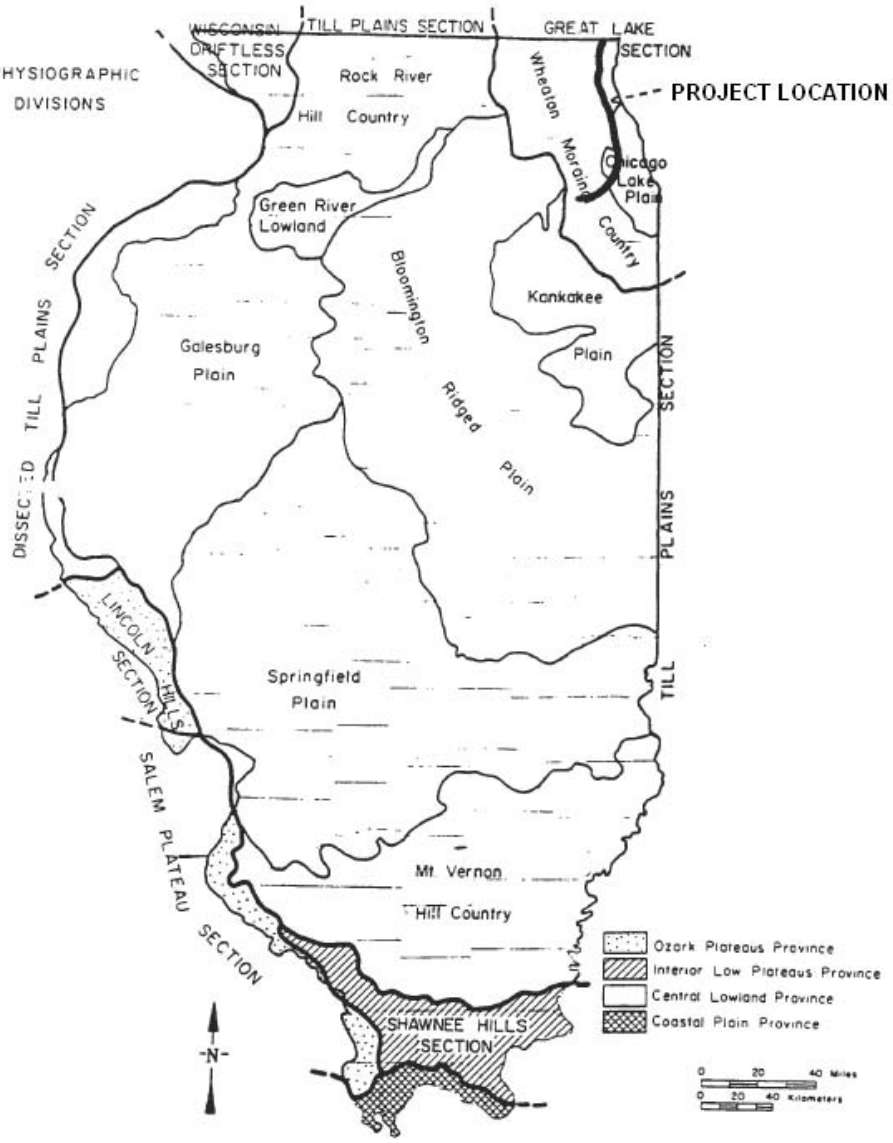

Figure 1. Physiographic Divisions of Illinois (Willman et al., 1975)

7. The Des Plaines River originates in Racine and Kenosha Counties in southeastern Wisconsin. The river enters Illinois in Lake County, flowing southward through Cook County to Riverside, Illinois, where it turns sharply east and then curves to the southwest. At Riverside, the river is joined by a major tributary, Salt Creek. This is where the Des Plaines II study area terminates. The river continues to flow southwest, through Will County where it joins with DuPage and Kankakee Rivers at the headwaters of the Illinois River in Grundy County.

8. Of 83 tributaries joining the Des Plaines River in the study area, 68 are less than a few miles in length and their flow is intermittent. Three larger tributaries joining the Des Plaines River in Wisconsin are Root River, Kilbourn Road Ditch, and Boughton Creek. Major tributaries of the Des Plaines River in Illinois portion of the study area are (listed from north to south) Mill Creek, Bull Creek, Indian Creek, Aptakisic Creek, Buffalo-Wheeling Creek, McDonald Creek, Feehanville Ditch, Weller Creek, Farmer's-Prairie Creek, Willow-Higgins Creek, Crystal Creek, and Silver Creek. Salt Creek, Addison Creek, Flag Creek, and Sawmill Creek flow into the river below the Des Plaines II study area. All of these larger tributaries, except Farmer's-Prairie Creek, enter the river from the west.

Bedrock Geology

9. The surface bedrock of the region consists predominantly of rock of the Silurian System (Figure 2). There is a geologic contact between the Silurian, Ordovician, and Pennsylvanian Systems at the headwaters of the Illinois River. The Upper Des Plaines River is located within a region where the seismic probability is minor. The closest geologic structure to the project area is the Des Plaines Disturbance faults located near the boundary of the northeast corner of DuPage and Cook Counties. This disturbance encircles the Paleozoic Undifferentiated area shown on Figure 2. The Sandwich fault is several miles southwest of the project area. Bedrock in the region is principally dolomite of the Niagran and Alexandrian Series since the Silurian System includes the Niagran Series underlain by the Alexandrain Series.

Figure 2. General Bedrock Geology of Project Area

Surficial Geology

10. The entire Chicago region was buried under several hundred feet of glacial ice that spread over the region from the northeast during the Illinoisan and particularly the Woodfordian Substage of the Wisconsian glacial stages of the Pleistocene Epoch. The glaciers were largely part of the Lake Michigan Lobe. The glaciers retreated from the Chicago region about 13,500 years ago leaving a series of moraine deposits and several large lakes in the order of 200 to 250 feet wide. The deposits range in thickness from several feet to about 400 feet, as shown in Figure 3.

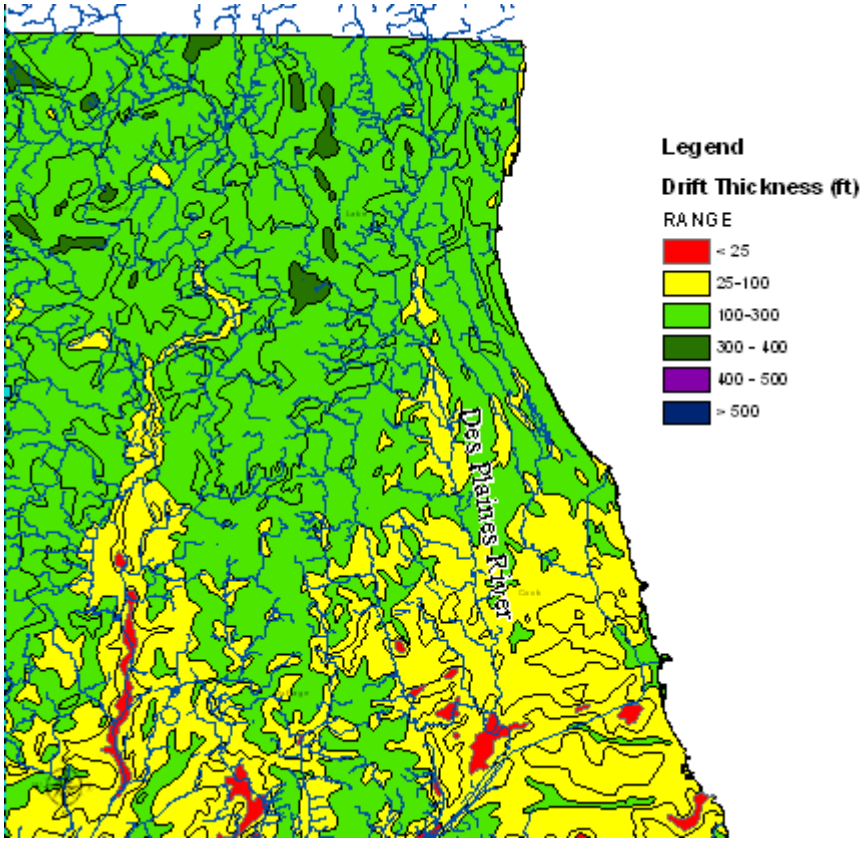

Figure 3. General Thickness of Overburden in Project Area

11. Due to glacial scouring and alluvial deposition, the Chicago area is a lake plain, surrounded by moraines paralleling former shorelines of glacial Lake Chicago. The Des Plaines River is a primary drainage feature in northeastern Illinois. The river valley where the river has historically meandered and changed course can be as wide as one mile in some places. Over the last 200 years, the river has become increasingly channelized due to urbanization, reducing the Des Plaines River's opportunity for meandering.

12. Glacial till, glaciolacuatrine and glaciofluvial deposits are the major materials deposited on top of the Silurian dolomite bedrock in Lake and Cook Counties. The major topographic features in these counties reflecting the influence of glacial deposition (moraines); till plains and sand and gravel outwash plains; a few knob-like hills of sand and gravel (kames); and the Sag, Fox, and Des Plaines River valleys which were drainage-ways for glacial melt-waters. Sand and gravel accumulated as valley trains along these rivers.

13. Till is the most abundant glacial overburden material in Lake and Cook counties. This material consists of unsorted debris deposited by glacial ice and is composed of pebbles, cobbles, and boulders embedded in a matrix of clay, silt and sand. Because of extensive urbanization, there are many areas of Cook County where geologic materials have been affected by human activities. It is recognized that a few feet of miscellaneous fills and/or regraded topsoil and other surficial material underline most of the metropolitan Chicago area.

14. Soils along the Des Plaines River include well sorted sands and gravels in the valleys and glacial outwash in the terraces. Predominant soil types along the Des Plaines River include Zurich, Grays, Wauconda, and Fox silt loams, and Sawmill silty clay loam (Soil Conservation Service, 1970).

15. Within the Des Plaines River Valley, the surficial soils are primarily fluvial deposits consisting of varying amounts of clay, silt, sand, and sometimes gravel. These deposits generally range from 20 to 35 feet thick, but in some areas do extend down to bedrock. The alluvium is underlain by clean medium textured sands and gravels varying in thickness from 25 to 30 feet.

LOCAL GEOLOGY

Bedrock Geology

16. The surface bedrock within the study areas consist predominantly of rock or the Silurian System which is principally dolomite of the Niagran and Alexandrian Series. Based on soil borings and well logs, the depth to bedrock ranges from about 15 to 270 feet with the limestone being the principal rock type; however, there are layered deposits of limestone and shale with the presence of sandstone increasing with depth.

Surficial Geology

17. Surficial geology present within the study area consists of the eastern flank of the Valparaiso (undifferentiated) moraine, the valley between the Tinley and Park Ridge ground moraines and Lake Chicago plain deposits in the northern, middle, and lower reaches, respectively. The surficial deposits at project feature locations consist of alluvium (Sawmill), herbaceous organic material (Houghton Muck), earth fill (Orthents, Urban), and underlying loess and glacial outwash (Pella, Mundelein, Barrington, Kane). All the deposits are of the Pleistocene Series of the Quaternary System of the Wisconsian Stage, and Woodfordian Substage. A soil map of each site can be seen in Attachment 1.

18. Based on the USDA Soil Survey data summarized in Table 1, surface soils at the project areas for levees, reservoirs, and pump station consists of silt loam, silty clay loam, and Houghton Muck (Soil Conservation Service, Version 6, 2011). A portion of the DPLV09 Levee did not have data available, as it was described as ‘Urban Land.’ Road raise and dam removal sites are not shown, as the existing conditions along roads has already been altered and dams are in water.

Table 1. Surface Soils at Reservoir, Levee, and Pump Station Sites

Site (USGS maps located in Attachment 1)	**Silty Clay Loam**	**Silt Loam**	**Houghton Muck**	**'Urban Land'**
Adler Park Levee (DPLV15)*	54%	46%		
Aptakisic Reservoir (ACRS08)	40%	60%		
Bull Creek Reservoir (BCRS02)*	25%	22%	53%	
Lake Mary Anne PS (FPCI01)	50%	50%		
DPLV09 Floodwall/Levee	65%	15%		20%
Campground Road Reservoir (DPRS15)*	13%	87%		
Groveland Levee (DPLV01)	100%			
DPLV04 Floodwall/Levee	8%	25%		67%
DPLV05 Floodwall/Levee	24%	16%		60%

**Removed from consideration*

Subsurface Investigations

19. Subsurface investigations were performed by AECOM during the fall of 2011 whose report can be found in Attachment 2. Twelve (12) borings were completed amongst the sites listed below.

- Bull Creek Reservoir (BCRS02) – Four (4) borings with one at 50' and three at 30'. *This site was removed from consideration after the borings were completed.* Completed analyses are still included in the report.
- DPLV09 Levee – Two (2) borings at 35', each in 2011 and an additional eight (8) borings ranging from 25 to 35 ft in 2013.
- Groveland Avenue Levee (DPLV01) – Two (2) borings at 30', each.
- Adler Park Levee (DPLV15) – Two (2) borings at 25', each. *This site was removed from consideration after the borings were completed.* Completed analyses are still included in the report.
- Silver Creek Reservoir (SCMC01) – Two (2) borings with one at 30' and one at 35'. *This site was removed from consideration after the borings were completed.* The logs are still in the AECOM report but are not mentioned further in this appendix, as no design work was completed.
- DPLV04 Levee – Four (4) borings are planned for fall 2013.
- DPLV05 Levee – Five (5) borings are planned for fall 2013.

20. Each site was investigated by AECOM using the Illinois State Water Survey – Well Database to find previous water well logs. These logs are also included in AECOM's reports in Attachment 2.

21. In addition to collecting soil boring data, the investigation performed by AECOM gathered information about the road raise, structure modification and dam removal sites and included it in their report located in Attachment 2. Several sites have been removed since the investigation including the BNSF Bridge modification and all the road raises except DPBM04. The dam removal sites are still included and consist of Dam #1 in Wheeling, Dam #2 in Wheeling, Dempster Avenue Dam in Des Plaines, Touhy Avenue Dam in Park Ridge, and Dam #4 (Devon Ave Dam) in Rosemont.

22. A second investigation was completed by AECOM in spring 2013 and this report can also be found in Appendix 2. Eight soil borings were completed along the DPLV09 alignment to depths of 25.8 to 36.5 ft.

23. Listed below is a summary of the information gathered from each of the sites. For the complete reports, refer to Attachment 2.

24. There were several sites which had previous explorations completed at or near proposed Des Plaines II projects. These boring logs and maps can be found in Attachment 3.

Structure Modifications:

- Lake Mary Anne Pump Station (FPCI01) – Plate 1 – New borings for this site were not completed at this time.
    - The IDOT as builts of an existing 96" pipe along the south side of Golf Road include a soil profile completed using borings completed in 1973 by G.H. Otto. These borings encountered layers of both sandy and clayey soils to about elevation 622 NGVD. Below this elevation, clay till was encountered to the termination depth of the borings of about elevation 620 to 605. These are included in the AECOM Report in Attachment 2.
    - Previous borings uncovered through the Illinois State Water Survey include four water well logs near the project. However, the logs did not include any soil or water data online but there could be information filed at the ISWS office.
- BNSF Railroad Bridge (DPBM01) – *This site was removed from the proposed plan*. DP2-11-11 is about 450 feet north of this bridge. See the Groveland Floodwall section for information on this log. The investigation found one nearby water well log from the ISWS. However, this log does not include any soil or water data online but there could be information filed at the ISWS office.
    - BNSF provided several drawings of the existing bridge which have cross sections of two soil borings completed in 1900. These cross sections encountered gravel underlain by soft to hard clay. Beneath the clay, gravel and tough clay was encountered with the boring terminating in bedrock. These cross sections do not include elevation data or thicknesses of the layers. These drawings are not included in this Feasibility Report as they are protected from disclosure as provided by the Critical Infrastructure Information Act of 2002. See 6 U.S.C. sec. 133 (a) (2) (A) for more information.

Reservoirs:

- Bull Creek Reservoir (BCRS02) – Plate 2 – *This site was removed from the proposed plan.* Of the four borings completed at this site, DP2-11-06 was completed to 50 feet below grade and DP2-11-07, 08, and 09 were completed to 30 feet. DP2-11-06 was completed near the proposed outflow structure, DP2-11-07 was completed near the inlet structure, and DP2-11-08 and 09 were completed along the perimeter dike. Topsoil was encountered at each boring location, with varying thicknesses of ½ to 2 feet. DP2-11-06 and 07 encountered about 2 feet of clay fill beneath the topsoil. Beneath the fill and/or topsoil, the Houghton Muck layer identified in the soil survey was encountered in DP2-11-07 and 08 as soft organic clay and peat to a depth of 8 to 10 feet. The other two borings (DP2-11-06 and 09) did not encounter this organic material. Beneath the organic material, fill and/or topsoil, stiff to very stiff lean clay was encountered to the termination depths, other than DP2-11-06. DP2-11-06 encountered very dense fine to coarse gravel at about 48 feet below grade. When the borehole extended into this layer, a natural gas pocket was released and dissipated until the next day when the hole was backfilled. Water was not observed in DP2-11-06 or 09, but was encountered about ½ to 3 feet below grade in DP2-11-07 and 08. These logs are included in Attachment 2.
    - Previous borings uncovered through the Illinois State Water Survey include fourteen water well logs near the project. These well logs were completed based on general observations and may not be as accurate as borings completed specifically for classification. Eleven extend to depths of about 10 to 12 feet while three extend 257 to 314 feet below grade. Bedrock was encountered in the deep borings between 218 and 270 feet below grade. The overburden soils encountered mostly clay with a few layers of organic soils and sand. Water was noted in BCR-1 only, at about 80 feet below grade. These logs are included in Attachment 2.
- Aptakisic Creek Reservoir (ACRS08) – Plate 3 – New borings for this site were not completed at this time although it is anticipated to consist of mostly clay materials based on the soil survey.
    - Previous borings uncovered through the Illinois State Water Survey include six water well logs near the project. These well logs were completed based on general observations and may not be as accurate as borings completed specifically for classification. They extend to depths of about 86 to 149 feet below grade and encountered mostly clay with a few sand layers. Only ACR-6 noted rock, which was encountered at 130 feet below grade. Water was observed between 42 to 72 feet below grade. These logs are included in Attachment 2.
- Campground Road Reservoir (DPRS15) – Plate 4 – *This site was removed from the proposed plan.* New borings for this site were not completed at this time although it is anticipated that the site consists of silty and clayey material, based on the soil survey.

- The soil borings completed for DPLV09 are on the opposite side of the Des Plaines River, about 1,000 ft west of the proposed reservoir site. These encountered mostly clay and some silt.

Levees:

- DPLV09 Levee/Floodwall – Plate 5 – Two borings along the centerline of the levee/floodwall were completed to 35 feet in 2011; DP-11-14 and 15. These were completed in a relatively small section of the proposed levee; in between Oakton Street and Everett Street. An additional eight borings were completed in 2013 which extended the complete length of the proposed levee; from Ashland Ave to Jarvis Ave and designated DP2-13-01 thru DP2-13-08. DP2-11-15, DP2-13-01, and DP2-13-05 encountered about 4 to 6 inches of asphalt underlain while the rest encountered about 5 to 18 inches of topsoil. Beneath the surface materials, fill soils were encountered to approximately 2 feet below grade in DP2-13-01 thru DP2-13-04. DP2-13-05 encountered about 9.5 ft and DP2-13-06 and DP2-13-08 encountered about 6 ft. These fill materials consist of reworked site soils. Deleterious materials were generally not found with the exception of glass pieces and the fact that DP2-13-05 required a minor relocation due to an unknown obstruction. The native materials consist of very stiff clay with a few small sand lenses/layers. The bottom of some of the borings consisted of very hard silt. Water was encountered in each boring except DP2-11-14, DP2-11-15, and DP2-13-08. Where water was encountered, it generally is around a similar elevation as the Des Plaines River. These logs are included in Attachment 2.
    - On the opposite bank of the Des Plaines River near the north end of the proposed DPLV09 Levee/Floodwall, there is an existing levee named Levee 50 (Rand Road Levee). This levee system protects Des Plaines, IL on the east bank with levee, floodwall, and a clay embankment along a railroad berm. It was completed in 2011 with a crest elevation of 636 NAVD88. The previous borings were completed by Christopher B. Burke Engineering, Ltd. in 1998 and STS in 2002. The centerline of Levee 50 is closest to the northernmost portion of the proposed DPLV09 levee at around 300 feet. In general, these borings encountered about 2 to 7 feet of sand beneath the fill soils underlain with tough to very tough clay. These logs are in Attachment 3.
    - Soil borings completed for the Des Plaines Tunnel in 1978 are also near the proposed DPLV09 alignment. These borings were completed on both sides of the Des Plaines River, with several within 500 ft of the proposed project. These borings encountered clayey and silty soils, similar to the other subsurface investigations. These logs can also be found in Attachment 3.
    - Previous borings uncovered through the Illinois State Water Survey include three water well logs near the project. However, the logs did not include any soil or water data online but there could be information filed at the ISWS office.

- Groveland Avenue Levee (DPLV01) – Plate 6 – Borings DP2-11-10 and 11 were completed along the proposed floodwall alignment with DP2-11-10 near the north end of Groveland Avenue and DP2-11-11 near the south end. Both borings encountered about ¾ feet of topsoil at the surface. Beneath the topsoil, each encountered silty clay fill to about 5 feet below grade underlain by native medium stiff silty clay with a 1-foot thick sand layer in DP2-11-11 at about 8 feet below grade. At about 9-½ to 10 feet below grade, dense silt was encountered in DP2-11-10 while loose silty sand was encountered in DP2-11-11. Beneath the silt in DP2-11-10, hard silty clay at about 13 feet below grade was encountered to about 17.5 feet where auger refusal on inferred bedrock was encountered. Beneath the silty sand in DP2-11-11, dense silt was encountered at about 20 feet with hard silty clay encountered at 25 feet below grade. This extended to the termination depth of the boring at 30.5 feet. Water was observed between 7-½ and 12 feet below grade. These logs are included in Attachment 2.
    - North of Forest Avenue along the same line as the proposed floodwall, the existing berm had been modified in 2004 as a Section 14 USACE project. This project reduced seepage by replacing part of the old berm with compacted clay and removing vegetation. Five borings were completed along this stretch by Professional Service Industries, Inc. (PSI) in May 1988 labeled B-1 thru B-5 which extended between 4.5 and 21.5 feet below grade. B-4 and B-5 encountered clay fill to about 4-½ feet where the borings were terminated. The other borings encountered silty sand at about 8 to 10-½ feet below grade with B-1 and B-3 terminating in this material at about 11-½ feet. B-2 encountered weathered rock at about 15 feet to the termination depth of about 21-½ feet below grade. These logs are in Attachment 3.
    - Previous borings uncovered through the Illinois State Water Survey include five water well logs near the project. However, the logs did not include any soil or water data online but there could be information filed at the ISWS office.
- Adler Park Levee (DPLV15) – Plate 7 – *This site was removed from the proposed plan.* Borings DP2-11-01 and 02 were completed along the proposed levee alignment to 25 feet below grade. These borings encountered medium stiff to stiff lean clay with a few intermittent sand seams/layers. Both borings terminated about 25 feet below grade, with DP2-11-01 ending in dense fine to coarse sand and DP2-11-02 ending in very stiff lean clay. Water was encountered between 12 and 18 feet below grade. These logs are included in Attachment 2.
    - The USACE North Libertyville Estates Levee project is less than 1,000 feet west of the proposed Adler Park Levee. North Libertyville was completed in September 1998 and protects a residential area with a levee at elevation 657.5 feet NGVD29 (a 33-year flood, approximately). There are several borings within 750 feet of the proposed Adler Park levee. They were completed by Patrick Drilling, Inc. in late 1990 and are labeled CB-NL-12-90 thru CB-NL-15-90. Each extends about 25 feet below grade and encountered similar conditions along the east edge of the project, encountering lean clay to at least 3 feet below grade underlain by a mix of sand, silt, and clay. Water was observed between about 5 to 10 feet below grade. The logs are located in Attachment 3.

- Previous borings uncovered through the Illinois State Water Survey include five water well logs near the project. These well logs were completed based on general observations and may not be as accurate as borings completed specifically for classification. They extend to depths of 136 to 200 feet below grade and encountered mostly clay with a few sand layers. Each encountered bedrock, except for DPLV15-3, between 121-½ and 129 feet below grade. Water was observed between 10 to 45 feet below grade.

Structure Modification:

- First Avenue Bridge – *This site was removed from the proposed plan.* The investigation found six nearby water well logs from the ISWS. However, these logs do not include any soil or water data online but there could be information filed at the ISWS office.
  - The IDOT as builts provided in Attachment 2 did not include any soil information for this site.

Dam Removal Sites:

- Dam #1 – There are paved drives on both banks as this dam used to be used as a ford. Additionally, there are parking lots on both banks near Dam #1 which are part of the Forest Preserve District of Cook County. The reinforced concrete dam has a flat broad crest with a smooth straight sloped face and about 4.8 feet tall and 127 feet wide.
- Dam #2 – The west bank is a generally grassy area with a parking lot and gravel river access path about 500 feet north of Dam #2. The east bank is generally dense forest. Both banks are owned by the Forest Preserve District of Cook County. The reinforced concrete dam has a flat broad crest with a smooth step-like face and used to be used as a river ford. It is about 4.3 feet tall and 151 feet wide.
- Dempster Avenue Dam – The west bank at the dam has an approximately 5 foot tall wall up to River Road and the east bank is a recreational path and Campground Road. The reinforced concrete dam has a round broad crest with a smooth steep convex sloped face with a boat portage the east bank. It is about 5.5 feet tall and 106 feet wide. The Dempster Ave Dam is near the existing Levee 50 project.
- Touhy Avenue Dam – Both the east and west bank are owned by the Forest Preserve District of Cook County and are covered with trees. There is a walking path close to the east bank. The reinforced concrete dam has a round broad crest with a smooth convex sloped face with a boat portage on the east bank. It is about 5.5 feet tall and 106 feet wide.
- Dam #4 (aka Devon Ave Dam) – Both the east and west bank are owned by the Forest Preserve District of Cook County and are covered with trees. The reinforced concrete dam has a round broad crest with a smooth convex sloped face with a boat portage on the west bank. It is about 5.5 feet tall and 106 feet wide.

DESIGN ANALYSIS

Purpose

25. The purpose of this analysis is to determine the constructability of the earthen structures based on the limited amount of subsurface investigation completed as part of this feasibility study. Poorly suited soils will be identified, such as organic soils and coarse grained soils where seepage is disadvantageous. Settlement of levees and reservoir berms were analyzed using procedures outlined in EM 1110-1-1904. Slope stability and seepage of levees and reservoir berms was analyzed using SLOPE/W and SEEP/W software, respectively. Analysis for structures such as road raises, floodwalls, pump stations, spillways, etc. will be completed during the design phase.

Lake Mary Anne Pump Station (FPCI01) – Plate 1

26. Analyses could not be done for the Lake Mary Anne Pump Station as soil borings were not completed prior to this feasibility report. Based on the USDA Soil Survey, this site is anticipated to encounter mostly silt and clay soils which would be appropriate for construction of a pump station and underground pipe. A subsurface investigation will be required prior to the design phase to determine more accurate information.

27. The Illinois Department of Transportation provided the as builts for two existing drainage pipes that run parallel with Golf Road. One pipe is a 96 inch storm sewer which runs along the south side of Golf Road and is between elevations of about 620 to 630 NGVD. The other pipe is also a storm sewer that is 18 inch diameter and runs along the center of Golf Road between elevations 640 and 635 NGVD. The proposed pipe connecting the lakes should take care to avoid these pipes.

28. To construct the pipe that connects the two lakes, the most feasible method is to directional drill beneath the existing utilities. The IDOT as builts include a soil profile, which indicate that sandy layers were encountered as deep as elevation 622 NGVD and the water table around 631 NGVD. Therefore, the new pipe should be constructed around elevation 615 to 620 NGVD to avoid the existing pipes and be fully in the clay till. Soil borings should be completed to create a soil profile along the proposed drive line.

Bull Creek Reservoir (BCRS02) – Plate 2, 2a *(removed from consideration)*

29. The main obstacle in designing a reservoir at the Bull Creek site is the presence of ‘Houghton Muck’ soils consisting of organic clay and peat, as shown on Plates 2 (plan) and 2a (profile). This layer is highly compressible and therefore requires remediation to reduce settlement after construction.

30. Based on the USDA Web Soil Survey, Houghton Muck is present beneath approximately 70% of the berm on the existing plan. While the berm can be shifted to reduce this percentage, there is no way to construct the berm without intersecting this subsurface soil. Additional data could show that some areas have a relatively thin layer of these organic soils compared to the 8 to 10 feet encountered in the two borings on the west side of the site.

31. Other areas that did not encounter the organic clays would be suitable for construction as the materials encountered are stiff to very stiff lean clay, such as the two borings completed on the east side of the site. This material is relatively easy to work with and impermeable. The detailed settlement, stability, and seepage analyses are in Attachment 4.

Settlement

32. The settlement analyses for the two different site characteristics; with organics and without provided two different anticipated settlements. Boring logs DP2-11-07 (western portion) and 09 (eastern portion) were used for the comparison where DP2-11-07 estimates about 7 feet of settlement, while DP2-11-09 estimates less than ¾-foot. Of the seven feet of settlement in DP2-11-07, about 5-½ feet is attributed to the 8-½ foot thick peat and organic clayey silt layers. This is based on rough estimates. A more precise analysis based on new laboratory testing results of the materials should be completed to determine a more accurate number.

33. One option to prevent this high amount of settlement is to remove and replace the peat and clayey silt layers, which are a maximum of 12-½ feet below grade in the borings completed. However, other options should be considered as removal could become difficult and costly. Pre-loading the berm footprint using on-site clay and installing wick drains would consolidate the soft materials prior to the construction of the actual berm. Laboratory data is required to determine the length of time and amount of load necessary to consolidate the materials to an appropriate level. Settlement of structures such as the inlet and outlets should be analyzed during the design phase.

Stability

34. The stability analysis was based on the soil conditions of both with and without organic soils present using DP2-11-07 (west side) and DP2-11-09 (east side) to determine the cross sections. SLOPE/W software was used to determine factors of safety for both the end of construction and long term stability of the berm at both locations. Based on the analyses, in areas where no organic soils are present, either through removal or if none are present in the first place, the reservoir berms can be sloped with a 2.5H: 1V on the inner side and 2H: 1V on the outer side. In areas where peat and clayey silt are present and are not removed, the inner and outer slopes must be flattened to at least 5H: 1V and 3H: 1V, respectively.

35. This analysis is based on the tallest anticipated berm at this stage in the project. Once actual cross sections are developed for the berm, the stability should be analyzed again. Additional strength data for the soils should also be gathered, particularly for the organic soils as they are likely unavoidable when laying out a useful reservoir footprint.

Seepage

36. A seepage analysis completed by SEEP/W also used the cross section presented by DP2-11-07 with a completely full and saturated reservoir with organic soils present. Based on this analysis, the anticipated seepage is in the order of $4.5*10^{-4}$ gallons per minute per foot of berm. This is considered an insignificant amount of seepage.

37. However, the exit gradient produced with the organic layers present creates conditions that may produce piping and sand boils. In order to mitigate this risk, a cutoff trench could be installed through the peat and clayey silt soils. This trench would have to be at least 5 feet wide at the bottom and be sloped to prevent cave-ins. Additional sample collection and laboratory testing should be completed to determine the actual material properties and calculate a more precise seepage analysis.

38. Alternatively, in areas with thick peat layers, sheet pile can be installed through the organic material to reduce seepage and piping. This would eliminate the need excavate the unstable peat material to install a cutoff trench. The sheet pile would need to extend at least 2 feet beyond the peat and organic clayey silt.

Construction

39. The silty clay encountered in the soil borings would be appropriate to construct the reservoir berms while the organic materials present should not be used for berm construction. If the peat layer is left in place, the berms should expect settlement on the order of several feet and pre-loading using wick drains and overbuild should be used. In areas without peat, about ¾-foot should be anticipated for overbuild while areas with peat should be analyzed on a case-by-case basis.

40. Construction activities where peat soils are present should be limited, as they are very compressible and equipment may become stuck. Excavating into the peat layer may also become challenging as this layer is very soft and is almost always encountered below the water table. Water was encountered as little as ½-foot below grade in areas with organic soils while the other borings did not encounter groundwater. Therefore, it is likely that the water encountered is perched in the organic material on top of the silty clay in the form of a marsh/pond. To avoid excavating into the water, it is recommended to use sheet pile instead of a clay cutoff trench beneath the berm and install wick drains to drain the organic layer.

Additional Information

41. In order to properly design this reservoir, additional information is required. Depending on the actual extents of the organic layer, the method of construction can be greatly affected. Additional soil borings should be completed to determine the extents of this layer and where to align the berm to avoid this subsurface layer. Once the extents and depth of this layer is better quantified, a refined alignment for the reservoir can be developed. Compression curves and conductivity values should be developed from laboratory tests to better estimate the anticipated settlement, as well as, the seepage potential.

Aptakisic Creek Reservoir (ACRS08) – Plate 3

42. Analyses could not be done for the Aptakisic Creek Reservoir as soil borings were not completed at the time of this Appendix. Based on the USDA Soil Survey and ISWS water well logs, this site is anticipated to encounter mostly clay soils which would be appropriate for reservoir construction with low permeability and stable slopes. The descriptions in the ISWS well logs include some sands and gravels near the profile surface. If these sandy soils are present on the site and within 5 feet or so of the surface, a cutoff trench should be installed. A seepage analysis should be completed to determine the extents of a cutoff trench once the subsurface profile is known. Groundwater was encountered deep below the surface and will likely not be encountered during construction. A subsurface investigation will be required prior to the design phase to determine more accurate information.

Campground Road Reservoir (DPRS15) – Plate 4 *(removed from consideration)*

43. Analyses could not be done for the Campground Road Reservoir as soil borings were not completed at the time of this Appendix. Based on the USDA Soil Survey and on soil borings completed for the DPLV09 levee stretch, this site is anticipated to encounter mostly clay soils which would be appropriate for reservoir construction with low permeability and stable slopes. Groundwater is not anticipated to be encountered during excavation. A subsurface investigation will be required prior to the design phase to determine more accurate information.

DPLV09 Levee/Floodwall – Plate 5, 5a

44. The soil borings were completed in 2011 and 2013 for the length of DPLV09 from Ashland Avenue to Fargo Avenue. Plan and profile views of the completed borings are shown on Plates 5 and 5a, respectively. The below analysis only examines the area where the 2011 soil borings were taken, however, the additional borings from 2013 further reinforce the anticipated conditions. DPLV09 will consist of both clay levee and floodwall. The detailed settlement, stability, and seepage analyses for the floodwall and levee portion are in Attachment 4.

Settlement

45. The settlement analysis used the conditions presented in DP2-11-15 and calculated the settlement of levee to be on the order of about ¾ foot or less. The floodwall settlement will be evaluated in the design phase.

Stability

46. The levee stability analysis was completed using SLOPE/W software and modeled using the profile from DP2-11-15. End of construction, long term, and rapid drawdown cases were analyzed which determined the DPLV09 Levee can be constructed with a 2.5H: 1V slope.

47. The floodwall was analyzed with ETL-1110-2-575 for a flood-side gap in cohesive soils, rotational stability failure around the floodwall toe, and consolidation of the land side soils. The sheet pile toe was assumed to extend to the top of the very dense silt, at about 603.5 NAVD. This depth may increase or decrease depending on a structural analysis to be completed during design phase. Based on these parameters, the floodwall appears stable to construct.

Seepage

48. Levee and floodwall seepage analyses were completed using the results from DP2-11-15 for the levee and DP2-11-14 for the floodwall. SEEP/W software was used which determined this site would be minimally susceptible to seepage for levee and floodwall construction. Piping was also analyzed and was determined not to be a mitigating factor using the available soil stratum. The floodwall depth will likely not be controlled by seepage cutoff since the subsurface is clay. Additional soil investigations may encounter sand layers near the surface of the soil stratum which would increase the risk of seepage.

Construction

49. Based on the available data, this site appears to be suitable for levee and floodwall construction as no soft or coarse grained soil strata were encountered within the top 10 feet of the soil strata. The levees should include about ¾-foot of overbuild based on the data available at this time. Clay present at the site would be suitable for levee construction, although since there will be a limited amount of excavation, an offsite source will be required.

50. Near the north end of this proposed levee/floodwall, there is an existing retaining wall that is about 500 feet long. If the existing wall does not provide a sufficient cutoff or would not be able to support additional height, then it will likely have to be torn out and a new wall installed.

51. For the floodwall, piles may be difficult to drive into the extremely dense silt present about 20 to 25 feet below grade. Groundwater is not anticipated near the surface.

Additional Information

52. The soil borings completed did not encounter any soils that would be unsuitable for levee/floodwall construction. The shallowest layer of permeable materials is the silty sand layer in DP2-13-05 about 9.5 to 12 ft below grade. However, this would be cut off by the proposed floodwall in this area. Additional soil borings should be completed so that generally 3 soil borings every 1,000 feet are completed. These borings should be collected on the landside, riverside, and centerline. Laboratory tests including hydraulic conductivity and compression tests should be completed to better determine the soil characteristics.

DPLV04 Levee/Floodwall – Plate 8

53. Analyses could not be done for the DPLV04 levee/floodwall as soil borings were not completed at the time of this Appendix. Based on the USDA Soil Survey, this site is anticipated to encounter mostly clay soils which would be appropriate for levee/floodwall construction with low permeability and stable slopes. The ISWS well log database was investigated but none of the available logs had subsurface data. A subsurface investigation is planned for fall 2013, and depending on when this is completed; stability, settlement and seepage analyses will be added to this report prior to submittal.

DPLV05 Levee/Floodwall – Plate 9

54. Analyses could not be done for the DPLV05 levee/floodwall as soil borings were not completed at the time of this Appendix. Based on the USDA Soil Survey, this site is anticipated to encounter mostly clay soils which would be appropriate for levee/floodwall construction with low permeability and stable slopes. The ISWS well log database was investigated but none of the available logs had subsurface data. A subsurface investigation is planned for fall 2013, and depending on when this is completed; stability, settlement and seepage analyses will be added to this report prior to submittal.

Groveland Avenue Levee (DPLV01) – Plate 6, 6a

55. The Groveland Avenue Levee is anticipated to be constructed with a steel sheet pile floodwall with a concrete façade. This site encountered clay and silty sand underlain by very dense silt, clay and bedrock. Plan and profile views of the AECOM and PSI borings are shown on Plates 6 and 6a. Structural stress analyses will be performed on the floodwalls to determine the required depth of piling during the detailed design phase of this study. The detailed stability and seepage analyses for the floodwall are in Attachment 4.

Stability

56. The floodwall was analyzed with ETL-1110-2-575 for a flood-side gap in cohesive soils, rotational stability failure around the floodwall toe, and consolidation of the land side soils. The sheet pile toe was assumed to extend through the sand layers, at about 601 NAVD in DP2-11-10 and 592 NAVD in DP2-11-11. Additional borings may also modify the minimum

required depth. The depth of the sheet piling will likely depend on the depth of the permeable sandy layers rather than the required depth for structural stability. Based on this analysis using DP2-11-11, the floodwall appears stable to construct.

Seepage

57. Floodwall seepage analysis was completed using the results from DP2-11-11. SEEP/W software was used which determined this site would be minimally susceptible to seepage but piping may occur in areas where sands are present in the subsurface. To reduce the potential for piping, the silty sand layers should be cut off with the sheet piling. This is near elevation 592 NAVD88 in DP2-11-11, which equates to a 26-foot long sheet pile. In DP2-11-10, the sand layer was encountered to about elevation 601 NAVD88, which equates to a 17-foot sheet pile. Additional soil investigations are required to better map the sandy subsurface layers that require cutoff to reduce the risk of seepage and piping.

Construction

58. The floodwall may experience difficulty driving piles into the hard clay and extremely dense silt encountered as shallow as 13 feet below grade or elevation 601. Water was encountered as shallow as 7 feet below grade. However, since floodwall construction does not include much excavation, groundwater in not expected to be encountered during construction.

Additional Information

59. Additional soil investigations should be completed along the alignment of this proposed floodwall. Generally, 3 soil borings every 1,000 feet is suitable to locate most unsuitable soils. These borings should be collected on the landside, riverside, and centerline. Laboratory tests including hydraulic conductivity and compression tests should be completed to better determine the soil characteristics.

Adler Park Levee (DPLV15) – Plate 7 *(removed from consideration)*

60. This site encountered clay with a few sand seams/layers. Plan and profile views of the borings are shown on Plates 7 and 7a. This is consistent with the anticipated conditions as the adjacent North Libertyville Levee soil borings encountered similar strata. Therefore, like the North Libertyville Levee, this levee will likely require an inspection trench to cut off potential shallow seepage paths. The detailed settlement, stability, and seepage analyses are in Attachment 4.

Settlement

61. The settlement analysis used the conditions presented in DP2-11-01 and calculated it to be on the order of ¾-foot or less. Soil borings adjacent to the project site did not encounter any soils that may result in higher anticipated settlements than this estimate.

Stability

62. The North Libertyville Estates Levee was constructed with slopes that are either 2H: 1V away from the Des Plaines River or 2.5H: 1V along the river. The analysis for Adler Park used SLOPE/W software and the profile from DP2-11-01. Conditions at end of construction, long term, and rapid drawdown were analyzed which determined a 2.5H: 1V slope is recommended.

Seepage

63. At the North Libertyville Estates Levee, the clay levee was constructed after a 5-foot deep inspection trench was dug. The project was completed in 1998 but during high water events in the early 2000's, several sand boils developed. Because of this, the North Libertyville project was modified in 2007 to include several relief wells that allow water to gravity flow to the surface while preventing subsurface soils from flowing, as well.

64. Based on the seepage analysis completed using SEEP/W, seepage of water to the protected side is insignificant; however, piping is an issue. To mitigate this, a 2-foot wide cutoff trench could be constructed through the upper sand layer and backfilled with clay. At DP2-11-01, this layer extends to about 3-½ feet below grade while DP2-11-02 did not encounter the sand layer. This layer may be deeper in other places not investigated.

Construction

65. Based on the available data, this site appears to be suitable for levee construction with the only issue of shallow coarse-grained material. The levees should include about ¾-foot of overbuild based on the data available at this time. Clay present at the site would be suitable for levee construction, although since there will be a limited amount of excavation, an offsite source will be required. Groundwater was encountered at least 12 feet below grade in the soil borings, and is not anticipated to be encountered during construction.

66. The site does have an existing stream about 5 feet wide and 1 foot deep, south of the houses along Sprucewood Lane. This stream should still be able to discharge into the Des Plaines River so the flow would have to be altered to go through a pipe with a closure mechanism.

Additional Information

67. Additional soil investigations should be completed along the alignment of this proposed levee and floodwall. Generally, 3 soil borings every 1,000 feet is suitable to locate most unsuitable soils. These borings should be collected on the landside, riverside, and centerline. Laboratory tests including hydraulic conductivity and compression tests should be completed to better determine the soil characteristics.

Bridge Modifications

68. The First Avenue Bridge will be raised by about 5 feet over the Des Plaines River and is about 250 feet long and 4 lanes wide. The as builts provided by IDOT include utilities, cross sections of the road, and information about the bridge piers; which should be examined to determine the existing conditions for design.

BNSF Railroad Bridge Pier Extension *(removed from consideration)*

69. The BNSF Bridge modification will involve modifying the piers in the river as well as excavating portions of the existing banks to improve flow. Once cross sections are developed for the banks, stability analyses should be completed. As for the pier modifications, geotechnical data will likely be necessary to construct the longer piers with concrete supported on either footings or piles. As noted in the Groveland Avenue soil borings, very dense silts and bedrock are relatively shallow in this area and would increase the difficulty in driving piles if encountered. The drawings provided to the Government by BNSF are not included in this Feasibility Report as they are protected from disclosure as provided by the Critical Infrastructure Information Act of 2002. See 6 U.S.C. sec. 133 (a) (2) (A).

Dam Removals

70. Since the dams that are proposed to be removed are all less than 5-½ feet tall, instability issues are not anticipated along the channel. Bank stabilization may be required as most of these dams have significant concrete structures along the banks. Dams #1, #2, Touhy, and #4 are all bordered on both sides by forest preserve, so the demolition will not affect any other structures. However, the Dempster Ave Dam west end terminates into a retaining wall which supports River Road. Further analyses should be completed to determine if removal of this portion of the dam would affect the stability of River Road. Dempster Ave Dam is also adjacent to the proposed DPLV09 so any work should be coordinated with this project.

SUMMARY AND CONCLUSIONS

71. The geotechnical recommendations for various project features developed for this report are based on subsurface information available from the 2011 AECOM investigation performed as part of this feasibility study (Attachment 2). Boring information of other projects within 1,000 feet of the proposed sites, well log data, and soil survey maps were also used for the recommendations presented. This report contains sufficient contingencies in the cost estimate to cover uncertainties in the design until an extensive investigation and analysis is completed during the design phase. Essential geotechnical recommendations developed for various features of the project are summarized below.

Table 2. Summary Table of Design Considerations

Site	Type	Acceptable Slope	Overbuild	Seepage/Piping Prevention
FPCI01	Pump Station	N/A	TBD	N/A
BCRS02	Reservoir on Clay	2.5:1 inner, 2:1 outer	<3/4 foot	none
	Reservoir on Peat	5:1 inner, 3:1 outer	4-7 feet	clay cutoff or sheet pile
ACRS08	Reservoir	TBD	TBD	TBD
DPLV09	Levee	2.5:1	<3/4 foot	none
	Floodwall	N/A	TBD	sheet pile
DPRS15	Reservoir	TBD	TBD	TBD
DPLV01	Floodwall	N/A	TBD	sheet pile
DPLV15	Levee	2.5:1	<3/4 foot	clay cutoff
DPLV04	Floodwall	N/A	TBD	TBD
	Levee	TBD	TBD	TBD
DPLV05	Floodwall	N/A	TBD	TBD
	Levee	TBD	TBD	TBD

Levees and Floodwalls

72. Adler Park Levee and Groveland Floodwall encountered coarse grained materials that increase the possibility of seepage and piping while DPLV09 did not. The levees in which coarse grained materials could be present should include an inspection trench backfilled with clay while the floodwall should extend to competent fine-grained material. The levee and floodwall sites did not encounter soils that may increase the risk of undue settlement or stability problems. Levee construction should estimate about ¾- foot of overbuild to account for settlement at this time. All levees will be constructed with 10-foot wide crests and the slopes are acceptable at a 2.5H: 1V ratio using competent clay fill placed to meet specified density and compaction requirements. The floodwall structural designs will be completed during the final design phase of each respective project.

Reservoirs

73. The Bull Creek Reservoir site encountered peat in several borings that increases the difficulty of constructing the berm. Several options such as removal and pre-loading should be considered as stated earlier in this report. The soil borings encountered this layer as deep as 10 feet below grade at the site, although other areas did not encounter it at all. With the unsuitable soils removed or not encountered, the slopes of the berm on the inside and outside can be constructed with 2.5H: 1V and 2H: 1V ratios, respectively. If the organic soils are left in place, the reservoir side slopes should be at least 5H: 1V and 3H: 1V for the inner and outer slopes, respectively. With organic soils present, a seepage and piping barrier needs to be in place in the form of a clay cutoff or sheet pile. The clay encountered in the soil borings appears to be suitable for berm construction. The remaining reservoir sites require subsurface investigations prior to developing recommendations.

REFERENCES

Butts, Thomas and Ralph Evans. Illinois State Water Survey – Circular 132. Effects of Channel Dams on Dissolved Oxygen Concentrations in Northeastern Illinois Streams. 1978.

Corps of Engineers. 2003. Slope Stability. Engineering and Design, Engineer Manual 1110-2-1902.

Corps of Engineers. 2000. Design and Construction of Levees. Engineering and Design, Engineer Manual 1110-2-1913.

Corps of Engineers. 1990. Settlement Analysis. Engineering and Design, Engineer and Design 1110-1-1904.

Corps of Engineers. 1986. Seepage Analysis and Control for Dams. Engineering and Design, Engineer Manual 1110-2-1901.

Corps of Engineers, 2011. Evaluation of I-Walls. Engineering and Design, Engineer Technical Letter 1110-2-575.

Corps of Engineers. Riverside, Illinois Section 14 Planning and Design Analysis Report. 2003. Appendix D: Geotech.

Des Plaines River – Rand Park Flood Control Phase II Pump Station and Railroad Embankment Seal. As-Built Set. 2003. State of Illinois Department of Natural Resources Project Number FR-415.

Humphrey, Aaron and Jamie Matus. 2012. Des Plaines II Site Investigations and Subsurface Investigation and Research. Geotechnical Exploration Report. AECOM Project Number 60223274.

Humphrey, Aaron and Paul Tarvin. 2013. Des Plaines DPLV09 Investigation. Geotechnical Exploration Report. AECOM Project Number 60299932.

North Libertyville Estates Levee, Lake County, Illinois, Section 205 Flood Control Project. As-Built Set. 2000. Corps of Engineers Project Number DACW23-97-C-0030.

United States Department of Agriculture, Natural Resource Conservation Service. Web Soil Survey. http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx.

Willman, H.B. 1971. Summary of the Geology of the Chicago Area. Illinois State Geological Survey. Circular 460. 77p.

Willman, H.B. 1973. Rock Stratigraphy of the Silurian System in Northeastern and Northwestern Illinois. Illinois State Geological Survey. Circular 479. 55p.

Willman, H.B., et al. 1975. Handbook of Illinois Stratigraphy. Illinois State Geological Survey. Bulletin 95. 261p.