Great Lakes Water Authority

Freud Pump Station Improvement Project

State Revolving Fund (SRF)

Project Plan - DRAFT

April 2022

Freud Pump Station Improvents Project

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Project Plan

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Acronyms and Abbreviations

ADA	Americans with Disabilities Act
CCPS	Conner Creek Pump Station
CSO	Combined Sewer Overflow
DRI	Detroit River Interceptor
DWSD	Detroit Water and Sewerage Department
EGLE	Michigan Department of Environment, Great Lakes, and Energy
FPS	Freud Pump Station
FRP	Fiber Reinforced Plastic
GLWA	Great Lakes Water Authority
MGD	million gallons per day
PVC	Polyvinyl Chloride
WRRF	Waste Resource Recovery Facility

1 Executive Summary

The Freud and Conner Creek pumping systems are key components in relaying wastewater and storm water generated in the eastern portion of Detroit. The dry weather flow is conveyed to the Fairview Sewage Pump Station, and ultimately, to the Detroit Water Resource Recovery Facility (WRRF), while wet weather flow is conveyed to the Conner Creek CSO facility. The operation of these facilities is critical to prevent flooding of stakeholders' premises, but they also protect the water quality in the Detroit River and ultimately the drinking water supply for Detroit. The conveyance system is very complex involving at least eight interceptors/sewers, multiple regulating structures, three large pump stations, and a CSO treatment system. The conveyance system has grown and been modified numerous times over the past 100-years with the last major improvement being the construction of the Conner Creek CSO Basin and Treatment Facility which was placed into operation in 2005.

The Freud Pump Station (FPS) was constructed in the mid-1950s primarily to handle the overflows from the Conner Creek Pump Station (CCPS). When the capacity of the CCPS is exceeded, the East Jefferson Relief Sewer overflows to the Fox Creek and Ashland Relief Sewers. The original concept was for the FPS and the Fox Creek and Ashland Relief Sewers to store approximately 20 million gallons for return to the CCPS through the East Jefferson Relief sewer when the CCPS could handle the flow. The operation concept of Freud was changed when the Conner Creek CSO Facility was placed into operation. The Freud Pump Station has eight storm water pumps with a firm storm pumping capacity of 2,030 million gallons per days. The station also includes two pumps in the center of the wet well that were originally intended for dewatering. These two pumps currently pump dry weather sanitary flow. Storm pumps convey flow to the Conner Creek CSO Basin and Treatment Facility for screening, settling and disinfection prior to discharge to Conner Creek and the Detroit River.

The purpose of the Freud Pump Station Improvements Project is to make modifications and improvements to enhance protection of the health, safety and welfare of residents served by the pump station for the next 50+ years. The focus of the project is to improve operability, reliability, integrity, and maintainability of the station over the life of the facility. Primary scope items include rehab of the eight storm water pumps including replacement of the pump rotating assembly, line shafts, and concrete pump supports; installing new dewatering pumps inside the Freud Pump Station with an approximate 10.8 MGD firm capacity, providing dedicated access to the Freud Pump wet well to allow draining, cleaning, inspections, and maintenance; and construction of a new Freud Sanitary Pump Station approximately 1.5 blocks east of the existing storm pump station. The sanitary pump station will be constructed over the two 16-ft diameter tunnels that convey flow to the existing Freud Pump Station. The structure includes provisions to add stop logs in the two 16-ft tunnels to isolate Freud Storm Pump Station. The stop logs, along with the improved access to the wet well at the existing Freud Pump Station, will enable Great Lakes Water Authority (GLWA) to inspect, clean and maintain the wet well. The proposed structure will include a sanitary pump station with a firm capacity of 30 million gallons per day to manage dry weather flows. Sanitary pumps will discharge to a proposed 36-inch force on Navahoe Street that will connect to the 9-ft diameter Detroit River Interceptor (DRI) on East Jefferson.

The proposed project will improve the reliability of the station and reduce the risk of collection system surcharging and combined sewage backups into basements. The pump station improves water quality during storm events by conveying flow to the Conner Creek CSO Facility for treatment prior to discharge to the Detroit River.

2 Project Plan Contents

2.1 Delineation of Study Area

Freud Pump Station includes 8 communities serviced by GLWA. GLWA’s service area within the corporate limits of the City of Detroit includes Grosse Pointe, Grosse Pointe Park, Grosse Pointe Farms, Grosse Pointe Woods, Harper Woods, Eastpointe, Roseville, and St. Clair Shores. The study area encompasses a population of approximately 263,400.

The project components include rehabilitation of the existing storm station, existing storm pumps, line shaft, steady bearings, and couplings; replacement of existing storm wet well dewatering pumps; provide storm wet well isolation; provide storm wet well access; and design of a 30 MGD sanitary pump station.

2.2 Environmental Setting

2.2.1 Soils and Geology

A geotechnical report of the project area was completed on March 30, 2021 by NTH (Detroit, Michigan). See **Appendix A** for the Geotechnical Exploration Services, Freud Pump Station Isolation Shaft Report.

2.2.2 Fauna

As many as 50 species of mammals are estimated to inhabit areas within the City of Detroit. Listed as threatened species by the State of Michigan are the least shrew, southern bog lemming, and pine vole. Rare or scarce species include Thompson's pygmy shrew, horny bat, and badger. The evening bat, eastern pipistrelle, and prairie vole are listed as peripheral species.

Surveys conducted by the Audubon Society from 1954 to 1965 recorded a total of 305 species of birds in the Detroit-Windsor area. At least three (3) million waterfowl migrate annually into and through the area.

The Detroit River is an important wintering area for ducks because the United States side of the river rarely freezes due to warm water discharges. An average of 51,000 ducks occupy the river, with counts varying from a high of 155,000 to a low of 21,000. Whistling swans also frequent the area each spring. As many as 18,000 of the birds have been observed at one time, but the average number is about

10,000. These counts may represent as much as 14 percent of the total population of whistling swans in eastern North America.

Two bird species are designated as endangered in Michigan. They are the Peregrine Falcon (Falco peregrinus) and Kirtland's Warbler (Dendrocia Kirtlandii). Only the Peregrine Falcon is known to exist in the Study Area, where it is making a comeback. Six threatened species may also be present in the Study Area. They are Cooper's Hawk (Accipiter cooperi, Bonaparte); Redshouldered Hawk (Buteo lineatus, Gmelin); Marsh Hawk (Circus Cyaneus, Linneaus); Piping Plover (Charadvius melodies, Ord); Barn Owl (Tyto alba, Scopoli); and Loggerhead Shrike (Lanius ludovicianus, Ord).

There are 28 species of reptiles that may be present in the Study Area, none of which is listed as endangered. Threatened reptiles include the Eastern Box Turtle, Kirtland's Water Snake, and the Black Rat Snake. Rare species are the Wood Turtle, Spotted Turtle, Eastern Spiny Softshell Turtle, and the Fivelined Skink.

There are 19 amphibians that may inhabit the Study Area. There are no amphibians considered endangered in Michigan. The Small mouthed Salamander is the only threatened species that is likely to occur in the Study Area. The Four-toed Salamander is a rare species that likely inhabits the Study Area.

This project is not expected to have any negative impact on the species identified.

2.2.3 Historical/Archeological Sites

An archaeological literature review and assessment, and an above-ground historic resource literature review for the Freud Pump Station Improvement Project were completed by the 106 Group (St. Paul, Minnesota). The literature review and assessment reports have been included as **Appendix B** (Archaeological Literature Review and Assessment for the Freud Pump Station Improvement Project), and **Appendix C** (Above-Ground Resources Literature Review for the Freud Pump Station Improvement Project.

2.3 Land Use in the Study Area

The existing land use within the City of Detroit is comprised predominantly of residential, commercial, and industrial uses. Majority of the land in the area has previously been developed. The study area is in the industrial portion of the Detroit Metro area. Future plans of the study area will include acquisition of up to 20 properties that are mostly vacant parcels or contain abandoned structures. Demolition of these abandoned structures and establishing new boundaries will ensure space for development of the new Sanitary Pump Station. Improvements to the existing Freud Pump Station will be contained within the exiting property boundaries.

2.4 Population and Flow Data

2.4.1 Population

The GLWA currently provides wholesale water services to eight southeast Michigan communities including Grosse Pointe, Grosse Pointe Park, Grosse Pointe Farms, Grosse Pointe Woods, Harper Woods, Eastpointe, Roseville, and St. Clair Shores. The existing population served is approximately 263,400.

The existing population served as depicted in **Figure 1** (provided by EGLE), is approximately 263,400

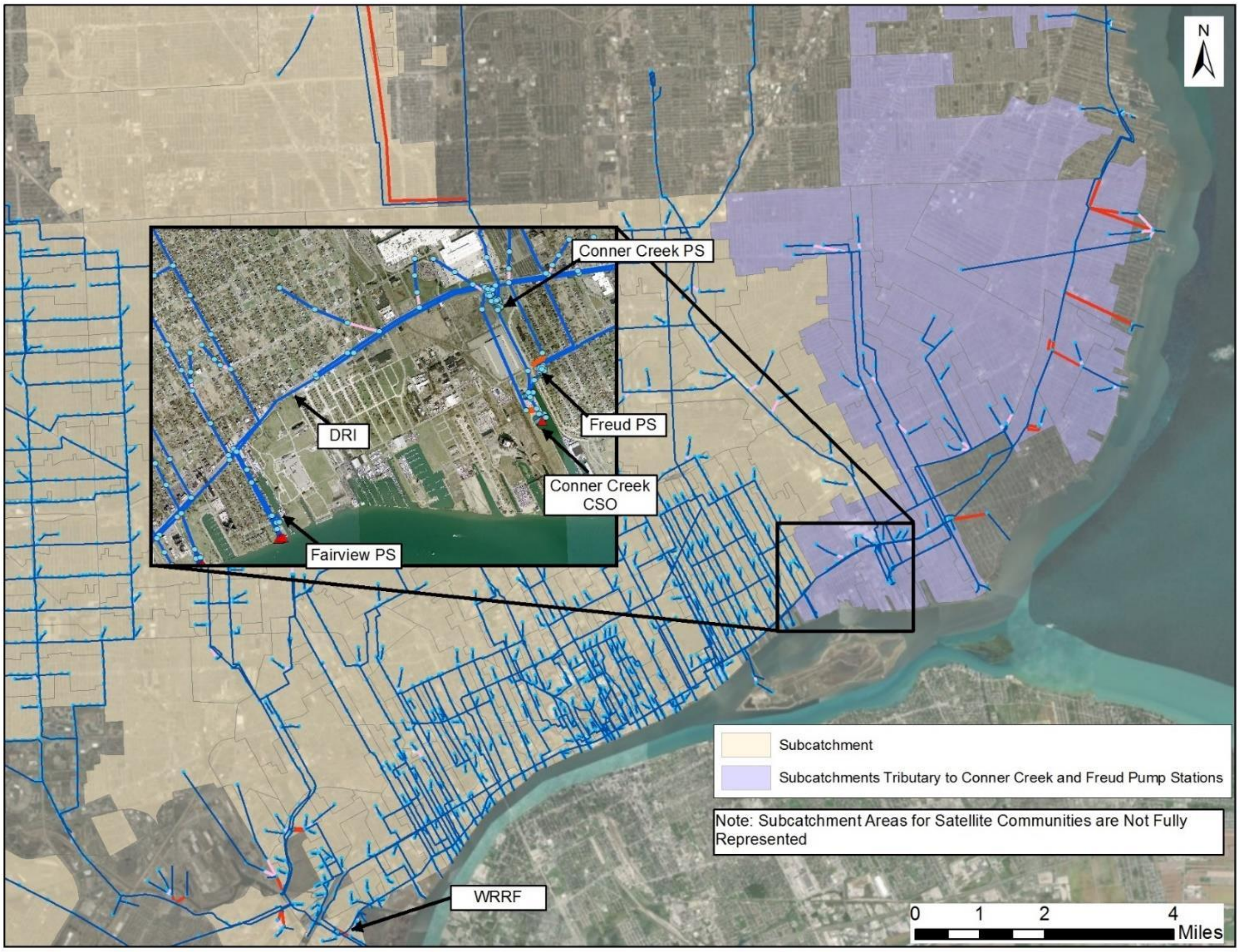


Figure 1: *Population Served*

A. The current and future population to be served by the proposed project.

   The served population is approximately 263,400 people. The serviced population will remain the same in the future. The population is highly based around residential use.

B. Population projections for the study area for the next 5, 10, and 20 years.

   GLWA has performed calculated population projections for the study area through 2060 in the Wastewater Master Plan (see **Table 1**).

***Table 1:** Population Projections for the Study Area*

First and Second Tier Member	Population Type	Existing 2018	Projection								
		2018	2020	2025	2030	2035	2040	2045	2050	2055	2060
Allen Park	Total	28,804	26,971	26,493	26,386	26,517	26,881	27,045	26,263	26,082	25,901
	GLWA	2,650	2,465	2,437	2,428	2,440	2,473	2,488	2,503	2,518	2,533
	Member Comments:	No Comments Provided									
Center Line	Total & GLWA	9,046	8,983	9,000	9,032	9,066	9,100	9,114	9,121	9,139	9,156
	Member Comments:	No Significant Changes Projected									
Dearborn	Total	101,785	101,185	100,886	101,248	101,938	102,644	103,684	104,724	105,764	106,804
	GLWA	92,624	92,078	91,806	92,136	92,764	93,406	94,352	95,299	96,245	97,192
	Member Comments:	Based on 7/10/18 Meeting: "Use Higher of the two Projections for the 2050 to 2060 time period"									
Detroit	Total & GLWA	657,119	638,140	631,668	640,533	657,136	675,608	694,812	714,016	733,220	752,424
	Member Comments:										
Farmington	Total	10,220	10,402	10,420	10,471	10,589	10,764	10,795	10,826	10,857	10,888
	GLWA	8,730	8,886	8,901	8,945	9,045	9,195	9,221	9,248	9,274	9,301
	Member Comments:	2015 - 2030: In fill and redevelopment					2035 - 2060: No predicted in fill or redevelopment				
Grosse Pointe	Total & GLWA	5,326	5,274	5,249	5,257	5,192	5,179	5,194	5,147	5,124	5,101
	Member Comments:	Survey was not Received									
Grosse Pointe Farms	Total & GLWA	9,476	9,248	9,058	9,031	9,112	9,062	9,111	8,955	8,905	8,854
	Member Comments:	No Comments Provided									
Grosse Pointe Park	Total & GLWA	11,555	12,183	12,095	12,024	12,017	12,094	12,201	12,308	12,415	12,522
	Member Comments:	2015 time Period: "fully developed land, estimated from 2010"									
Hamtramck	Total & GLWA	22,902	23,463	22,879	23,038	23,135	23,186	23,349	23,512	23,675	23,838
	Member Comments:	2025 time period: Wayne County Jail might close									
Highland Park	Total & GLWA	11,398	11,512	11,628	11,745	11,862	11,981	12,102	12,223	12,346	12,470
	Member Comments:	2020 through 2060: Projecting Conservative 0.2% growth due to redevelopment									
Melvindale	Total & GLWA	10,160	9,826	9,543	9,584	9,710	9,772	9,830	9,888	9,946	10,004
	Member Comments:	Not Provided									

First and Second Tier Member		Population Type	Existing 2018	Projection								
Evergreen Farmington Sewerage Disposal System (EFDS)	**Auburn Hills**	Total	24,732	26,081	27,123	27,294	27,524	27,838	28,084	28,330	28,576	28,822
		GLWA	1,270	1,339	1,392	1,401	1,413	1,429	1,442	1,454	1,467	1,479
		Member Comments:	No Comments Provided									
	Beverly Hills	Total	10,320	10,121	9,960	9,949	9,949	9,959	10,029	10,099	10,169	10,239
		GLWA	8,812	8,642	8,505	8,495	8,495	8,504	8,564	8,623	8,683	8,743
		Member Comments:	No Comments Provided									
	Bingham Farms Bloomfield Hills	Total & GLWA	1,049	1,026	1,028	1,013	1,041	1,069	1,080	1,080	1,080	1,080
		Member Comments:	No Comments Provided									
		Total & GLWA	4,091	4,037	4,015	4,036	4,082	4,189	4,266	4,343	4,420	4,497
	Bloomfield Township	Member Comments:	No Comments Provided									
		Total & GLWA	41,364	41,192	41,340	41,212	41,446	41,917	42,188	42,459	42,730	43,001
		Member Comments:	No Comments Provided									
	Birmingham	Total	20,516	21,162	21,525	21,732	22,000	22,261	22,251	22,241	22,231	22,221
		GLWA	14,715	15,178	15,439	15,587	15,779	15,967	15,959	16,325	16,527	16,728
		Member Comments:	Redevelopment 2050-2060									
	Farmington	Total	10,220	10,402	10,420	10,471	10,589	10,764	10,795	10,826	10,857	10,888
		GLWA	1,490	1,516	1,519	1,526	1,544	1,569	1,574	1,578	1,583	1,587
		Member Comments:	No Comments Provided									
	Farmington Hills	Total & GLWA	80,033	80,442	81,290	82,283	83,452	84,448	85,200	85,200	85,200	85,200
		Member Comments:	No Comments Provided									
	Franklin Village	Total & GLWA	3,009	2,904	2,889	2,873	2,849	2,925	2,972	3,100	3,200	3,300
		Member Comments:	No Comments Provided									
	Keego Harbor	Total & GLWA	3,039	3,094	3,069	3,078	3,116	3,092	3,148	3,204	3,260	3,316
		Member Comments:	No Comments Provided									
	Lathrup Village	Total & GLWA	3,982	3,949	3,881	3,850	3,852	3,887	3,803	3,719	3,635	3,551
		Member Comments:	No Comments Provided									
	Orchard Lake Village	Total & GLWA	2,353	2,228	2,235	2,231	2,300	2,269	2,263	2,263	2,263	2,263
		Member Comments:	No Comments Provided									
	Southfield	Total	77,859	81,229	81,895	82,092	82,606	83,000	83,816	84,632	85,448	86,264
		GLWA	70,603	73,659	74,263	74,441	74,907	75,265	76,005	76,745	77,484	78,224
		Member Comments:	No Comments Provided									
	Troy	Total	85,299	84,164	83,561	83,409	83,586	83,880	83,911	83,942	83,973	84,004
		GLWA	15,235	15,032	14,925	14,897	14,929	14,982	14,987	14,993	14,998	15,004
		Member Comments	No Comments Provided									
	West Bloomfield Township	Total	65,847	66,660	65,992	66,953	68,631	69,763	69,854	69,945	70,036	70,127
		GLWA	44,906	45,461	45,005	45,661	46,805	47,577	47,639	47,701	47,763	47,825
		Member Comments:	No Comments Provided									

First and Second Tier Member		Population Type	Existing 2018					32,706				
outheast Macomb anitary District (SEMSD)	**Eastpointe**	Total & GLWA	32,706	32,884	31,378	30,555	30,499	30,729	30,843	29,837	29,455	31,185
		Member Comments:	No Comments Provided									
	Roseville	Total & GLWA	47,892	47,525	47,304	46,850	46,697	46,924	46,995	46,527	46,366	46,205
		Member Comments:	No Comments Provided									
	St. Clair Shores	Total & GLWA	60,208	60,986	61,936	62,734	62,595	63,308	63,276	63,244	63,212	63,180
		Member Comments:	No Comments Provided									
	Harper Woods	Total	15,108	14,598	14,387	14,368	14,400	14,602	14,682	14,762	14,842	14,922
		GLWA	14,100	13,624	13,427	13,410	13,439	13,628	13,703	13,777	13,852	13,927
		Member Comments:	No Comments Provided									
	Grosse Pointe Shores	Total & GLWA	2,532	2,447	2,409	2,440	2,499	2,539	2,555	2,571	2,587	2,603
		Member Comments:	No Comments Provided									
	Grosse Pointe Woods	Total & GLWA	15,721	15,262	15,132	15,004	14,948	14,870	15,077	14,731	14,627	14,523
		Member Comments:	No Comments Provided									
Oakland Macomb Interceptor Drain Drainage District Malcomb Interceptor Drain Drainage District (OMIDDD-MIDDD)	**Chesterfield Township**	Total	44,986	48,356	50,892	53,011	54,034	54,674	54,721	54,768	54,815	54,862
		GLWA	42,737	45,938	48,347	50,360	51,332	51,940	51,985	52,030	52,074	52,119
		Member Comments:	No Comments Provided									
	Clinton Township	Total & GLWA	98,523	105,493	108,546	109,376	110,395	111,416	111,937	112,459	112,980	113,501
		Member Comments:	No Comments Provided									
	Fraser	Total & GLWA	14,741	15,001	15,009	15,017	15,025	15,033	15,049	15,065	15,081	15,097
		Member Comments:	No Comments Provided									
	Harrison Township	Total	25,702	26,623	26,765	26,907	27,509	28,111	29,074	30,037	31,000	31,963
		GLWA	23,623	24,544	24,686	26,907	27,509	28,111	29,074	30,037	31,000	31,963
		Member Comments:	No Comments Provided									
	Lenox Township	Total & GLWA:	5,463	5,522	5,913	6,647	7,258	7,359	7,322	8,011	8,390	8,768
		Member Comments:	No Comments Provided									
	Macomb Township	Total	88,223	90,124	93,733	96,320	98,779	98,779	97,427	101,908	103,692	105,477
		GLWA	80,000	83,000	87,200	90,100	92,900	94,850	95,000	99,636	102,293	104,950
		Member Comments:	No Comments Provided									
	New Haven	Total & GLWA	4,966	5,044	4,895	4,867	4,884	4,841	4,692	4,707	4,663	4,619
		Member Comments:	No Comments Provided									
	Shelby Township	Total	73,647	78,129	81,801	82,566	83,237	83,228	83,354	83,480	83,606	83,732
		GLWA	41,629	44,498	47,880	48,601	48,998	48,992	49,066	49,140	49,214	49,288
		Member Comments:	No Comments Provided									
	Sterling Heights	Total & GLWA	133,847	134,714	136,619	138,617	139,504	140,123	141,021	141,919	142,817	143,715
		Member Comments:	No Comments Provided									
	Utica	Total	4,565	4,883	5,133	5,205	5,278	5,188	5,290	5,392	5,494	5,596
		GLWA	4,815	5,133	5,383	5,455	5,528	5,438	5,540	5,642	5,744	5,846
		Member Comments:	No Comments Provided									
	Washington Township	Total	26,447	30,460	31,694	35,119	36,969	37,314	37,227	40,936	42,769	44,602
		GLWA	19,347	22,283	23,085	25,312	26,515	26,740	26,683	29,188	30,415	31,642
		Member Comments:	No Comments Provided									

First and Second Tier Member		Population Type	Existing 2018	Projection								
Oakland Macomb Interceptor Drain Drainage District Clinton-Oakland Sewage Disposal District (OMID-COSDOS)	**Auburn Hills**	Total	24,732	26,081	27,123	27,294	27,524	27,838	28,084	28,330	28,576	28,822
		GLWA	23,463	24,743	25,731	25,893	26,111	26,409	26,643	26,876	27,109	27,343
		Member Comments:	No Comments Provided									
	Clarkston Village	Total & GLWA	876	847	871	875	909	911	919	927	935	943
		Member Comments:	No Comments Provided									
	Independence Township	Total	35,074	36,918	37,471	38,298	39,174	39,782	39,922	40,062	40,202	40,342
		GLWA	17,823	18,760	19,041	19,461	19,907	20,216	20,287	20,358	20,429	20,500
		Member Comments:	No Comments Provided									
	Lake Angelus	Total	300	301	304	295	295	285	290	295	300	305
		GLWA	0	0	0	0	0	0	0	0	0	300
		Member Comments:	No Comments Provided									
	Lake Orion Village	Total	2,830	3,044	3,086	3,130	3,203	3,236	3,295	3,354	3,413	3,472
		GLWA	2,491	2,680	2,717	2,755	2,820	2,849	2,901	2,900	2,900	2,900
		Member Comments:	No Comments Provided									
	Oakland Charter Township	Total	18,176	21,032	21,822	23,887	24,858	26,004	25,924	25,844	25,764	25,684
		GLWA	9,083	10,510	10,905	11,937	12,422	12,995	12,955	12,915	12,875	12,835
		Member Comments:	No Comments Provided									
	Orion Township	Total	35,287	34,815	34,925	35,409	36,570	37,269	37,032	36,795	36,558	36,321
		GLWA	32,950	32,509	32,612	33,064	34,148	34,801	34,580	34,358	34,137	33,916
		Member Comments:	No Comments Provided									
	Oxford Village	Total	3,077	2,837	2,885	2,941	2,953	2,943	2,890	2,837	2,784	2,731
		GLWA	2,554	2,355	2,395	2,441	2,451	2,443	2,399	2,401	2,500	2,600
		Member Comments:	No Comments Provided									
	Oxford Township	Total	16,772	17,720	17,640	18,761	18,976	19,409	19,449	19,489	19,529	19,569
		GLWA	8,076	8,532	8,494	9,033	9,137	9,345	9,365	9,384	9,403	9,422
		Member Comments:	No Comments Provided									
	Rochester	Total & GLWA	13,181	14,164	14,424	14,423	14,454	14,584	14,657	15,026	15,216	15,405
		Member Comments:	No Comments Provided									
	Rochester Hills	Total	73,706	75,288	76,940	77,382	78,711	79,399	79,709	80,019	80,329	80,639
		GLWA	69,904	71,404	72,971	73,390	74,651	75,303	75,597	75,891	76,185	76,479
		Member Comments:	No Comments Provided									
	Waterford Township	Total	74,656	72,080	72,389	72,729	73,020	73,539	74,059	74,579	75,099	75,619
		GLWA	74,656	72,080	72,389	72,729	73,020	73,539	74,000	74,000	74,000	74,000
		Member Comments:	No Comments Provided									
	West Bloomfield Township	Total	65,847	66,660	65,992	66,953	68,631	69,763	69,854	69,945	70,036	70,127
		GLWA	20,941	21,199	20,987	21,292	21,826	22,186	22,215	22,244	22,273	22,302
		Member Comments:	No Comments Provided									

First and Second Tier Member		Population Type	Existing 2018	Projection								
Rouge Valley (RVDS)	Canton Township	Total	92,521	99,462	101,086	106,261	110,226	112,102	114,119	116,136	118,153	120,170
		GLWA	3,945	4,241	4,310	4,531	4,700	4,780	4,866	4,952	5,038	5,124
		Member Comments:	Survey was not Received									
	Dearborn Heights	Total	59,371	61,070	60,865	61,472	62,132	62,246	62,542	62,838	63,134	63,430
		GLWA	39,790	40,929	40,792	41,198	41,641	41,717	41,916	42,114	42,312	42,511
		Member Comments:	Survey was not Received									
	Garden City	Total & GLWA	26,994	26,058	26,049	26,394	26,555	26,647	26,764	26,881	26,998	27,115
		Member Comments:	Survey was not Received									
	Inkster	Total	25,760	25,385	24,808	24,366	24,259	24,263	24,420	24,577	24,734	24,891
		GLWA	25,631	25,258	24,684	24,244	24,138	24,142	24,298	24,454	24,610	24,766
		Member Comments:	Survey was not Received									
	Livonia	Total & GLWA	94,159	92,342	91,997	92,415	92,923	93,665	94,228	94,791	95,354	95,917
		Member Comments:	Survey was not Received									
	Northville	Total	5,828	5,765	5,798	5,888	6,005	6,113	6,183	6,253	6,323	6,393
		GLWA	5,657	5,596	5,628	5,715	5,829	5,934	6,002	6,070	6,138	6,206
		Member Comments:	Survey was not Received									
	Northville Township	Total	30,306	33,921	34,771	35,292	36,157	36,282	36,886	37,490	38,094	38,698
		GLWA	171	191	196	199	204	205	208	212	215	218
		Member Comments:	Survey was not Received									
	Novi	Total & GLWA	60,458	63,966	64,801	65,638	66,609	67,061	67,417	67,773	68,129	68,485
		GLWA	54,026	57,161	57,907	58,655	59,523	59,927	60,245	60,563	60,881	61,199
		Member Comments:	Survey was not Received									
	Plymouth	Total & GLWA	8,872	9,090	9,341	9,468	9,534	9,592	9,786	9,980	10,174	10,368
		Member Comments:	Survey was not Received									
	Plymouth Township	Total	27,440	28,843	29,130	29,622	30,121	30,598	30,649	30,700	30,751	30,802
		GLWA	1,105	1,161	1,173	1,192	1,213	1,232	1,234	1,236	1,238	1,240
		Member Comments:	Survey was not Received									
	Redford	Total	47,880	45,349	44,719	44,758	44,772	45,064	45,277	45,490	45,703	45,916
		GLWA	46,571	44,109	43,497	43,535	43,548	43,832	44,039	44,247	44,454	44,661
		Member Comments:	Survey was not Received									
	Romulus	Total	24,010	23,918	24,425	24,706	24,836	25,818	26,330	26,842	27,354	27,866
		GLWA	2,364	2,355	2,405	2,433	2,445	2,542	2,592	2,643	2,693	2,744
		Member Comments:	Survey was not Received									
	Van Buren Township	Total	29,274	30,773	31,898	33,163	34,064	35,398	35,966	36,534	37,102	37,670
		GLWA	7,047	7,408	7,679	7,983	8,200	8,521	8,658	8,795	8,931	9,068
		Member Comments:	Survey was not Received									
	Wayne	Total & GLWA	17,010	16,189	15,867	15,995	15,737	15,810	15,910	16,010	16,110	16,210
		Member Comments:	Survey was not Received									
	Westland	Total & GLWA	83,452	83,455	83,475	83,405	83,841	84,462	85,427	86,392	87,357	88,322
		Member Comments:	Survey was not Received									

First and Second Tier Member		Population Type	Existing 2018	Projection								
S.E. Oakland (GWK)	Berkley	Total & GLWA	15,166	14,592	14,807	14,889	14,997	14,913	14,964	15,015	15,066	15,117
		Member Comments:	No Comments Provided									
	Beverly Hills	Total	10,320	10,121	9,960	9,949	9,949	9,959	10,029	10,099	10,169	10,239
		GLWA	1,508	1,479	1,455	1,454	1,454	1,455	1,465	1,476	1,486	1,496
		Member Comments:	No Comments Provided									
	Birmingham	Total	20,516	21,162	21,525	21,732	22,000	22,261	22,251	22,241	22,231	22,221
		GLWA	5,801	5,984	6,086	6,145	6,221	6,294	6,292	6,436	6,515	6,595
		Member Comments:	No Comments Provided									
	Clawson	Total & GLWA	11,661	11,494	11,674	11,647	11,736	11,834	11,935	12,036	12,137	12,238
		Member Comments:	No Comments Provided									
	Ferndale	Total & GLWA	20,428	20,173	20,635	20,793	20,942	21,164	21,069	20,974	20,879	20,784
		Member Comments:	No Comments Provided									
	Hazel Park	Total & GLWA	16,016	14,886	14,817	14,604	14,532	14,550	14,448	14,500	14,500	14,500
		Member Comments:	No Comments Provided									
	Huntington Woods	Total & GLWA	6,230	6,247	6,246	6,222	6,267	6,257	6,247	6,237	6,227	6,217
		Member Comments:	No Comments Provided									
	Madison Heights	Total & GLWA	30,749	29,275	29,614	29,520	29,456	29,672	29,757	29,800	29,800	29,800
		Member Comments:	No Comments Provided									
	Oak Park	Total & GLWA	30,837	30,186	29,919	29,539	29,380	29,291	29,129	28,967	28,805	28,643
		Member Comments:	No Comments Provided									
	Pleasant Ridge	Total & GLWA	2,489	2,395	2,447	2,462	2,468	2,449	2,518	2,600	2,650	2,775
		Member Comments:	No Comments Provided									
	Royal Oak	Total & GLWA	59,510	59,930	60,556	60,838	60,665	61,112	61,612	62,000	62,000	62,000
		Member Comments:	No Comments Provided									
	Royal Oak Township	Total & GLWA	2,378	2,449	2,407	2,368	2,333	2,343	2,313	2,283	2,253	2,223
		Member Comments:	No Comments Provided									
	Southfield	Total	77,859	81,229	81,895	82,092	82,606	83,000	83,816	84,632	85,448	86,264
		GLWA	7,256	7,570	7,632	7,651	7,699	7,735	7,811	7,887	7,964	8,040
		Member Comments:	No Comments Provided									
	Troy	Total	85,299	84,164	83,561	83,409	83,586	83,880	83,911	83,942	83,973	84,004
		GLWA	70,064	69,132	68,636	68,512	68,657	68,898	68,924	68,949	68,975	69,000
		Member Comments:	No Comments Provided									
Summation		Total	3,109,514	3,130,187	3,147,597	3,186,284	3,231,476	3,272,637	3,305,482	3,345,047	3,380,862	3,418,865
		GLWA	2,752,672	2,756,773	2,769,676	2,799,893	2,836,706	2,873,542	2,903,855	2,939,306	2,971,592	3,006,367

2.4.2 Flow

Wastewater flows in the GLWA system have been analyzed in the past for both dry and wet periods. The Freud Storm Pump Station has a firm capacity of 2,000 MGD and is crucial to maintain operability of managing wet weather flow. For purposes of the analysis, dry weather flows were determined based on an examination of water consumption, and metering data. Historical data collected, showed a daily average consumption of 30 MGD. The 30 MGD reflects water production rates with adjustments for those municipalities who receive water from GLWA, but who do not discharge wastewater into the system.

2.5 Economic Characteristic

A. The economic structure and major employers.
    - Chrysler manufacturing has a large presence in the study area, as well as several other industrial facilities west of the project site. The existing Freud Pump Station is at the corner of Freud St and Tennessee Avenue. Otherwise, the immediate project area is mostly residential with several vacant or abandoned parcels.

B. The median annual household income in the study area.
    - $32,498 according to 2020 census (https://www.census.gov/quickfacts/detroitcitymichigan)

2.6 Existing Facilities

A. The method of wastewater treatment and the physical condition of facilities (i.e., years in service, capacity, and efficiency of the major components).

Current physical conditions are showing wear and are approaching or surpassed the expected useful life. The interior and exterior of the station has structural damage and must be repaired. Many components of the pump station are not code compliant and require attention.

The two sanitary pumps are located at the lowest level in the station and handle the dry weather sanitary flow. These pumps were originally dewatering pumps for intermittent use but were repurposed for full time use as sanitary pumps and may not be operating within the original design range. The pumps are removed for rebuilding/replacement periodically and are switched with spares that are kept on hand at the station. The condition of the pumps is good with minor corrosion of some of the hardware and the steel supports.

The eight Storm Pumps are original to the station that was built in 1954. The pumps are in fair condition but all have multiple layers of paint, which is peeling over a large portion of the pumps with corrosion covering large portions due to moisture at the lower level in the station. The concrete support piers show various levels of cracking from very minor hairline cracks to major cracks on a couple of the piers, although no pieces of concrete are missing. The discharge piping for the pumps is also showing a significant amount of corrosion.

The Sump Pumps consist of two submersible pumps installed in a pit at the lowest level of the station and a third submersible pump, which is sitting on the floor adjacent to the sump. The two pumps in the pit are inaccessible. All the pumps are in service and functioning. The piping for pumps #1 and #2 show corrosion on the steel piping, and some piping has been replaced with PVC piping. Pump #3 appears to have been added later than the others and is piped with PVC piping. There is also an open electrical box for the pump controls that needs a cover.

The two Sanitary Pump Influent Gates are located below the sanitary pumps and are a knife gate style valve. These have a significant amount of corrosion and one of the operator supports is delaminating due to the corrosion. The electric actuator for gate #10 has been removed and a handwheel has been installed on the gear operator.

The two Sanitary Discharge Gates are gate valves installed in a pit outside the station along the fence. The gate valves and associated piping have significant corrosion due to moisture in the pit. The valve operators and electric actuators are of an older style and have multiple layers of paint that is peeling in some areas. The flexible conduit for Gate #10 is split and is separating from the junction box, and has exposed wiring. It is not known if this actuator is functional.

The Overflow Gate is located on the discharge for sanitary pump #10 and is an enclosed knife gate type. Corrosion of the valve is minimal, but there is peeling paint exposing what is likely the factory paint underneath. The valve stem and operator are in good condition.

The Dewatering Gate is a cast iron style sluice gate with an electric actuator located just inside the station near the loading dock. The gate and stem appear serviceable, but have some corrosion. The gate operator and electric actuator are in good condition and have minimal corrosion, but are an older style. GLWA staff reports that this gate has never been operated.

The Air Compressor System is a horizontal tank style with a belt driven compressor pump and is located on the motor floor of the station. The pressure gauge is in poor condition and is missing the glass. There have been reliability issues in the past and the compressor pump may have been rebuilt or replaced at some point, as it appears newer than the remainder of the system.

The Bridge Crane has a 20-ton capacity and is likely original to the station construction in 1954. Corrosion is minimal and operation appears to be good, as it was in use during the day of the condition assessment, although it was only used to lift tools from the lower level. Operators noted that the crane does make noise when it is under a greater load lifting pumps.

The exterior masonry brick is in good condition from the main floor level and above. Below the main floor level, there is, in certain areas, efflorescence in addition to deteriorating concrete and rusting metal (see photos). Cleaning, tucking, pointing repair work of masonry as well as cleaning and repairs/replacement of concrete and/or metal support work is needed. At this time, the mortar issues are mostly cosmetic but in some areas, tucking, pointing and repairs are warranted or they may become structural concerns in the future. For bidding purposes, it is recommended to include 20% of wall area for tucking, pointing, or repair work. This can be handled as part of the base bid or an allowance. Overall, the glazed masonry on the interior side of the exterior walls is in good condition. It does not appear that repair or replacement are required at this time.

In most of the building areas, the quarry tile is in good condition. However, certain areas have significant damage or have detached completely from the subfloor and require replacement. This is particularly the case in the loading dock area as well as on the exterior of the North part of the building. GLWA staff requested alternate floor options for the loading area that do not involve tile and that will better withstand the loads and frequent movement in this area. Metal tracks were suggested for moving the heavy equipment from the crane drop off to the exterior dock and vice versa. Arcadis recommends additional investigation into equipment that can better move the pumps into and out of the facility. The existing floor finish (quarry tile) can be removed and replaced with new tile or terrazzo flooring and the metal tracks can be installed. However, Arcadis believes that if it is the intent to continue to use the existing skid in the future to move the pumps, any new flooring will eventually be damaged, regardless of metal tracks. We can help investigate options such as air pallets which utilize compressed air. For the exterior of the North part of the building, we recommend removal of the existing tile, grinding and sealing of the existing concrete beneath the tile, but no replacement tile unless some new floor finish is desired by the owner. It should also be noted that the current stairway up to the loading dock is not code compliant and must be replaced in its entirety. If accessibility is warranted for the facility, a ramp can be designed along with the new stair.

No leakage problems were observed on the interior or exterior of this building. Minimal standing water. The roof appears to be in reasonably good condition. Additionally, the roof drains appear to be adequately removing water from the roofs.

Personnel doors and frames appear to be in good condition. If door replacement is desired by the owners as part of this work, insulated FRP (fiber reinforced plastic) or insulated metal doors are recommended.

The exterior overhead door and personnel door and window assembly (second row, left) has been modified over the years. It may be desirable by the owner for Arcadis to propose a redesign of this entryway, replacing both doors and the windows to provide a more functional configuration for current use.

The window frames appear to be original and are in reasonably good condition. The glass was replaced with an opaque, flexible material to deal with a problem of vandals attempting to break the glass. It is our understanding that the owners would like to replace the opaque material with something transparent (clear glass) or translucent (frosted glass) to permit daylight to enter the facility. The material selected will be resistant to vandalism. If the owners desire operable windows in certain locations, those window frames will require replacement.

The toilet room fixtures are in fair condition. It may be desirable to replace these as part of the current work and update them to comply with current ADA (accessibility) requirements. However, it may be noted that the existing toilet room is only accessible by traveling up a flight of stairs to the main building entry (no accessible entry exists). Nevertheless, if the toilet room will receive new fixtures, the new fixtures and toilet room layout will be required to comply with current accessibility requirements, particularly if an accessible ramp to get to the main floor level will be provided as part of this work.

The existing personnel elevator is not functioning properly and requires replacement currently. A new elevator will be selected as part of the design and specifications of this work.

B. The method of sludge handling/disposal and the status of the Residuals Management Program.

There is no sludge handling/disposal.

C. The type of collection facilities, including the physical condition and location of existing collector sewers, interceptors, outfalls, and pump stations.

The current sanitary water discharges to the DRI, which discharges to the Water Recourse Recovery Facility (WRRF). The current storm water discharges to the Conner Creek CSO facility.

The Freud Pump Station consists of one main building, housing both the storm water, sanitary pumps, and three ancillary structures. The three ancillary structures include the Transformer Containment Pad, Generator and Diesel Fuel Storage Tank Pad and Perimeter Wall, and East Site Retaining Wall.

D. The location of all treatment plants, sludge management and industrial pretreatment facilities, pumping station, and collection systems.

The pump station is located at the intersection of Freud Street and Tennessee Street in the northeast portion of Detroit. The station is in the industrial part of the city and Chrysler manufacturing plants are in proximity. The Chrysler manufacturing plants pretreat their water on their own before discharging into the DRI. The Freud Pump Station is located along the Detroit River. Wet weather is collected from Detroit’s east side and pumped to the Conner Creek CSO facility.

E. The design capacity, existing flows, and characteristics of wastes.

The current facility has a firm capacity of 2000 MGD with a daily dry weather flow of 30 MGD In the event of overflowing, water discharges to the Conner Creek CSO next to the Freud Pump Station.

F. The average and peak dry-weather and wet-weather flows received by the treatment and collection facilities.

The Freud Storm Pump Station has a firm capacity of 2,000 MGD and dry weather conditions typically operate at 30 MGD.

G. The existence of any combined sewers and their impact on wastewater treatment and collection facilities.

The Freud Pump Station influent is part of a combined sewer collection system. Dry weather flow is conveyed to the WRRF while wet weather flow is pumped to the Conner Creek Pump Station Combined Sewer Overflow (CSO) facility.

H. The location of all system bypasses, including sanitary sewer overflows (SSO), with their frequency, duration, and cause.

The Freud Pump Station influent is part of a combined sewer collection system. Dry weather flow is conveyed to the WRRF while wet weather flow is pumped to the Conner Creek Combined Sewer Overflow (CSO) facility.

I. The location of all combined sewer overflows (CSO), with their frequency, duration, and cause.

The GLWA collection system consists of nine CSO basins, including the Conner Creek CSO facility.

J. An evaluation of pump station capacities.

The Freud Storm Pump Station has a firm capacity of 2000 MGD and an average daily dry weather flow of 30 MGD.

K. The adequacy of pump stations (e.g., backup power, alarms, controls, wet well/dry well separation) in maintaining sewer system integrity.

The existing Freud Pump Station storm pumps are adequate to handle the wet weather pumping demands. However, expected service life limitations require improvements to maintain reliability. The wetwell in the existing Freud Pump Station is a single, combined wet well that receives flow from the two 16-foot diameter sewers, with no ability to isolate or separate. The new Sanitary Pump Station structure will include the ability to isolate the existing Freud Pump Station wet well.

L. The existence of any operation or maintenance problems.

Recommended maintenance:

Isolation of Individual Sanitary Pump Units- Provide the ability to reliably and safely isolate or remove the individual pumping units for maintenance without impacting the performance of the other pumping units. The existing station layout provides isolation for the Dewatering/Sanitary Pumps, but not for the Storm Pumps.

Isolation of Wet Wells- Provide the ability to reliably and safely isolate the pump station wet wells to allow maintenance. This is a criterion of GLWA, as there is currently no means to prevent flow from entering the existing Freud Pump Station combined wet well from the 16-ft diameter sewers.

Equipment Removal Safety- Provide provisions to facilitate removal of pumps, motors, and other major mechanical or electrical equipment. Individual pump and motor removal shall not interfere with continued operation of remaining pumps.

M. An evaluation of the system’s climate resiliency. The system’s ability to withstand and respond to changes resulting from climatic factors, such as increased flooding risks, increased intensity or frequency of storm events, should be evaluated. The availability of back-up power to continue facility operations should be discussed.

   The 100-year flood elevation is EL 579.00 NAVD88 (EL 99.75 Detroit Datum) based on the FEMA NFIP firm map 26163C0302E (February 2, 2012). The Freud Storm Pump Station is outside of the 100-year flood elevation. The current Freud Storm Pump Station has a finished floor elevation of EL 585.23 NAVD88 (EL 105.98 Detroit Datum), and the Freud Sanitary Station will have a finished floor elevation of EL 508.25 NAVD88 (EL 101.00 Detroit Datum).

   The Freud Pump Station has three power utility feeds from Detroit Edison that each connect into an existing four bus, ringed configuration switchgear. In addition, the Freud Pump Station has four existing 2,281 KVA generators that were installed in 1999, and are paralleled together and connected only to one utility feeder (Porter Substation Feeder 132A). The generator system is configured to provide standby power to the one switchgear bus that it is connected to (Bus 2); the existing generators are not connected to Ludden Substation Feeder 161 nor the Ludden Substation Feeder 208. The generator system provides standby power to the entire Bus 2, including two existing Storm Pumps, one Dewatering Pump, and a House Power transformer/panel.

2.7 Fiscal Sustainability Plan

In addition to the GLWA Asset Management Plan, which includes the Freud Pump Station, a physical Condition Assessment was completed by the Arcadis team at the Conner Creek and Freud Pump Stations on August 22nd and 23rd, 2017 (see **Appendix D**). The assessment focused on taking inventory and assessing the existing facilities and assets at each pump station, including but not limited to the structures and architectural elements, storm water and sanitary pumping systems, bridge cranes, and electrical and HVAC systems. Design professionals included an architect, and structural, process mechanical, HVAC/plumbing, and electrical/instrumentation and control engineers.

The Freud Pump Station functions as part of the overall wastewater collection system for Detroit’s eastside. During dry weather conditions, the normal water and energy usage is minimal in order to provide pumping operations necessary to convey wastewater to the WRRF. During wet weather conditions, the energy usage can be high due to the operation of large stormwater pumps. However, the stormwater pumps are powered with synchronous motors to maximize the power efficiency used to convey water. Aside from the time of operating the stormwater pumps, water and energy usage is low. As part of the proposed improvements, some of the water lines will be replaced to extend the expected useful life and minimize potential for leaks due to aging assets.

2.8 Need for the Project

The Freud Pump Station is a key component in relaying wastewater and storm water generated in the eastern portion of Detroit. The operation of these facilities is critical to prevent flooding of stakeholders' premises. The Freud Storm Pump Station has a firm capacity of 2,000 MGD and this must be maintained.

The purpose of the Freud Pump Station Improvements Project is to make modifications and improvements to the pump station to protect the health, safety and welfare of residents served by improving operability, reliability, integrity, and maintainability. Primary scope items include rehab of the storm water pumps including replacement of the pump rotating assembly, line shafts, and concrete pump supports for managing the station capacity of 2,000 MGD, design of a single isolation shaft with a 30 MGD firm sanitary capacity to manage dry weather flow conditions, installing new dewatering pumps inside the Freud Pump Station to provide access to the Freud Pump wet well to allow draining, cleaning, inspections, and maintenance.

The flooding events of 2021 to reinforce the need for the Freud Pump Station to operate reliably. The Freud Sanitary Pump Station is needed to allow for safe isolation of the Freud Storm Pump Station for inspection, repairs as needed to ensure proper functionality. The existing Freud Storm Pump Station dewatering pumps were never intended to operate as daily sanitary service. The current Freud Storm Pump Station dewatering pumps are operating outside the allowable operating range which requires the pumps to be repaired and serviced yearly.

2.8.1 Orders

As of this date there are no court orders, federal or state enforcement orders, and/or administrative consent orders. However, the recent 2021 flooding events in the service area demonstrated the need for this project.

2.8.2 Projected Needs for the Next 20 Years

The updated changes will allow for better reliability, isolation, and long-term dependability. The current pump station lacks access to the wet well. The new Sanitary Pump Station structure will allow for wet well isolation at the existing Freud Pump Station. Minor adjustments and maintenance will be the extent of work needed in the near future of the pump station.

2.8.3 Future Environment without the Proposed Project

The proposed project will improve the reliability of the station and reduce the risk of collection system surcharging and combined sewage backups into basements. The pump station improves water quality during storm events by conveying flow to the Conner Creek CSO Facility for treatment prior to discharge to the Detroit River. Without proceeding with the proposed project, GLWA will be challenged to reliably protect the health, safety, and welfare of the citizens within the service area of the Freud

Pump Station. This challenge is related to maintaining the reliability of the pumping system with the potential for sewer back-up and flooding related to the increasing frequency and intensity of storms and their impact on the existing combined sewer system.

3 Analysis of Alternatives

3.1 Identification of Potential Alternatives

See **Appendix E** (Freud and Conner Creek Pump Station Improvements, Concept Alternatives Evaluation, November 2017) for potential alternatives considered. As this project relates only the Freud Pump Station, the Conner Creek Pump Station was also included in this Concept Alternatives Analysis report.

4 Selected Alternative

4.1 Basis of Design

See **Appendix F** (Freud Pump Station Improvements, Basis of Design Report, August 2020) for information on selected alternative.

4.1.1 Relevant Design Parameters

Alternative 2 - Significant Improvements of Freud Pump Station - This alternative receives the highest ranking, as it satisfies most of the operational and maintenance requirements. Although this alternative largely plans to utilize the existing Freud Pump Station infrastructure, the storm pump configuration and pumping capacity is acceptable. Plus, the addition of a new Sanitary Pump Station allows for improved isolation and maintenance long term. Since the alternatives were analyzed, the project team has identified the final location for the new Sanitary Pump Station to be located within the existing Freud Street, directly over the existing 16-foot parallel sewers (Ashland and Fox Creek Relief Sewers), between Conner Street and Navahoe Street.

4.1.2 Property Acquisition

The selected alternative, specifically the new Sanitary Pump Station and the requirement to permanently re-route Freud Street around the pump station, requires 20 parcels to be purchased. GLWA is currently in varying stages of closing on each property but has verbally accepted terms on all properties to be acquired.

4.1.3 Project Maps

See **Appendix F** (Freud Pump Station Improvements, Basis of Design Report, August 2020) for a site plan of the new Sanitary Pump Station.

4.1.4 Sensitive Features

Construction will not occur in or near environmentally or other sensitive features, therefore, no mitigation measures are necessary.

The work sequence to install the improvements at the pump station will require a great deal of coordination, since the station needs to remain in operation to convey both dry and wet weather flows as necessary.

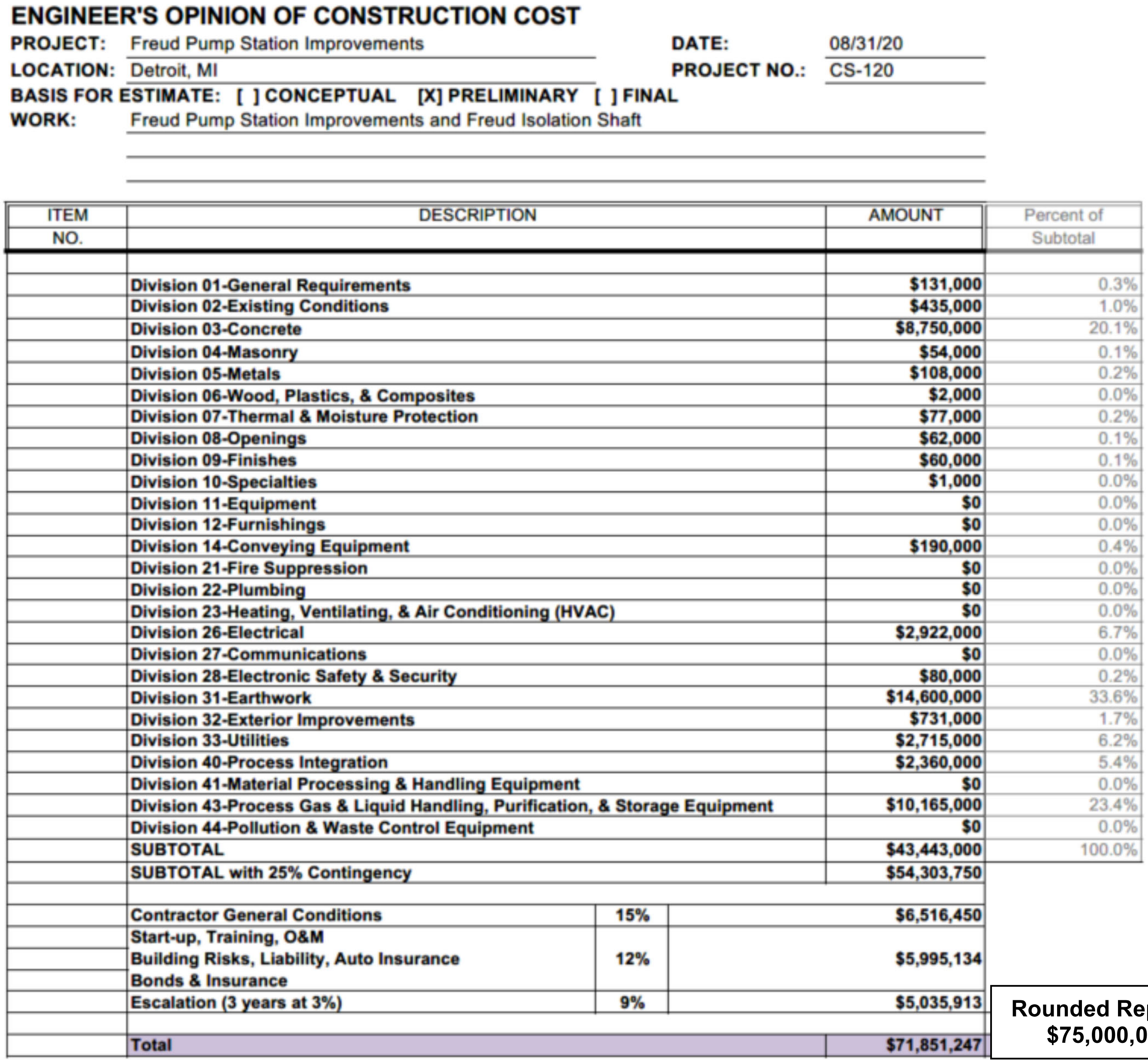
Freud Street will be rerouted and realigned, resulting in road closure during the construction process. The street will be demolished, and utilities will be redirected to install the sanitary wet well, isolation gate risers, and structural framing.

4.1.5 Schedule for Design and Construction

The Freud Pump Station Improvement Project Construction Schedule is planned as follows:

- Design Complete – 2Q22
- Construction Start – 2Q23
- Project Completion – 4Q26

4.1.6 Cost Summary



ENGINEER'S OPINION OF CONSTRUCTION COST

PROJECT: Freud Pump Station Improvements **DATE:** 08/31/20

LOCATION: Detroit, MI **PROJECT NO.:** CS-120

BASIS FOR ESTIMATE: [ ] CONCEPTUAL [X] PRELIMINARY [ ] FINAL

WORK: Freud Pump Station Improvements and Freud Isolation Shaft

ITEM NO.	DESCRIPTION		AMOUNT	Percent of Subtotal
	Division 01-General Requirements		**$131,000**	0.3%
	Division 02-Existing Conditions		**$435,000**	1.0%
	Division 03-Concrete		**$8,750,000**	20.1%
	Division 04-Masonry		**$54,000**	0.1%
	Division 05-Metals		**$108,000**	0.2%
	Division 06-Wood, Plastics, & Composites		**$2,000**	0.0%
	Division 07-Thermal & Moisture Protection		**$77,000**	0.2%
	Division 08-Openings		**$62,000**	0.1%
	Division 09-Finishes		**$60,000**	0.1%
	Division 10-Specialties		**$1,000**	0.0%
	Division 11-Equipment		**$0**	0.0%
	Division 12-Furnishings		**$0**	0.0%
	Division 14-Conveying Equipment		**$190,000**	0.4%
	Division 21-Fire Suppression		**$0**	0.0%
	Division 22-Plumbing		**$0**	0.0%
	Division 23-Heating, Ventilating, & Air Conditioning (HVAC)		**$0**	0.0%
	Division 26-Electrical		**$2,922,000**	6.7%
	Division 27-Communications		**$0**	0.0%
	Division 28-Electronic Safety & Security		**$80,000**	0.2%
	Division 31-Earthwork		**$14,600,000**	33.6%
	Division 32-Exterior Improvements		**$731,000**	1.7%
	Division 33-Utilities		**$2,715,000**	6.2%
	Division 40-Process Integration		**$2,360,000**	5.4%
	Division 41-Material Processing & Handling Equipment		**$0**	0.0%
	Division 43-Process Gas & Liquid Handling, Purification, & Storage Equipment		**$10,165,000**	23.4%
	Division 44-Pollution & Waste Control Equipment		**$0**	0.0%
	SUBTOTAL		**$43,443,000**	100.0%
	SUBTOTAL with 25% Contingency		**$54,303,750**	
	Contractor General Conditions	**15%**	**$6,516,450**	
	Start-up, Training, O&M **Building Risks, Liability, Auto Insurance** **Bonds & Insurance**	**12%**	**$5,995,134**	
	Escalation (3 years at 3%)	**9%**	**$5,035,913**	
	Total		**$71,851,247**	

Rounded Report #
$75,000,000

4.2 Authority to Implement the Selected Alternative

GLWA has the legal authority, capability, and willingness to plan, finance, build, operate, and maintain the facilities associated with this project. While GLWA has the authority to advance the project, GLWA has also solicited input, feedback, and buy-in from DWSD, GLWA Member Communities, and a separate Value Engineering Technical Team.

4.3 User Costs

The project cost variables include the following items:

A. Capital expenditures (e.g., debt retirement, hook-up/tap-in fees, special assessments).

Probable capital cost is estimated at $75,000,000

B. Operation and maintenance.

The updated improvements will allow for better reliability, isolation, and long-term dependability and maintainability. The operation and maintenance costs at the existing Freud Pump Station are expected to be reduced from current conditions. However, since the Sanitary Pump Station will be brand new, an element of additional operation and maintenance cost and associated effort will be introduced. However, the design of the new station has been coordinated with the GLWA operation and maintenance team to minimize effort and maximize maintainability for the long-term.

The Freud Pump Station Improvements Project recommended in this Project Plan is targeted for low interest loan assistance through the SRF program. The availability of loan funds is dependent on annual appropriations and the placement of the projects on the Priority List prepared annually by EGLE.

Repayment of the SRF loan through annual debt retirement payments will impact the customer rates resulting in increased user costs. This impact to customer rates is generally determined by dividing the additional expenses among the users in the service area as summarized in **Table 2**. The annualized cost of the project was calculated using the conversion factor 0.0454 and the following formula:

$$A = PW \times [(i(1 + i)^n)/((1 + i)^n - 1)]$$

Where:

A = Equivalent Annual Cost

PW = Present Worth

i = Interest Rate through SRF Loan (2.125%)

n = Number of Years (30)

[(i(1 + i)n)/((1 + i)n – 1)] = Conversion Factor

Table 2: *User Cost Impact for the Freud Pump Station Improvement Project*

Item	**Improvements**
Total Cost of Project	$75,000,000
Annualized Cost of Project (assuming SRF interest rate of 2.125% over 30 years)	$3,405,000
Service Area Households	263,400
Estimated Household User Cost	~$12.93 / household / year

4.4 Disadvantaged Community

The Freud Pump Station is located within the limits of the City of Detroit, in an identified disadvantaged community. Per the published census data link below, 33.2% of people living in the community are in poverty. (https://www.census.gov/quickfacts/fact/table/detroitcitymichigan#)

The SRF program includes provisions for qualifying the applicant community as a disadvantaged community. The benefits for communities with a population of 10,000 or more that quality for the disadvantaged community status consist of:

- Award of 30 additional priority points.
- Possible extension of the loan term to 30 years or the useful life of the components funded, whichever is earlier. The estimated useful life for the major components of the project is 50 years. GLWA is aware that the SRF program offers both 20 and 30 year loan terms and will evaluate which term is the most appropriate for GLWA and its customers.

ELGE requires submittal of a Disadvantaged Community Status Determination Worksheet to determine if the community qualifies for this status. A template worksheet is included in **Appendix G** and will be completed in the final Project Plan.

4.5 Useful Life

The Freud Pump Station was constructed in 1954 and the reliability of the facility in general is nearly the end of its expected useful life. While some repairs and maintenance has been completed over the years, more significant improvements are necessary to enhance dependability and maintainability of the pump station. Architectural and structural repairs are necessary to extend the facility's use for the next 50+ years. HVAC improvements are needed to improve ventilation per the current building code and to update the mechanical equipment for the next 15 – 20 years. Pumping and process equipment improvements and replacement will also extend the useful life for the next 15 – 20 years.

5 Evaluation of Environmental Impacts

5.1 Analysis of Impacts

5.1.1 Direct Impacts

Construction of the proposed project is not expected to have an adverse effect on historical, archaeological, geographic, or cultural areas, as the construction activities will occur in the areas within the project boundaries. The proposed project will not detrimentally affect the water quality of the area, wetlands, endangered species, wild and scenic rivers, or unique agricultural lands.

More significant direct impacts are associated with the proposed change to the existing Freud Street as a result of the new Sanitary Pump Station construction. Traffic impacts will be coordinated during the construction phase, and a new traffic pattern will be permanently implemented after the project is complete.

The design drawings reflect the minimal demolition necessary to clear vacant parcels and remove abandoned structures in the vicinity of the new Sanitary Pump Station. New easements and rights-of-way will be established associated with the Freud Street realignment.

Construction activities will be normally conducted during the weekday, daylight hours. Once construction is complete, the normal operation of the new Sanitary Pump Station will have negligible impact on the surrounding residents. Coordination with the City of Detroit departments has been conducted and input has been incorporated into the design.

Construction activities and operations after construction at the existing Freud Pump Station are negligible and expected to be generally unchanged from current conditions.

5.1.2 Indirect Impacts

It is not anticipated that GLWA’s proposed improvements to the Freud Pump Station will alter the ongoing pattern of growth and development in the study area. Growth patterns in the service area are subject to local use and zoning plans, thus providing further opportunity to minimize indirect impacts.

5.1.3 Cumulative Impacts

Providing improvements to the existing collection system, especially improving pumping reliability, will provide an overall positive cumulative impact over time. Public confidence is expected to build over time.

6 Mitigation

6.1 General

Where adverse impacts cannot be avoided, mitigation methods will be implemented. Mitigating measures for the projects such as soil erosion control, if required, will be utilized as necessary and in accordance with applicable laws. Details will be further specified in the construction contract documents used for the project.

6.2 Short-Term Construction-Related Impacts

Short-term impacts due to construction activities such as noise, dust, minor traffic disruption, and deep construction activities cannot be avoided. However, efforts will be made to minimize the adverse impacts by use of thorough design and well-planned construction sequencing. Site restoration will minimize the adverse impacts of construction, and adherence to the Soil Erosion and Sedimentation Act will minimize the impacts due to disturbance of the soil structure, if such disturbance is found to be necessary. Specific techniques will be specified in the construction contract documents.

6.3 Mitigation of Long-Term Impacts

The rerouting of Freud Street will be a long-term impact that is unavoidable in order to intercept the existing 16-foot sewer below the existing Freud Street. Recognizing the impact, the design has worked with the City of Detroit to incorporate feedback and design elements related to aesthetic and traffic flow intended to minimize negativity associated with the long-term impact.

Additional adverse long-term impacts due to the proposed project are not anticipated. The aesthetic impacts of construction activities within the boundaries of the WRRF will be mitigated by site restoration.

6.4 Mitigation of Indirect Impacts

In general, it is not anticipated that mitigative measures to address indirect impacts will be necessary for the recommended improvements addressed in this Project Plan. The proposed improvements do not promote growth in areas not currently served by GLWA. Therefore, indirect impacts are not likely to be a significant concern for these improvements.

7 Public Participation

7.1 Public Hearing

7.1.1 Public Hearing Advertisements and Notice

A Public Hearing Notice was published to alert parties interested in this Project Plan and request input prior to its adoption. In addition, a direct mail notification was sent to the potentially interested parties included on a mailing list provided by GLWA. This direct mail notice included an invitation to comment. No comments were received to-date.

7.1.2 Public Hearing Transcript

A formal public hearing on the draft Project Plan will be held before the GLWA Board of Water Commissioners on Wednesday, May 25th, 2022. The hearing will include a presentation on the project, as well as an opportunity for public comment and questions.

7.1.3 Public Hearing Content

This section of the Project Plan will be updated following the public hearing.

7.2 Adoption of Project Plan

This section of the Project Plan will be updated following the public hearing.

Appendix A

Geotechnical Exploration Services, Freud Pump Station Isolation Shaft Report

REPORT

Geotechnical Exploration Services
Freud Pump Station Isolation Shaft
GLWA Contract No. CS-120
Detroit, Michigan

Arcadis of Michigan, LLC
607 Shelby Street, Suite 400
Detroit, MI 48226

March 30, 2021 (Revised April 22, 2021) **NTH Project No. 61-200414-02**

NTH Consultants, Ltd.
2990 W. Grand Blvd., M-10
Detroit, MI 48202

NTH Consultants, Ltd.

Infrastructure Engineering
and Environmental Services

2990 W. Grand Blvd. Suite M-10
Detroit, MI 48202
313.237.3900
313.237.3909 Fax

Mr. Jeffry Swartz, P.E.
Project Manager
Arcadis of Michigan, LLC
607 Shelby Street, Suite 400
Detroit, MI 48226

March 30, 2021
NTH Project No. 61-200414-02
(Revised April 22, 2021)

RE: Geotechnical Data Report
Freud Pump Station Isolation Shaft
GLWA Contract No. CS-120
Detroit, Michigan

Dear Mr. Swartz:

We are pleased to submit this "Geotechnical Data Report" performed for the Freud Pump Station Isolation Shaft located in Detroit, Michigan, as part of the Great Lakes Water Authority Contract No. CS-120. We performed this work in accordance with the agreed-upon scope of work outlined in our Proposal No. 61-200414, dated October 12, 2020.

We appreciate the opportunity to have been of service to you. Should you have any questions, or require additional information, please call.

Sincerely,

NTH Consultants, Ltd.

Anthony R. Brehmer, P.E.
Project Engineer

Charles J. Roarty, Jr., P.E.
Project Manager

ARB/CJR/mam

Attachments

TABLE OF CONTENTS

APPENDIX A

1.0 INTRODUCTION AND PROJECT BACKGROUND

1.1 INTRODUCTION

NTH Consultants, Ltd. (NTH) was retained by Arcadis of Michigan to perform subsurface utility and geotechnical investigations and provide engineering evaluation services for the construction of the proposed Freud Pump Station Isolation Shaft located along Freud Street between Conner Street and Navahoe Street, east of the existing Freud Pump Station in Detroit, Michigan.

The purpose of the subsurface utility and geotechnical studies are to provide as-built locations of existing utilities as well as explore the general subsurface conditions to obtain sufficient site-specific data at the currently anticipated location of the proposed isolation shaft. The data obtained during this investigation are presented in subsequent sections of this report.

1.2 PROJECT DESCRIPTION

The Freud Pump Station was originally constructed in 1954 to handle the flows from the Ashland Relief Sewer and the Fox Creek Relief Sewer. The existing pump station includes storm water pumps that discharge to the Conner Creek CSO Facility and dewatering pumps that discharge dry weather flow into the East Jefferson Relief Sewer to the Conner Creek Pump Station. The stormwater pump station currently has a firm capacity of 2.03 billion gallons per day (BGD), and the sanitary pump station has a firm capacity of 13 million gallons per day (MGD).

As part of the Great Lakes Water Authority (GLWA) CS-120 effort, we understand the Freud Storm Pump Station will be rehabilitated and a new Freud Sanitary Pump Station will be added, along with provisions to isolate the wet well for maintenance and cleaning purposes. The Freud Storm Pumping Station will continue to have a firm capacity of 2.03 billion gallons per day (BGD), and the Freud Sanitary Pump Station will have a new firm capacity of 30 million gallons per day (MGD). The new isolation gates and sanitary pump station will be combined into a single structure called Freud Isolation Shaft located on the Ashland Relief Sewer and Fox Creek Relief Sewer. As part of this work, Freud Street will also be re-aligned around the Freud Isolation Shaft.

The proposed Freud Isolation Shaft has an inside diameter of 70 feet and extends to an approximate depth of 75 feet. The proposed shaft is located along Freud Street between Conner Street and Navahoe Street, constructed atop the existing 16-foot inside diameter Ashland and Fox Creek Relief sewers. It is understood that both relief sewers are to remain in-service during construction. In addition to the isolation shaft, two isolation gates are planned within each of the existing 16-foot diameter sewers to direct dry weather flow to a sanitary wet well. The proposed wet well is located between and below the existing sewers and contains six (6) submersible pumps mounted to guide rails to pump sanitary flow to a new approximately 5-foot diameter sanitary pipe routed to Tennessee Street, west of the isolation shaft. A control building is planned at grade near the isolation shaft to house the electrical equipment for the gates and the pumps.

1.3 SITE DESCRIPTION

The site of the proposed Freud Isolation Shaft is located along Freud Street, east of the existing Freud Pump Station between Conner Street and Navahoe Street in Detroit, Michigan. The current planned location for the shaft is within the Right-of-Way of Freud Street. This site is currently a residential neighborhood with numerous abandoned buildings and empty parcels immediately adjacent to the site. Overhead power lines are present along the north side of Freud Street, and what appear to be gas blowoff outlets are present in the northwest corner of the intersection of Freud Street and Navahoe Street. In addition to the visible utilities, several critical underground utilities exist below Freud Street, Conner Street, Navahoe Street, and along the alley extending perpendicular to Freud Street between Conner and Navahoe Streets.

1.4 REGIONAL GEOLOGY

1.4.1 General Geology

The Freud Isolation Shaft site is located at the southeast margin of the Michigan geologic basin and in the Erie-Huron lowland. The geology of this area is characterized by variable, unconsolidated, overburden of glacial and glaciofluvial deposits, termed drift, ranging from approximately 50 to 160 feet in thickness. The glacial drift deposits are underlain by relatively flat-lying Mid-Devonian aged sedimentary rocks that are primarily non-clastic in origin. The sedimentary rock formations that directly underlie the overburden in this region of Wayne County include the Mid-Devonian Dundee Limestone and the Detroit River Dolomites of the Detroit River Group.

1.4.2 Soil Overburden

Most of the soils in Wayne County are of glacial origin, due to the history of glaciers advancing and retreating in the Midwest during the Pleistocene Epoch. The upper soil formations within the downtown and surrounding areas of Detroit generally consist of a relatively thick mantle of Wisconsin-aged lacustrine clays that, with the exception of the near-surface deposits, typically range from soft to stiff in consistency. The lacustrine soils were deposited as sediments from a series of glacial lakes impounded between the ice front and the Inner Defiance Moraine located near the northwest corner of Wayne County. The upper 10 to 20 feet of these deposits have been desiccated, resulting in soils of stiff to hard consistency near the surface. It is very common, especially in developed and urban areas, to encounter randomly placed fill deposits and remnants of previous developments overlying the desiccated soils, or to find that portions of the desiccated soils have been replaced by non-engineered fill materials. The clay soils frequently contain intermittent sand and gravel layers that were produced from glacial rivers carrying coarser sediments as lake levels fluctuated.

The lacustrine clay deposits are typically underlain by a thin layer of highly over-consolidated glacial till that has Standard Penetration Resistances in excess of 100 blows and generally consists of sand, silt, and gravel within a clay matrix. This formation is locally termed “hardpan” and usually overlies the bedrock formation. The hardpan is typically cohesive in nature, although depending on the amount of clay binder, it may behave as a granular material in some areas.

Granular zones may be contained within or may overlie the generally cohesive hardpan. The hardpan is generally believed to be Illinoian in age and can contain calcium carbonate producing a cemented condition.

1.4.3 Bedrock Geology

Two non-clastic sedimentary rock formations from the Middle Devonian Period underlie the glacial soils in this area of Detroit. These formations, in order of increasing geologic age, are the Dundee Limestone and the Detroit River Dolomites of the Detroit River Group.

The Dundee Limestone is described as gray, buff to light brown, very thin to massively bedded, cherty limestone and dolomite. The Dundee is known to contain cherty and siliceous beds with secondary calcite and fossiliferous zones. The Dundee is an oil and gas producer and, as such, vuggy zones containing hydrocarbon deposits are frequently encountered within test borings extended into this material.

The Detroit River Group is subdivided into the Anderdon, Lucas, Amherstburg, and Sylvania formations. With the exception of the Sylvania sandstones, the other formations can be difficult to distinguish and, hence, are known collectively as the Detroit River Dolomites. The Detroit River Dolomite is described collectively as a gray, buff, brown, or white finely crystalline to granular dolomite, occasionally argillaceous and/or cherty. The Anderdon is a high-calcium limestone from 20 to 30 feet in thickness and cannot always be differentiated from the overlying Dundee Limestone. Relatively small cavities of irregular shape and size are common within this formation.

1.4.4 Bedrock Structure

The bedrock in Michigan has an irregular basin shape in which the layers of sedimentary rock dip toward the central area of the Southern Peninsula from all directions. Moving from the center of the structural basin in an outward direction, rock outcrops are older with increasing distance from the center of the basin. Likewise, it can be anticipated that the thickness of the respective formation decreases with increasing distance from the center of the basin.

Due to the position of Wayne County along the southeast rim of the structural basin, the Paleozoic rocks that comprise the basin in this area have a regional inclination, or dip, to the northwest with each unit becoming buried by successively younger beds in the direction of the dip. The regional dip is very slight and believed to be typically less than 50 feet per mile. It should be noted the inclination is not always constant due to rock flexures known to exist within the outer edges of the basin.

The topography of the bedrock surface within Wayne County is somewhat variable and characterized by numerous irregularities in the bedrock surface. The irregularities are believed to have developed long before the Pleistocene epoch and were then subsequently modified by repetitive glacial action. Of noteworthy significance is the existence of ancient stream valleys that incise the bedrock surface.

1.4.5 Regional Seismology

Although geological evidence for the existence of faults is occasionally encountered in areas where the bedrock is masked by glacial deposits, according to a seismic probability map prepared by the United States Geological Survey, Michigan lies in a region of low risk for earthquake occurrence. While tremors from earthquakes centered in other regions have been perceived in this area, only 34 earthquakes with epicenters in Michigan have been recorded since 1872. With the exception of two seismic events that occurred in the Keweenaw Peninsula at the turn of the 20th century, all recorded events possessed an intensity level less than VI on the modified Mercalli scale, where shaking level observations were reported.

According to the Geologic Survey Division of the Michigan Department of Environmental Quality (MDEQ), the majority of the above-referenced seismic events can be attributed to slippage along deep-seated Precambrian faults and are not believed to involve faulting of the overlying Paleozoic units.

1.4.6 Regional Groundwater Conditions

The near-surface granular deposits and fill layers in the Detroit area often contain groundwater that is perched above the underlying predominantly clay strata. This groundwater forms an intermittent unconfined aquifer, which varies seasonally in depth and extent. In addition, confined groundwater is often contained within relatively thin granular layers which are occasionally present within the thick cohesive deposits present throughout the region. Such confined aquifers are usually limited in extent and likewise, the recharge capabilities are usually limited.

Confined groundwater is also contained within granular portions of the hardpan, as well as the upper fractured reaches of the limestone and dolomite bedrock in the region. The potentiometric surface of this confined aquifer is on the order of 5 to 20 feet above the Detroit River, which acts as a regional discharge feature. The bedrock formation in the region is generally highly fractured within its upper reaches and usually possesses significant recharge potential. Groundwater encountered within the rock formations typically contains dissolved sulfide and methane that are released as hydrogen sulfide and methane gas upon exposure to the atmosphere.

2.0 GEOTECHNICAL EXPLORATION ACTIVITIES

2.1 SUBSURFACE UTILITY ENGINEERING

Prior to mobilizing to the site to perform the Subsurface Utility Engineering (SUE) investigation, a MISS DIG design ticket was placed. MISS DIG Member utilities provided as-built plans of their respective infrastructure throughout the project area. In addition to the MISS DIG design ticket, Arcadis provided preliminary utility locations for all utilities within the proposed project area. A review of the provided utility plans was performed prior to commencement of field work, to understand the number, location, and general size of critical utilities.

Fieldwork for the SUE exploration was performed over the period of November 9 through November 10, 2020. Methods employed for this exploration consisted of utility line locating using a Radiodetection RD 7000 and Rycom 8839v3 as well as geophysical surveying using a Noggin Smartcart Ground Penetrating Radar (GPR) with 250 MHz antenna. Once the approximate horizontal locations of subsurface utilities were designated in the field, the locations were marked at the ground surface using pin flags and/or paint.

The designated subsurface utility markings were measured from existing landmarks in the field. These measurements were then compared to data previously provided by Arcadis for accuracy. The location of each of the utilities is presented in the Exploration Location Plan, attached herein as Figure No. 1 of the Appendix.

In addition to the non-intrusive SUE investigation, a series of sewer probes, designation as PR-1 through PR-5 were performed along an array generally perpendicular to the Fox Creek Relief Sewer. Please note, sewer probes could not be performed for the Ashland Relief Sewer due to overhead and underground utilities.

Sewer probes were drilled by DLZ American Drilling, Inc. under the full-time observation of NTH field engineers on March 11 and 12, 2021. The sewer probes were advanced from ground surface to the terminal depths using a CME-75 truck mounted rotary drill rig with $2^1/_4$-inch hollow stem augers. In general, the hollow stem augers were advanced to a depth of approximately 30 feet; whereafter the drilling rods with a $1^3/_8$-inch inside diameter, split-barrel sampler were pushed through the hollow stem augers a distance of 18 inches or until an obstruction was encountered. If an obstruction was hit, the sewer probe was completed. If an obstruction was not encountered, the hollow stem augers were advanced through the 18-inch zone and the process was repeated.

2.2 GEOTECHNICAL FIELD INVESTIGATION

The field exploration also consisted of drilling five test borings, designated as TB-1 through TB-5, as shown on the Exploration Location Plan presented as Figure No. 1 of the Appendix. Please note test boring TB-5 and sewer probe PR-2 are at the same location. Test borings TB-1 through TB-4 were performed outside of the proposed shaft location at locations clear of utilities, while TB-5 was performed within the proposed shaft location.

Prior to mobilizing to drill the borings, we requested that underground utilities be marked by contacting the MISS DIG system.

The test borings were drilled by DLZ American Drilling, Inc. under the full-time observation of NTH field engineering staff between March 9 and March 12, 2021. The borings were drilled using either a CME-75 or CME-55 truck mounted rotary drill rig. As indicated on the test boring logs, the borings ranged in depth from 33.5 feet, at the location of TB-5, to depths of 104.8 feet to 128.9 feet for test borings TB-1 through TB-4.

Test borings TB-1 through TB-4 were advanced from the ground surface to depths ranging from 5 feet to 6 feet using a hand auger to ensure the location was clear of any shallow utility lines. After the locations were cleared, test borings TB-1 and TB-3 were advanced to a depth of approximately 10 feet using $3^{1}/_{4}$-inch hollow stem augers, while test borings TB-2 and TB-4 were advanced using $2^{1}/_{4}$-inch hollow stem augers. Once the augers achieved the depths cited above, the auger sections were removed from the borehole and a 4-inch inside diameter casing was pushed into the augured hole and seated into undisturbed soil. Below these depths, the borings were continued to the terminal depth using a $3^{7}/_{8}$-inch tricone bit and wash rotary drilling techniques. At the location of TB-5/PR-2, $2^{1}/_{4}$-inch hollow stem augers were used to advance the borehole from ground surface to the terminal depth of 33.5 feet, at which the Fox Creek Relief Sewer was encountered.

In general, soils were classified but samples were not collected during hand auger drilling. Following the hand auger, samples were collected at intervals of 2½ feet within the upper ten feet, and at five-foot intervals below that depth; however, some adjustments were made to the sampling intervals due to subsurface conditions encountered during drilling operations.

Most soil samples were obtained using a $1^{3}/_{8}$-inch inside diameter, split-barrel sampler with liner insert and the Standard Penetration Test (SPT) method (ASTM D1586), described on the attached General Notes, Figure No. 2 of the Appendix. In addition to the SPT samples, a number of relatively undisturbed, thin-walled tube samples (Shelby tubes) were collected from the native cohesive soils in general accordance with the requirements of ASTM D1587.

The soil samples recovered from the test borings were sealed in containers and transported to our laboratory for further classification and testing. We will retain these samples for 60 days after the date of this report. At that time, we will dispose of the samples unless we are otherwise instructed. At the completion of drilling, the test borings were backfilled with bentonite-cement grout.

In addition to the soil sampling described above, a total of eight field vane shear tests (VST) were performed at the test boring locations. The vane shear tests, used to assess the undrained shear strength and the remolded undrained shear strength of cohesive soils in the field, were performed on select cohesive soils with consistencies in the range of soft to stiff in general accordance with the requirements of ASTM D2573. The VST method involves placing a four-blade vane in the undisturbed soil and rotating it at a controlled rate using a hand-powered device at the ground surface to measure the torque required to shear a cylinder of the soil with the limits of the vane blades. The maximum torque is then converted to the unit shearing resistance of the soil failure surface. Upon completion of the vane shear test, the remolded strength is assessed by measuring the maximum torque required to turn the vane in a similar manner after relatively quickly rotating the vane five to ten times. The two test values are used to compute the soil sensitivity.

2.3 PRESENTATION OF DATA

We have evaluated the soil and groundwater conditions encountered in the test borings and have presented these conditions in the form of individual Logs of Test Boring, Figure Nos. 3 through 7 of the Appendix. In addition to subsoil stratification, the test boring logs present the Standard Penetration Resistance (which is identified by the symbol “N” on the boring logs), observed groundwater levels, drilling and sampling information, selected laboratory test results, and other pertinent data. General Notes defining the nomenclature used on the logs and elsewhere in this report are presented in Figure No. 2 of the Appendix. Ground surface elevations shown on the Logs of Test Borings for the borings were provided by Arcadis following drilling. We have also included Logs of Test Boring for the sewer probes drilled during this investigation, Figure Nos. 8 through 11 of the Appendix.

The results of vane shear testing are presented on the Vane Shear Test Reports, Figure Nos. 12 through 19 of the Appendix. In addition, the VST results have been converted to equivalent unconfined compressive strength values and are reported on the respective test boring logs. During the VSTs performed at both depths within test boring TB-1 (VS-1 and VS-2), and at a depth of 48.5 feet within test boring TB-3 (VS-1), an inconsistent, higher reading was noted between two relatively similar readings. These anomalies may be a result of large particles (gravel) coming in contact with the vanes during testing, frictional lenses encountered after a small rotational displacement in the generally cohesive layer, or inconsistent speed of rotation. Larger gauge readings correspond to higher shear strengths which may not be representative of the overall soil structure. As such, these anomalies have been ignored. The in-situ shear strengths presented on the vane shear test reports along with the equivalent unconfined compressive strength presented on the boring logs representative the corrected strengths respectively.

The test boring logs included with this report have been prepared on the basis of field and laboratory classification and testing. The stratification shown on the test boring logs represents the soil conditions at the actual explored locations. Variations in subsoil conditions may occur between and away from the borings. Additionally, the stratigraphic lines represent the approximate boundary between the soil types; however, the transition may be more gradual than what is shown.

Additionally, representative photographs of SUE markings were recorded by NTH and are included as Figure No. 21 in the Appendix. Please note that the depths of the facilities were not determined for utilities other than the Fox Creek Relief Sewer.

2.4 LABORATORY TESTING

Representative soil samples collected from the test borings were subjected to testing at NTH's laboratory facility to evaluate pertinent engineering characteristics of the subsoils. The testing included the measurement of the natural moisture content and in-place dry density for selected soil samples and unconfined compressive strength for representative cohesive soils. Several representative samples of cohesive soils were subjected to Atterberg Limits testing (ASTM D4318) to assess the liquid and plastic limits of the soils. The results of the laboratory testing are presented on the Tabulation of Laboratory Test Data, Figure No. 20 in the Appendix. The natural moisture content, in-place dry density, and unconfined compressive strength values are also shown on the respective test boring logs.

In addition to laboratory testing, field pocket penetrometer measurements were made on cohesive soil samples obtained from the test borings as an aid in evaluating their unconfined compressive strengths. The pocket penetrometer values readings are indicated on the boring logs.

3.0 SUBSURFACE CONDITIONS

3.1 SUBSOIL CONDITIONS

3.1.1 Stratigraphy

In general, the soil conditions consist of fill deposits underlain by extensive strata of native clay soils overlying very compact silt deposits, which in turn are underlain by hard to very hard silty clay deposits to the explored depths.

Fill Deposits – Fill deposits encountered within the test borings generally consist of sand with varying amounts of clay, silt, and gravel that extend to depths ranging from 5.5 feet to 7.3 feet. Due to the nature of our sampling, a consistency of the material was not determined for much of the area. At the location of TB-5, the fill materials were found to be very loose.

Native Soil Materials – Underlying the fill materials within each of the test borings, the native soils at the site consist of cohesive brown and gray silty clay that extend to a depth ranging from 99 feet to 113 feet below ground surface. In general, the brown and gray cohesive soils have consistencies of stiff to hard extending from below the existing fill to a depth of 17 feet at the location of TB-1, TB-2, TB-3, 18 feet at the location of TB-5, and to a depth of 21 feet at the location of TB-4. At the location of TB-4 a layer of medium to stiff gray silty clay was encountered below the stiff to hard silty clay to a depth of 42 feet. Below the stiff to hard and medium to stiff silty clay, a layer of soft to medium gray silty clay was encountered at each of the boring locations to depths ranging from 72 feet to 78 feet. A layer of medium to very stiff silty clay was encountered below the soft of medium silty clay to depths ranging from 92 feet to 99 feet within test borings TB-1 through TB-4. At the location of test borings TB-1, TB-2, and TB-4, the medium to very stiff silty clay was underlain by a layer of very stiff to very hard silty clay to depths of 102 feet at the location of test boring TB-2, the terminal depth of TB-4, and a depth of 113 feet at TB-1. Underlying the medium to stiff silty clay at test boring TB-3 and the very stiff to very hard silty clay layer encountered at test borings TB-1 and TB-2, a layer of very compact sandy silt was encountered to depths of 102 feet at TB-3, the terminal depth of TB-2, and 117.5 feet at the location of TB-1. Below the very compact silty sand layer, a layer of hard to very hard silty clay was encountered at the location of TB-1. Below the hard to very hard silty clay at TB-1 and the very compact sandy silt at TB-3, a layer of glacial till, locally termed “hardpan”, consisting of very hard silty clay was encountered to the terminal depths of each boring. This formation is typically encountered in the area at depths ranging from approximately 90 to 120 feet and generally consists of sand, silt, and gravel within a clay matrix that is highly compressed due to the presence of glacial ice during the last ice age. Hardpan is typically underlain by native bedrock formations, which in the vicinity of the site are expected to consist of the Dundee Limestone formation.

3.2 GROUNDWATER CONDITIONS

Groundwater observations were made within the upper reaches of the bore holes prior to switching to wash rotary drilling methods. Groundwater was not encountered during drilling at any of the test boring locations prior to commencement of wash rotary drilling. Please note, groundwater observations during drilling in predominantly cohesive soils are not necessarily indicative of the static groundwater level. This is due to the low permeability of such soils and the tendency of drilling operations to seal off the natural paths of groundwater flow. The long-term groundwater level may be inferred from sample color observations, such as the transition from brown to gray in the soil strata.

The presence of predominately granular fill deposits at the ground surface overlying the relatively impermeable native clay strata would lend itself to the development of a perched groundwater table. Fluctuations in the ground water levels at this site should be anticipated with seasonal variations and following periods of prolonged precipitation.

3.3 UNDERGROUND UTILITIES

Based on the results of the MISS DIG design ticket and SUE services combined with information provided by Arcadis, a number of critical utilities were found within the proposed footprint of the Freud Isolation Shaft. In addition to the two 16-foot inside diameter relief sewers, two water mains, two storm sewers, two communication lines, and two gas lines were found within the Right-of-Way of Freud Street.

Comparing the results of the current SUE investigation to the topographic survey provided by Arcadis indicates a similar utility layout. Two water mains, one 16-inch diameter and one 24-inch diameter, run along the southern right of way of Freud Street. However, the recent SUE investigation indicates the water mains are approximately 3 feet north of the current ‘as-built’ locations provided by Arcadis.

The current SUE investigation also indicated two gas lines, which were not indicated on the Arcadis provided topographic survey. The first gas line runs along the eastern right-of-way of Conner Street crossing Freud Street, and the second appears to be a service line for the nearby abandoned building on the northeast corner of Freud Street and Conner Street.

As stated previously in this report, the Fox Creek Relief Sewer was located by drilling a series of five (5) sewer probes within the proposed footprint of the isolation shaft. Based on review of the Detroit Water and Sewerage Department (DWSD) as built drawings provided by Arcadis, the Fox Creek Relief Sewer has an inside diameter of 16 feet. Additionally, the drawings indicate two possible linings for this portion of the Fox Creek Relief Sewer. The first possible lining consists of a primary liner consisting of approximately 4 to 6 inches of rib and lagging and a secondary lining 15 inches of concrete. The alternative consists of a primary liner consisting 16 inches of block over 15 inches of concrete as a secondary liner. During the probing process, a sample of wood from the outside of the tunnel was attained using a split barrel sampler, indicating the primary lining of the Fox Creek sewer is rib and lagging. As such, we have estimated the Fox Creek Relief Sewer to have an outside diameter of approximately 19 feet 6 inches.

Following the sewer probing, the approximate coordinates, and depths at which the sewer was encountered were plotted in space. From these points, circles with a diameter of 19’-6” feet were plotted centered on each point of contact with the tunnel. The zone where these circles overlap is estimated to be the center line of the sewer at the spring line. The location and depth of the sewer is estimated as shown in Figure No. 1 of the Appendix.

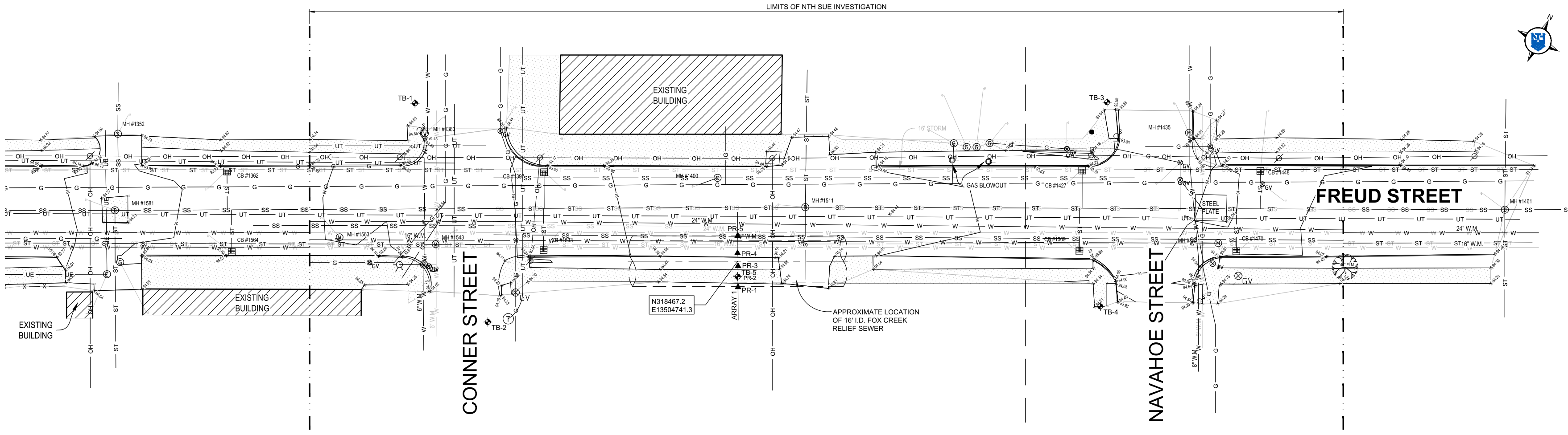
4.0 DATA REVIEW AND LIMITATIONS

This report is intended for specific use in the design and construction of the proposed Freud Pump Station Isolation Shaft in Detroit, Michigan, as described herein. Our work was performed in accordance with the prevailing standard of practice in this area at the time the work was performed. No other warranty, express or implied, is provided or intended.

This report is intended for the exclusive use of Arcadis of Michigan, LLC and Great Lakes Water Authority. This report presents NTH's opinion as of this date, based on the results of the study described herein and, on the information, provided during the course of the study. The results of this study may not be relied upon by parties other than those identified above without the prior knowledge and written consent of NTH Consultants, Ltd.

The scope of the present exploration was limited to evaluation of subsurface conditions for the construction of the proposed shaft, and other related aspects of development. No chemical, environmental, or hydrological testing or analyses were performed as part of this geotechnical study.

APPENDIX



NOTE

ORIGINAL UTILITY CAD FILE AND TOPOGRAPHIC SURVEY SHOWN IN GRAY BENEATH SUE LINEWORK. SEE REFERENCE NOTES THIS SHEET.

EXPLORATION LOCATION PLAN

SCALE: 1" = 20'
GRAPHIC SCALE
20 0 20
1" = 20'

REFERENCE

BASE CAD FILE AND TOPOGRAPHIC SURVEY PROVIDED BY NEDERVELD OF ANN ARBOR, MICHIGAN AS PREPARED FOR ARCADIS OF MICHIGAN, LLC AS PART OF DRAWING TITLED "GLWA FREUD PUMP STATION - TOPOGRAPHIC SURVEY", PROJECT No. 20500038, SHEET No. TO.2, DATED 7/13/2020.

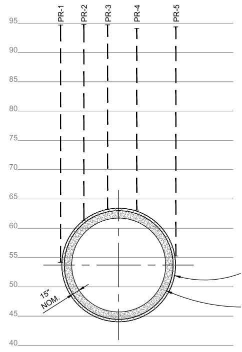
GEOTECHNICAL LEGEND

- ⯐ TEST BORING DRILLED BY DLZ-AMERICAN DRILLING, INC. UNDER THE OBSERVATION OF NTH CONSULTANTS, LTD. MARCH 9, 2021 THROUGH MARCH 12, 2021
- ▲ SEWER PROBES ADVANCED BY DLZ-AMERICAN DRILLING, INC. UNDER THE OBSERVATION OF NTH CONSULTANTS, LTD. ON MARCH 11 & 12, 2021

NOTE: TB-5 ALSO SHOWN AS PR-2 FOR LOCATION OF EXISTING SEWER.

SEWER PROBE SUMMARY

PROBE DESIGNATION	DEPTH SEWER ENCOUNTERED (FEET)
PR-1	40.5
PR-2	33.5
PR-3	31.5
PR-4	31.0
PR-5	39.1



REREFENCE
SEWER SECTION BASED ON CITY OF DETROIT DEPARTMENT OF PUBLIC WORKS DRAWING "FOX CREEK DISTRICT - FOX CREEK RELIEF SEWER - FREUD AVE. OUTLET, TYPICAL SECTIONS & DETAILS", AS SHOWN IN "TYPICAL REINFORCED SECTION - FROM STA. 0+67.86 TO STA. 10+18.82", JOB No. PW-674, DRAWING No. 1804-9, SHEET 9 OF 11, DATED SEPT. 1951

SEWER PROBE SECTION

SCALE: 1" = 10'
GRAPHIC SCALE
10 0 10
1" = 10'

LEGEND

△	Benchmark / Control	Ⓔ	Electric Manhole
◍	Catch Basin - Round	Ⓖ	Gas Manhole
▦	Catch Basin - Square	□TR	Transformer
○CO	Cleanout	∅	Utility Pole
✿	Deciduous Tree	Ⓦ	Water Manhole
✹	Evergreen Tree	⊗WV	Water Valve
⊗GV	Gas Valve	—— C ——	Cable TV
⟨—	Guy Anchor	—— UE ——	Underground Electric
HH	Hand Hole	—— FO ——	Fiber Optic
⚲	Hydrant	—— G ——	Gas
●	Iron - Set	—— OH ——	Overhead Utility
○	Iron - Found	—— SS ——	Sanitary
☼	Light Pole	—— ST ——	Storm
⚑E	Miss Dig Flag - Electric	—— UT ——	Underground Telephone
Ⓜ	Manhole	—— W ——	Watermain
○S	Sign	— X — X —	Fence
Ⓢ	Sanitary Sewer Manhole	▭	Asphalt
Ⓓ	Stormwater Manhole	▭	Concrete
Ⓣ	Telephone/Communication Manhole	▨	Existing Building

NTH Consultants, Ltd.

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Lansing, MI ♦ Grand Rapids, MI
Cleveland, OH

REVISIONS

REV	DESCRIPTION	DATE	BY

PROJECT NAME:
GLWA FREUD
PUMP STATION

PROJECT LOCATION:
DETROIT, MICHIGAN

NTH PROJECT NO.: 61-200414	CAD FILE NAME: D20041401
DESIGNED BY: PJ/ZP	INCEP DATE: 21-Jan-21
DRAWN BY: DET	DRAWING SCALE: 1" = 20'
CHECKED BY: CJR	PLOT DATE: 22-Apr-21

SHEET TITLE:
EXPLORATION
LOCATION PLAN

SHEET REFERENCE NUMBER:
1
SHEET OF

PLOTTED: 4/22/2021 12:55 PM

GENERAL NOTES

TERMINOLOGY

Unless otherwise noted, all terms utilized herein refer to the Standard Definitions presented in ASTM D653.

PARTICLE SIZES

Boulders - Greater than 12 inches (305mm)
Cobbles - 3 inches (76.2mm) to 12 inches (305mm)
Gravel - Coarse - 3/4 inches (19.05 mm) to 3 inches (76.2mm)
Fine - No. 4 - 3/16 inches (4.75mm) to 3/4 inches (19.05 mm)
Sand - Coarse - No. 10 (2.00mm) to No. 4 (4.75mm)
Medium - No. 40 (0.425mm) to No. 10 (2.00mm)
Fine - No. 200 (0.074mm) to No. 40 (0.425mm)
Silt - 0.005mm to 0.074mm
Clay - Less than 0.005mm

CLASSIFICATION

The major soil constituent is the principal noun, i.e., clay, silt, sand, gravel. The second major soil constituent and other minor constituents are reported as follows:

Second Major Constituent (percent by weight)	Minor Constituents (percent by weight)
Trace - 1 to 12%	Trace - 1 to 12%
Adjective - 12 to 35% (clayey, silty, etc.)	Little - 12 to 23%
	Some - 23 to 33%
And - Over 35%	

COHESIVE SOILS

If clay content is sufficient so that clay dominates soil properties, clay becomes the principal noun with the other major soil constituent as modified; i.e., silty clay. Other minor soil constituents may be included in accordance with the classification breakdown for cohesionless soils; i.e., silty clay, trace of sand, little gravel.

Consistency	Unconfined Compressive Strength (psf)	Approximate Range of (N)
Very Soft	Below 500	0 - 2
Soft	500 - 1000	3 - 4
Medium	1000 - 2000	5 - 8
Stiff	2000 - 4000	9 - 15
Very Stiff	4000 - 8000	16 - 30
Hard	8000 - 16000	31 - 50
Very Hard	Over 16000	Over 50

Consistency of cohesive soils is based upon an evaluation of the observed resistance to deformation under load and not upon the Standard Penetration Resistance (N).

COHESIONLESS SOILS

Density Classification	Relative Density %	Approximate Range of (N)
Very Loose	0 - 15	0 - 4
Loose	16 - 35	5 - 10
Medium Compact	36 - 65	11 - 30
Compact	66 - 85	31 - 50
Very Compact	86 - 100	Over 50

Relative density of cohesionless soils is based upon the evaluation of the Standard Penetration Resistance (N), modified as required for depth effects, sampling effects, etc.

SAMPLE DESIGNATIONS

AS - Auger Sample - directly from auger flight
BS - Miscellaneous Sample - bottle or bag
S - Split Spoon Sample - ASTM D1586
LS - Split Spoon Sample S with Liner Insert 3 inches in length
ST - Shelby Tube Sample - 3 inch diameter unless otherwise noted
PS - Piston Sample - 3 inch diameter unless otherwise noted
RC - Rock Core - NX core unless otherwise noted
CS - Continuous Sample - from rock core barrel or continuous sampling device
VS - Vane Shear

STANDARD PENETRATION TEST (ASTM D1586) - A 2.0" outside-diameter, 1-3/8" inside-diameter, split barrel sampler is driven into undisturbed soil by means of a 140-pound weight falling freely through a vertical distance of 30 inches. The sampler is normally driven three successive 6-inch increments. The total number of blows required for the final 12 inches of penetration is the Standard Penetration Resistance (N).

LOG OF TEST BORING NO: TB-1

Project Name: GLWA CS-120 Freud Pump Station
Project Location: Detroit, Michigan

NTH Consultants, Ltd.
NTH Proj. No.: 61-200414-02
Checked By: A. Brehmer

SUBSURFACE PROFILE

GROUND SURFACE ELEVATION: 94.7

ELEV	Description	DEPTH
94.4	SIDEWALK: CONCRETE (3-inches)	0.3
92.7	FILL: Dark Gray and Brown SILTY SAND with Little Clay and Trace Gravel	2.0
87.4	FILL: Dark Gray SILTY SAND with Trace Clay and Gravel	7.3
81.7	Hard Brown SILTY CLAY with Trace Sand and Gravel, Frequent Silt Partings	13.0
77.7	Stiff Brown and Gray SILTY CLAY with Trace Sand and Gravel	17.0
64.7	Soft to Medium Gray SILTY CLAY with Trace Sand and Gravel	

ELEV. (FT): 90, 85, 80, 75, 70, 65

SOIL SAMPLE DATA

DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
5								
	LS-1	3 6 8	14	12				>*9000
10	LS-2	9 13 15	28	12		13.7	125.0	19,760
15	LS-3	3 5 5	10	3				
20	LS-4	2 2 2	4	6				< *500
25	LS-5	WOH 3 2	5	18				*500
30	LS-6	WOH WOH 3	3	18		17	118.5	660

Total Depth: *128.9 FT*
Drilling Start Date: *3/9/21*
Drilling End Date: *3/10/21*
Inspector: *B. Stachkunis*
Contractor: *DLZ-American Drilling Company*
Driller: *K. Conrad*
Drilling Method:
Hand auger to 6.5'. CME-75 truck-mounted drilling rig using 2-1/4" ID HSA to 10'. Remove augers and install 4" steel casing to 10'; whereafter 3-7/8" OD tricone roller bit to EOB.
Plugging Procedure:
Backfill with grout and soil cuttings. Topped with concrete patch.

Water Level Observation:
No groundwater was encountered to a depth of 10'. Due to the introduction of drilling fluid at 10', no meaningful groundwater information was collected below this depth.

Notes:
** - Pocket Penetrometer Value*
WOH - Weight of Hammer
^ - Vane Shear Test Strength converted to Unconfined Compressive Strength
*** - Low Failure Strain*

Approximate GPS Coordinates:
N: 318465 E: 13504604

Figure No. 3

LOG OF TEST BORING NO: TB-1

Project Name: GLWA CS-120 Freud Pump Station
Project Location: Detroit, Michigan

NTH Consultants, Ltd.
NTH Proj. No.: 61-200414-02
Checked By: A. Brehmer

SUBSURFACE PROFILE						SOIL SAMPLE DATA							
ELEV. (FT)	PRO-FILE	ELEV	GROUND SURFACE ELEVATION: 94.7	DEPTH	DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
60			Soft to Medium Gray SILTY CLAY with Trace Sand and Gravel		35	LS-7	2 4 3	7	14				< *500
55					40	LS-8	WOH 2 2	4	18				< *500
50					45	LS-9	WOH 1 2	3	18				< *500
45					50	LS-10	WOH 1 2	3	18				< *500
						ST-1	P U S H		24		34.0	88.8	1,400**
						VS-1	-- -- --						^1,990
40					55	LS-11	WOH 1 2	3	18				< *500
35					60	LS-12	WOH 1 2	3	18				< *500
30					65	LS-13	WOH 1 3	4	18				< *500

LOG OF TEST BORING NO: TB-1

Project Name: GLWA CS-120 Freud Pump Station
Project Location: Detroit, Michigan

NTH Consultants, Ltd.
NTH Proj. No.: 61-200414-02
Checked By: A. Brehmer

SUBSURFACE PROFILE					SOIL SAMPLE DATA								
ELEV. (FT)	PRO-FILE	ELEV	GROUND SURFACE ELEVATION: 94.7	DEPTH	DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
		26.7											
25			Soft to Medium Gray SILTY CLAY with Trace Sand and Gravel		70	LS-14	1 3 3	6	18		20.7	112.6	1,240
		22.7		72.0		ST--	P U S H		0				
						ST--	P U S H		0				
20					75	VS-2	-- -- --						^3,040
15					80	LS-15	1 4 2	6	18				< *500
10			Medium to Stiff Gray SILTY CLAY with Trace Sand and Gravel, Frequent Silt Partings		85	LS-16	WOH 3 3	6	18				*500
5					90	LS-17	3 4 7	11	18				*1000
0					95	LS-18	4 7 8	15	13				*2500
		-2.3		97.0									
-5					100	LS-19	10 21 17	38	16				*4000
			Very Stiff to Hard Gray SILTY CLAY with Little Gravel and Trace Sand										
-10					105	LS-20	52 72 78	150	18				*9000

LOG OF TEST BORING NO: TB-1

Project Name: GLWA CS-120 Freud Pump Station
Project Location: Detroit, Michigan

NTH Consultants, Ltd.
NTH Proj. No.: 61-200414-02
Checked By: A. Brehmer

SUBSURFACE PROFILE

GROUND SURFACE ELEVATION: 94.7

ELEV	DESCRIPTION	DEPTH
-11.3		
	Very Stiff to Hard Gray SILTY CLAY with Little Gravel and Trace Sand	
-18.3		113.0
	Very Compact Gray SANDY SILT with Little Clay and Trace Gravel	
-22.8		117.5
	Hard to Very Hard Gray SILTY CLAY with Little Gravel and Trace Sand	
-28.3		123.0
	HARDPAN: Very Hard Gray SILTY CLAY with Trace Sand and Gravel, Occasional Rock Fragments	
-34.2		128.9

END OF BORING AT 128.9 FEET.

SOIL SAMPLE DATA

DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
110	LS-21	22 24 33	57	18				
115	LS-22	77 94 117	211	18				
120	LS-23	84 55 39	94	3				
	LS-24	18 25 40	65	6				>*9000
	LS-25	70 77/4"	77/4"	8				>*9000
125								
	LS-26	77/5"	77/5"	3				

LOG OF TEST BORING NO: TB-2

Project Name: GLWA CS-120 Freud Pump Station
Project Location: Detroit, Michigan

NTH Consultants, Ltd.
NTH Proj. No.: 61-200414-02
Checked By: A. Brehmer

SUBSURFACE PROFILE

GROUND SURFACE ELEVATION: 94.1

ELEV	DESCRIPTION	DEPTH
93.6	PAVEMENT: ASPHALT (7-inches)	0.5
92.6	FILL: Light Brown Crushed GRAVELLY SAND with Trace Clay and Silt	1.5
86.9	FILL: Dark Gray SILTY SAND with Little Clay and Trace Gravel	7.2
85.1	Stiff Mottled Gray and Brown SILTY CLAY with Trace Sand and Gravel	9.0
82.1	Very Stiff Brown SILTY CLAY with Trace Sand and Gravel	12.0
77.1	Stiff Gray SILTY CLAY with Trace Sand and Gravel	17.0
64.1	Soft to Medium Gray SILTY CLAY with Trace Sand and Gravel	

ELEV. (FT): 90, 85, 80, 75, 70, 65

SOIL SAMPLE DATA

DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
5								
	LS-1	1 2 6	8	8				*3000
10	LS-2	5 8 13	21	14				*8000
15	LS-3	1 5 4	9	13		17.4	117.0	2,640
20	LS-4	WOH 2 3	5	15				*500
25	LS-5	WOH 2 2	4	16				< *500
30	LS-6	WOH 2 2	4	17				< *500

Total Depth: *110 FT*
Drilling Start Date: *3/11/21*
Drilling End Date: *3/12/21*
Inspector: *Z. Paydawy/B. Stachkunis*
Contractor: *DLZ-American Drilling Company*
Driller: *L. Bartlett*

Drilling Method:
Hand auger to 5.5'. CME-55 truck-mounted drilling rig using 3-1/4" ID HSA to 10'. Remove augers and install 4" steel casing to 10'; whereafter 3-7/8" OD tricone roller bit to EOB.

Plugging Procedure:
Backfill with grout and soil cuttings. Topped with asphalt patch.

Water Level Observation:
No groundwater was encountered to a depth of 10'. Due to the introduction of drilling fluid at 10', no meaningful groundwater information was collected below this depth.

Notes:
** - Pocket Penetrometer Value*
WOH - Weight of Hammer
^ - Vane Shear Test Strength converted to Unconfined Compressive Strength

Approximate GPS Coordinates:
N: 318403 E: 13504667

Figure No. 4

LOG OF TEST BORING NO: TB-2

Project Name: GLWA CS-120 Freud Pump Station
Project Location: Detroit, Michigan

NTH Consultants, Ltd.
NTH Proj. No.: 61-200414-02
Checked By: A. Brehmer

SUBSURFACE PROFILE					SOIL SAMPLE DATA								
ELEV. (FT)	PRO-FILE	ELEV	GROUND SURFACE ELEVATION: 94.1	DEPTH	DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
60			Soft to Medium Gray SILTY CLAY with Trace Sand and Gravel		35	LS-7	WOH 2 2	4	15				< *500
55					40	LS-8	WOH 1 2	3	17				< *500
						ST-1	P U S H				21.8	107.0	920
						VS-1	-- -- --						^1,740
50					45	LS-9	WOH 2 1	3	13				< *500
45					50	LS-10	WOH 2 3	5	18				< *500
40					55	LS-11	WOH 1 3	4	18				< *500
35					60	LS-12	WOH 2 2	4	18				< *500
						ST-2	P U S H		24		20.5	109.2	1,740
						VS-2	-- -- --						^1,240
30					65	LS-13	1 2 2	4	18				< *500

LOG OF TEST BORING NO: TB-2

Project Name: GLWA CS-120 Freud Pump Station
Project Location: Detroit, Michigan

NTH Consultants, Ltd.
NTH Proj. No.: 61-200414-02
Checked By: A. Brehmer

SUBSURFACE PROFILE

ELEV. (FT)	PRO-FILE	ELEV	GROUND SURFACE ELEVATION: 94.1	DEPTH
25 20	▨	26.1 18.1	Soft to Medium Gray SILTY CLAY with Trace Sand and Gravel	76.0
15 10 5	▨	2.1	Stiff to Very Stiff Gray SILTY CLAY with Trace Sand and Gravel	92.0
0 -5	▨	-7.9	Hard to Very Hard Gray SILTY CLAY with Trace Sand and Gravel	102.0
-10	▨		Very Compact Gray SANDY SILT with Little Clay and Trace Gravel	

SOIL SAMPLE DATA

DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
70	LS-14	WOH 2 2	4	18				< *500
75	LS-15	WOH 2 3	5	18				< *500
80	LS-16	1 6 8	14	18				*1000
85	LS-17	10 12 14	26	16		18.8	115.8	3,420
90	LS-18	31 35 17	52	18				
95	LS-19	31 76 75/2"	151/8"	16				>*9000
100	LS-20	24 35 38	73	8				>*9000
105	LS-21	52 86 78/3"	164/9"	8				

LOG OF TEST BORING NO: TB-2

Project Name: GLWA CS-120 Freud Pump Station
Project Location: Detroit, Michigan

NTH Consultants, Ltd.
NTH Proj. No.: 61-200414-02
Checked By: A. Brehmer

SUBSURFACE PROFILE						SOIL SAMPLE DATA							
ELEV. (FT)	PRO-FILE	ELEV	GROUND SURFACE ELEVATION: 94.1	DEPTH	DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
-15	▨	-11.9 -15.9	Very Compact Gray SANDY SILT with Little Clay and Trace Gravel	110.0	110	LS-22	60 66 64	130	12				
-20 -25 -30 -35 -40 -45			END OF BORING AT 110.0 FEET.										

LOG OF TEST BORING NO: TB-3

Project Name: GLWA CS-120 Freud Pump Station
Project Location: Detroit, Michigan

NTH Consultants, Ltd.
NTH Proj. No.: 61-200414-02
Checked By: A. Brehmer

SUBSURFACE PROFILE

ELEV. (FT)
90
85
80
75
70

ELEV	GROUND SURFACE ELEVATION: 94.2	DEPTH
93.8	TOPSOIL: Dark Gray and Brown SILTY SAND with Gravel	0.4
92.2	SIDEWALK: CONCRETE (3-inches)	2.0
89.2	FILL: Dark Gray and Brown SILTY SAND with Little Clay and Trace Gravel	5.0
88.2	FILL: Gray and Brown SANDY CLAY with Little Silt and Trace Gravel	6.0
81.7	Very Stiff to Hard Brown and Gray SILTY CLAY with Little Sand and Trace Gravel	12.5
77.2	Stiff Brown and Gray SILTY CLAY with Trace Sand and Gravel	17.0
66.2	Soft to Medium Gray SILTY CLAY with Trace Sand and Gravel, Frequent Silt Partings	

SOIL SAMPLE DATA

DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
5								
	LS-1	6 10 13	23	8				>*9000
10	LS-2	7 12 15	27	12				>*9000
15	LS-3	5 4 6	10	12				*2500
20	LS-4	2 2 3	5	18		17.7	116.8	960
25	LS-5	WOH 2 2	4	18				< *500

Total Depth: *109.6 FT*
Drilling Start Date: *3/10/21*
Drilling End Date: *3/11/21*
Inspector: *B. Stachkunis*
Contractor: *DLZ-American Drilling Company*
Driller: *K. Conrad*

Drilling Method:
Hand auger to 5'. CME-55 truck-mounted drilling rig using 2-1/4" ID HSA to 10'. Remove augers and install 4" steel casing to 10'; whereafter 3-7/8" OD tricone roller bit to EOB.

Plugging Procedure:
Backfill with grout and soil cuttings. Topped with concrete patch.

Water Level Observation:
No groundwater was encountered to a depth of 10'. Due to the introduction of drilling fluid at 10', no meaningful groundwater information was collected below this depth.

Notes:
** - Pocket Penetrometer Value*
WOH - Weight of Hammer
^ - Vane Shear Test Strength converted to Unconfined Compressive Strength

Approximate GPS Coordinates:
N: 318585 E: 13504840

Figure No. 5

LOG OF TEST BORING NO: TB-3

Project Name: GLWA CS-120 Freud Pump Station
Project Location: Detroit, Michigan

NTH Consultants, Ltd.
NTH Proj. No.: 61-200414-02
Checked By: A. Brehmer

SUBSURFACE PROFILE					SOIL SAMPLE DATA								
ELEV. (FT)	PRO-FILE	ELEV	GROUND SURFACE ELEVATION: 94.2	DEPTH	DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
65			Soft to Medium Gray SILTY CLAY with Trace Sand and Gravel, Frequent Silt Partings		30	LS-6	WOH WOH 2	2	18				< *500
60					35	LS-7	12 10 5	15	9				*1000
55					40	LS-8	WOH 1 2	3	18				< *500
50					45	LS-9	WOH 1 1	2	18				< *500
						ST-1	P U S H		24				*500
						VS-1	-- -- --						^1,550
45					50	LS-10	WOH 1 2	3	18		36.3	87.7	400
40					55	LS-11	WOH 1 2	3	18				< *500
35					60	LS-12	WOH 2 3	5	18				*500
		31.2											

LOG OF TEST BORING NO: TB-3

Project Name: GLWA CS-120 Freud Pump Station
Project Location: Detroit, Michigan

NTH Consultants, Ltd.
NTH Proj. No.: 61-200414-02
Checked By: A. Brehmer

SUBSURFACE PROFILE

GROUND SURFACE ELEVATION: 94.2

ELEV. (FT): 30, 25, 20, 15, 10, 5, 0

ELEV	DESCRIPTION	DEPTH
	Soft to Medium Gray SILTY CLAY with Trace Sand and Gravel, Frequent Silt Partings	
16.2		78.0
	Medium to Stiff Gray SILTY CLAY with Trace Sand and Gravel, Occasional Silt and Sand Seams	
12.2		82.0
	Medium to Stiff Gray SILTY CLAY with Trace Sand and Gravel	

SOIL SAMPLE DATA

DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
65	LS-13	WOH 2 3	5	18				*500
	ST-2	PUSH		24		19.1	111.8	1,380
	VS-2	-- -- --						^2,300
70	LS-14	WOH 3 3	6	18				*500
75	LS-15	WOH 1 2	3	18		26.7	101.1	690
80	LS-16	WOH 4 2	6	18				< *500
85	LS-17	2 3 3	6	18				< *500
90	LS-18	2 4 5	9	18				*1000
95	LS-19	4 6 5	11	18		21.6	108.4	1,720

LOG OF TEST BORING NO: TB-3

Project Name: GLWA CS-120 Freud Pump Station
Project Location: Detroit, Michigan

NTH Consultants, Ltd.
NTH Proj. No.: 61-200414-02
Checked By: A. Brehmer

SUBSURFACE PROFILE					SOIL SAMPLE DATA								
ELEV. (FT)	PRO-FILE	ELEV	GROUND SURFACE ELEVATION: 94.2	DEPTH	DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
-5		-4.8		99.0									
			Very Compact Gray SANDY SILT with Trace Gravel		100	LS-20	15 32 24	56	16				
		-6.8		101.0									
-10					105	LS-21	51 79 78/2"	157/8"	14				>*9000
			HARDPAN: Very Hard Gray SILTY CLAY with Trace Sand and Gravel										
-15		-15.4		109.6		LS-22	18 46 78/1"	124/7"	12				>*9000
			END OF BORING AT 109.6 FEET.										
-20													
-25													
-30													
-35													

LOG OF TEST BORING NO: TB-4

Project Name: GLWA CS-120 Freud Pump Station
Project Location: Detroit, Michigan

NTH Consultants, Ltd.
NTH Proj. No.: 61-200414-02
Checked By: A. Brehmer

SUBSURFACE PROFILE

GROUND SURFACE ELEVATION: 94.2

ELEV	DESCRIPTION	DEPTH
93.8	SIDEWALK: CONCRETE (4.5-inches)	0.4
92.7	FILL: Black GRAVELLY SAND with Little Clay and Trace Silt	1.5
89.7	FILL: Light Brown SILTY SAND with Little Clay and Trace Gravel	4.5
88.7	FILL: Brown CLAYEY SAND with Trace Silt and Gravel	5.5
82.2	Very Stiff Gray and Brown SILTY CLAY with Trace Sand and Gravel	12.0
73.2	Stiff to Very Stiff Brown SILTY CLAY with Trace Sand and Gravel	21.0
64.2	Medium to Stiff Gray SILTY CLAY with Trace Sand and Gravel	

SOIL SAMPLE DATA

DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
	LS-1	4 9 10	19	13				*7000
10	LS-2	6 10 13	23	11				*9000
15	LS-3	2 5 7	12	12		18.6	115.9	4,580
20	LS-4	2 3 4	7	14				*4000
25	LS-5	1 3 2	5	1				
30	LS-6	WOH 2 2	4	15				< *500

Total Depth: *104.8 FT*
Drilling Start Date: *3/10/21*
Drilling End Date: *3/11/21*
Inspector: *Z. Paydawy/L. Granger*
Contractor: *DLZ-American Drilling Company*
Driller: *L. Bartlett*

Drilling Method:
Hand auger to 5.5'. CME-55 truck-mounted drilling rig using 3-1/4" ID HSA to 10'. Remove augers and install 4" steel casing to 10'; whereafter 3-7/8" OD tricone roller bit to EOB.

Plugging Procedure:
Backfill with grout and soil cuttings. Topped with concrete patch.

Water Level Observation:
No groundwater was encountered to a depth of 10'. Due to the introduction of drilling fluid at 10', no meaningful groundwater information was collected below this depth.

Notes:
** - Pocket Penetrometer Value*
WOH - Weight of Hammer
^ - Vane Shear Test Strength converted to Unconfined Compressive Strength
WOR - Weight of Drilling Rods

Approximate GPS Coordinates:
N: 318514 E: 13504874

Figure No. 6

LOG OF TEST BORING NO: TB-4

Project Name: GLWA CS-120 Freud Pump Station
Project Location: Detroit, Michigan

NTH Consultants, Ltd.
NTH Proj. No.: 61-200414-02
Checked By: A. Brehmer

SUBSURFACE PROFILE

GROUND SURFACE ELEVATION: 94.2

ELEV	Description	DEPTH
	Medium to Stiff Gray SILTY CLAY with Trace Sand and Gravel	
52.2		42.0
	Soft to Medium Gray SILTY CLAY with Trace Sand and Gravel	

SOIL SAMPLE DATA

DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
35	LS-7	1 3 2	5	16				< *500
	ST-1	P U S H		23		13.8	121.2	2,200
40								
	VS-1	-- -- --						^1,740
45	LS-8	WOH 1 2	3	18				< *500
50	LS-9	WOR 1 2	3	18		45.0	76.6	660
55								
60	LS-10	WOH 2 3	5	18				*1000
65	LS-11	WOH 2 3	5	18				*1000

LOG OF TEST BORING NO: TB-4

Project Name: GLWA CS-120 Freud Pump Station
Project Location: Detroit, Michigan

NTH Consultants, Ltd.
NTH Proj. No.: 61-200414-02
Checked By: A. Brehmer

SUBSURFACE PROFILE					SOIL SAMPLE DATA								
ELEV. (FT)	PRO-FILE	ELEV	GROUND SURFACE ELEVATION: 94.2	DEPTH	DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
		26.2											
25													
			Soft to Medium Gray SILTY CLAY with Trace Sand and Gravel		70	LS-12	1 3 3	6	18				*1000
		22.2		72.0									
20													
					75	LS-13	WOH WOH 1	1	18				< *500
						ST-2	P U S H		22		24.8	100.8	1,100
15													
					80	VS-2	-- -- --						^3,240
			Medium to Stiff Gray SILTY CLAY with Trace Sand and Gravel										
10													
					85	LS-14	1 4 5	9	18				*1500
5													
					90	LS-15	3 3 7	10	18				*2000
		1.2		93.0									
0													
					95	LS-16	11 15 28	43	16				>*9000
-5			Hard to Very Hard Gray SILTY CLAY with Trace Sand and Gravel, Occasional Sand Partings										
					100	LS-17	24 46 54/4"	94/10"	14				>*9000
-10													
		-10.6		104.8		LS-18	25 35 53/4"	88/10"	16				>*9000
			END OF BORING AT 104.8 FEET.										

LOG OF TEST BORING NO: TB-5/PR-2

Project Name: GLWA CS-120 Freud Pump Station
Project Location: Detroit, Michigan

NTH Consultants, Ltd.
NTH Proj. No.: 61-200414-02
Checked By: A. Brehmer

SUBSURFACE PROFILE

GROUND SURFACE ELEVATION: 94.8

ELEV	DESCRIPTION	DEPTH
94.4	SIDEWALK: CONCRETE (4.5-inches)	0.4
90.8	FILL: Very Loose Brown and Black SILTY SAND with Little Clay and Gravel	4.0
88.6	FILL: Very Loose Gray SILTY SAND with Little Clay and Gravel	6.2
85.5	Very Stiff Mottled Gray and Brown SILTY CLAY with Trace Sand and Gravel	9.3
82.8	Hard Brown SILTY CLAY with Trace Sand and Gravel	12.0
76.8	Stiff Gray SILTY CLAY with Trace Sand and Gravel	18.0
64.8	Soft to Medium Gray SILTY CLAY with Trace Sand and Gravel	

ELEV. (FT): 90, 85, 80, 75, 70, 65

SOIL SAMPLE DATA

DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
	LS-1	2 2 1	3	8				
5	LS-2	1 1 2	3	10				
	LS-3	5 8 12	20	5				*6000
10	LS-4	8 12 15	27	8		13.8	124.0	13,700
15	LS-5	3 5 5	10	13				*2000
20	LS-6	1 2 2	4	15				*500
25	LS-7	3 3 3	6	11				*1000
30	LS-8	1 3 2	5	16				*500

Total Depth: *33.5 FT*
Drilling Start Date: *3/12/21*
Drilling End Date: *3/12/21*
Inspector: *Z. Paydawy*
Contractor: *DLZ-American Drilling Company*
Driller: *K. Conrad*
Drilling Method:
CME-55 truck-mounted drilling rig using 2-1/4" ID HSA to EOB.

Plugging Procedure:
Borehole backfilled with grout and capped with concrete.

Water Level Observation:
No groundwater encountered during or upon completion of drilling.

Notes:
** - Pocket Penetrometer Value*

Refusal encountered at 33.5 feet. Wood noted in tip of sampler upon recovery.

Approximate GPS Coordinates:
N: 318462 E: 13504744

Figure No. 7

LOG OF TEST BORING NO: TB-5/PR-2

Project Name: GLWA CS-120 Freud Pump Station
Project Location: Detroit, Michigan

NTH Consultants, Ltd.
NTH Proj. No.: 61-200414-02
Checked By: A. Brehmer

SUBSURFACE PROFILE					SOIL SAMPLE DATA								
ELEV. (FT)	PRO-FILE	ELEV	GROUND SURFACE ELEVATION: 94.8	DEPTH	DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
	▨		Soft to Medium Gray SILTY CLAY with Trace Sand and Gravel										
		61.3		33.5									
60			Fox Creek Relief Sewer Encountered at 33.5 Feet. END OF BORING AT 33.5 FEET.										
55													
50													
45													
40													
35													
30													

LOG OF TEST BORING 61-200414-02.GPJ NTH CORPORATE.GDT 4/22/21

LOG OF TEST BORING NO: PR-1

Project Name: GLWA CS-120 Freud Pump Station
Project Location: Detroit, Michigan

NTH Consultants, Ltd.
NTH Proj. No.: 61-200414-02
Checked By: A. Brehmer

SUBSURFACE PROFILE						SOIL SAMPLE DATA							
ELEV. (FT)	PRO-FILE	ELEV	GROUND SURFACE ELEVATION: 94.7	DEPTH	DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
90					5								
85					10								
80			Profile Drill		15								
75					20								
70					25								
65		64.7		30.0	30								

Total Depth: *40.5 FT*
Drilling Start Date: *3/11/21*
Drilling End Date: *3/11/21*
Inspector: *Z. Paydawy*
Contractor: *DLZ-American Drilling Company*
Driller: *K. Conrad*
Drilling Method:
CME-55 truck mounted drilling rig using 2-1/4" ID HSA to EOB

Plugging Procedure:
Borehole backfilled with grout and capped with soil cuttings.

Water Level Observation:
Groundwater conditions were not recorded.

Notes:
Refusal encountered at 40.5 feet. Wood noted in tip of sampler upon recovery.

Approximate GPS Coordinates:
N: 318158 E: 13504746

Figure No. 8

LOG OF TEST BORING NO: PR-1

Project Name: GLWA CS-120 Freud Pump Station
Project Location: Detroit, Michigan

NTH Consultants, Ltd.
NTH Proj. No.: 61-200414-02
Checked By: A. Brehmer

SUBSURFACE PROFILE						SOIL SAMPLE DATA							
ELEV. (FT)	PRO-FILE	ELEV	GROUND SURFACE ELEVATION: 94.7	DEPTH	DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
60 55		54.2	Profile Drill	40.5	35 40								
50 45 40 35 30			Fox Creek Relief Sewer Encountered at 40.5 Feet. END OF BORING AT 40.5 FEET.										

LOG OF TEST BORING NO: PR-3

NTH Consultants, Ltd.

Project Name: GLWA CS-120 Freud Pump Station
Project Location: Detroit, Michigan
NTH Proj. No.: 61-200414-02
Checked By: A. Brehmer

SUBSURFACE PROFILE					SOIL SAMPLE DATA							
ELEV. (FT)	PRO-FILE	ELEV / GROUND SURFACE ELEVATION: 94.8	DEPTH	DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
90				5								
85				10								
80		Profile Drill		15								
75				20								
70				25								
65		64.8	30.0	30								

Total Depth: *31.5 FT*
Drilling Start Date: *3/11/21*
Drilling End Date: *3/11/21*
Inspector: *Z. Paydawy*
Contractor: *DLZ-American Drilling Company*
Driller: *K. Conrad*
Drilling Method:
CME-55 truck mounted drilling rig using 2-1/4" ID HSA to EOB

Plugging Procedure:
Borehole backfilled with grout and capped with soil cuttings.

Water Level Observation:
Groundwater conditions were not recorded.

Notes:
Refusal encountered at 31.5 feet. Wood noted in tip of sampler upon recovery.

Approximate GPS Coordinates:
N: 318466 E: 13504742

Figure No. 9

LOG OF TEST BORING NO: PR-3

Project Name: GLWA CS-120 Freud Pump Station
Project Location: Detroit, Michigan

NTH Consultants, Ltd.
NTH Proj. No.: 61-200414-02
Checked By: A. Brehmer

SUBSURFACE PROFILE						SOIL SAMPLE DATA							
ELEV. (FT)	PRO-FILE	ELEV	GROUND SURFACE ELEVATION: 94.8	DEPTH	DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
		63.3	Profile Drill	31.5									
			Fox Creek Relief Sewer Encountered at 31.5 Feet. END OF BORING AT 31.5 FEET.										
60													
55													
50													
45													
40													
35													
30													

LOG OF TEST BORING 61-200414-02.GPJ NTH CORPORATE.GDT 4/22/21

LOG OF TEST BORING NO: PR-4

Project Name: GLWA CS-120 Freud Pump Station
Project Location: Detroit, Michigan

NTH Consultants, Ltd.
NTH Proj. No.: 61-200414-02
Checked By: A. Brehmer

SUBSURFACE PROFILE						SOIL SAMPLE DATA							
ELEV. (FT)	PRO-FILE	ELEV	GROUND SURFACE ELEVATION: 94.1	DEPTH	DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
90													
					5								
85													
					10								
80													
			Profile Drill		15								
75													
					20								
70													
					25								
65													
		64.1		30.0	30								

Total Depth: *31 FT*
Drilling Start Date: *3/11/21*
Drilling End Date: *3/11/21*
Inspector: *Z. Paydawy*
Contractor: *DLZ-American Drilling Company*
Driller: *K. Conrad*
Drilling Method:
CME-55 truck mounted drilling rig using 2-1/4" ID HSA to EOB

Plugging Procedure:
Borehole backfilled with grout and capped with soil cuttings.

Water Level Observation:
Groundwater conditions were not recorded.

Notes:
Refusal encountered at 31.0 feet. Wood noted in tip of sampler upon recovery.

Approximate GPS Coordinates:
N: 318470 E: 13504739

Figure No. 10

LOG OF TEST BORING NO: PR-4

Project Name: GLWA CS-120 Freud Pump Station
Project Location: Detroit, Michigan

NTH Consultants, Ltd.
NTH Proj. No.: 61-200414-02
Checked By: A. Brehmer

SUBSURFACE PROFILE						SOIL SAMPLE DATA							
ELEV. (FT)	PRO-FILE	ELEV	GROUND SURFACE ELEVATION: 94.1	DEPTH	DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
		63.1	Profile Drill	31.0									
			Fox Creek Relief Sewer Encountered at 31 Feet. END OF BORING AT 31.0 FEET.										
60													
55													
50													
45													
40													
35													
30													

LOG OF TEST BORING 61-200414-02.GPJ NTH CORPORATE.GDT 4/22/21

LOG OF TEST BORING NO: PR-5

Project Name: GLWA CS-120 Freud Pump Station
Project Location: Detroit, Michigan

NTH Consultants, Ltd.
NTH Proj. No.: 61-200414-02
Checked By: A. Brehmer

SUBSURFACE PROFILE					SOIL SAMPLE DATA								
ELEV. (FT)	PRO-FILE	ELEV	GROUND SURFACE ELEVATION: 94.4	DEPTH	DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
90					5								
85					10								
80			Profile Drill		15								
75					20								
70					25								
65		64.4		30.0	30								

Total Depth: *39.1 FT*
Drilling Start Date: *3/12/21*
Drilling End Date: *3/12/21*
Inspector: *Z. Paydawy*
Contractor: *DLZ-American Drilling Company*
Driller: *K. Conrad*
Drilling Method:
CME-55 truck mounted drilling rig using 2-1/4" ID HSA to EOB

Plugging Procedure:
Borehole backfilled with grout and capped with soil cuttings.

Water Level Observation:
Groundwater conditions were not recorded.

Notes:
Refusal encountered at 39.1 feet. Wood noted in tip of sampler upon recovery.

Approximate GPS Coordinates:
N: 318476 E: 13504737

Figure No. 11

LOG OF TEST BORING NO: PR-5

Project Name: GLWA CS-120 Freud Pump Station
Project Location: Detroit, Michigan

NTH Consultants, Ltd.
NTH Proj. No.: 61-200414-02
Checked By: A. Brehmer

SUBSURFACE PROFILE						SOIL SAMPLE DATA							
ELEV. (FT)	PRO- FILE	ELEV	GROUND SURFACE ELEVATION: 94.4	DEPTH	DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
60			Profile Drill		35								
55		55.3		39.1									
			Fox Creek Relief Sewer Encountered at 39.1 Feet. END OF BORING AT 39.1 FEET.										
50													
45													
40													
35													
30													

NTH Consultants, Ltd.
Professional Engineering & Environmental Services

VANE SHEAR TEST REPORT

Project Name:	GLWA CS-120 Freud Pump Station Isolation Shaft			***NTH Project No:***	61-200414
Project Location:	Detroit, MI			***Checked By:***	A. Brehmer
Test No:	VS-1			***Test Boring No:***	TB-1
Test Elevation:	41.2	***Test Depth (ft):***	***53.5***	***Date:***	March 9, 2021

VANE DATA

Torque Arm Length (in): 12

Vane Diameter (in): 2.5

Vane Constant (*): 2.59

FORCE GAGE READINGS

Rate of rotation is to one turn of crank every five seconds. Gage readings are to be recorded every 5 degrees.

(10 turns of crank = 5 degrees of rotation)

UNDISTURBED CONDITION		REMOLDED CONDITION (1 minute)	
Degree of Rotation	**Gage Reading (lbs)**	**Degree of Rotation**	**Gage Reading (lbs)**
5	14	5	15
10	31	10	16
15	40	15	16
20	32	20	16
25	30	25	
30		30	
35		35	
40		40	
45			

CALCULATIONS

	UNDISTURBED	REMOLDED
Maximum Force Gage Reading for Vane (F) lbs.	32	16
Torque (T) in-lbs = Torque Arm x (F)	384	192
Ultimate Shear Strength (S) psf = (T) x Vane Constant	995	497

Sensitivity = (S Undisturbed) / (S Remolded) = 2

Performed By: B. Stachkunis

NOTES:

Degree of Sensitivity: 2 = insensitive 4 = moderately sensitive 8 = extra sensitive

* Vane Constants: 3.625" dia. Vane = 0.905 2.5" dia. Vane = 2.59 2.0" dia. Vane = 5.17

FIGURE No. 12

NTH Consultants, Ltd.
Professional Engineering & Environmental Services

VANE SHEAR TEST REPORT

Project Name:	GLWA CS-120 Freud Pump Station Isolation Shaft			***NTH Project No:***	61-200414
Project Location:	Detroit, MI			***Checked By:***	A. Brehmer
Test No:	VS-2			***Test Boring No:***	TB-1
Test Elevation:	19.2	***Test Depth (ft):***	***75.5***	***Date:***	March 9, 2021

VANE DATA

Torque Arm Length (in): 12

Vane Diameter (in): 2.5

Vane Constant (*): 2.59

FORCE GAGE READINGS

Rate of rotation is to one turn of crank every five seconds. Gage readings are to be recorded every 5 degrees.

(10 turns of crank = 5 degrees of rotation)

UNDISTURBED CONDITION		REMOLDED CONDITION (1 minute)	
Degree of Rotation	**Gage Reading (lbs)**	**Degree of Rotation**	**Gage Reading (lbs)**
5	28	5	24
10	45	10	24
15	54	15	24
20	49	20	
25	49	25	
30		30	
35		35	
40		40	
45			

CALCULATIONS

	UNDISTURBED	REMOLDED
Maximum Force Gage Reading for Vane (F) lbs.	49	24
Torque (T) in-lbs = Torque Arm x (F)	588	288
Ultimate Shear Strength (S) psf = (T) x Vane Constant	1523	746

Sensitivity = (S Undisturbed) / (S Remolded) = 2.0

Performed By: B. Stachkunis

NOTES: Degree of Sensitivity: 2 = insensitive 4 = moderately sensitive 8 = extra sensitive

* Vane Constants: 3.625" dia. Vane = 0.905 2.5" dia. Vane = 2.59 2.0" dia. Vane = 5.17

FIGURE No. 13

NTH Consultants, Ltd.
Professional Engineering & Environmental Services

VANE SHEAR TEST REPORT

Project Name:	GLWA CS-120 Freud Pump Station Isolation Shaft			***NTH Project No:***	61-200414
Project Location:	Detroit, MI			***Checked By:***	A. Brehmer
Test No:	VS-1			***Test Boring No:***	TB-2
Test Elevation:	50.6	***Test Depth (ft):***	***43.5***	***Date:***	March 11, 2021

VANE DATA

Torque Arm Length (in):	12	***Vane Diameter (in):***	2.5	***Vane Constant (*):***	2.59

FORCE GAGE READINGS

Rate of rotation is to one turn of crank every five seconds. Gage readings are to be recorded every 5 degrees.

(10 turns of crank = 5 degrees of rotation)

UNDISTURBED CONDITION		REMOLDED CONDITION (1 minute)	
Degree of Rotation	**Gage Reading (lbs)**	**Degree of Rotation**	**Gage Reading (lbs)**
5	12	5	6
10	14	10	8
15	16	15	9
20	18	20	11
25	21	25	10
30	24	30	
35	28	35	
40	28	40	
45	27		

CALCULATIONS

	UNDISTURBED	**REMOLDED**
Maximum Force Gage Reading for Vane (F) lbs.	28	11
Torque (T) in-lbs = Torque Arm x (F)	336	132
Ultimate Shear Strength (S) psf = (T) x Vane Constant	870	342

Sensitivity = (S Undisturbed) / (S Remolded) = 2.5

Performed By: B. Stachkunis

NOTES: Degree of Sensitivity: 2 = insensitive 4 = moderately sensitive 8 = extra sensitive

* Vane Constants: 3.625" dia. Vane = 0.905 2.5" dia. Vane = 2.59 2.0" dia. Vane = 5.17

FIGURE No. 14

NTH Consultants, Ltd.
Professional Engineering & Environmental Services

VANE SHEAR TEST REPORT

Project Name:	GLWA CS-120 Freud Pump Station Isolation Shaft			***NTH Project No:***	61-200414
Project Location:	Detroit, MI			***Checked By:***	A. Brehmer
Test No:	VS-2			***Test Boring No:***	TB-2
Test Elevation:	30.6	***Test Depth (ft):***	***63.5***	***Date:***	March 11, 2021

VANE DATA

Torque Arm Length (in): 12

Vane Diameter (in): 2.5

Vane Constant (*): 2.59

FORCE GAGE READINGS

Rate of rotation is to one turn of crank every five seconds. Gage readings are to be recorded every 5 degrees.

(10 turns of crank = 5 degrees of rotation)

UNDISTURBED CONDITION		REMOLDED CONDITION (1 minute)	
Degree of Rotation	Gage Reading (lbs)	Degree of Rotation	Gage Reading (lbs)
5	10	5	10
10	16	10	10
15	18	15	10
20	19	20	12
25	19	25	13
30	20	30	
35		35	
40		40	
45			

CALCULATIONS

	UNDISTURBED	REMOLDED
Maximum Force Gage Reading for Vane (F) lbs.	20	13
Torque (T) in-lbs = Torque Arm x (F)	240	156
Ultimate Shear Strength (S) psf = (T) x Vane Constant	622	404

Sensitivity = (S Undisturbed) / (S Remolded) = 1.5

Performed By: B. Stachkunis

NOTES: Degree of Sensitivity: 2 = insensitive 4 = moderately sensitive 8 = extra sensitive

* Vane Constants: 3.625" dia. Vane = 0.905 2.5" dia. Vane = 2.59 2.0" dia. Vane = 5.17

FIGURE No. 15

NTH Consultants, Ltd.
Professional Engineering & Environmental Services

VANE SHEAR TEST REPORT

Project Name: GLWA CS-120 Freud Pump Station Isolation Shaft

NTH Project No: 61-200414

Project Location: Detroit, MI

Checked By: A. Brehmer

Test No: VS-1

Test Boring No: TB-3

Test Elevation: 45.7

Test Depth (ft): **48.5**

Date: March 10, 2021

VANE DATA

Torque Arm Length (in): 12

Vane Diameter (in): 2.5

Vane Constant (*): 2.59

FORCE GAGE READINGS

Rate of rotation is to one turn of crank every five seconds. Gage readings are to be recorded every 5 degrees.

(10 turns of crank = 5 degrees of rotation)

UNDISTURBED CONDITION		REMOLDED CONDITION (1 minute)	
Degree of Rotation	Gage Reading (lbs)	Degree of Rotation	Gage Reading (lbs)
5	22	5	10
10	28	10	12
15	25	15	12
20	25	20	12
25	25	25	
30		30	
35		35	
40		40	
45			

CALCULATIONS

	UNDISTURBED	REMOLDED
Maximum Force Gage Reading for Vane (F) lbs.	25	12
Torque (T) in-lbs = Torque Arm x (F)	300	144
Ultimate Shear Strength (S) psf = (T) x Vane Constant	777	373

Sensitivity = (S Undisturbed) / (S Remolded) = 2.1

Performed By: B. Stachkunis

NOTES: Degree of Sensitivity: 2 = insensitive 4 = moderately sensitive 8 = extra sensitive

* Vane Constants: 3.625" dia. Vane = 0.905 2.5" dia. Vane = 2.59 2.0" dia. Vane = 5.17

FIGURE No. 16

NTH Consultants, Ltd.
Professional Engineering & Environmental Services

VANE SHEAR TEST REPORT

Project Name:	GLWA CS-120 Freud Pump Station Isolation Shaft			***NTH Project No:***	61-200414
Project Location:	Detroit, MI			***Checked By:***	A. Brehmer
Test No:	VS-2			***Test Boring No:***	TB-3
Test Elevation:	25.7	***Test Depth (ft):***	***68.5***	***Date:***	March 10, 2021

VANE DATA

Torque Arm Length (in): 12

Vane Diameter (in): 2.5

Vane Constant (*): 2.59

FORCE GAGE READINGS

Rate of rotation is to one turn of crank every five seconds. Gage readings are to be recorded every 5 degrees.

(10 turns of crank = 5 degrees of rotation)

UNDISTURBED CONDITION		REMOLDED CONDITION (1 minute)	
Degree of Rotation	Gage Reading (lbs)	Degree of Rotation	Gage Reading (lbs)
5	23	5	23
10	34	10	23
15	37	15	23
20	37	20	
25	36	25	
30	35	30	
35		35	
40		40	
45			

CALCULATIONS

	UNDISTURBED	REMOLDED
Maximum Force Gage Reading for Vane (F) lbs.	37	23
Torque (T) in-lbs = Torque Arm x (F)	444	276
Ultimate Shear Strength (S) psf = (T) x Vane Constant	1150	715

Sensitivity = (S Undisturbed) / (S Remolded) = 1.6

Performed By: B. Stachkunis

NOTES: Degree of Sensitivity: 2 = insensitive 4 = moderately sensitive 8 = extra sensitive

* Vane Constants: 3.625" dia. Vane = 0.905 2.5" dia. Vane = 2.59 2.0" dia. Vane = 5.17

FIGURE No. 17

NTH Consultants, Ltd.
Professional Engineering & Environmental Services

VANE SHEAR TEST REPORT

Project Name:	GLWA CS-120 Freud Pump Station Isolation Shaft			***NTH Project No:***	61-200414
Project Location:	Detroit, MI			***Checked By:***	A. Brehmer
Test No:	VS-1			***Test Boring No:***	TB-4
Test Elevation:	52.7	***Test Depth (ft):***	***41.5***	***Date:***	March 10, 2021

VANE DATA

Torque Arm Length (in):	12	***Vane Diameter (in):***	2.5	***Vane Constant (*):***	2.59

FORCE GAGE READINGS

Rate of rotation is to one turn of crank every five seconds. Gage readings are to be recorded every 5 degrees.

(10 turns of crank = 5 degrees of rotation)

UNDISTURBED CONDITION		REMOLDED CONDITION (1 minute)	
Degree of Rotation	**Gage Reading (lbs)**	**Degree of Rotation**	**Gage Reading (lbs)**
5	6	5	15
10	9	10	16
15	15	15	17
20	22	20	17
25	25	25	17
30	27	30	
35	28	35	
40	28	40	
45	28		

CALCULATIONS

	UNDISTURBED	REMOLDED
Maximum Force Gage Reading for Vane (F) lbs.	28	17
Torque (T) in-lbs = Torque Arm x (F)	336	204
Ultimate Shear Strength (S) psf = (T) x Vane Constant	870	528

Sensitivity = (S Undisturbed) / (S Remolded) = 1.6

Performed By: L. Granger

NOTES:	Degree of Sensitivity:	2 = insensitive	4 = moderately sensitive	8 = extra sensitive
	* Vane Constants:	3.625" dia. Vane = 0.905	2.5" dia. Vane = 2.59	2.0" dia. Vane = 5.17

FIGURE No. 18

NTH Consultants, Ltd.
Professional Engineering & Environmental Services

VANE SHEAR TEST REPORT

Project Name:	GLWA CS-120 Freud Pump Station Isolation Shaft			***NTH Project No:***	61-200414
Project Location:	Detroit, MI			***Checked By:***	A. Brehmer
Test No:	VS-2			***Test Boring No:***	TB-4
Test Elevation:	13.7	***Test Depth (ft):***	***80.5***	***Date:***	March 10, 2021

VANE DATA

Torque Arm Length (in):	12	***Vane Diameter (in):***	2.5	***Vane Constant (*):***	2.59

FORCE GAGE READINGS

Rate of rotation is to one turn of crank every five seconds. Gage readings are to be recorded every 5 degrees.

(10 turns of crank = 5 degrees of rotation)

UNDISTURBED CONDITION		REMOLDED CONDITION (1 minute)	
Degree of Rotation	**Gage Reading (lbs)**	**Degree of Rotation**	**Gage Reading (lbs)**
5	10	5	9
10	17	10	16
15	25	15	20
20	32	20	23
25	40	25	25
30	45	30	27
35	48	35	27
40	52	40	27
45	52	45	
50	52	50	

CALCULATIONS

	UNDISTURBED	REMOLDED
Maximum Force Gage Reading for Vane (F) lbs.	52	27
Torque (T) in-lbs = Torque Arm x (F)	624	324
Ultimate Shear Strength (S) psf = (T) x Vane Constant	1616	839

Sensitivity = (S Undisturbed) / (S Remolded) = 1.9

Performed By: L. Granger

NOTES:	Degree of Sensitivity:	2 = insensitive	4 = moderately sensitive	8 = extra sensitive
	* Vane Constants:	3.625" dia. Vane = 0.905	2.5" dia. Vane = 2.59	2.0" dia. Vane = 5.17

FIGURE No. 19

Project No.	61-200414	NTH Consultants, Ltd.	GLWA CS-120 Freud Pump Station Isolation Shaft

TABULATION OF LABORATORY TEST DATA

Boring / Test Pit / Probe Designation	Sample Number	Depth of Sample Tip (ft)	Elevation of Sample Tip (ft)	Unconfined Compressive Strength (psf)	Failure Strain (%)	Natural Water Content (% of dry weight)	In-Place Dry Density (lbs/cu.ft)	PERMEABILITY (CM/SEC)	PARTICLE SIZE DISTRIBUTION (%)							ATTERBERG LIMITS (%)			Apparent Specific Gravity	Loss On Ignition (%)	Unified Soil Classification
									Colloids	Clay	Silt	Fine Sand	Medium Sand	Coarse Sand	Gravel	Liquid Limit	Plastic Limit	Plasticity Index			
TB-1	LS-2	10.0	84.7	19,760	15.0	13.7	125.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TB-1	LS-6	30.0	64.7	660	15.0	17.0	118.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TB-1	ST-1	52.0	42.7	1,400	6.2	34.0	88.8	--	--	--	--	--	--	--	--	37	19	18	--	--	--
TB-1	LS-14	70.0	24.7	1,240	15.0	20.7	112.6	--	--	--	--	--	--	--	--	27	15	12	--	--	--
TB-2	LS-3	15.0	79.1	2,640	15.0	17.4	117.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TB-2	ST-1	42.0	52.1	920	15.0	21.8	107.0	--	--	--	--	--	--	--	--	27	14	13	--	--	--
TB-2	ST-2	62.0	32.1	1,740	15.0	20.5	109.2	--	--	--	--	--	--	--	--	25	14	11	--	--	--
TB-2	LS-17	85.0	9.1	3,420	15.0	18.8	115.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TB-3	LS-4	20.0	74.2	960	15.0	17.7	116.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TB-3	LS-10	50.0	44.2	400	15.0	36.3	87.7	--	--	--	--	--	--	--	--	38	20	18	--	--	--
TB-3	ST-2	67.0	27.2	1,380	15.0	19.1	111.8	--	--	--	--	--	--	--	--	23	13	10	--	--	--
TB-3	LS-15	75.0	19.2	690	15.0	26.7	101.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TB-3	LS-19	95.0	-0.8	1,720	15.0	21.6	108.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TB-4	LS-3	15.0	79.2	4,580	15.0	18.6	115.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TB-4	ST-1	37.0	57.2	2,200	12.4	13.8	121.2	--	--	--	--	--	--	--	--	19	12	7	--	--	--
TB-4	LS-9	50.0	44.2	660	15.0	45.0	76.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TB-4	ST-2	77.0	17.2	1,100	14.5	24.8	100.8	--	--	--	--	--	--	--	--	28	15	13	--	--	--
TB-5	LS-4	10.0	84.8	13,700	15.0	13.8	124.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TB-5	LS-8	30.0	64.8	720	15.0	25.4	103.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--

FIGURE No. 20

SUBSURFACE UTILITY ENGINEERING PHOTO LOG

Photograph 1: 16" Watermain along Freud Street looking west.

SUBSURFACE UTILITY ENGINEERING PHOTO LOG

Photograph 2: 24" Watermain, storm sewer, and gas main along Freud Street looking west.

FIGURE No. 21

SUBSURFACE UTILITY ENGINEERING PHOTO LOG

Photograph 3: Water gate valve and ATT communication at northwest corner of Freud Street and Conner Street.

SUBSURFACE UTILITY ENGINEERING PHOTO LOG

Photograph 4: Communications duct bank crossing Conner Street looking west.

FIGURE No. 21

SUBSURFACE UTILITY ENGINEERING PHOTO LOG

Photograph 5: Gas man and communications duct back crossing Freud Street at Conner Street looking north.

FIGURE No. 21

SUBSURFACE UTILITY ENGINEERING PHOTO LOG

Photograph 6: Gas valve at southeast corner of Freud Street and Navahoe Street looking east.

SUBSURFACE UTILITY ENGINEERING PHOTO LOG

Photograph 7: Gas valve at southeast corner of Freud Street and Conner Street looking south.

SUBSURFACE UTILITY ENGINEERING PHOTO LOG

Photograph 8: Gas main along Freud Street at Navahoe Street looking west

FIGURE No. 21

SUBSURFACE UTILITY ENGINEERING PHOTO LOG

Photograph 9: Gas main along Freud Street west of Conner Street looking west.

SUBSURFACE UTILITY ENGINEERING PHOTO LOG

Photograph 10: Gas line through the intersection of Freud Street and Conner Street looking northeast.

SUBSURFACE UTILITY ENGINEERING PHOTO LOG

Photograph 11: Storm sewer along Freud Street and alley looking east

Appendix B

Archaeological Literature Review and Assessment for the Freud Pump Station Improvement Project

106GROUP
Connecting People + Place + Time

ARCHAEOLOGICAL LITERATURE REVIEW AND ASSESSMENT FOR THE FREUD PUMP STATION IMPROVEMENT PROJECT

Detroit, Wayne County, Michigan

April 2022

ARCHAEOLOGICAL LITERATURE REVIEW AND ASSESSMENT FOR THE FREUD PUMP STATION IMPROVEMENT PROJECT

Detroit, Wayne County, Michigan

SHPO File No. Pending

Arcadis of Michigan Project No. 30047523, Task F4.2

106 Group Project No. 3000

SUBMITTED TO:
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REPORT AUTHOR:
Jason Rufledt, B.A.

April 2022

MANAGEMENT SUMMARY

During March and April 2022, 106 Group conducted an archaeological literature review and assessment for the Freud Pump Station Improvement Project (Project) located Detroit, Wayne County, Michigan. The Project includes below-ground installation of a 2,000-linear foot, 36-inch force main on Navahoe Street, from Jefferson Avenue East to Freud Street; construction of a new shaft maintenance building on Freud Street; realignment of Freud Street to accommodate the shaft maintenance building; and improvements to the existing Freud Pump Station located at 12300 Freud Street. The Project, proposed by Arcadis of Michigan, is seeking a low interest loan through the Clean Water State Revolving Fund (SRF)—federal funds administrated by the Michigan Department of Environment, Great Lakes, and Energy—and, therefore, must comply with Section 106 of the National Historic Preservation Act of 1966, as amended, as well as applicable state mandates governing archaeological resources.

The Project is located in the Jefferson Chalmers neighborhood, Detroit, Wayne County, Michigan. An appropriate Area of Potential Effects (APE) for archaeology includes all areas of potential ground disturbance and is the same as the Project area, totaling approximately 8.1 acres (3.3 hectares [ha]). The archaeological investigation included a literature review and desktop assessment. The literature review consisted of a review of documentation of previously identified archaeological sites that overlap the APE, and of surveys previously conducted within the APE. Due to schedule constraints faced by the client, the literature review was conducted before data was received from the Michigan State Historic Preservation Office. Data obtained in 2021 as part of the archaeological literature review for Connors Creek Sewer System Rehabilitation Project conducted by 106 Group was used, due to the geographical proximity of the two projects' APEs (Rufledt, Que, and Bray 2021). The results of the literature review based on the 2021 data will be compared to the 2022 data and updated, as necessary, once it is received. Historical maps and aerial photographs were also reviewed to aid in the archaeological investigation. The desktop assessment identified whether the Project has the potential to impact unknown intact archaeological resources that may be potentially eligible for listing in the National Register of Historic Places.

Research indicates that one archaeological study has been previously conducted within the APE. No prehistoric-period archaeological sites have been recorded within the APE. The potential for intact prehistoric-period archaeological resources within the APE is assessed as low due to the APE's historical setting of a swampy plain and disturbance from early urban construction.

No historic-period archaeological sites have been recorded within the APE. Given the chronology of development in the area between annexation and the development of residential and commercial structures, the potential for intact historic-period archaeological resources within the APE is assessed as low. 106 Group recommends no further work for the Project as planned.

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1.0 INTRODUCTION

During March and April 2022, 106 Group conducted an archaeological literature review and assessment for the Freud Pump Station Improvement Project (Project) located Detroit, Wayne County, Michigan. The Project includes below-ground installation of a 2,000-linear foot, 36-inch force main on Navahoe Street, from Jefferson Avenue East to Freud Street; construction of a new shaft maintenance building on Freud Street; realignment of Freud Street to accommodate the shaft maintenance building; and improvements to the existing Freud Pump Station located at 12300 Freud Street. The Project, proposed by Arcadis of Michigan, is seeking a low interest loan through the Clean Water State Revolving Fund (SRF)—federal funds administrated by the Michigan Department of Environment, Great Lakes, and Energy—and, therefore, must comply with Section 106 of the National Historic Preservation Act of 1966, as amended, as well as applicable state mandates governing archaeological resources.

The Project is located in the Jefferson Chalmers neighborhood, Detroit, Wayne County, Michigan (Figure 1). An appropriate Area of Potential Effects (APE) for archaeology includes all areas of potential ground disturbance and is the same as the Project area, totaling approximately 8.1 acres (3.3 hectares [ha]). The archaeological investigation included a literature review and desktop assessment. The literature review consisted of a review of documentation of previously identified archaeological sites that overlap the APE, and of surveys previously conducted within the APE. Due to schedule constraints faced by the client, the literature review was conducted before data was received from the Michigan State Historic Preservation Office (SHPO). Data obtained in 2021 as part of the archaeological literature review for Connors Creek Sewer System Rehabilitation Project conducted by 106 Group was used, due to the geographical proximity of the two projects' APEs (Rufledt, Que, and Bray 2021). The results of the literature review based on the 2021 data will be compared to the 2022 data and updated, as necessary, once it is received. Historical maps and aerial photographs were also reviewed to aid in the archaeological investigation. The desktop assessment identified whether the Project has the potential to impact unknown intact archaeological resources that may be potentially eligible for listing in the National Register of Historic Places (NRHP).

The following report describes project methodology, results, and recommendations for the Freud Pump Station Improvement Project. Appendix A contains a list of Project personnel.

Freud Pump Station Improvement Project Archaeological Literature Review and Assessment

Detroit, Wayne County, Michigan

🟨 Project Area/APE

▨ Previous Archaeological Study

Service Layer Credits: Copyright:© 2013 National Geographic Society, i-cubed

Source: 106 Group; Arcadis

Map Produced by 106 Group 4/12/2022

0 230 Meters

0 625 Feet

1:12,000

106GROUP

Project Location and Literature Review Results

Figure 1

2.0 OBJECTIVES

The primary objectives of the literature review were to identify whether any known archaeological sites exist within the APE and to identify whether any portion of the APE may have been previously surveyed. The objective of the archaeological assessment was to assess whether the Project has the potential to impact unknown intact archaeological resources that may be potentially eligible for listing in the NRHP. The results of this investigation aid in determining what, if any, additional archaeological studies may need to be completed to comply with federal and state law. All work was conducted in accordance with *The Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation* [48 Federal Register 44716-44740] (National Park Service [NPS] 1983).

3.0 AREA OF POTENTIAL EFFECTS

An appropriate APE for archaeology includes all areas of potential ground disturbance and is the same as the Project area, totaling approximately 8.1 acres (3.3 ha). The Project includes below-ground installation of a 2,000-linear foot, 36-inch force main on Navahoe Street, from Jefferson Avenue East to Freud Street; construction of a new shaft maintenance building on Freud Street; realignment of Freud Street to accommodate the shaft maintenance building; and improvements to the existing Freud Pump Station located at 12300 Freud Street.

4.0 METHODS

4.1 Literature Review

On March 25, 2022, data pertaining to previously identified archaeological sites and surveys previously conducted within the APE was requested from SHPO. This request included information on archaeological sites within a one-mile (1.6-kilometer [km]) radius of the APE in order to provide a broader context. Due to schedule constraints faced by the client, the literature review was conducted before data was received from SHPO. Data obtained in 2021 as part of the archaeological literature review for Connors Creek Sewer System Rehabilitation Project conducted by 106 Group was used, due to the geographical proximity of the APEs for both projects (Rufledt, Que, and Bray 2021). Therefore, the current archaeological literature review was limited to archaeological sites within or overlapping the APE. The results of the literature review based on the 2021 data will be compared to the 2022 data and updated, as necessary, once it is received. Reports of previous archaeological investigations were also reviewed to determine if any portion of the APE had been previously surveyed and, therefore, would not require further investigation. In addition, multiple documentary sources were consulted, including United States Geological Survey (USGS) topographic quadrangles, historical plat maps, and aerial photographs.

4.2 Archaeological Assessment

The assessment was based on the results of the literature review only, and no site visit was conducted.

Areas generally assessed as having a greater probability to contain intact archaeological sites included undisturbed portions of the APE that are:

- located within 500 feet (ft) (150 meters [m]) of an existing or former water source of 40 acres (19 ha) or greater in extent, or within 500 ft (150 m) of a former or existing perennial stream;
- located on topographically prominent landscape features;
- located within 300 ft (100 m) of a previously reported site; or
- located within 300 ft (100 m) of a former or existing historical structure or feature (such as a building foundation or cellar depression).

Areas assessed as having a relatively low potential for containing intact archaeological resources included inundated areas, former or existing wetland areas, poorly drained areas, areas with slope of 20 degrees or greater, and areas of extensive disturbance.

5.0 RESULTS

5.1 Literature Review

5.1.1 Previous Studies

Research indicated that one previous archaeological study has been conducted within the APE (Table 1). In 1981, a literature cultural resource survey and field inspection was conducted in the area bounded by the Detroit River, Jefferson Avenue, Alter Road, and Clairpointe Street (including the segment that is Clairpointe Avenue). This study examined areas mostly to the south and east of the APE, but encompasses the entire APE. The land use history study resulted in an assessment of low archaeological sensitivity for most of the area, including the APE. Areas of higher archaeological sensitivity were confined to elevated sand and gravel formations along the Fox Creek and Windmill Pointe (approximately 1.5 miles (2.4 km) southeast of the APE at the shoreline of the Detroit River) (Branstner and Barton 1981).

Table 1. Previous Archaeological Studies within the APE

Author	Year	Report Title
Branstner, Mark C. and David Barton	1981	A Literature Cultural Resource Survey and Field Inspection of the Jefferson Chalmers and Gray Haven Project Areas, Detroit, Michigan

5.1.2 Previously Identified Resources

Research indicates that no archaeological sites have been recorded within or overlapping the APE. The SHPO data request pertaining to previously identified archaeological sites included information on archaeological sites within a one-mile (1.6- km) radius of the APE in order to provide a broader context. Due to schedule constraints faced by the client, the literature review was conducted before data was received from SHPO. Data obtained in 2021 as part of the archaeological literature review for Connors Creek Sewer System Rehabilitation Project conducted by 106 Group was used, due to the geographical proximity of the APEs for both projects (Rufledt, Que, and Bray 2021).

5.1.3 Environmental History Overview

The nearest naturally occurring water source, Conners Creek, is adjacent to the western extent of the APE. The Detroit River is approximately 0.75 miles (1.2 km) south of the southern boundary of the APE. Soil associations for the APE include Fluvaquentic Eutrudepts-Urban land-Wauseon complex, 0 to 2 percent slopes (approximately 94 percent of the APE) and Ziegenfuss-Urban land complex, 0 to 2 percent slopes (approximately 6 percent of the APE) (Natural Resources Conservation Service [NRCS] 2022). The NRCS describes these soils as somewhat poorly drained to poorly drained with little slope (NRCS 2022).

The APE is in the Maumee Lake Plain of the Huron/Erie Lake Plains Ecoregion 57, characterized by flat topography and poorly drained fertile soils (Environmental Protection Agency [EPA] 2022). Prior to

Euroamerican settlement, the Huron/Erie Lake Plains Ecoregion was dominated by closed-canopy forests of elm-ash swamp and beech. Today, much of the area has been cleared and artificially drained, containing highly productive farmland (EPA 2022).

5.1.4 Historical Research

The APE is located in the Jefferson Chalmers neighborhood of Detroit. The neighborhood's origins date to the early 1700s, when the city started as a Frech outpost, Fort Pontchartrain du détroit (City of Detroit 2007). The main street of the fort was Ste. Anne Street, which ran down the middle of the present-day Jefferson Avenue (which itself was an early Indian trail that ran along the Detroit River) (City of Detroit 2007). The land surrounding the APE was originally a large marsh that the French called Le Grand Marais, which was low, flat, marshy, and covered with wild grass. By the 1750s, the Grand Marais was sparsely populated (City of Detroit 2007). Through the rest of the eighteenth century, Fort Pontchartrain became a palisaded community and eventually expanded greatly when the British seized the territory during the French and Indian War. A short time later, in 1771, the Potowatami that had settled west of the city sold their land and departed the area (ASC Group, Inc. 2011). The territory of Michigan was created in January 1805 and Detroit was chosen as its capitol. The early nineteenth century saw major development of the city after an 1805 fire destroyed much of it. The city was rebuilt with wider streets, and in 1807, Ste. Anne Street was widened and renamed Jefferson Avenue (City of Detroit 2007).

A Bureau of Land Management General Land Office (BLM GLO) plat from 1818 depicts the area of the APE. The plat from 1818, of Township 1 South, Range 12, shows the area of the APE as made up of rural areas and divisions with private claim numbers (BLM GLO 1818). These private claims were tracts of land that had been awarded or granted to people prior to the official survey of the area and included what were called ribbon farms. During the early settlement of Fort Pontchartrain, the King of France granted narrow tracts of land that extended from the river to a few miles inland to use as farms for the new French settlers (City of Detroit 2007). Also noted on the GLO map is Trombleys Creek, forming the eastern border of a block of private claims, and running to the southeast in the general vicinity of the APE (BLM GLO 1818). The creek, first named "Riviere du Grand Marais" by French explorers, was later known as Trombley's Creek, named after a French settler, then Connor Creek (City of Detroit 2007). The spelling of the creek has varied throughout historical documentation. On current maps, it is spelled "Conners."

A map of Wayne County from 1873 shows the city of Detroit as a dense urban area, with municipalities, roads, and railroads radiating out from the central core (Walling 1873). The area of the APE shows the private claims and a road matching the present-day orientation of Jefferson Avenue (Walling 1873). Although other areas of the city were growing rapidly, the tracts of land in the Grand Marais developed at a slower pace (City of Detroit 2007). However, in the late 1870s, property owners began digging drainage ditches, which initiated the draining of the Grand Marais. In 1880, the Wayne County Drain Commission authorized the drainage of the area surrounding the Fox Creek, east of the APE. This draining of the land and the improvement of transportation in the area led to the development of subdivisions (City of Detroit 2007). This development is depicted on an 1894 map, which further shows the urbanization of the area, including landowner plots, names, and industry (Brown 1894). The creek (spelled Connor's Creek on this map) is depicted as a meandering stream from the north to the Detroit River (Brown 1894).

An early topographic map, from 1905, depicts marshy areas and the ribbon farms along the Detroit River, just east of the city of Detroit, which is depicted as a dense urban center (USGS 1905). By 1918, the density along the riverfront shifted east, creating industry along the riverfront in the area of the APE, and by 1923 and 1938, streets are named within the APE and the riverfront appears completely developed (USGS 1918, Cram 1923, USGS 1938).

Sanborn maps from 1929 and 1949 provide detail of structures depicted within the APE. The portion of the APE that presently lies between Clairpointe and Tennessee shows dwellings in this area of the APE in 1929, and dwellings and an industrial building in 1949 (Sanborn Map Company 1929a, 1949a). The portion of the APE that overlaps parcels on the south side of Freud, between Conner and Navahoe, shows dwellings and a filling station on both of these maps. On the north side of Freud, the APE overlaps parcels that contained dwellings, shops, and a mission (the mission replaced a store on the corner of Conner and Freud on the 1949 Sanborn) (Sanborn map company 1929b, 1929c, 1949b, 1949c). The Sanborn maps also show water pipes within the streets of the APE. The 1929 map shows a 16-inch water pipe within Freud Street and water pipes ranging from 6-inch to 24-inch within the north-south streets of the APE (Sanborn map company 1929a, 1929b, 1929c, 1949a, 1949b, 1949c).

Although no maps were obtained showing dates of sanitary sewer services for residents, research indicated that sanitary sewers within the city of Detroit were available beginning in 1861, when Detroit initiated a sewer-building project, and adding supplementary sewers as territory was annexed (Johnson 2010). The land that includes the Jefferson Chalmers neighborhood, where the APE is located, was annexed to the city of Detroit relatively early, in 1907. It was then known then as the village of Fairview, and its residents voted for annexation in order to receive a necessary sewer system, which the city of Detroit could afford (Drawing Detroit 2015). The subdivision where the APE is located arose around 1920, due to the automotive plants of the Connor Creek Industrial Area (City of Detroit 2007). Extant residential structures within the APE were built between 1917 and 1957 (City of Detroit 2022). Prior to 1940, the 1.5 million people that lived in the cities of Detroit, Highland Park, Hamtramck, and Grosse Pointe disposed of waste into sewers emptying into various creeks (including Conners Creek) leading to the Detroit River, and into sewers emptying into the Detroit River itself. By 1920, approximately 275 miles of public sewers had been constructed within the city of Detroit, and between 1920 and 1930, another approximately 300 miles of public sewers were constructed (Johnson 2010).

Historical aerial photographs confirm the development of the APE and the surrounding areas. The earliest aerial photograph available is a GigaPan made up of stitched-together individual photos from 1949. It provides a panoramic view of Wayne County, including the city of Detroit. By the time the 1949 photos were taken, the APE was completely filled with residential structures of the Jefferson Chalmers neighborhood (Patterson 1949). Between 1951 and 1957, the only significant change within the APE was between Clairpointe Street and Tennessee Street. Aerial photographs show the structures in this area replaced by a large building within that time frame (NETR 1951, 1957). The larger structure is extant on current maps, but not labeled. Research indicates this structure is the Freud Pumping Station, primarily a storm pumping station (Camp Dresser and McKee [CDM] 2003). By 1983, Clairpointe Street was shifted approximately one block to the west to its present location bordering Connor Creek (NETR 1983), and later photographs show the declining density of structures within the APE and the surrounding neighborhood (NETR 1999, 2002).

5.2 Archaeological Assessment

There are no previously recorded prehistoric period archaeological sites within or overlapping the APE. The western boundary of the APE is adjacent to Conners Creek, and the Detroit River is approximately 0.75 miles (1.2 km) to the south of the southern boundary of the APE. Prior to Euroamerican settlement, the land around the area of present-day Detroit was a poorly drained clay plain and would have been dominated by wet meadows, forests, and prairies. But sandy drainages and beach ridges dissected the clay plain, and these sandy ridges within the city have proven to contain prehistoric sites in the past (ASC Group 2011). Research indicates that the sandy ridges or landforms discussed by ASC Group (2011) do not exist within the APE. In addition, the APE is in a heavily developed and urban area, with development of roadways and infrastructure, including subsurface utilities, dating from the early twentieth century through today. Therefore, the potential for previously unidentified intact prehistoric period archaeological resources to exist within the APE is assessed as low.

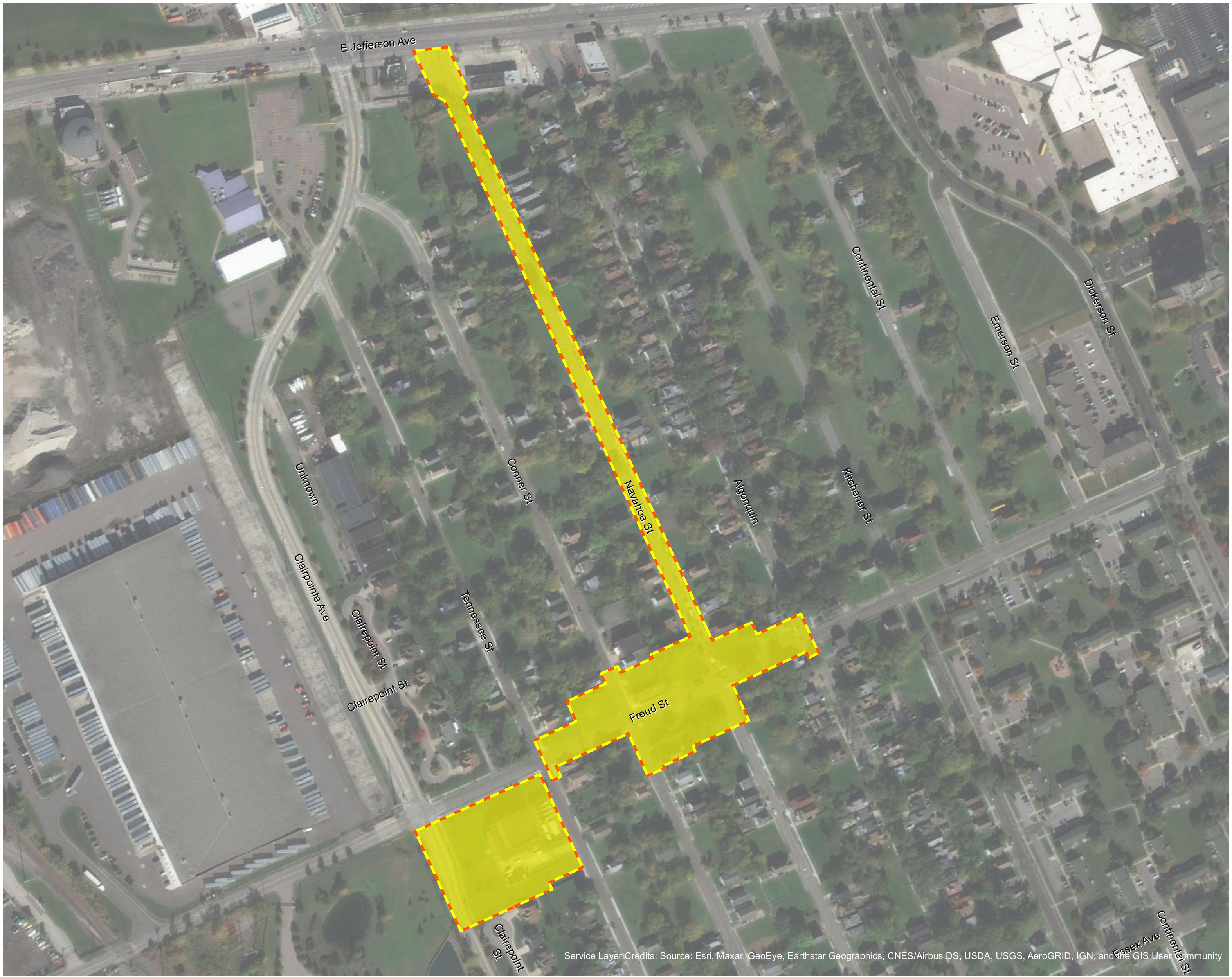
There are no historic period archaeological sites within or overlapping the APE. Potentially significant archaeological resources such as buried foundations, privies, and refuse deposits may be associated with historical structures, particularly residential structures. In the nineteenth and early twentieth centuries, it would have been common for residents to dispose of their garbage either as sheet refuse, in a specific location on the property, or within a privy pit. Privy deposits are often some of the most data-rich archaeological features in the historic-period landscape. Artifacts in privy features are typically densely deposited, deposits tend to be stratified, and privy shafts were often dug deeply enough that deposits may survive intact despite surface disturbance. Such deposits can provide information regarding many aspects of domestic life, including foodways, clothing, religious or ritual habits, sanitation, and household upkeep or maintenance.

The residential structures depicted on the 1929 Sanborn maps were first constructed around 1920. Build dates for non-extant structures were not available, but the earliest extant residential structure was built in 1917 (City of Detroit 2022). The city of Detroit had initiated a sewer-building program in 1861, adding sewers to annexed territory. The Jefferson Chalmers neighborhood was annexed relatively early, in 1907, and the subdivision arose around 1920. By that time, there were approximately 275 miles of sewer in the city. Based on these circumstances, the residential structures with the APE depicted on the 1929 Sanborn map likely had sewer service and did not have privies, and thus there is a low potential for intact significant archaeological deposits that may be associated with shaft features like privies. Other types of potential archaeological features in this area, such as foundations, would be unlikely to provide additional significant information beyond what is found in historical documentation. Therefore, the parcels within the APE containing former or extant structures are assessed as possessing low archaeological potential (Figure 2). The portion of the APE that contains the Freud Pump Station is also assessed as possessing low archaeological potential, due to the ground disturbance from the construction of the pump station in the late 1950s (Figure 2).

The APE includes streets within its boundaries – Freud Street, Navahoe Street, Conner Street, and Algonquin Street. These streets have been roadways since historic-period development began. Behaviors and activities that could have created potentially significant archaeological signatures are unlikely to have occurred within such roadways. Therefore, the potential for most types of significant, intact historic-period archaeological resources (such as building foundations, privies, or refuse deposits) within road rights of way is assessed as low (Figure 2).

Freud Pump Station Improvement Project Archaeological Literature Review and Assessment

Detroit, Wayne County, Michigan



Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Source: 106 Group; Arcadis

Map Produced by 106 Group 4/12/2022

▨ Project Area/APE

🟨 Low Potential for Archaeological Resources

0 60 Meters

0 160 Feet

1:3,187

106GROUP

Archaeological Assessment Results

Figure 2

6.0 RECOMMENDATIONS

Research indicates that one archaeological study has been previously conducted within the APE. No prehistoric-period archaeological sites have been recorded within the APE. The potential for intact prehistoric-period archaeological resources within the APE is assessed as low due to the APE's historical setting of a swampy plain and disturbance from early urban construction.

No historic-period archaeological sites have been recorded within the APE. Given the chronology of development in the area between annexation and the development of residential and commercial structures, the potential for intact historic-period archaeological resources within the APE is assessed as low. 106 Group recommends no further work for the Project as planned.

REFERENCES CITED

ASC Group, Inc.

2011 *Phase I Archaeological Literature Review, Land Use History and Disturbance Assessment, Woodward Avenue Light Rail Transit Project, Detroit, Michigan*. City of Detroit, Department of Transportation. Electronic document, https://www.michigan.gov/documents/mdot/MDOT-Woodward_Ave._Light_Rail_Transit_Project_FEIS_Archaeological_Literature_Review_Land_Use_History_and_Disturbance_Assessment_Final_Tech_Report_410345_7.pdf, accessed April 1, 2022.

Branstner, Mark C., and David Barton

1981 *A Literature Cultural Resource Survey and Field Inspection of the Jefferson Chalmers and Gray Haven Project Areas, Detroit, Michigan.* Research Analysts, Inc. On File at the State Historic Preservation Office, Lansing, Michigan.

Brown, Mason L.

1894 Wayne County and part of Oakland and Macomb. Electronic document, https://www.loc.gov/item/2012593012/, accessed March 29, 2022.

Bureau of Land Management, General Land Office [BLM GLO]

1818 Township No. 1 North, Range 12 East of the Mer. (Mich Ter.). United States Department of the Interior.

Camp Dresser & McKee [CDM]

2003 Detroit Wastewater and Sewerage Department Wastewater Master Plan Executive Summary. Electronic document, https://www.nrc.gov/docs/ML1126/ML112620177.pdf, accessed April 1, 2022.

City of Detroit

2007 Proposed Jefferson-Chalmers Historic Business District. Electronic document, https://detroitmi.gov/sites/detroitmi.localhost/files/2018-08/Jefferson-Chalmers%20HD%20Final%20Report.pdf, accessed April 1, 2022.

2022 Office of the Assessor. Electronic document, https://detroitmi.gov/departments/office-chief-financial-officer/ocfo-divisions/office-assessor, accessed April 12, 2022.

Cram, George F.

1923 City of Detroit. Electronic document, Wayne County and part of Oakland and Macomb. Electronic document, http://cartweb.geography.ua.edu/lizardtech/iserv/calcrgn?cat=North%20America%20and%20Unit ed%20States&item=States/Michigan/Michigan1923b.sid&wid=1000&hei=900&rops=item(Name,Description),cat(Name,Description)&style=default/view.xsl&plugin=true, accessed March 29, 2022.

Drawing Detroit
2015 Detroit Annexation 1806-1926. Electronic document, http://www.drawingdetroit.com/detroit-annexation-1806-1926/#:~:text=Detroit%20was%20officially%20incorporated%20on,lost%20this%20designation%20until%201815).&text=Detroit%20is%20reincorporated%20as%20a,and%20east%20to%20the%20river), accessed April 6, 2022.

Environmental Protection Agency [EPA]
2022 Ecoregion Download Files by State – Region 5. Electronic document, https://www.epa.gov/eco-research/ecoregion-download-files-state-region-5#pane-20/, accessed March 29, 2022.

Johnson, Barry Neal
2010 *Wastewater Treatment Comes to Detroit: Law, Politics, Technology And Funding*. Wayne State University Dissertations. Paper 195. Electronic document, https://huw.wayne.edu/research/wastewater_treatment_comes_to_detroitlaw_politics_technology.pdf, accessed April 1, 2022.

National Environmental Title Research, LLC [NETR]
1951 Historical Aerial Photograph, Wayne County, Michigan. Electronic document, https://www.historicaerials.com/viewer/, accessed March 30, 2022.

1957 Historical Aerial Photograph, Wayne County, Michigan. Electronic document, https://www.historicaerials.com/viewer/, accessed March 30, 2022.

1983 Historical Aerial Photograph, Wayne County, Michigan. Electronic document, https://www.historicaerials.com/viewer/, accessed March 30, 2022.

1999 Historical Aerial Photograph, Wayne County, Michigan. Electronic document, https://www.historicaerials.com/viewer/, accessed March 30, 2022.

2002 Historical Aerial Photograph, Wayne County, Michigan. Electronic document, https://www.historicaerials.com/viewer/, accessed March 30, 2022.

National Park Service [NPS]
1983 Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation. *Federal Register* 48(190):44716-44740.

Natural Resources Conservation Service [NRCS]

2022 Web Soil Survey, United States Department of Agriculture. Electronic document, https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm, accessed March 29, 2022.

Patterson, Devin

1949 Wayne County Michigan circa 1949 (including City of Detroit). Electronic document, http://gigapan.com/gigapans/147450, accessed March 30, 2022.

Rufledt, Jason, Erin Que, and Madeleine Bray

2021 *Cultural Resources Literature Review and Archaeological Assessment for the Connors Creek Sewer System Rehabilitation Project. St. Paul, MN.* Submitted by The 106 Group Ltd. Submitted to Brown and Caldwell LLC.

Sanborn Map Company

1929a Sanborn Fire Insurance Map from Detroit, Wayne County, Michigan. Electronic document, https://www.loc.gov/resource/g4114dm.g03985192911/?sp=80&st=image&r=-0.115,-0.018,0.592,0.343,0, accessed March 30, 2022.

1929b Sanborn Fire Insurance Map from Detroit, Wayne County, Michigan. Electronic document, https://www.loc.gov/resource/g4114dm.g03985192911/?sp=65&st=image&r=-0.235,0.477,1.471,0.853,0, accessed March 30, 2022

1929c Sanborn Fire Insurance Map from Detroit, Wayne County, Michigan. Electronic document, https://www.loc.gov/resource/g4114dm.g03985192911/?sp=67&st=image&r=0.273,0.074,0.853,1.473,90, accessed March 30, 2022.

1949a Sanborn Fire Insurance Map from Detroit, Wayne County, Michigan. Electronic document, https://www.loc.gov/resource/g4114dm.g03985194911/?sp=80&r=-0.031,0.04,0.692,0.401,0, accessed March 30, 2022.

1949b Sanborn Fire Insurance Map from Detroit, Wayne County, Michigan. Electronic document, https://www.loc.gov/resource/g4114dm.g03985194911/?sp=65&st=image&r=-0.274,0.687,0.989,0.573,0, accessed March 30, 2022.

1949c Sanborn Fire Insurance Map from Detroit, Wayne County, Michigan. Electronic document, https://www.loc.gov/resource/g4114dm.g03985194911/?sp=67&st=image&r=0.049,-0.077,0.926,1.598,90, accessed March 30, 2022.

United States Geological Society [USGS]

1905 Michigan, Detroit Quadrangle, 1:62,500, Henry Gannett, Chief Topographer. United States Department of the Interior.

1918 Michigan, Grosse Pointe Quadrangle, 1:62,500, Henry Gannett, Chief Topographer. United States Department of the Interior.

1938 Michigan, Belle Isle Quadrangle, 1:24,000, Henry Gannett, Chief Topographer. United States Department of the Interior.

Walling, H.F.

1873 Map of Macomb County, Michigan. Electronic document, https://www.davidrumsey.com/luna/servlet/s/sk3p35, accessed March 29, 2022.

APPENDIX A: PROJECT PERSONNEL

LIST OF PERSONNEL

Project Manager	Adam Kaeding, Ph.D.
Principal Investigator	Madeleine Bray, M.A., RPA
Archaeologist	Jason Rufledt, B.A.
Graphics and GIS	Molly McDonald, MGIS

Appendix C

Above-Ground Resources Literature Review for the Freud Pump Station Improvement Project

106GROUP
Connecting People + Place + Time

ABOVE-GROUND RESOURCES LITERATURE REVIEW FOR THE FREUD PUMP STATION IMPROVEMENT PROJECT

Detroit, Wayne County, Michigan

April 2022

ABOVE-GROUND RESOURCES LITERATURE REVIEW FOR THE FREUD PUMP STATION IMPROVEMENT PROJECT

Detroit, Wayne County, Michigan

SHPO File No. Pending

Arcadis of Michigan Project No. 30047523, Task F4.2

106 Group Project No. 3000

SUBMITTED TO:
Arcadis of Michigan, LLC
607 Shelby Street, Suite 400
Detroit, MI 48226

SUBMITTED BY:
106 Group
1295 Bandana Blvd N. #335
St. Paul, MN 55108

PRINCIPAL INVESTIGATOR:
Erin Que, M.A.

REPORT AUTHORS:
Steve Gallo, PhD
Erin Que, M.A.

April 2022

MANAGEMENT SUMMARY

During March and April 2022, 106 Group conducted an above-ground historic resources literature review for the Freud Pump Station Improvement Project (Project) located in Detroit, Wayne County, Michigan. The proposed Project includes below-ground installation of a 2,000 linear foot, 36-inch force main on Navahoe Street, from Jefferson Avenue East to Freud Street; construction of a new shaft maintenance building on Freud Street; realignment of Freud Street to accommodate the shaft maintenance building; and improvements to the existing Freud Pump Station building located at 12300 Freud Street. The Project, proposed by Arcadis of Michigan, is seeking a low interest loan through the Clean Water State Revolving Fund (SRF)—federal funds administrated by the Michigan Department of Environment, Great Lakes, and Energy—and, therefore, must comply with Section 106 of the National Historic Preservation Act of 1966, as amended, as well as applicable state mandates governing above-ground historic resources.

An appropriate Area of Potential Effects (APE) for above-ground resources accounts for any physical, auditory, visual, or sociocultural (i.e., land use, traffic patterns, public access) impacts to historic properties. Potential effects of this Project include permanent physical, visual, auditory, and sociocultural effects, as well as temporary visual, auditory, and sociocultural effects during construction. Based on the current Project plans, the recommended above-ground resources APE includes first-tier standing structures adjacent to the force main and existing Freud Pump Station building, as well as second-tier standing structures surrounding the new shaft maintenance building. The recommended above-ground resources APE includes approximately 20.7 acres (8.4 hectares [ha]). The literature review consisted of a review of documentation of previously identified above-ground resources within the above-ground resources APE and of surveys previously conducted within the above-ground resources APE, as well as desktop analysis to identify above-ground resources within the APE that are 40 years of age or older and, therefore, meet the criteria for survey according to the *Michigan Above-Ground Survey Manual*.[1] Due to schedule constraints faced by the client, the literature review was conducted before data was received from the Michigan State Historic Preservation Office (SHPO). Data obtained in 2021 as part of the above-ground resources literature review for the Connors Creek Sewer System Rehabilitation Project conducted by 106 Group was used to inform this literature review, due to the geographical proximity of the two projects' APEs.[2] The results of the literature review based on the 2021 data will be compared to the 2022 data and updated, as necessary, once it is received. Erin Que, M.A., served as principal investigator for architectural history.

There are no previously identified above-ground resources within the APE, and no above-ground resource surveys have been previously conducted within the APE. 106 Group identified 39 individual properties within the APE that are 40 years of age or older and may meet the criteria for survey. Consultation with SHPO is recommended to determine if a reconnaissance survey is recommended in order to comply with Section 106.

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[1] Katie Kolokithas and Diane Tuinstra, *Michigan Above-Ground Survey Manual* (Lansing, MI: Michigan State Historic Preservation Office, 2018), 6.

[2] Jason Rufledt, Erin Que, and Madeleine Bray, *Cultural Resources Literature Review and Archaeological Assessment for the Connors Creek Sewer System Rehabilitation Project* (St. Paul, MN: 106 Group, 2021).

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1.0 INTRODUCTION

During March and April 2022, 106 Group conducted an above-ground historic resources literature review for the Freud Pump Station Improvement Project (Project) located in Detroit, Wayne County, Michigan. The proposed Project includes below-ground installation of a 2,000 linear foot, 36-inch force main on Navahoe Street, from Jefferson Avenue East to Freud Street, construction of a new shaft maintenance building on Freud Street, realignment of Freud Street to accommodate the shaft maintenance building, and improvements to the existing Freud Pump Station building located at 12300 Freud Street. The Project, proposed by Arcadis of Michigan, is seeking a low interest loan through the Clean Water State Revolving Fund (SRF)—federal funds administrated by the Michigan Department of Environment, Great Lakes, and Energy—and, therefore, must comply with Section 106 of the National Historic Preservation Act of 1966, as amended, as well as applicable state mandates governing above-ground historic resources.

The Project is located in the Jefferson Chalmers neighborhood, Detroit, Wayne County, Michigan. An appropriate Area of Potential Effects (APE) for above-ground resources accounts for any physical, auditory, visual, or sociocultural (i.e., land use, traffic patterns, public access) impacts to historic properties. Potential effects of this Project include permanent physical, visual, auditory, and sociocultural effects, as well as temporary visual, auditory, and sociocultural effects during construction. Based on the current Project plans, the recommended above-ground resources APE includes first-tier standing structures adjacent to the force main and existing Freud Pump Station building, as well as second-tier standing structures surrounding the new shaft maintenance building. The recommended above-ground resources APE includes approximately 20.7 acres (8.4 hectares [ha]). The literature review consisted of a review of documentation of previously identified above-ground resources within the above-ground resources APE and of surveys previously conducted within the above-ground resources APE, as well as desktop analysis to identify above-ground resources within the APE that are 40 years of age or older and, therefore, meet the criteria for survey according to the *Michigan Above-Ground Survey Manual*.[3] Due to schedule constraints faced by the client, the literature review was conducted before data was received from SHPO. Data obtained in 2021 as part of the above-ground resources literature review for the Connors Creek Sewer System Rehabilitation Project conducted by 106 Group was used, due to the geographical proximity of the two projects' APEs.[4] The results of the literature review based on the 2021 data will be compared to the 2022 data and updated, as necessary, once it is received.

The following report describes project methodology, previous investigations, results, and recommendations for the Freud Pump Station Improvement Project. A list of Project personnel can be found in the Appendix.

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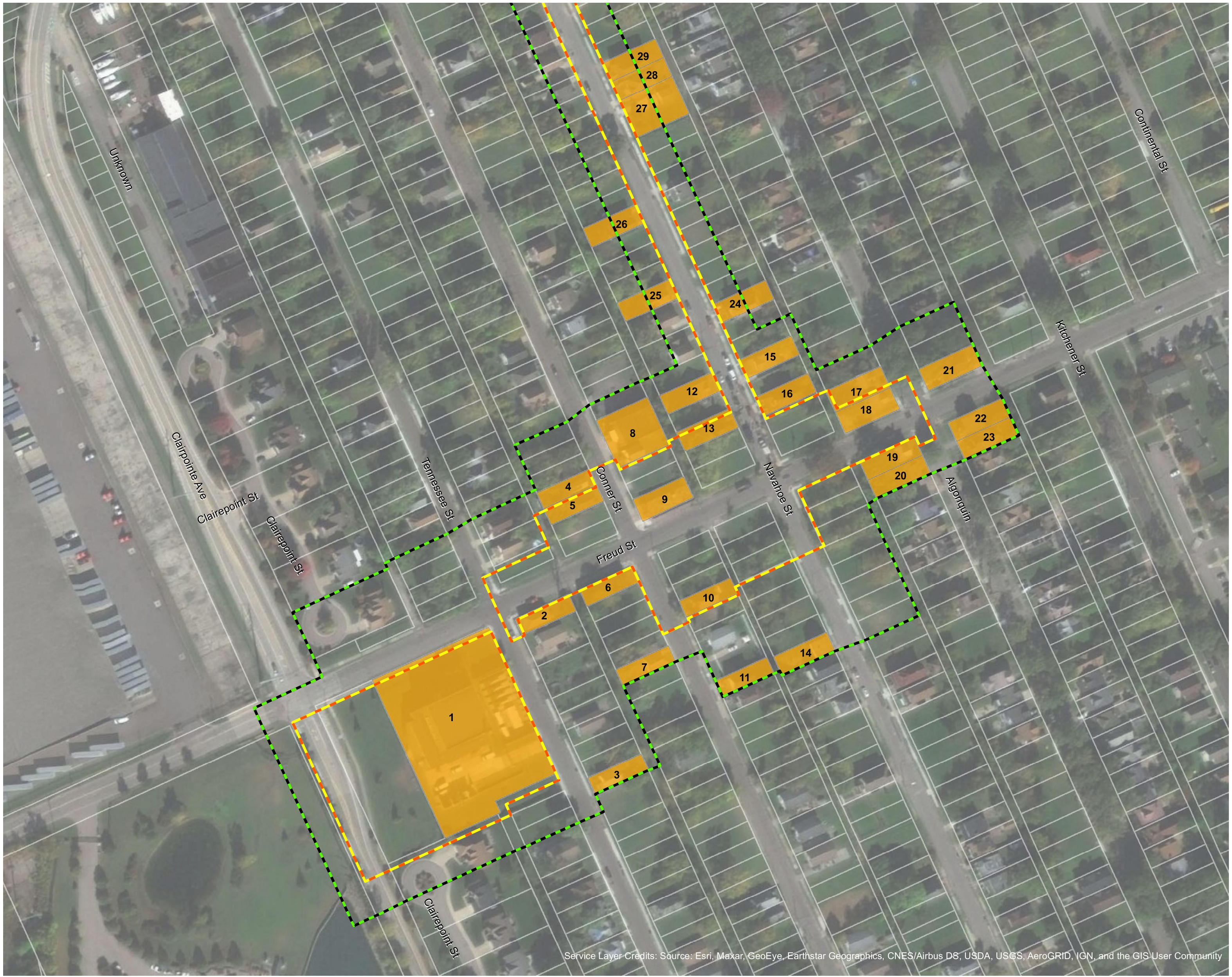
[3] Kolokithas and Tuinstra, *Michigan Above-Ground Survey Manual*, 6.

[4] Rufledt, Que, and Bray, *Cultural Resources Literature Review and Archaeological Assessment for the Connors Creek Sewer System Rehabilitation Project.*



Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Source: 106 Group; Arcadis; City of Detroit, MI

Map Produced by 106 Group 4/7/2022

Freud Pump Station Improvement Project Above-Ground Resources Literature Review

Detroit, Wayne County, Michigan

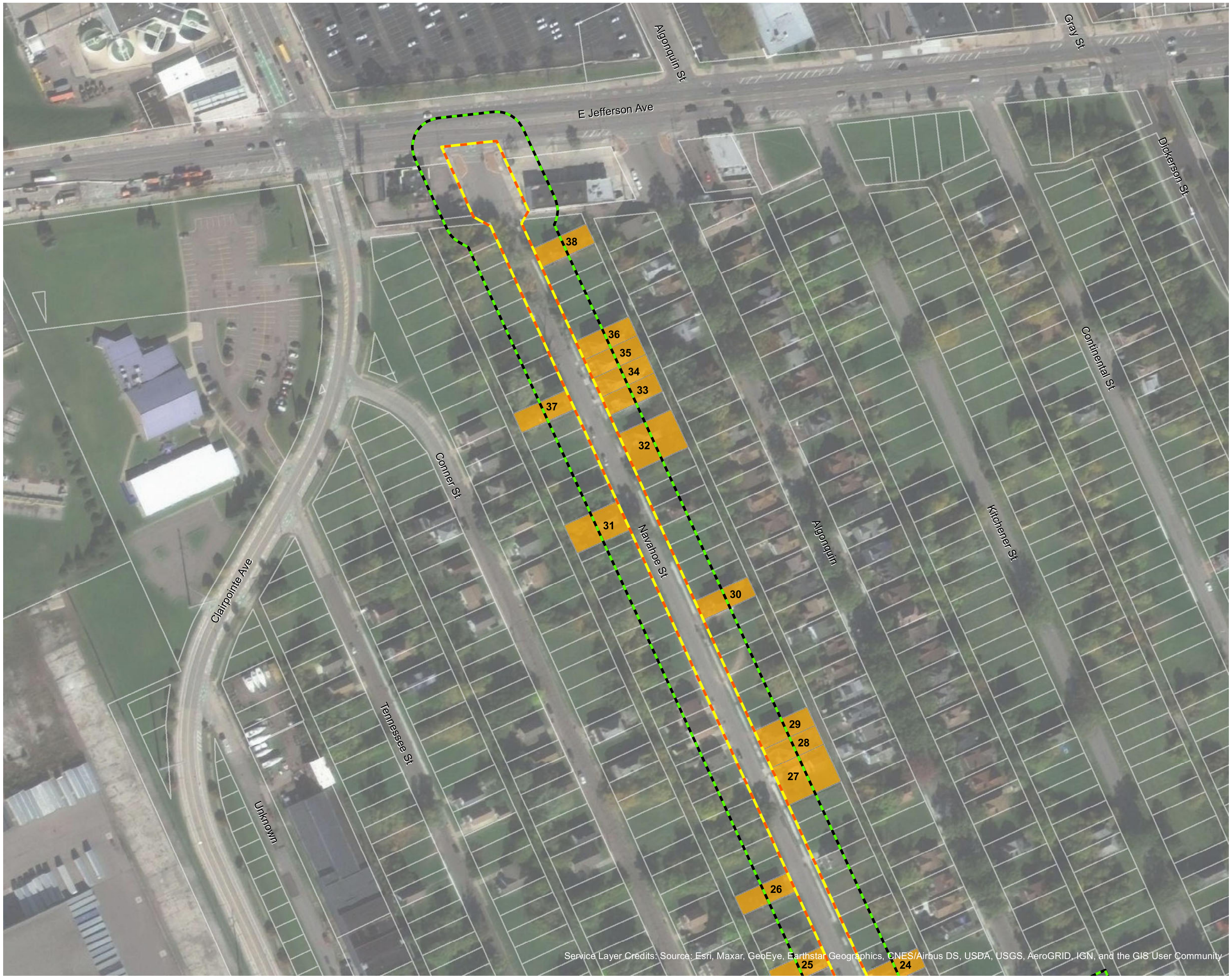
🟥	Project Area
🟩	Area of Potential Effects
🟧	40 Years of Age or Older

0 40 Meters
0 100 Feet
1:2,000

106GROUP

Project, Location, APE, and Above-Ground Resources 40 Years of Age or Older (South Half)

Figure 1



Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Source: 106 Group; Arcadis; City of Detroit, MI

Map Produced by 106 Group 4/7/2022

Freud Pump Station Improvement Project Above-Ground Resources Literature Review

Detroit, Wayne County, Michigan

▭ Project Area

▭ Area of Potential Effects

🟧 40 Years of Age or Older

0 40 Meters
0 100 Feet
1:2,000

106GROUP

Project, Location, APE, and Above-Ground Resources 40 Years of Age or Older (North Half)

Figure 2

2.0 METHODS

2.1 Objectives

The primary objective of the above-ground resources literature review was to identify whether there are any previously documented above-ground resources within the APE, to identify whether any portion of the APE may have been previously surveyed, and determine whether or not there are properties located within the APE that are eligible for reconnaissance-level survey according to the criteria established in the *Michigan Above-Ground Survey Manual*.[5] The results of this investigation will aid in determining what, if any, additional above-ground resource studies may need to be completed to comply with federal and state law. All work was conducted in accordance with *The Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation* and the *Michigan Above-Ground Survey Manual*.[6]

2.2 Area of Potential Effects

An appropriate APE for above-ground resources accounts for any physical, auditory, visual, or sociocultural (i.e., land use, traffic patterns, public access) impacts to historic properties. The proposed Project includes four primary undertakings: below-ground installation of a 2,000 linear foot, 36" force main beneath Navahoe Street, Freud Street, and East Jefferson Avenue; construction of a new isolation shaft maintenance building (approximately 34 feet tall, 86 feet long, and 49 feet wide) with an associated courtyard (approximately 16 feet tall, 86 feet long, and 71 feet wide) on Freud Street, between Conner Street and Navahoe Street; the realignment of Freud Street around the north side of the new building; and improvements to the existing Freud Pump Station building located at 12300 Freud Street, including the addition of a 49-foot-tall enclosed stair tower on the north elevation (width and length not currently known) and the replacement of existing fencing. Potential effects of this Project include permanent physical, visual, auditory, and sociocultural effects due to the demolition of existing buildings, the construction of a new shaft maintenance building; potential noise effects related to the new building's regular operation; and the alteration of traffic patterns. The Project will also include temporary visual, auditory, and sociocultural effects during construction. Based on the current Project plans, the above-ground resources APE includes a 50-foot buffer around the location of the proposed force main installation to account for any adjacent properties that may have visibility of the Project during construction. The APE also includes first-tier standing structures surrounding the existing Freud Pump Station building, as well as a 50-foot buffer on its west side to account for any potential alterations to, or disruptions to traffic flow on, Clairpointe Avenue during construction, which are not currently anticipated. While the enclosed stair tower is taller than the 37-foot-tall Freud Pump Station building, its addition onto an existing building is not expected to generate additional visual effects that impact properties beyond the first-tier standing structures already included in the APE. The APE also includes first-tier standing structures surrounding the location of the new isolation shaft maintenance building to account for adjacent properties that may be impacted by the potential auditory, visual, and sociocultural

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[5] Kolokithas and Tuinstra, *Michigan Above-Ground Survey Manual*.

[6] Kolokithas and Tuinstra, *Michigan Above-Ground Survey Manual*; National Park Service, "Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation," *Federal Register* 48, no. 190 (1983):44716-44740.

effects of the Project. A second-tier structure located at 650-652 Conner Street is included because it is taller than the first-tier structure located directly to the north and will therefore have visibility of the proposed isolation shaft maintenance building. The east side of Navahoe Street within 340 feet of the Project area has no standing structures. However, effects beyond this distance are not anticipated; therefore, the first-tier standing structure at 630 Navahoe Street is not included in the APE.

2.3 Background Research

On March 25, 2022, data pertaining to previously inventoried above-ground resources and surveys previously conducted within the above-ground resources APE was requested from the SHPO. Due to schedule constraints faced by the client, the literature review was conducted before data was received from SHPO. Data obtained in 2021 as part of the above-ground resources literature review for Connors Creek Sewer System Rehabilitation Project conducted by 106 Group was used, due to the geographical proximity of the APEs for both projects.[7] The results of the literature review based on the 2021 data will be compared to the 2022 data and updated, as necessary, once it is received.

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[7] Rufledt, Que, and Bray, *Cultural Resources Literature Review and Archaeological Assessment for the Connors Creek Sewer System Rehabilitation Project*.

3.0 LITERATURE REVIEW

3.1 Previous Studies

Research indicates that no previous above-ground resources surveys have been conducted within the above-ground resources APE.

3.2 Previously Inventoried Resources

Research indicates that there are no previously inventoried above-ground resources within the above-ground resources APE.

3.3 Resources 40 Years of Age or Older

According to the *Michigan Above-Ground Survey Manual*, properties 40 years of age or older are eligible for survey and evaluation to determine their potential eligibility for inclusion in the National Register of Historic Places (NRHP).[8] Based on a review of available parcel data and additional desktop research, 106 Group identified 39 individual above-ground resources within the APE that are 40 years of age or older and are, therefore, may meet the criteria for reconnaissance-level survey (see Figures 1 and 2 and Table 1). While Table 1 includes only 38 entries, the parcel identified as number 8 contains two above-ground resources with individual addresses (722 and 728 Conner Street).

Table 1. Above-Ground Resources 40 Years of Age or Older

Map ID	Address	Build Year	Parcel Number
1	669 Tennessee Street (12300 Freud Street)	ca. 1957[9]	21045878-87
2	694 Tennessee Street	1915	21045755
3	640 Tennessee Street	1920	21045745
4	721 Conner Street	1921	21046483
5	713 Conner Street	1917	21046484
6	693 Conner Street	1925	21046487
7	667 Conner Street	1923	21046492
8	722/728 Conner Street	Ca. 1951[10]	21046009-11

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[8] Kolokithas and Tuinstra, *Michigan Above-Ground Survey Manual*, 6.

[9] The build year for this property was not listed in data obtained from the City of Detroit Office of the Assessor. The date of construction was estimated using historic aerial photographs. Nationwide Environmental Title Research, LLC, "Historic Aerials," NETR Online, April 6, 2022, https://www.historicaerials.com/viewer.

[10] The build year for this property was not listed in data obtained from the City of Detroit Office of the Assessor. The date of construction was estimated using historic aerial photographs. Nationwide Environmental Title Research, LLC, "Historic Aerials," NETR Online, April 6, 2022, https://www.historicaerials.com/viewer.

Map ID	Address	Build Year	Parcel Number
9	700 Conner Street	1952	21046006
10	678 Conner Street	1920	21046002
11	650 Conner Street	1917	21045997
12	733 Navahoe Street	1922	21046698
13	717 Navahoe Street	1922	21046700
14	651 Navahoe Street	1921	21046710
15	732 Navahoe Street	1922	21046610
16	716 Navahoe Street	1917	21046608
17	713 Algonquin Street	1922	21047189
18	705 Algonquin Street	1923	21047190
19	695 Algonquin Street	1922	21047191
20	689 Algonquin Street	1919	21047192
21	704 Algonquin Street	1922	21046813
22	694 Algonquin Street	1919	21046812
23	686 Algonquin Street	1919	21046811
24	752 Navahoe Street	1923	21046613
25	767 Navahoe Street	1924	21046693
26	795 Navahoe Street	1922	21046689
27	822 Navahoe Street	1974	21046623-4
28	836 Navahoe Street	1918	21046625
29	844 Navahoe Street	1920	21046626
30	892 Navahoe Street	1924	21046633
31	935 Navahoe Street	1916	21046669
32	954 Navahoe Street	1920	21046641-2
33	968 Navahoe Street	1923	21046644
34	976 Navahoe Street	1917	21046645
35	982 Navahoe Street	1917	21046646
36	990 Navahoe Street	1917	21046647

Map ID	Address	Build Year	Parcel Number
37	977 Navahoe Street	1923	21046663
38	1024 Navahoe Street	1916	21046652

4.0 RESULTS AND RECOMMENDATIONS

Research indicates that no previous above-ground resources surveys have been conducted within the above-ground resources APE for this Project. Likewise, no previously inventoried properties were identified within the above-ground resources APE during the literature review. Desktop analysis identified 39 individual properties within the APE that are 40 years of age or older and, may meet the criteria for reconnaissance survey (see Figures 1 and 2 and Table 1). As the Project undertaking involves potentially permanent physical, visual, auditory, and sociocultural effects to properties within the APE, Consultation with SHPO is recommended to determine if a reconnaissance survey is recommended in order to comply with Section 106.

REFERENCES CITED

Kolokithas, Katie and Diane Tuinstra. *Michigan Above-Ground Survey Manual*. Lansing, MI: State Historic Preservation Office, 2018.

National Park Service. “Secretary of the Interior’s Standards and Guidelines for Archeology and Historic Preservation.” *Federal Register* 48, no. 190 (1983): 44716-44740.

Nationwide Environmental Title Research, LLC. “Historic Aerials.” NETR Online. April 6, 2022. https://www.historicaerials.com/viewer.

Rufledt, Jason, Erin Que, and Madeleine Bray. *Cultural Resources Literature Review and Archaeological Assessment for the Connors Creek Sewer System Rehabilitation Project*. St. Paul, MN: 106 Group, 2021.

APPENDIX A: PROJECT PERSONNEL

LIST OF PERSONNEL

Project Manager	Adam Kaeding, PhD
Principal Investigator	Erin Que, M.A.
Historian	Steve Gallo, PhD
Graphics and GIS	Molly McDonald, MGIS

Appendix D

Freud and Conner Creek Pump Station Improvements Condition Assessment Report

Great Lakes Water Authority

FREUD AND CONNER CREEK PUMP STATION IMPROVEMENTS

Condition Assessment Report

October 2017

FREUD AND CONNER CREEK PUMP STATION IMPROVEMENTS

Condition Assessment Report

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Prepared for:

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Our Ref.:

DE000775.1203

Date:

October 13, 2017

CONTENTS

EXECUTIVE SUMMARY

A physical Condition Assessment was completed by the Arcadis team at the Conner Creek and Freud Pump Stations on August 22nd and 23rd, 2017. The assessment focused on the existing facilities and assets at each pump station, including but not limited to the structures and architectural elements, storm water and sanitary pumping systems, bridge cranes, and electrical and HVAC systems. Design professionals included an architect, and structural, process mechanical, HVAC/plumbing, and electrical/instrumentation and control engineers.

In addition, we were accompanied in the field by Mr. Tom Hall, Maintenance Foreman for GLWA. Mr. Hall provided very valuable input and background that were useful in developing this Condition Assessment Report.

The field observations and reported content presented herein are representative of our professional assessment of the existing facilities. This information will be useful to our team as we develop and recommend suggested improvements to be included in the scope of this design project for upgrades to both pump stations. Design alternatives and final recommendations will be presented under separate cover, and represented as the Basis of Design Report.

Architectural Condition Assessment – Freud and Conner Creek Pump Stations

The Conner Creek Pump Station consists of three main structures and seven ancillary structures. The three main structures consist of the Storm Water Pump Station (Main Building), Primary Switchgear Building, and Sanitary Pump Station. The seven ancillary structures include the Transformer Containment Pad, Regulator Chamber, Generator and Diesel Fuel Storage Pad, Gate Structure and Raised Stop Log Structure, Transfer Switch Electrical Enclosure, Surge Tank, and Backwater Gate Structure.

The Freud Pump Station consists of one main building which houses both the storm water and sanitary pumps, as well three ancillary structures. The three ancillary structures include the Transformer Containment Pad, Generator and Diesel Fuel Storage Tank Pad and Perimeter Wall, and East Site Retaining Wall.

The buildings on the Conner Creek site are generally in fair condition. These buildings received maintenance repairs over the years including some significant improvements in 2016. The building at the Freud Pump Station is generally in fair condition. A description of the architectural deficiencies associated with each building is provided below.

Conner Creek Sanitary and Storm Water Pump Station

The Storm Pump Station was constructed around 1928 and is structurally sound, but there are some current cosmetic issues as well as the potential for damage to the finishes and structure in the future. The structure is a circular building comprised of a stone block base, masonry brick upper walls, copper gutter and downspouts, a sloped roof with asphalt shingles, and clerestory windows. The existing copper downspouts come down from the roof gutters, through the top of the exterior masonry walls, and down the inside face of the exterior walls. There has been significant water infiltration through the exterior walls over the years, most likely a result of the deteriorating roof (which was replaced in 2016) but also because of the downspouts penetrating the exterior masonry wall. As part of the recent improvements, the roof was completely replaced, the exterior masonry brick was tucked, pointed, or replaced, but the original copper gutters and downspouts were preserved. It is our understanding that the recent improvements have reduced water infiltration but not completely halted it, particularly at one downspout at the southwest corner of the building. A summary of observations and assessments follow below.

The Sanitary Pump Station (rectangular building between Jefferson Avenue and Storm Water Pump Station) is comprised of masonry brick walls, a flat membrane roof, and glass block fenestration.

Arcadis was unable to locate the buildings at Conner Creek on the National Register of Historic Buildings. If the owner is aware of any of these buildings being on the National Registry, this would place restrictions on what can be done with replacement of windows and other building elements.

Exterior Walls – exterior side

The masonry brick on the exterior face of the exterior walls was repaired, tucked, and pointed in 2016. Visually, the replaced mortar is noticeable as a different color from the original. For bidding purposes, it may be desirable to include 20% of wall area for tucking, pointing, or repair work for any mortar the contractor may find that was not adequately addressed during the previous work. This can be handled as part of the base bid or an allowance. There remains staining of the brick in certain areas from roof drainage through the gutters and downspouts. GLWA staff informed us during our site assessment that leakage is still occurring from the gutters and downspouts which may lead to future damage of masonry. Arcadis observed evidence of water traveling down the inside face of the exterior wall in at least one location as well as evidence on the floor of water infiltration (see photo below in sections "*Exterior Walls – interior side*" and "*Floors*").

One possible option to reduce the potential for future damage to the exterior walls is to remove the existing interior downspouts altogether, infill the wall penetrations, and install new exterior downspouts. If this option is not desirable, it is recommended to more thoroughly evaluate each downspout penetration of the exterior wall to determine if there are gaps through which water is getting inside the building.

Exterior Walls – interior side

Overall, the glazed masonry on the interior side of the exterior walls is in good condition. However, some areas have water damage requiring surface cleaning at a minimum. It is possible that there is still leakage occurring from the gutters and downspouts which may lead to future damage of exterior and interior masonry.

Floors

Overall, the quarry tile is in good condition. However, some areas have water damage requiring surface cleaning. As described in the paragraphs above and as can be seen in the photos of the wall and floor, it appears there is still leakage occurring from the downspouts where they penetrate the exterior wall and run down the inside face of the exterior wall, which may lead to future damage to the tile if not corrected.

Roof

The roof of the Storm Pump Station was replaced in 2016. It appears to be in good condition. The original existing copper gutters and downspouts were preserved in place. GLWA staff informed Arcadis that there is still some leaking into the building, but this may be a result of the downspouts penetrating the exterior wall as opposed to problems with the roof itself.

A consideration for roof replacement in the future is standing seam metal, which comes at greater initial cost when compared to asphalt shingles, but has a significantly longer useful life span with less maintenance – reduced lifecycle cost.

The roof of the Sanitary Pump Station (photos below) appears to be in reasonably good condition with minimal water ponding. There was some evidence on the interior of the building at the roof connecting the Storm Pump Station to the Sanitary Pump Station of water infiltration and it may be desirable to inspect flashing at this location.

Gutters and Downspouts

Copper gutters and downspouts appear to be sound and in good condition, but based on information provided by GLWA staff and visual observations during our site assessment, there appear to be leaks from the downspouts on the inside of the building and possibly into the wall cavity itself.

It is advisable to examine the back of the gutters to determine if leaks are occurring between the back of the gutters and the exterior face of the exterior walls. Additionally, there are options for lining original gutters with an EPDM membrane to further reduce water infiltration.

As part of current improvements, it may be desirable to perform a more thorough review of each downspout where they connect to the gutters, where they penetrate the exterior wall, and their entire length down the exterior wall, as well as the entire circumference of the gutters to determine if there are specific locations that may still have leaks.

Doors

Personnel doors and frames appear to be in good condition. The overhead door and frame at the south of the storm pump structure (circular building) are in a state of deterioration and it may be desirable to replace the door, door frame, and weatherstripping. If replacing the door, insulated door is recommended.

The overhead door and frame at the east side of the Sanitary Pump Station appears to be in good condition – see below.

Windows

The window frames appear to be original and are in reasonably good condition, with rusting in some places. The glass was replaced at some point with plexiglass. It may be desirable to replace the window frames with new fiber reinforced plastic (FRP) or other rust proof material. However, this may be cost prohibitive. Arcadis was unable to locate the buildings at Conner Creek on the National Register of Historic Buildings. If the owner is aware of any of these buildings being on the National Registry, this would place restrictions on what can be done with replacement of windows and other building elements.

08/22/2017
Main Building- Windows

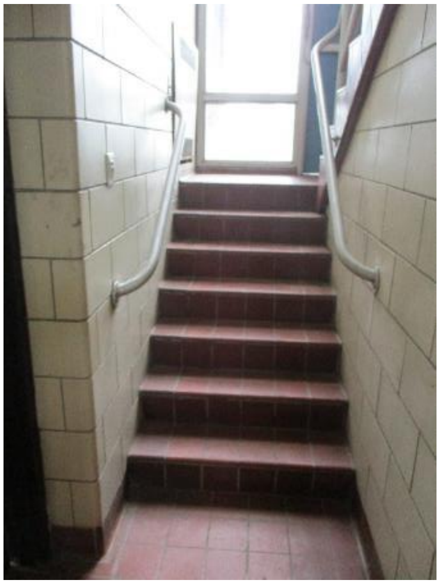
08/22/2017
Main Building- Windows

08/23/2017
Main Building- Windows

08/22/2017
Main Building- Windows

Toilet Room

The toilet room fixtures are in fair condition. It may be desirable to replace these as part of the current work and update them to comply with current ADA requirements. However, it may be noted that the existing toilet room is only accessible by traveling down a flight of stairs. Nevertheless, if the toilet room will receive new fixtures, the new fixtures and toilet room layout will be required to comply with current accessibility requirements.



Elevator – personnel

The existing personnel elevator is not functioning properly and requires replacement. A new elevator will be selected as part of the design and specifications of this work.

ELEVATOR- PASSENGER- #P-7895

08/23/2017

ELEVATOR- PASSENGER- #P-7895

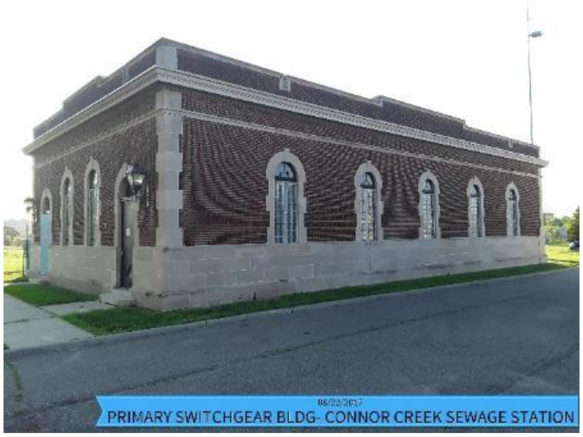
08/23/2017

Conner Creek: Primary Switchgear Building

The Primary Switchgear Building was constructed around 1928 and is structurally sound and overall good visual appearance on both the exterior and interior. The structure is comprised of a stone block base, masonry brick upper walls, interior downspouts, and a flat membrane roof. A summary of observations and assessments follow below.

Exterior Walls – exterior side

The masonry brick on the exterior face of the exterior walls is in good condition and does not require repairs or replacement at this time unless minor tucking, pointing, or patching is desired. At this time, the mortar is in reasonably good condition and tucking, pointing, or patching would be for cosmetic reasons only. For bidding purposes, it is recommended to include 20% of wall area for tucking, pointing, or repair work. This can be handled as part of the base bid or an allowance.

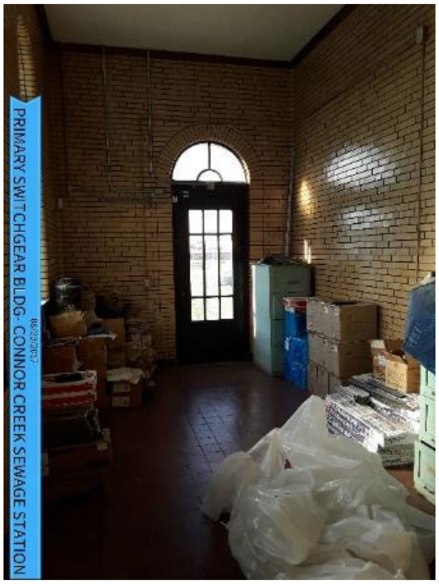


Exterior Walls – interior side

Overall, the glazed masonry on the interior side of the exterior walls is in good condition and does not require major repairs or replacement at this time unless minor patching or replacement of masonry with minor cosmetic damage is desired.

Floors

Overall, the quarry tile in this building is in good condition and does not require repairs at this time. Cleaning and polishing may be desirable.



Roof

The roof of this building is a flat membrane system and appears to be in reasonably good condition. There do not appear to be leakage problems at this time.

Downspouts

This building has interior roof downspouts which still function without leakage problems. Additionally, there are overflow scuppers that provide a code compliant method for observing if roof downspouts become blocked.

Doors

Newer steel personnel doors and frames (top row) appear to be in good condition with some rust on hinges. It may be desirable to replace the remaining original doors and door frames (bottom row below) which are in fair to poor condition. If replacing doors, insulated FRP doors and door frames are recommended, as is recessing the doors toward the interior of the exterior wall as much as feasible.

Windows

The upper portion of the windows is original and in fair condition, with rusting in some places. The lower portion of the windows and frames were removed and replaced with glass block. It may be desirable to remove the upper portion and replace with insulated FRP or other rust proof or rust resistant material. Arcadis was unable to locate the buildings at Conner Creek on the National Register of Historic Buildings. If the owner is aware of any of these buildings being on the National Registry, this would place restrictions on what can be done with replacement of windows and other building elements.

08/22/2017
Primary Switchgear- Windows

08/22/2017
Primary Switchgear- Windows

08/22/2017
Primary Switchgear- Windows

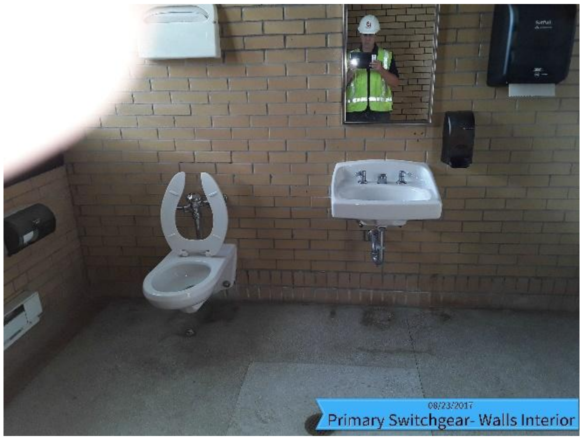
08/22/2017
Primary Switchgear- Windows

08/22/2017
Primary Switchgear- Windows

08/22/2017
Primary Switchgear- Windows

Toilet Room

The toilet room fixtures are in fair condition. It may be desirable to replace the fixtures as part of the current work and update them to comply with current ADA requirements. However, it may be noted that there is currently no accessible entry into this building. Nevertheless, if the toilet room will receive new fixtures, the new fixtures and toilet room layout will be required to comply with current accessibility requirements.


08/23/2017
Primary Switchgear- Walls Interior


08/23/2017
Primary Switchgear- Walls Interior


08/23/2017
Primary Switchgear- Walls Interior


08/23/2017
Primary Switchgear- Walls Interior


08/23/2017
Primary Switchgear- Walls Interior

Freud Pump Station

The Freud Pump Station was constructed in 1955 and is structurally sound (see structural), but is in need of some window and finish replacements. A summary of observations and assessments follow below.

Exterior Walls – exterior side

The exterior masonry brick is in good condition from the main floor level and above. Below the main floor level, there is, in certain areas, efflorescence in addition to deteriorating concrete and rusting metal (see photos). Cleaning, tucking, pointing repair work of masonry as well as cleaning and repairs/replacement of concrete and/or metal support work is needed. At this time, the mortar issues are mostly cosmetic but in some areas, tucking, pointing and repairs are warranted or they may become structural concerns in the future. For bidding purposes, it is recommended to include 20% of wall area for tucking, pointing, or repair work. This can be handled as part of the base bid or an allowance.

08/22/2017
Sewage Station- Walls Exterior

08/22/2017
Sewage Station- Walls Exterior


08/22/2017
Sewage Station- Walls Exterior


08/22/2017
Sewage Station- Walls Exterior


08/22/2017
Sewage Station- Walls Exterior


08/22/2017
Sewage Station- Walls Exterior


08/22/2017
Sewage Station- Walls Exterior

Exterior Walls – interior side

Overall, the glazed masonry on the interior side of the exterior walls is in good condition. It does not appear that repair or replacement are required at this time.


Sewage Station- Walls Interior


Sewage Station- Walls Interior


Sewage Station- Walls Interior

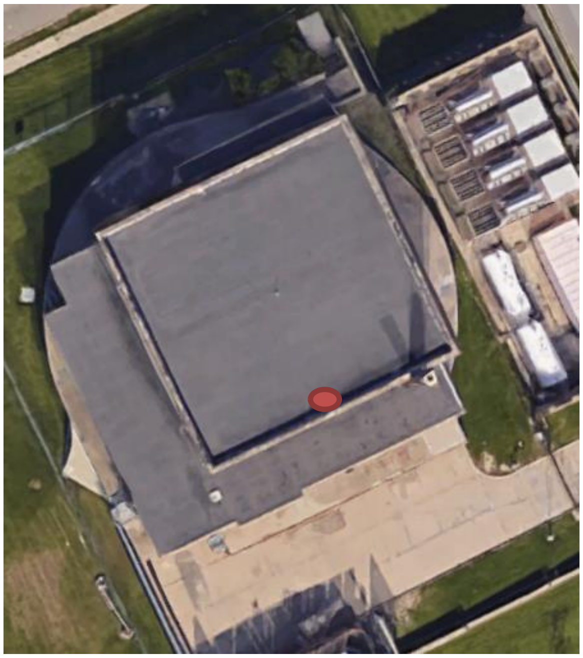

Sewage Station- Walls Interior

Floors

In most of the building areas, the quarry tile is in good condition. However, certain areas have significant damage or have detached completely from the subfloor and require replacement. This is particularly the case in the loading dock area as well as on the exterior of the North part of the building. GLWA staff requested alternate floor options for the loading area that do not involve tile and that will better withstand the loads and frequent movement in this area. Metal tracks were suggested for moving the heavy equipment from the crane drop off to the exterior dock and vice versa. Arcadis recommends additional investigation into equipment that can better move the pumps into and out of the facility. The existing floor finish (quarry tile) can be removed and replaced with new tile or terrazzo flooring and the metal tracks can be installed. However, Arcadis believes that if it is the intent to continue to use the existing skid in the future to move the pumps, any new flooring will eventually be damaged, regardless of metal tracks. We can help investigate options such as air pallets which utilize compressed air. For the exterior of the North part of the building, we recommend removal of the existing tile, grinding and sealing of the existing concrete beneath the tile, but no replacement tile unless some new floor finish is desired by the owner. It should also be noted that the current stairway up to the loading dock is not code compliant and must be replaced in its entirety. If accessibility is warranted for the facility, a ramp can be designed along with the new stair.

Roof

No leakage problems were observed on the interior or exterior of this building. Minimal standing water. The roof appears to be in reasonably good condition. GLWA staff mentioned that there was some roof repair work above stormwater motor #5 due to leakage (approximate location identified with red oval below).



Roof drains

No leakage problems were observed on the interior or exterior of this building. The roof drains appear to be adequately removing water from the roofs.

08/22/2017
BUILDING- MAIN- Freud Sewage Station

08/22/2017
BUILDING- MAIN- Freud Sewage Station

08/22/2017
BUILDING- MAIN- Freud Sewage Station

Doors

Personnel doors and frames appear to be in good condition. If door replacement is desired by the owners as part of this work, insulated FRP (fiber reinforced plastic) or insulated metal doors are recommended.

The exterior overhead door and personnel door and window assembly (second row, left) has been modified over the years. It may be desirable by the owner for Arcadis to propose a redesign of this entryway, replacing both doors and the windows to provide a more functional configuration for current use.

08/22/2017
Sewage Station- Doors

08/22/2017
Sewage Station- Doors

08/22/2017
Sewage Station- Doors

08/22/2017
Sewage Station- Doors


08/22/2017
Sewage Station- Doors


08/22/2017
Sewage Station- Doors


08/22/2017
Sewage Station- Doors


08/22/2017
Sewage Station- Doors


08/22/2017
Sewage Station- Doors

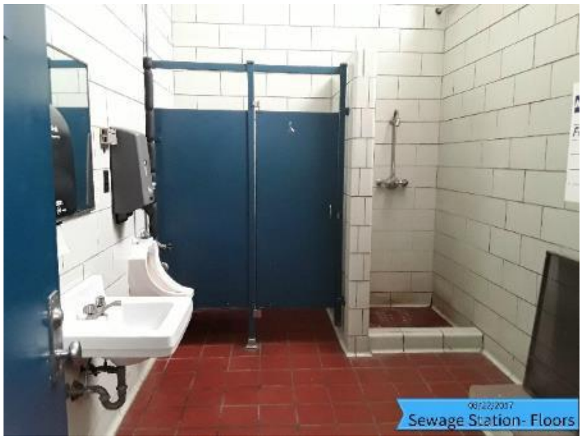

DANGER
HIGH VOLTAGE
08/22/2017
Sewage Station- Doors

Windows

The window frames appear to be original and are in reasonably good condition. The glass was replaced with an opaque, flexible material to deal with a problem of vandals attempting to break the glass. It is our understanding that the owners would like to replace the opaque material with something transparent (clear glass) or translucent (frosted glass) to permit daylight to enter the facility. The material selected will be resistant to vandalism. If the owners desire operable windows in certain locations, those window frames will require replacement.

Toilet Room

The toilet room fixtures are in fair condition. It may be desirable to replace these as part of the current work and update them to comply with current ADA (accessibility) requirements. However, it may be noted that the existing toilet room is only accessible by traveling up a flight of stairs to the main building entry (no accessible entry exists). Nevertheless, if the toilet room will receive new fixtures, the new fixtures and toilet room layout will be required to comply with current accessibility requirements, particularly if an accessible ramp to get to the main floor level will be provided as part of this work.



Elevator – personnel

The existing personnel elevator is not functioning properly and requires replacement at this time. A new elevator will be selected as part of the design and specifications of this work.

Mechanical Condition Assessment – Freud and Conner Creek Pump Stations

The Conner Creek Pump Station consists of three main structures and seven ancillary structures. The three main structures consist of the Storm Water Pump Station (Main Building), Primary Switchgear Building, and Sanitary Pump Station. The seven ancillary structures include the Transformer Containment Pad, Regulator Chamber, Generator and Diesel Fuel Storage Pad, Gate Structure and Raised Stop Log Structure, Transfer Switch Electrical Enclosure, Surge Tank, and Backwater Gate Structure.

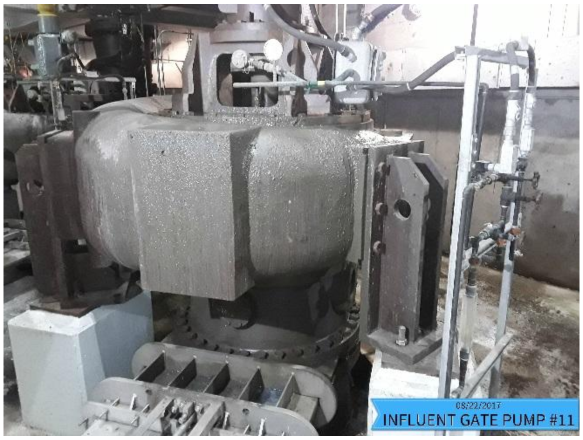
The Freud Pump Station consists of one main building which houses both the storm water and sanitary pumps, as well three ancillary structures. The three ancillary structures include the Transformer Containment Pad, Generator and Diesel Fuel Storage Tank Pad and Perimeter Wall, and East Site Retaining Wall.

A description of the mechanical equipment deficiencies associated with each building is provided below.

Conner Creek: Sanitary and Storm Water Pump Station

Sanitary Pumps

There are four sanitary pumps which are used to convey dry weather flow. These have experienced maintenance issues due to excessive wear and vibration believed to be caused by poor hydraulic conditions in the wet well. One of the pumps had been physically removed and was out of service at the time of the assessment. The general condition of the pumps is good, likely due to being rebuilt on a regular basis. The capacity of the pumps is questionable, as all four pumps are run on a regular basis to convey flow, leaving no standby pump or redundancy.



Sanitary Suction Knife Gates

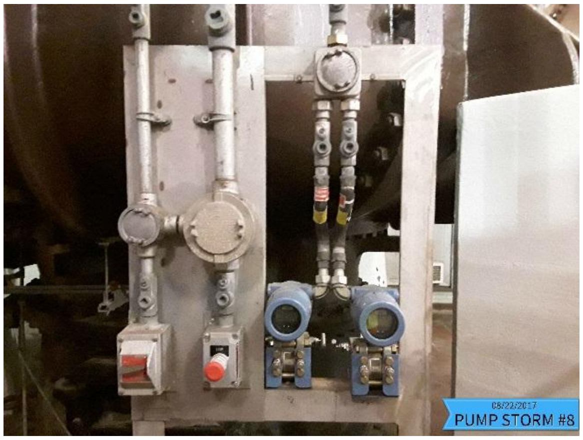
The sanitary suction knife gates are in good condition and are manually operated to isolate each of the four sanitary pumps from the wet well.

Sanitary Pump Station and Storm Water Pump Station Sump Pumps

There are two sump pumps in the northwest corner of the Sanitary Pump Station. The sump is the same depth as the sanitary wet well allowing the pumps to be used to dewater the wet well. The two sump pumps below the Boiler Room in the Storm Water Pump Station are used to dewater the storm water wet well. These submersible pumps are located on guide rails for lifting and maintenance. All four submersible sump pumps were not accessible but appeared to be in good condition. The ancillary piping and float switch controls appear to be in good condition.

Storm Pumps

The storm pumps are of original construction to the pumping station, installed in phases as capacity was needed over the years, and are in good condition externally. The concrete supports and ancillary piping systems are in good condition as well. Operational issues include problems with priming the pumps to put them in operation, which is addressed in the section on the Vacuum Priming Systems, and an inadequate seal water supply, which is pooled on top of the pumps and drawn into the pump case. Seal water is in short supply when several pumps are running.



Vacuum Priming Systems

The Vacuum Priming Systems are present as a stand-alone system for each of the storm pumps to fill the pump volutes with water, so that the pumps can be primed to start pumping during wet weather. Once the pumps are primed, they will continue in operation without the priming system running until they are shut down and the pump volute drains back to the wet well. These systems have been problematic and unreliable in the past, although the components and instrumentation appear to be in good condition. The vacuum priming systems are very complex, as they rely on multiple instruments and actuated valves to achieve the proper sequence in filling the pump volute. Any component failure or vacuum leak will leave the associated pump inoperable.

Conner Storage Gates at Backwater Gate Structure

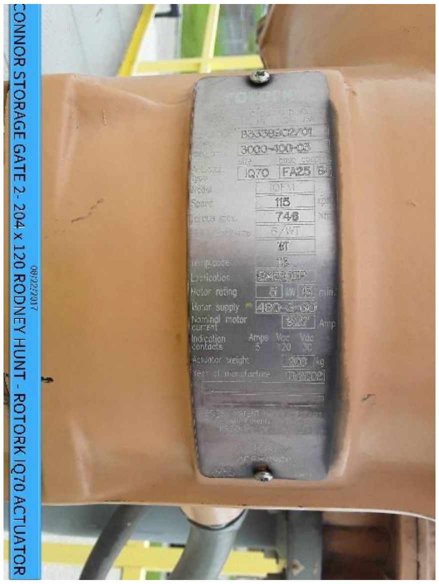
The Conner Storage Gates provide an outlet from the Conner Creek Sewer to the Conner Creek Open Channel. These were installed in 2002 and all nine appear to be in good condition with minimal corrosion, and appear fully operational. One item to note is that several of the motor/control enclosures were tagged with blue tape and marked “Needs 5 kW kit”. Damage was also noted on the flexible electrical conduit for one of the actuators.

Conner Storage Gate
Tag: CSG-2
Size: 204” x 120”
Supplier: Rodney Hunt Co.
Name: IQ70
Model: Rotork
Elect: 460/3/60

GLWA

08/22/2017
CONNOR STORAGE GATE 2- 204 x 120 RODNEY HUNT - ROTORK IQ70 ACTUATOR

08/22/2017
CONNOR STORAGE GATE 2- 204 x 120 RODNEY HUNT - ROTORK IQ70 ACTUATOR



08/22/2017
CONNOR STORAGE GATE 2- 204 x 120 RODNEY HUNT - ROTORK IQ70 ACTUATOR

rotork-gears – EXEECO
MADE IN ENGLAND
SERIAL No. C0041702- 7
TYPE IB11
RATIO 4-1
ORDER No. B3338902
SPEC. STD 125 kg

08/22/2017
CONNOR STORAGE GATE 2- 204 x 120 RODNEY HUNT - ROTORK IQ70 ACTUATOR

Storm Water Discharge Chamber Gates

As part of the 2016 Emergency Improvements, the priming weir crest in the storm water discharge channel was increased to EL 82.0 and two 30-inch diameter flow through pipes were added through the concrete weir. 30-inch control gates with electric actuators (extension stems labeled No. 2 and 3) were installed. Gates are used to control build-up of debris in the channel. As part of project, a new access hatch was added over the weir.

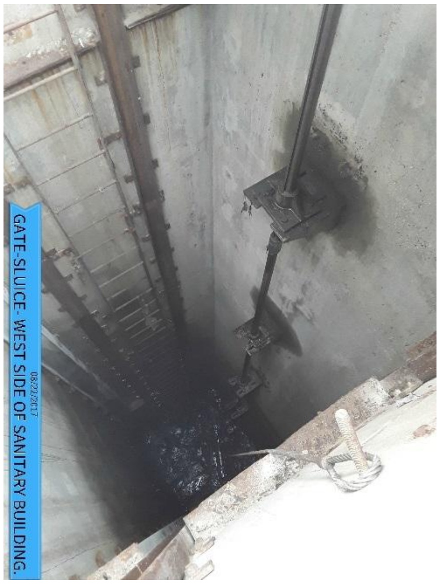
7-Foot Sluice Gate Between Forebay and Storm Water Outfall

This gate controls bi-directional flow between Conner Sewer forebay and the storm water outfall. As part of the 2016 Emergency Procurement Improvements, the actuator was modified to accept control and send feedback position to System Control Center.

Sanitary Sluice Gates

Sanitary Sluice Gates are located in drop shaft manholes located on the east and west side of the sanitary wet well. These gates provide isolation for the wet well along with a third gate connecting the sanitary wet well and the storm wet well. The gates themselves are inaccessible at the bottom of the structures, although the gate operators and actuators are above grade and appear operational.

Sanitary Sluice Gates are located in drop shaft manholes where coarse basket screens prevent large debris from entering the sanitary wet well. There is concern about screen blinding since the coarse basket screens are manually removed and cleaned. To address this and other concerns, the gate separating the sanitary and storm water wet wells is normally open. A previous evaluation noted that the drop at the sluice gate chambers results in entrained air which causes poor hydraulic conditions at the sanitary pumps.



Storm Water Wet Well Sluice Gates

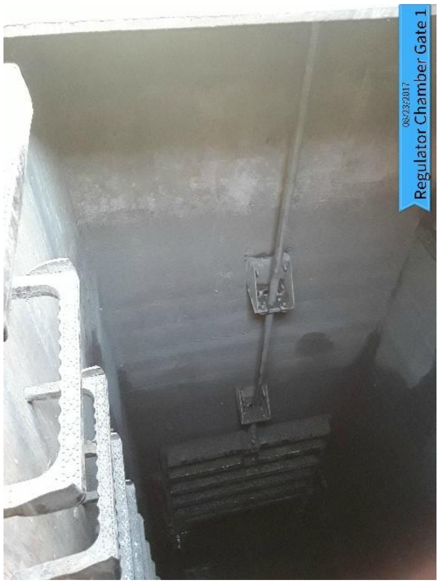
The two Storm Water Wet Well Sluice Gates are located at either end of the storm wet well with the actuators at the pump floor level in the station. The gates themselves are inaccessible below the floor level in the wet well. The gate operators and electric actuators appear operational. The south end sluice gate is 60-inches wide and 84-inches tall. The north end sluice gate is 60-inches wide and 60-inches tall. Although these gates can be closed to isolate the wet well, there are no provisions to isolate the wet well from the two 14-foot diameter East and West Jefferson Relief Sewers.


08/22/2017
STORM WATER WET WELL GATE SG-1


08/22/2017
STORM WATER WET WELL GATE SG-2

Regulator Chamber Gates

The Regulator Chamber Gates are fabricated stainless steel and are in good condition. The steel support assemblies and pedestal supports show rust on less than 10% of the surface and are in good condition. The gear operators and actuators are in good condition and show no corrosion. One item to note is that the grout under the steel supports appears that it was placed “dry” and has cracked and pieces are missing, although there appears to be nuts on the anchor bolts to provide support below the gate operators. This is mostly aesthetic, but may be allowing water to get to the anchor bolts.



Elevator

The elevator is likely original to the pumping station and is in poor condition. The elevator electrical and controls components are mounted on an open rack exposed and the elevator has experienced reliability issues in the past. The elevator has been in use beyond its expected useful life.

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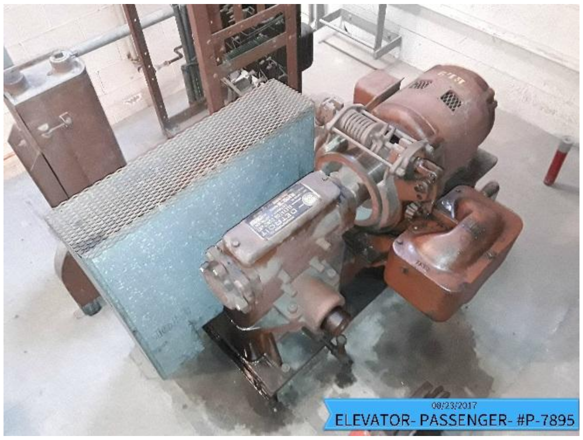
ELEVATOR- PASSENGER- #7384

08/23/2017
ELEVATOR- PASSENGER- #P-7895



08/23/2017
ELEVATOR- PASSENGER- #P-7895

08/23/2017
ELEVATOR- PASSENGER- #P-7895

Air Compressor

The Air Compressor was installed in 2004 and is in good condition with only minor corrosion around the mounting feet on the concrete pad.

Cranes

The crane in the sanitary pumping station consist of a 10-ton capacity bridge crane, and is likely original to the station, being built in the 1950's. It is in good condition and is functional, although one of the buttons on the pendant control is tagged as "caution button sticks".

The crane in the Storm Water Pumping Station consists of a 20-ton capacity circular bridge crane, and is original to the station in the 1920's. The motors and electrical controls have been more recently replaced, although it is not known when. The crane was operated by one of the GLWA staff during our visit and is functional.


08/23/2017
OVERHEAD CRANE (20 TON)


08/23/2017
OVERHEAD CRANE (20 TON)


08/23/2017
OVERHEAD CRANE (20 TON)


08/23/2017
OVERHEAD CRANE (20 TON)


08/23/2017
OVERHEAD CRANE (20 TON)

Freud Pump Station: Sanitary and Storm Water Pump Station

Sanitary Pumps

The two sanitary pumps are located at the lowest level in the station and handle the dry weather sanitary flow. These pumps were originally dewatering pumps for intermittent use but were repurposed for full time use as sanitary pumps and may not be operating within the original design range. The pumps are removed for rebuilding/replacement periodically and are switched with spares that are kept on hand at the station. The condition of the pumps is good with minor corrosion of some of the hardware and the steel supports.

Storm Pumps

The eight Storm Pumps are original to the station that was built in 1954. The pumps are in fair condition but all have multiple layers of paint, which is peeling over a large portion of the pumps with corrosion covering large portions due to moisture at the lower level in the station. The concrete support piers show various levels of cracking from very minor hairline cracks to major cracks on a couple of the piers, although no pieces of concrete are missing. The discharge piping for the pumps is also showing a significant amount of corrosion.


08/22/2017
PUMP #02 STORM


08/22/2017
PUMP #02 STORM


08/22/2017
PUMP #02 STORM

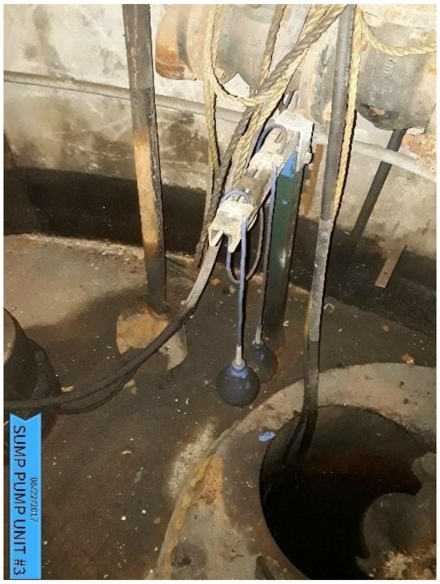

08/22/2017
PUMP #02 STORM


08/22/2017
PUMP #01 STORM


08/23/2017
PUMP #03 STORM

Sump Pumps

The Sump Pumps consist of two submersible pumps installed in a pit at the lowest level of the station and a third submersible pump, which is sitting on the floor adjacent to the sump. The two pumps in the pit are inaccessible. All the pumps are in service and functioning. The piping for pumps #1 and #2 show corrosion on the steel piping, and some piping has been replaced with PVC piping. Pump #3 appears to have been added later than the others and is piped with PVC piping. There is also an open electrical box for the pump controls that needs a cover.



Seal Water System

The Seal Water System consists of a break tank and fill valve assembly, which is located on an intermediate level between the motor floor and the pump level. This is in good condition with minimal corrosion and no issues were identified.

Wash Water Break Tank

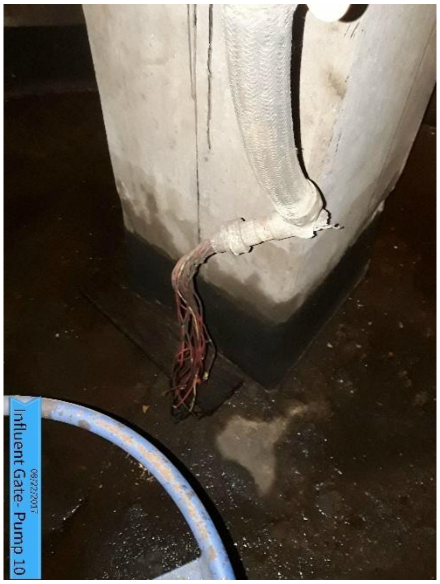
08/22/2017

Wash Water Break Tank

08/22/2017

Sanitary Pump Influent Gates

The two Sanitary Pump Influent Gates are located below the sanitary pumps and are a knife gate style valve. These have a significant amount of corrosion and one of the operator supports is delaminating due to the corrosion. The electric actuator for gate #10 has been removed and a handwheel has been installed on the gear operator.



Sanitary Flap Gates

The two Sanitary Flap Gates are installed in the discharge channel on the outside of the station. These are in fair condition with corrosion on both the gates and the hardware.

Sanitary Discharge Gates

The two Sanitary Discharge Gates are gate valves installed in a pit outside the station along the fence. The gate valves and associated piping have significant corrosion due to moisture in the pit. The valve operators and electric actuators are of an older style and have multiple layers of paint that is peeling in some areas. The flexible conduit for Gate #10 is split and is separating from the junction box, and has exposed wiring. It is not known if this actuator is functional.

Overflow Gate

The Overflow Gate is located on the discharge for sanitary pump #10 and is an enclosed knife gate type. Corrosion of the valve is minimal, but there is peeling paint exposing what is likely the factory paint underneath. The valve stem and operator are in good condition.

Dewatering Gate

The Dewatering Gate is a cast iron style sluice gate with an electric actuator located just inside the station near the loading dock. The gate and stem appear serviceable, but have some corrosion. The gate operator and electric actuator are in good condition and have minimal corrosion, but are an older style. GLWA staff reports that this gate has never been operated.

Air Compressor System

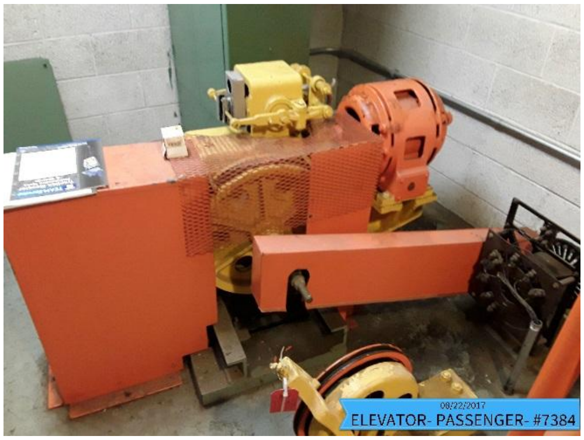
The Air Compressor System is a horizontal tank style with a belt driven compressor pump and is located on the motor floor of the station. The pressure gauge is in poor condition and is missing the glass. There have been reliability issues in the past and the compressor pump may have been rebuilt or replaced at some point, as it appears newer than the remainder of the system.

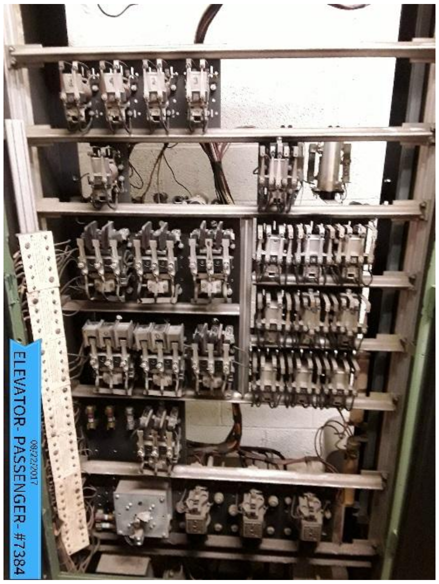
Bridge Crane

The Bridge Crane has a 20-ton capacity and is likely original to the station construction in 1954. Corrosion is minimal and operation appears to be good, as it was in use during the day of the condition assessment, although it was only used to lift tools from the lower level. Operators noted that the crane does make noise when it is under a greater load lifting pumps.

Elevator

The Elevator is likely original to the pumping station and is in fair condition. The elevator electrical and controls components are mounted on an open rack exposed and the elevator has experienced reliability issues in the past. The elevator has been in use beyond its expected useful life.





Structural Condition Assessment – Freud and Conner Creek Pump Stations

The Conner Creek Pump Station consists of three main structures and seven ancillary structures. The three main structures consist of the Storm Water Pump Station (Main Building), Primary Switchgear Building, and Sanitary Pump Station. The seven ancillary structures include the Transformer Containment Pad, Regulator Chamber, Generator and Diesel Fuel Storage Pad, Gate Structure and Raised Stop Log Structure, Transfer Switch Electrical Enclosure, Surge Tank, and Backwater Gate Structure.

The Freud Pump Station consists of one main building which houses both the storm water and sanitary pumps, as well three ancillary structures. The three ancillary structures include the Transformer Containment Pad, Generator and Diesel Fuel Storage Tank Pad and Perimeter Wall, and East Site Retaining Wall.

Discussion of interior and exterior masonry walls, flooring (on-top of the structural concrete slabs), roofing, windows and doors can be found in the Architectural portion of this Condition Assessment report.

A description of the structures and the observed structural deficiencies associated with each structure is provided below.

Conner Creek: Storm Water Pump Station (Main Building)

The Storm Water Pump Station houses the storm water pumps and has 3 floors starting at the top floor (approximately 4-feet above exterior grade) down to the pump floor level (approximately 31 feet below the top floor). The Storm Water Pump Station was constructed around 1928. The condition assessment summary for the Storm Water Pump Station structure has been broken down by floor level as follows:

Top Floor and Superstructure

The Storm Water Pump Station superstructure consists of a multi-wythe masonry wall system (brick exterior face and glazed brick interior face) with glaze brick enclosures around the structural steel building columns. The structural steel building columns support steel roof trusses that frame a lower and upper domed roof structure. Structural steel roof purlins span between steel truss members and support the 2x6 structural roof deck boards. There is a narrow (approximately 2-feet wide) wood walkway at the top of the lower roof that can only be accessed by a hanging ladder that is only accessible from the bridge crane walkway (when the bridge crane is orientated in just the right position). Circular clerestory windows are located above the walkway (above the low roof and below the upper roof). The structural slab for the top floor consists of reinforced concrete slab with integral reinforced concrete framing beams bearing on the perimeter substructure reinforced concrete walls and two interior columns rows down the center of the pump station.

The interior glazed brick walls are in good condition and the exterior brick walls are in fair condition. There are some areas of exterior brick that could require tuckpointing and some brick and mortar joint crack repairs. However, GLWA staff indicated that the exterior walls look significantly better than five years ago because of a construction project to remove and rebuild whole sections of exterior wall that had become deficient (out-of-plumb) and leaking. Significant staining was observed on the brick wall components, most likely from rainwater coming down the exterior face of the brick walls. The gutter system may need to be looked at in the future. Some of the mortar joints on the cast stone units have weathered. Some brick and mortar joint cracking in the interior glazed brick was also observed. See the Architectural portion of this Condition Assessment for further discussion and photos of the exterior and interior masonry walls.

The top slab of the pump station has tile flooring, so it could not be observed from above, but the underside of the top slab and the integral reinforced concrete framing beams appear to be in good condition with no signs of deflection, deterioration, or exposed resteel. The structural steel framing beams and steel bar grating over the pump removal access areas look to be in good condition with only minor surface corrosion observed.

The steel roof trusses, bridging, and roof purlins appear to be in good condition with only minor surface corrosion observed. The 2x6 structural roof deck boards appear to be in good condition.

The roof was not accessible during the site visit. GLWA staff indicated the upper and lower Main Building roofing was replaced with a new shingle roof in 2016. Also, a few wood deck boards were replaced but many of the 2x6 structural roof deck boards appear to be in good shape. The tops of the interior glazed brick masonry walls have experienced leaks in past, this is evident in the steel crane runway beam bottom flange corrosion discussed in following paragraph. Standing water was observed on floor at the west common corridor between storm and sanitary building. This leak location will need to be considered in the future project. It seems as though the roof replacement project in 2016 and the recent exterior brick masonry wall rebuild project may have solved a lot of past water leakage issues in the superstructure, but exterior gutters, soffits and drain pipes to inside were not touched in those projects.

The Main Building has a 20-ton overhead bridge crane that runs in a circular pattern on runway beams supported from columns located on the exterior walls. The bridge crane was was operated during the site visit and it was moved to access ladder above. The crane moved well but no lifting was done. GLWA staff indicated the crane should be inspected and serviced during the upcoming project. Surface corrosion was observed on most of the bottom flanges of the crane runway beams, most likely from past roof and wall leaks (before 2016 roofing replacement project and before exterior brick masonry wall rebuild project).

Wood boards for bridge crane walkway and upper circular clerestory walkway should be considered for replacement during the upcoming projet More reliable ladder access (and possibly a ladder cage) to the upper circular clerestory walkway should also be considered.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BUILDING- MAIN- Connor Creek Sewage Station


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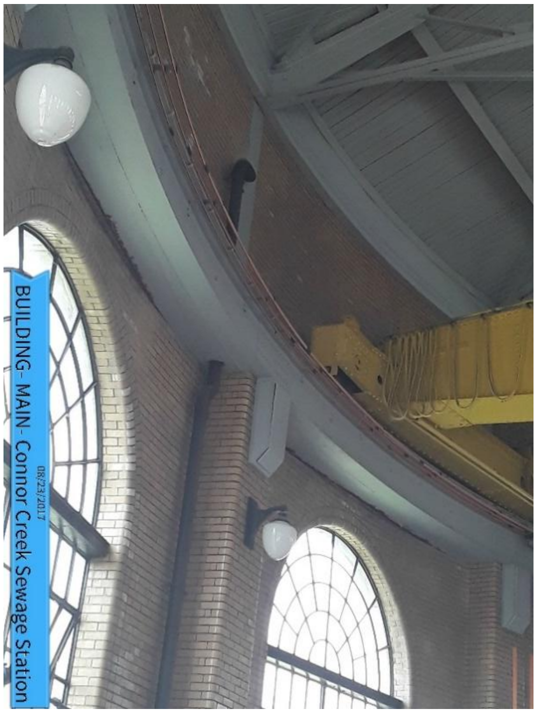
BUILDING- MAIN- Connor Creek Sewage Station



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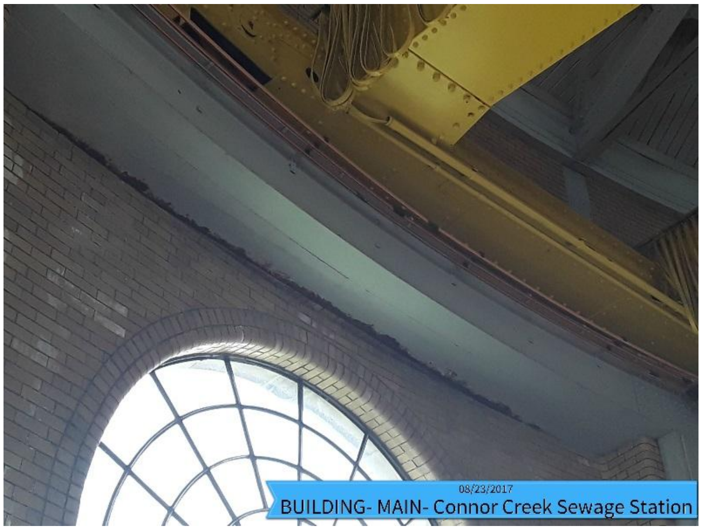
BUILDING- MAIN- Connor Creek Sewage Station



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BUILDING- MAIN- Connor Creek Sewage Station

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BUILDING- MAIN- Connor Creek Sewage Station

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BUILDING- MAIN- Connor Creek Sewage Station

08/23/2017
BUILDING- MAIN- Connor Creek Sewage Station


08/23/2017
OVERHEAD CRANE (20 TON)


08/23/2017
BUILDING- MAIN- Connor Creek Sewage Station


08/23/2017
BUILDING- MAIN- Connor Creek Sewage Station


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BUILDING- MAIN- Connor Creek Sewage Station

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BUILDING- MAIN- Connor Creek Sewage Station

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BUILDING- MAIN- Connor Creek Sewage Station

Second Floor Perimeter Walkways

The Second Floor Perimeter Walkways are reinforced concrete walkways (approximately 5-feet wide) that cantilever out away from the substructure perimeter walls. The walkway slabs have tile flooring, so the reinforced concrete walkway slab could not be observed from above, but the underside of the walkways look to be in good condition with no signs of deflection, deterioration, or exposed resteel. The handrail along the edges of the walkway are in good condition, are of proper height, and have only minor (if any) signs of corrosion.

The reinforced concrete substructure walls are covered with glazed tile so visual inspection could not be done on the concrete walls. However, the glazed wall tiles appear to be in good shape with only very spotty tile and grout cracking. Any major structural cracks would most likely have shown themselves through the glazed wall tiles. No signs of this was observed.

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DING- MAIN- Connor Creek Sewage Station - Second Floor Perimeter Walkways

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DING- MAIN- Connor Creek Sewage Station - Second Floor Perimeter Walkways

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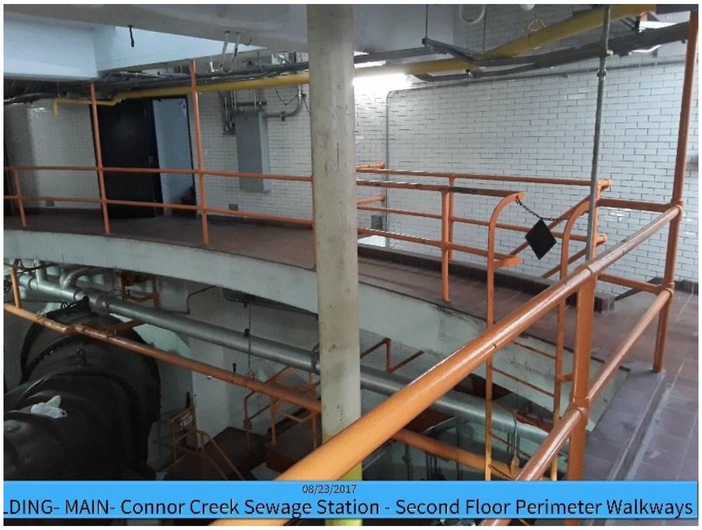
DING- MAIN- Connor Creek Sewage Station - Second Floor Perimeter Walkways



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DING- MAIN- Connor Creek Sewage Station - Second Floor Perimeter Walkways

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LDING- MAIN- Connor Creek Sewage Station - Second Floor Perimeter Walkways

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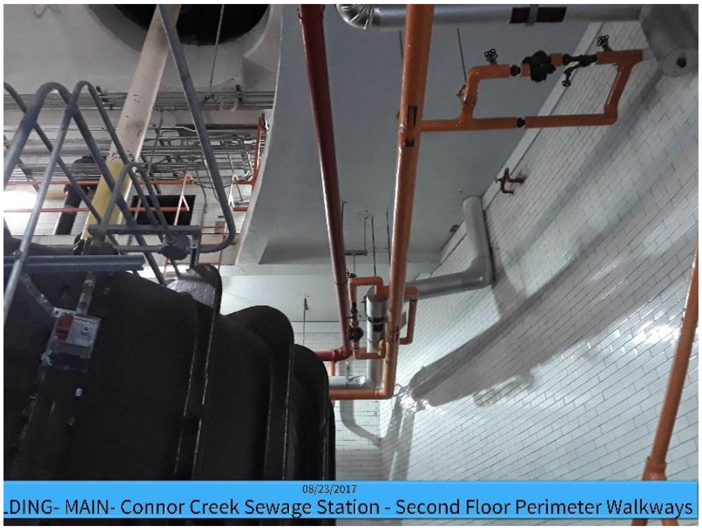
LDING- MAIN- Connor Creek Sewage Station - Second Floor Perimeter Walkways



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LDING- MAIN- Connor Creek Sewage Station - Second Floor Perimeter Walkways

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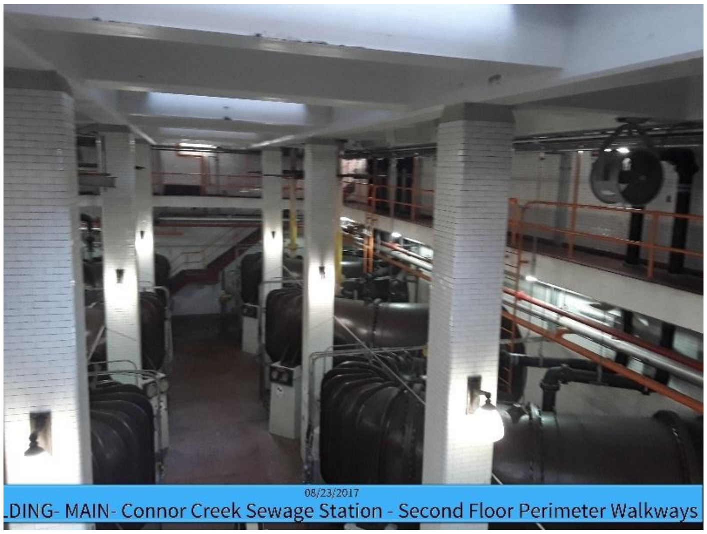
LDING- MAIN- Connor Creek Sewage Station - Second Floor Perimeter Walkways

Basement Level

The reinforced concrete substructure walls and concrete columns (supporting the top floor slab and support framing beams) are covered with glazed tile so visual inspection could not be done on these concrete items. However, the glazed wall tiles appear to be in good shape with only very spotty tile and grout cracking. Any major structural cracks would most likely have shown themselves through the glazed wall tiles. No signs of this was observed.

The reinforced concrete floor has tile flooring, so the reinforced concrete slab could not be observed. However, the tile floor appears to be in good shape with only very spotty tile and grout cracking. Any major structural cracks in the floor slab would most likely have shown themselves through the tile flooring. No signs of this was observed. Some puddles of water were observed on the floor between the pump and the wall at the north end of the basement. It could not be determined if these puddles were from the pump leaking or from the substructure concrete wall to floor slab interface. The concrete pump support piers are in good condition.


08/23/2017
DING- MAIN- Connor Creek Sewage Station - Second Floor Perimeter Walkways


08/23/2017
BUILDING- MAIN- Connor Creek Sewage Station - Basement Level


08/23/2017
BUILDING- MAIN- Connor Creek Sewage Station - Basement Level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BUILDING- MAIN- Connor Creek Sewage Station - Basement Level

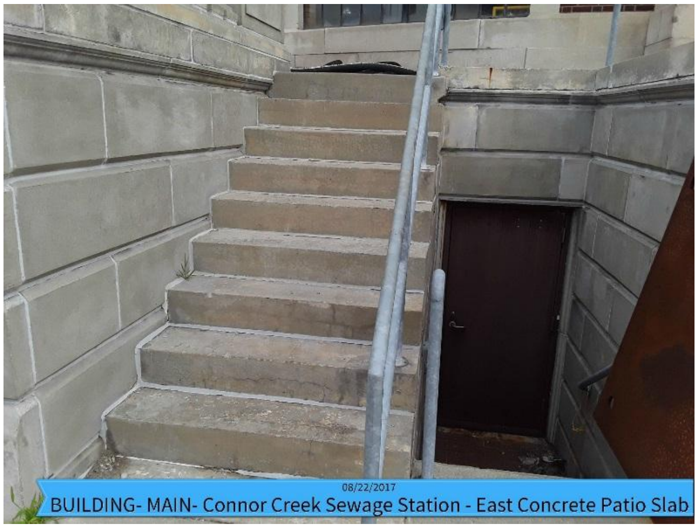

08/23/2017
BUILDING- MAIN- Connor Creek Sewage Station - Basement Level


08/23/2017
BUILDING- MAIN- Connor Creek Sewage Station - Basement Level


08/23/2017
BUILDING- MAIN- Connor Creek Sewage Station - Basement Level

East Exterior Concrete Patio Slab

The east exterior concrete patio slab is an extension of the Storm Water Pump Station top floor out to the east of the building. The existing top slab appears to be in good condition with only minor hairline cracks with caulked joints. Some slab joints have lost their joint filler and caulk and now have vegetation growing out of them. The top slab appears to shed water well. The steel floor door just outside the large overhead door to the Main Building has some surface corrosion on it. The decorative concrete railing around the perimeter of the patio slab is only 35 to 37-inches tall. The OHSA code height for fall protection will need to be revisited since this patio slab is approximately 4-feet up from existing grade.



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BUILDING- MAIN- Connor Creek Sewage Station - East Concrete Patio Slab

08/22/2017
BUILDING- MAIN- Connor Creek Sewage Station - East Concrete Patio Slab

Conner Creek: Sanitary Pump Station

The Sanitary Pump Station houses the sanitary pumps and has 4 floors starting at the top floor (approximately at grade) down to the lowest sump level (approximately 44 feet below the top floor). The Sanitary Pump Station was constructed in 1960. The condition assessment summary for the Sanitary Pump Station structure has been broken down by floor level as follows:

Top Floor and Superstructure

The Sanitary Pump Station superstructure has a double-wythe masonry wall system. Brick exterior face and glazed concrete block interior face (plain concrete block in the upper portions of wall above the bridge crane runway beams) with glazed concrete block enclosures surrounding the structural steel building columns. The structural steel building columns support structural steel roof beams that in turn support steel roof purlins. The steel roof purlins support the precast concrete roof deck channel slabs. The structural slab for the top floor consists of reinforced concrete slab with thickened reinforced concrete beams at the intermittently spaced embedded steel wide flange beam framing providing support of the top floor.

The interior glazed concrete block and upper plain concrete block walls are in good condition and the exterior brick walls are also in good condition. There are a few areas of exterior brick that could require some tuckpointing and some exterior brick and interior concrete block mortar joint cracks that were observed (minor joint cracking out of masonry pilasters and at the mid-height of the south wall).

The top slab of the pump station has tile flooring, so it could not be observed from above, but the underside of the slab looks to be in good condition. The embedded steel wide flange framing support beams embedded in the concrete floor and at the grated openings in the floor look to have minimal surface corrosion on them. The steel grating bearing bars have been stressed and warped in numerous locations on this floor (more noticeable on 2nd floor). These grating bearing bars were used as localized lifting points during equipment removal and replacement. It appears lifting lugs and eye bolts were installed between grating bearing bars for lifting and rigging.

The steel roof beams and roof purlins appear to be in good condition with only localized areas of surface corrosion. The precast concrete channel roof deck slabs appear to be in good condition as well with no signs of corrosion, deflection, exposed resteel or water leakage.

The roof was accessed and observed on a dry and sunny day the morning after it had rained. GLWA staff indicated the roofing was original and that it should be replaced in the future project. The roofing looked very good and seems like it had been replaced since the original construction in 1960. Roofing appears to shed water rather well with the only standing water observed along the east side between roof drains. No signs of water leakage (minor wall stains and/or efflorescence) were observed at the top of interior plain concrete block walls. The ladder leading up to the roof should be investigated to see if a cage is required per OHSA code requirements. Also, a short ladder leading between the access hatch roof and the main lower roof of the Sanitary Pump Station should be considered.

The building has a 10-ton overhead bridge crane that runs along runway beams on the east and west walls. The bridge crane was not operated during the site visit, but GLWA staff indicated the crane should be inspected and serviced during the upcoming project.

SEWAGE STATION - Top Floor and Superstructure

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SEWAGE STATION - Top Floor and Superstructure

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SEWAGE STATION

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SEWAGE STATION

08/23/2017

EWAGE STATION - Second Floor and Substructure - 2nd Floor up from Basement

08/23/2017

EWAGE STATION - Second Floor and Substructure - 2nd Floor up from Basement

08/23/2017
SEWAGE STATION - Top Floor and Superstructure

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SEWAGE STATION - Top Floor and Superstructure

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SEWAGE STATION - Top Floor and Superstructure

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SEWAGE STATION - Top Floor and Superstructure

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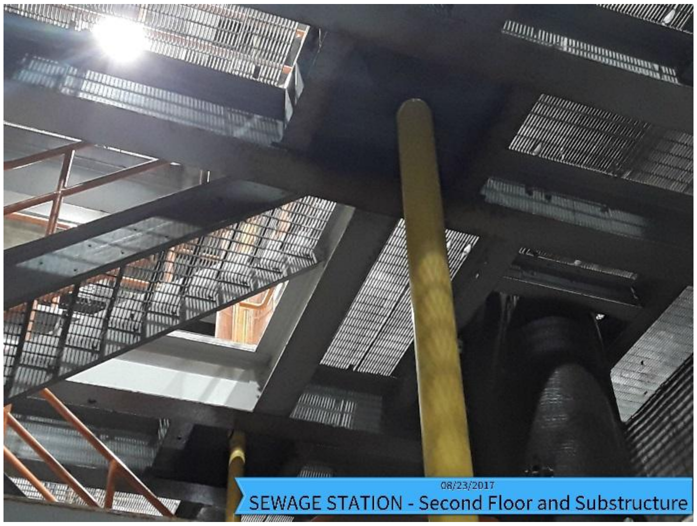
SEWAGE STATION - Top Floor and Superstructure

Second Floor and Substructure (2nd Floor up from Basement)

The floor consists of galvanized steel bar grating supported from structural steel wide-flange framing beams. The steel framing beams span the entire east-west width of the pump station and are connected to the concrete substructure walls. The grating, handrails, and steel wide-flange beam framing are in good condition with very little steel surface corrosion observed. However, a good amount of steel corrosion was observed from the underside when looking at the bottom flange and webs of the steel framing beams around the pump shafts. Steel grating bearing bars have been stressed and warped in numerous locations on this floor since they were used for localized lifting and rigging during equipment removal.

The reinforced concrete substructure walls were in good condition. Numerous hairline cracks and concrete cold joints (and/or rough form finish) from the original construction were observed. It also appears as though repair mortars and pastes have been applied to a few small, localized areas of the walls in the past to resolve minor leakage. These repairs appear to have resolved the minor leakage that was occurring. No exposed resteel was observed.



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SEWAGE STATION - Second Floor and Substructure

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SEWAGE STATION - Second Floor and Substructure

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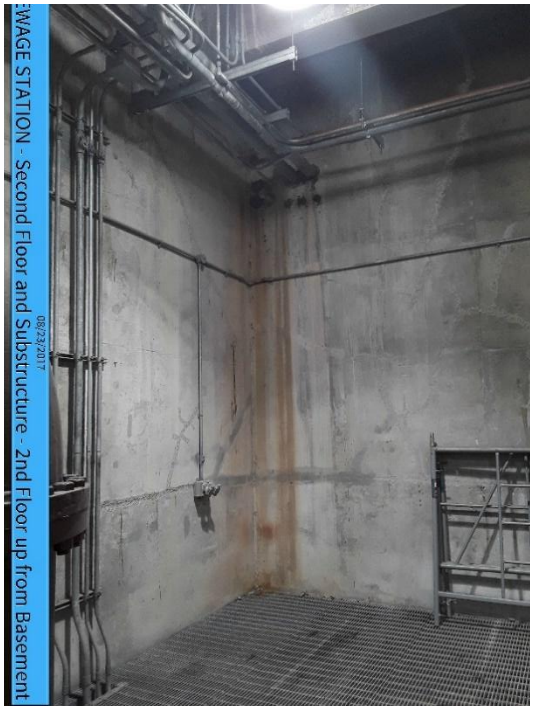
SEWAGE STATION - Second Floor and Substructure



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EWAGE STATION - Second Floor and Substructure - 2nd Floor up from Basement

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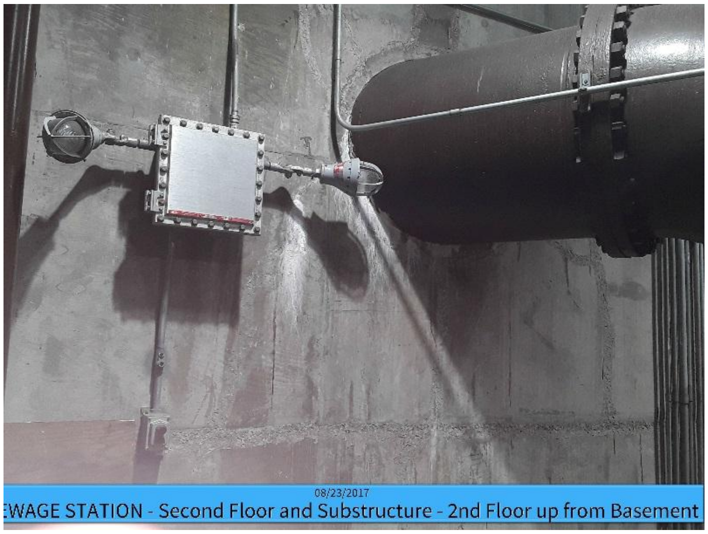
EWAGE STATION - Second Floor and Substructure - 2nd Floor up from Basement



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EWAGE STATION - Second Floor and Substructure - 2nd Floor up from Basement

Third Floor and Substructure (1st Floor up from Basement with no grating)

The floor consists of structural steel wide-flange framing beams, but no grating. The steel framing beams span the entire east-west width of the pump station and are connected to the concrete substructure walls. The handrail, stairs, and steel wide-flange beam framing are in good condition with some steel surface corrosion observed. However, steel surface corrosion was observed on the bottom and top flanges of the steel framing beams. And, a good amount of steel corrosion was observed from the underside when looking at the bottom flange and webs of the steel framing beams around the pump shafts. Portions of the steel framing beam bottom flanges have been removed in certain areas to allow for equipment and conduits. At these areas, it appears steel tubing was added adjacent to the bottom flange cutout to replace the flange area removed (a structural steel method to remedy cutouts).

No grating was ever placed on this floor during its original construction. According to GLWA staff, maintenance personnel must utilize this floor for lifting/rigging of equipment and maintenance of equipment. Consequently, loose wooden boards have been laid across various portions of the steel framing beams. GLWA staff requested steel grating be added to this floor level to allow for proper and safe maintenance and lifting/rigging operations.

The reinforced concrete substructure walls are in good condition. Numerous hairline cracks (one showing signs of past leakage) and concrete cold joints (and/or rough form finish) from the original construction were observed (cold joint just below 2nd floor level doesn't show signs of past leaking). It also appears as though repair mortars and pastes have been applied to a few small, localized areas of the walls (on east wall near south end) in the past to resolve minor leakage. These repairs appear to have resolved the minor leakage that was occurring. No exposed resteel was observed.


08/23/2017
ION - Third Floor and Substructure - 1st floor up from basement with no grating


08/23/2017
SEWAGE STATION - Third Floor and Substructure

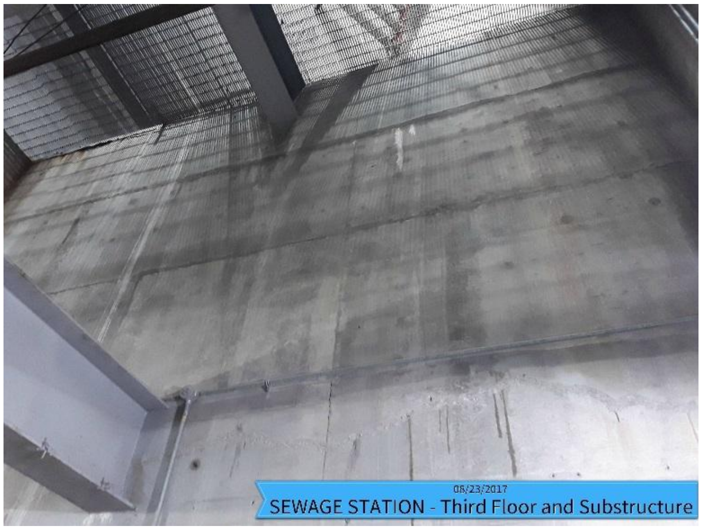

08/23/2017
SEWAGE STATION - Third Floor and Substructure


08/23/2017
SEWAGE STATION - Third Floor and Substructure


08/23/2017
SEWAGE STATION - Basement Level and Substructure


08/23/2017
SEWAGE STATION - Basement Level and Substructure


08/23/2017
SEWAGE STATION - Third Floor and Substructure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SEWAGE STATION - Third Floor and Substructure

Basement Level and Substructure

The reinforced concrete substructure walls are in good condition. Numerous hairline cracks (none showing signs of active leaking) were observed. No exposed resteel was observed. The concrete block framed elevator shaft walls appear to be in good condition. Concrete pump support piers are in good condition.

The reinforced concrete floor appears to be in good condition with only minor hairline cracks and no signs of leakage. Some puddles of water were observed on the floor, but these seem to be from the pumps since the puddles are away from walls.

Structural steel stairs and handrails look to be in good condition with minor surface corrosion.


08/23/2017
SEWAGE STATION - Basement Level and Substructure


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SEWAGE STATION - Basement Level and Substructure


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SEWAGE STATION - Basement Level and Substructure


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SEWAGE STATION - Basement Level and Substructure


08/23/2017
SEWAGE STATION - Basement Level and Substructure

Conner Creek: Primary Switchgear Building

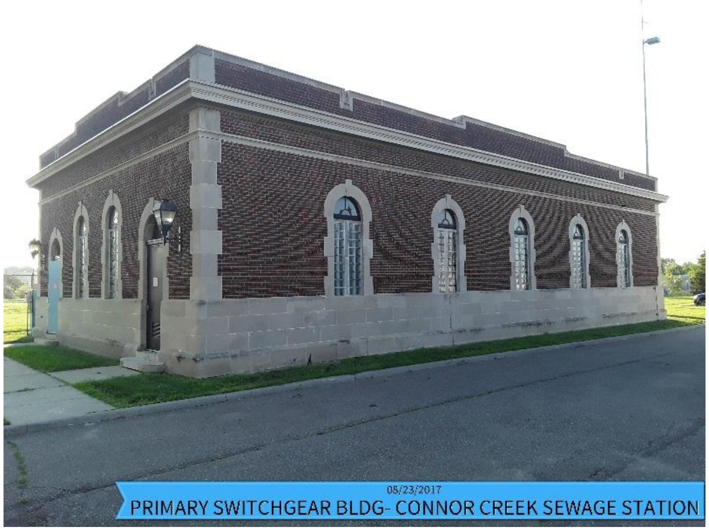
The Switchgear Building was constructed in 1925 at the same time as the Storm Water Pump Station. The superstructure of the building is constructed of a multi-wythe masonry wall system (brick exterior face and glazed brick interior face) with cast stone units at the base and corners of the exterior walls. The masonry walls support a reinforced concrete roof deck slab. The floor slab of the building is a reinforced concrete slab and there is a reinforced concrete basement under one half of the structure with a crawl space (reinforced concrete foundation walls) under the other half of the structure.

The interior glazed brick walls are in good condition and the exterior brick walls are in good condition. Areas of exterior brick and mortar joint cracks were observed. Some of the mortar joints on the cast stone units and under the concrete step into the building have weathered. Abandoned wall anchors and holes from previously wall supported equipment were observed in numerous locations on the interior walls. Some minor maintenance activities such as brick tuck-pointing, will be needed to keep further mortar joint deterioration from occurring and causing larger masonry wall issues in the future.

The floor slab of the building has tile flooring, so it could not be observed from above, but the underside of the slab looks to be in good condition (observed from the basement and the crawl space). The reinforced concrete basement walls are in good condition with only 2 minor hairline cracks observed. Ponding water was noticed along the north wall of the basement at the floor to wall interface. It had rained the day before.

The roof was accessed and observed on a dry and sunny day the morning after it had rained. The reinforced concrete roof deck appears to be in good condition with no signs of corrosion or deflection. GLWA staff indicated roofing should be considered for replacement as part of a future project. The roofing appears to shed water well and no standing water was observed. All mechanical equipment appears to be more than 10-feet away from roof parapet walls. Signs of water leakage (minor wall stains and efflorescence) were observed at the top of interior glazed brick walls in 3 locations under the plaster ceiling (just above the windows).

Exterior grade slopes away from structure on all sides of the building except for the north side. This might explain some of the minor water leakage that was observed in the basement along the basement wall to basement floor slab interface.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PRIMARY SWITCHGEAR BLDG- CONNOR CREEK SEWAGE STATION

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PRIMARY SWITCHGEAR BLDG- CONNOR CREEK SEWAGE STATION


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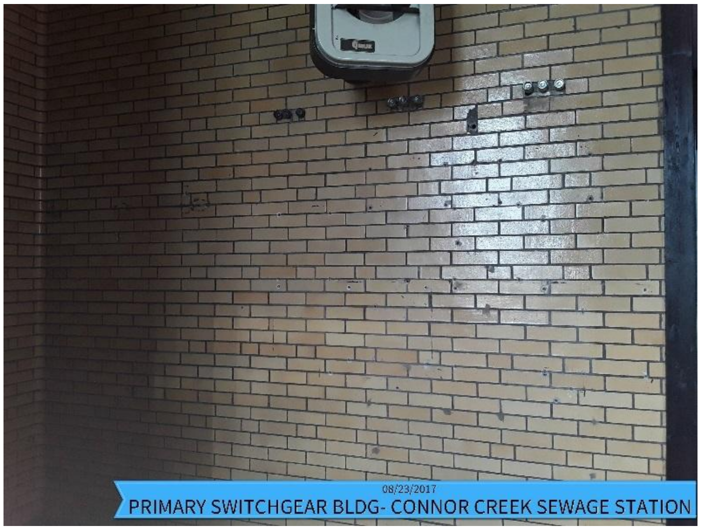
PRIMARY SWITCHGEAR BLDG- CONNOR CREEK SEWAGE STATION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PRIMARY SWITCHGEAR BLDG- CONNOR CREEK SEWAGE STATION


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08/23/2017
PRIMARY SWITCHGEAR BLDG- CONNOR CREEK SEWAGE STATION

Conner Creek: Seven Ancillary Structures

Transformer Containment Pad

The transformer containment pad consists of a concrete slab-on-grade with a perimeter concrete curb and chain link fencing. The date of construction of this containment pad is unknown. The existing concrete slab-on-grade appears to be in good condition with only minor hairline cracks at quarter points of the curb lengths. Portions of the west and south slab edges are starting to be undermined from lack of soil cover around the perimeter of the concrete-slab-on-grade. There does not appear to be a drain or sump inside of the containment curb, so not sure how rainwater gets out of the containment area. Debris has collected in the corner of the containment area. Containment requirements of the transformer fluids on this concrete slab-on-grade will need to be determined.

08/22/2017

BUILDING- MAIN- Connor Creek Sewage Station - Transformer Containment Pad

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BUILDING- MAIN- Connor Creek Sewage Station - Transformer Containment Pad

Regulator Chamber

The Regulator Chamber consists of three below-grade reinforced concrete structures whose concrete walls and top slab extend above grade by approximately two and a half feet with concrete walk slabs between them. The date of construction of this structure is around 1999. The concrete walls and top slab are in good condition with only hairline cracks in the top slab at the corners of the floor doors and vertical hairline cracks in the walls every 6 to 8 feet on center. A cold joint (construction joint) was observed at the top slab to wall pour joint. The top slab appears to be sufficient since no standing water was visible on the top slab. The aluminum floor door and frames look to be in good condition with only mild surface weathering.

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BUILDING- MAIN- Connor Creek Sewage Station - Regulator Chamber

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BUILDING- MAIN- Connor Creek Sewage Station - Regulator Chamber


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BUILDING- MAIN- Connor Creek Sewage Station - Regulator Chamber


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BUILDING- MAIN- Connor Creek Sewage Station - Regulator Chamber


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BUILDING- MAIN- Connor Creek Sewage Station - Regulator Chamber


08/22/2017
BUILDING- MAIN- Connor Creek Sewage Station - Regulator Chamber

Generator and Diesel Fuel Storage Pad

The generators and diesel fuel storage tanks are supported from a concrete slab-on-grade that was constructed in 1999. The existing slab-on-grade appears to be in good condition. GLWA staff indicated the original contractor did not properly slope the top surface of the concrete slab for drainage. Therefore, the contractor grinded portions of the slab between the enclosures to intentionally create some slope. This explains why the top surface appears eroded slightly in areas (to allow for water drainage between electrical enclosures). Portions of the slab edges are starting to be undermined from lack of soil cover around the perimeter of the concrete-slab-on-grade. A two-inch wide gap (with loss of joint filler and caulk) was observed in the joint between the concrete slab-on-grade under the generators and diesel fuel storage tanks.


08/22/2017
G- MAIN- Connor Creek Sewage Station - Generator and Diesel Fuel Storage Pad


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G- MAIN- Connor Creek Sewage Station - Generator and Diesel Fuel Storage Pad


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G- MAIN- Connor Creek Sewage Station - Generator and Diesel Fuel Storage Pad

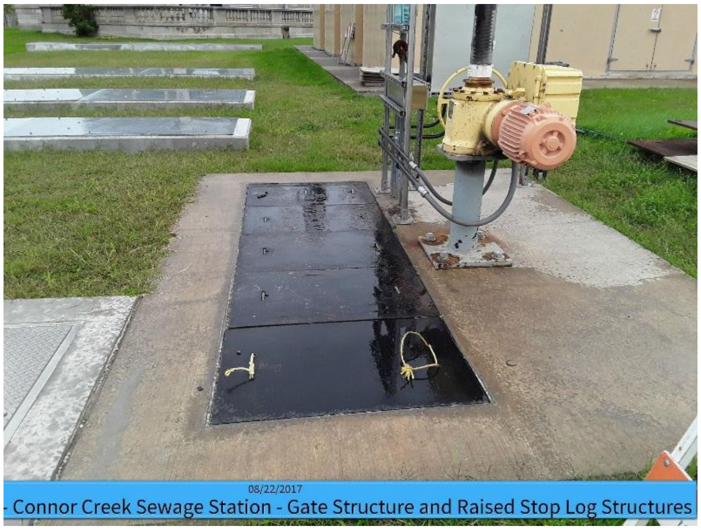

08/22/2017
G- MAIN- Connor Creek Sewage Station - Generator and Diesel Fuel Storage Pad

Gate Structure and Raised Stop Log Structure

The gate structure and raised stop log structure consists of one below-grade vault structure and four below grade stop log structures. The construction date for the below-grade vault structure is unknown but the four stop log structures were constructed in 2006. All structures extend six inches to one-foot above grade. The below grade vault structure concrete is in good condition with some surface corrosion on the top slab cover plates. The stop log concrete structures are in great condition and the aluminum cover plates are in great condition with no signs of weathering.


08/22/2017
- Connor Creek Sewage Station - Gate Structure and Raised Stop Log Structures


08/22/2017
- Connor Creek Sewage Station - Gate Structure and Raised Stop Log Structures


08/22/2017
- Connor Creek Sewage Station - Gate Structure and Raised Stop Log Structures


08/22/2017
- Connor Creek Sewage Station - Gate Structure and Raised Stop Log Structures

Transfer Switch Electrical Enclosure

The transfer switch electrical enclosure is supported from a concrete slab-on-grade. The structure was constructed in 1999, at the same time as the generator and diesel fuel storage pad. The existing slab-on-grade appears to be in fair condition with very few minor hairline cracks. GLWA staff indicated the original contractor did not properly slope the top surface of the slab for drainage. Therefore, the contractor grinded portions of the slab to intentionally create some slope. This explains why the top surface appears eroded slightly in areas. In some areas where the slab is flat or sloping back to the enclosure, concrete stains were observed (where water ponding is occurring).

Surge Tank

The surge tank structure is a below-grade reinforced concrete tank structure that extends approximately 3-feet above grade. The surge tank was constructed at the same time as the Storm Water Pump Station (1928). The reinforced concrete tank walls are covered by decorative cast stone pieces so they were unable to be viewed. The cast stone units along the perimeter walls are generally in fair condition. The reinforced concrete top slab of the surge tank is in poor condition. Numerous spider cracks, raised portions of slab, and hollow sounding portions of slab were observed. However, no exposed resteel was seen from the top slab. It appears the top slab of the surge tank was placed in multiple slab pours based on the construction joints seen. The top slab does not appear to drain well. Since no floor drains were found and not much slope on the top slab is available, the top slab may drain to the grated covers on the top slab. Dirt and concrete debris was observed in numerous places on the top slab. There are numerous steel floor plates covering the grating pieces on the top slab. Most of these steel floor plates are deformed and all show signs of surface corrosion. There is also no stair provided for accessing this top slab. The need for access to the top slab will need to be considered during the upcoming project.

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BUILDING- MAIN- Connor Creek Sewage Station - Surge Tank Top Slab

08/22/2017
BUILDING- MAIN- Connor Creek Sewage Station - Surge Tank Top Slab

Backwater Gate Structure

The backwater gate structure is a structure that extends both above and below-grade. The walls of the structure consist of oversized brick on the exposed face with structural steel frame columns and beams supporting an upper walkway on top of the structure. The upper walkway consists of aluminum plates and fiberglass handrail. The date of construction of this structure is around 1999. Numerous hairline spider cracks were observed in the 20-foot wide concrete slab-on-grades on both the east and west sides of Backwater Gate Structure. These slabs do not appear to drain surface water well based on the dark stains and dirt piles on various portions of these slabs. Minor surface corrosion was observed on the bottom of the steel beam flanges in some stretches of east and west side top walkway support beams (at the top of the brick wall). The aluminum cover plates appear to be in good condition. The fiberglass handrails and stair treads are in good condition, however, in spots, the fiberglass railing feels “sharp” and “abrasive” to bare hands.

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BUILDING- MAIN- Connor Creek Sewage Station - Backwater Gate Structure

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BUILDING- MAIN- Connor Creek Sewage Station - Backwater Gate Structure

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BUILDING- MAIN- Connor Creek Sewage Station - Backwater Gate Structure

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BUILDING- MAIN- Connor Creek Sewage Station - Backwater Gate Structure

Freud Pump Station: Main Building

The Freud Pump Station Main Building houses both the Storm Water and Sanitary pumps and has 5 floors starting at the top floor (approximately 5 feet above grade on east exterior side and 20 feet above grade on the west exterior side) down to the lowest sump level (approximately 83 feet below the top floor). The Freud Pump Station Main Building was constructed in 1955. The condition assessment summary for the Freud Pump Station Main Building structure has been broken down by floor level as follows:

Top Floor and Superstructure

The Freud Pump Station Main Building superstructure has a double-wythe masonry wall system (brick exterior face and glazed concrete block interior face) with glaze concrete block enclosures around the structural steel building columns. The structural steel building columns support steel roof trusses that have structural steel roof purlins supporting the precast concrete roof deck channel slabs. The structural slab for the top floor consists of reinforced concrete slab with thickened reinforced concrete beams at the intermittently spaced embedded steel wide flange beam framing providing support of the top floor.

The interior glazed concrete block walls are in very good condition and the exterior brick walls are in good condition. There are a few areas of exterior brick that could require some tuckpointing and some brick and mortar joint cracks were observed. Significant staining was observed on the lower brick wall components below the exterior top slabs. Some damage to the glazed concrete block at the northern crane stops was observed and the location and detail of crane stop should be revisited.

The top slab of the pump station has tile flooring, so it could not be observed from above, but the underside of the slab looks to be in good condition. The embedded steel wide flange framing beams embedded in the concrete floor look to have minimal surface corrosion on them. The condition assessment summary of the exterior top slabs (north, south, east, and west) are provided later in this report.

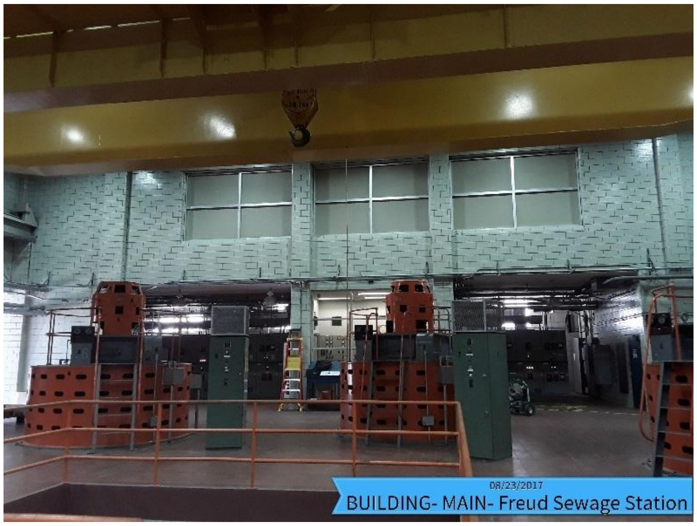
The steel roof trusses, bridging, and roof purlins appear to be in good condition with only localized areas of surface corrosion (minor surface corrosion was observed near the recent localized roof repair at the mid-point of the east wall). The precast concrete channel roof deck slabs appear to be in good condition.

The roof was accessed and observed shortly after a heavy rain event (rained heavy for twenty minutes about two hours before the roof was observed). The upper roof sheds water well with a high point in middle and roof drains at mid-points of the east and west walls. Some ponding along east and west wall edges was observed. The west low roof at the southwest end does not drain well as evidenced by ponding in the pictures, and no roof drain was found on the west low roof. The east and south low roofs seem to drain well with only minor ponding adjacent to wall in the drainage slope to drains. No active roof leaks were observed in the high or the low roof. GLWA staff indicated that there was a past roof leak along the mid-point of east wall in the upper roof (small localized area) and that had been repaired in the past 5 years. The roof leaked on pump below and shorted the pump. Some structural steel roof framing (purlins and roof truss) show signs of surface corrosion in this area as well as some other areas. GLWA staff indicated the high and low roofs were original and should be replaced. The ladder leading to the upper roof should be investigated to determine if a cage is required per OHSA code requirements.

The Main Building has a 20-ton overhead bridge crane that runs along runway beams on the east and west walls. The bridge crane was not operated during the site visit, but GLWA staff commented the crane strains to lift heavy pump components but does still work. GLWA staff requested the crane be inspected and serviced if needed during the upcoming project.

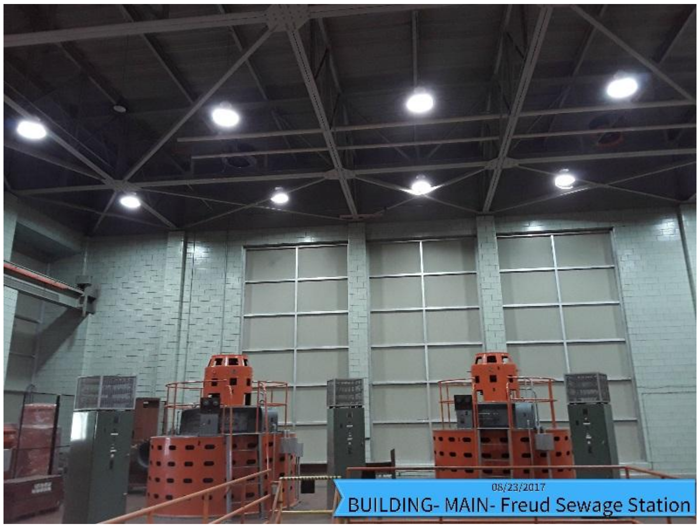
Numerous damaged floor tile (broken and scratched) and holes in the floor tile were observed inside the building adjacent to the east loading dock overhead door (Receiving Room and top floor of Pump Station just inside of Receiving Room). GLWA staff indicated damage was caused by contractors and maintenance personnel during loading and unloading of pumps and materials in and out of the Main Building. GLWA staff requested the upcoming project include better provisions for material handling such as floor or wall-mounted lugs or eye-bolts for easier movement of materials in and out of the building. A more suitable floor surface should also be considered in this area so it is not damaged when equipment is moved.

A temporary steel column base repair was observed at the overhead door adjacent to the east exterior top slab (loading dock). A more permanent repair for this steel column base is needed.



BUILDING- MAIN- Freud Sewage Station

BUILDING- MAIN- Freud Sewage Station



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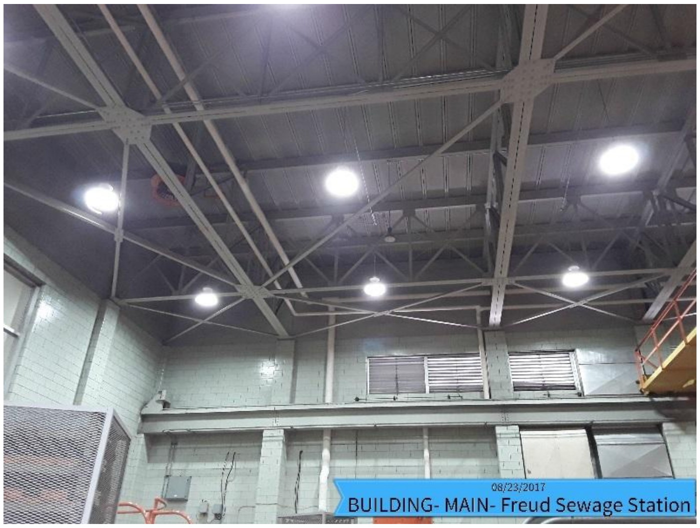

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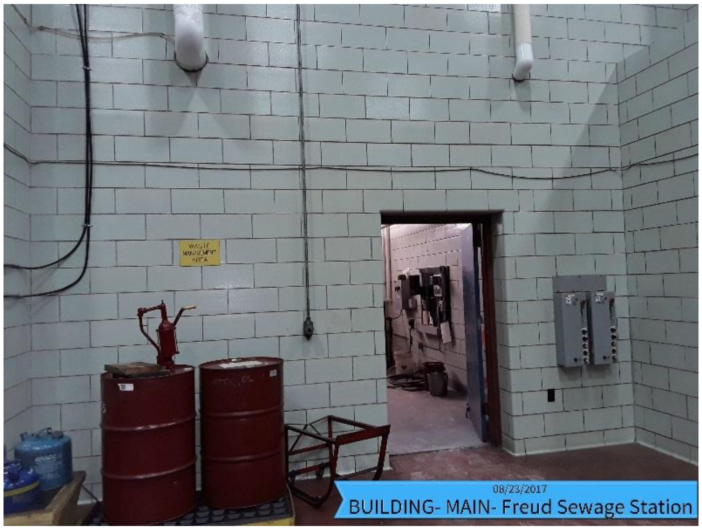

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BUILDING- MAIN- Freud Sewage Station

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BUILDING- MAIN- Freud Sewage Station - East Exterior Top Slab

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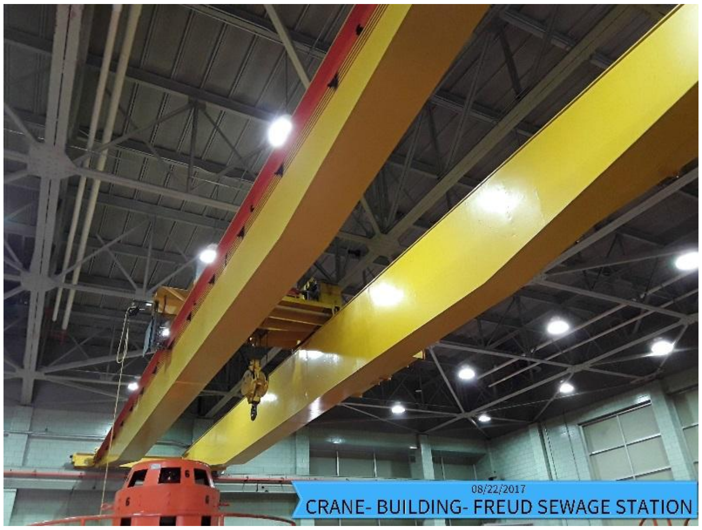
BUILDING- MAIN- Freud Sewage Station



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CRANE- BUILDING- FREUD SEWAGE STATION

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BUILDING- MAIN- Freud Sewage Station

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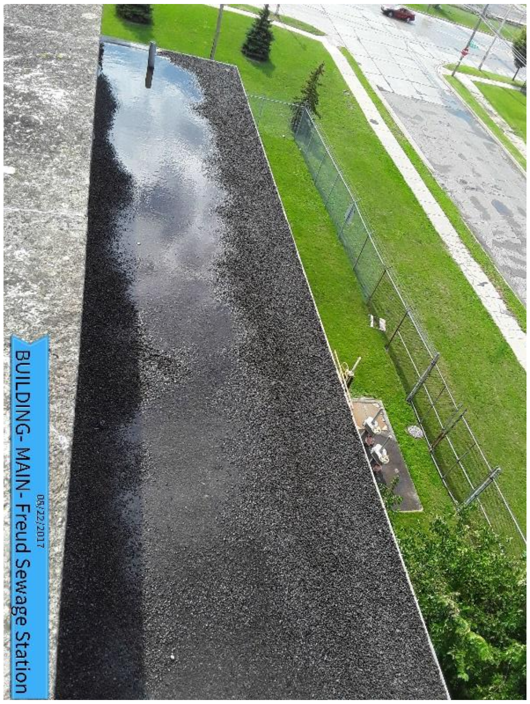
BUILDING- MAIN- Freud Sewage Station


BUILDING- MAIN- Freud Sewage Station
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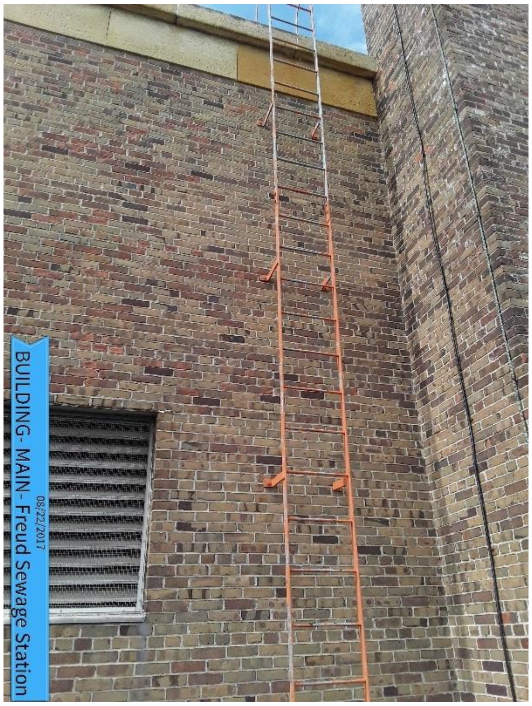
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BUILDING- MAIN- Freud Sewage Station


08/23/2017
BUILDING- MAIN- Freud Sewage Station

Second Floor and Substructure (1^{st} Floor down from Top)

The floor consists of painted steel bar grating supported from structural steel wide-flange beam framing. The framing is supported at the center of the pump station by four columns (that also frame the stair and pump removal shaft) and by the circular concrete caisson walls around the perimeter of the Pump Station. The grating, handrails, and steel wide-flange beam framing are in great condition with very little steel surface corrosion observed. Some minor paint bubbling was found on the southeast column of the center shaft just below 2nd floor.

The perimeter reinforced concrete caisson walls were in great condition and looked like they were just built. Only a few hairline cracks with very minor signs of past leakage were observed.


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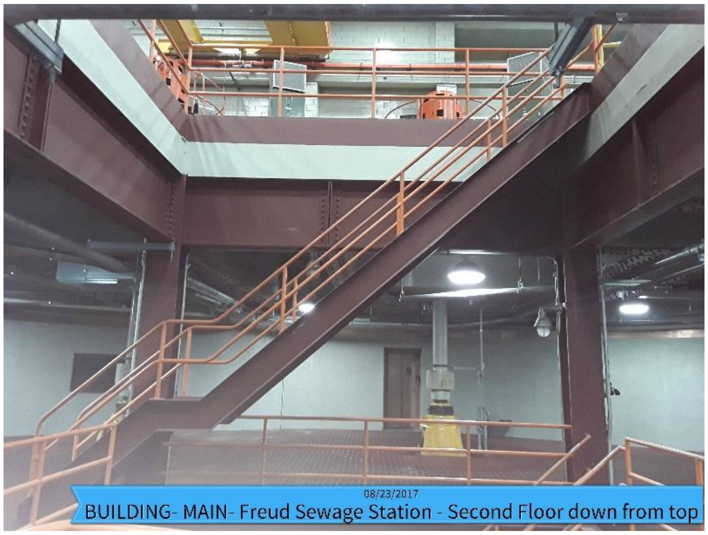
BUILDING- MAIN- Freud Sewage Station - Second Floor down from top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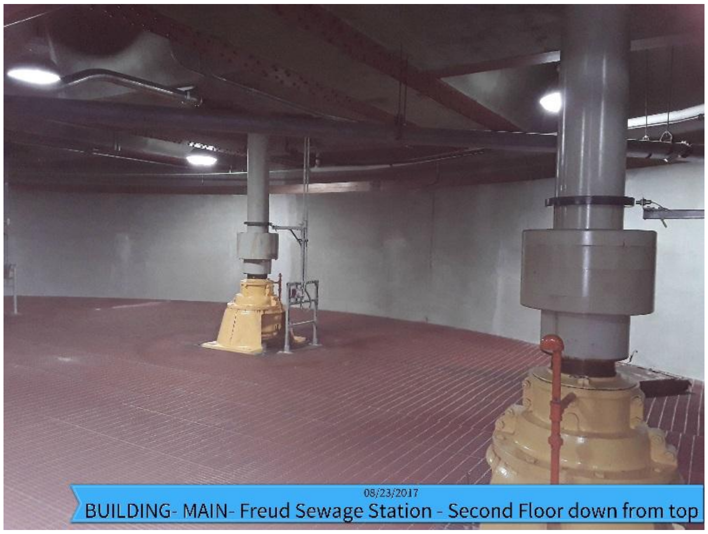
BUILDING- MAIN- Freud Sewage Station - Second Floor down from top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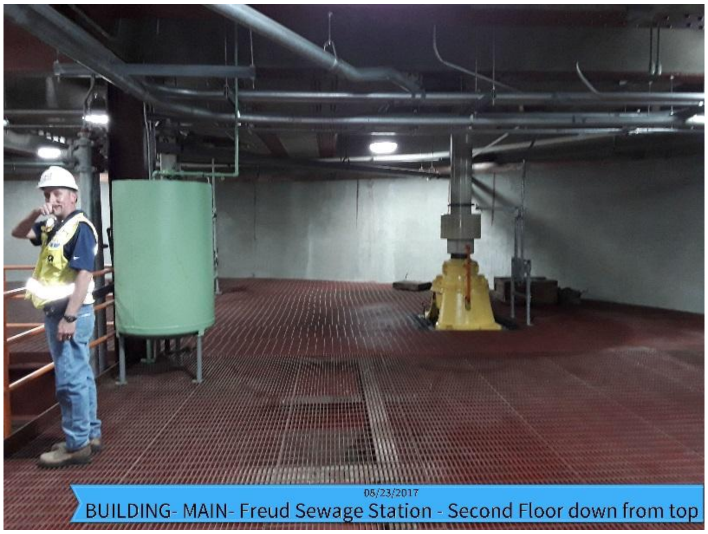
BUILDING- MAIN- Freud Sewage Station - Second Floor down from top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BUILDING- MAIN- Freud Sewage Station - Second Floor down from top

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BUILDING- MAIN- Freud Sewage Station - Second Floor down from top

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ING- MAIN- Freud Sewage Station - Second Floor - 1st floor down from top floor

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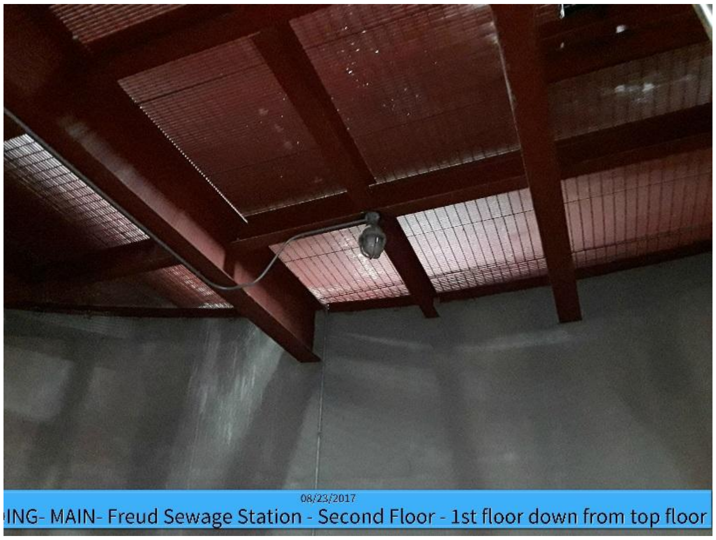
ING- MAIN- Freud Sewage Station - Second Floor - 1st floor down from top floor



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ING- MAIN- Freud Sewage Station - Second Floor - 1st floor down from top floor

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ING- MAIN- Freud Sewage Station - Second Floor - 1st floor down from top floor

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ING- MAIN- Freud Sewage Station - Second Floor - 1st floor down from top floor

Third Floor and Substructure (2nd Floor down from Top)

The floor consists of painted steel bar grating supported from structural steel wide-flange beam framing. The framing is supported at the center of the pump station by four columns (that also frames the stair and pump removal shaft) and by the circular concrete caisson walls around the perimeter of the Pump Station. The grating, handrails, and steel wide-flange beam framing are in good condition. Very little steel surface corrosion was observed on the grating and handrail. The structural steel wide-flange beam framing has some steel corrosion, specifically noticed on bottom flange when looking up at underside of framing. Steel grating bearing bars have been stressed and warped in numerous locations on this floor (more noticeable on 3rd floor than 2nd floor). These grating bearing bars were used as localized lifting points during equipment removal and replacement.

The perimeter reinforced concrete caisson walls are in good condition with some hairline cracks and signs of past minor leakage in north and northwest portions of the walls. More cracks with past leakage were observed above 3rd floor level than compared to the 2nd floor level above.

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BUILDING- MAIN- Freud Sewage Station - Third Floor - 2nd down from top floor

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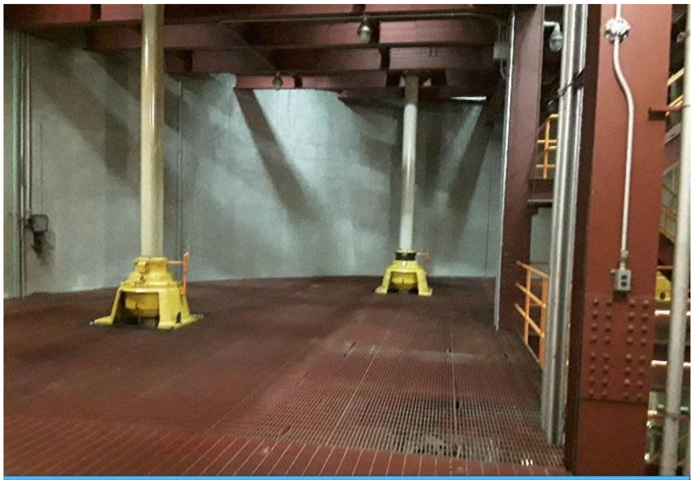
BUILDING- MAIN- Freud Sewage Station - Third Floor - 2nd down from top floor



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BUILDING- MAIN- Freud Sewage Station - Third Floor - 2nd down from top floor

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BUILDING- MAIN- Freud Sewage Station - Third Floor - 2nd down from top floor

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BUILDING- MAIN- Freud Sewage Station - Third Floor - 2nd down from top floor

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BUILDING- MAIN- Freud Sewage Station - Third Floor - 2nd down from top floor

Basement and Substructure (3rd Floor down from Top)

The perimeter reinforced concrete caisson walls are in good condition with numerous hairline cracks and signs of past minor leakage (efflorescence) of the walls observed. There were more cracks with past leakage noticed at and above the basement floor level than compared to 3rd floor level (above) and much more than compared to 2nd floor level (further above).

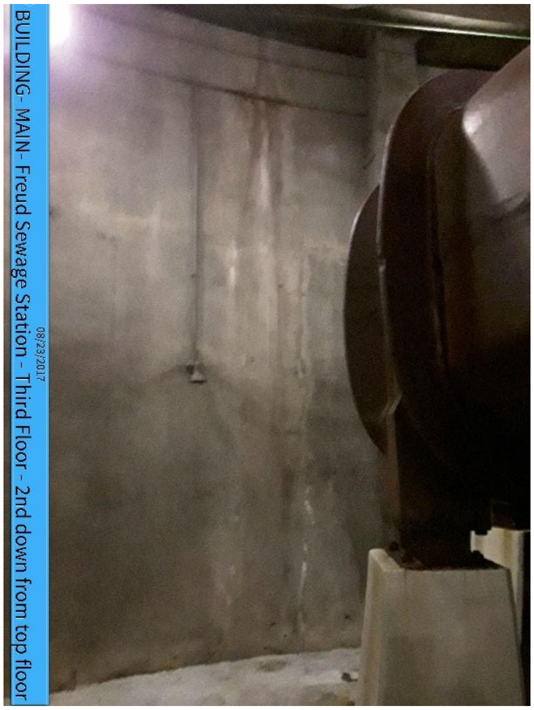
The reinforced concrete floor is painted so hard to see the top surface for cracks. Exposed resteel, maybe insufficient cover during original placement, was noticed in one area on the north side of center shaft. There are two bolted-down floor access hatches for access to the storm well. The construction of these floor hatches and the bolts used to restrain the access hatches poses a tripping hazard since plates and bolts stick up from floor.

Concrete pump support piers are in poor condition (the concrete pump support piers at Pump #5 are deficient). Ninety percent of all concrete pump support piers (6 piers per pump) show signs of concrete cold joints four inches down from the top of the support pier that may have been from original construction. A horizontal hairline crack is also found around all four sides of these concrete pump support piers at this cold joint level. It can be hard to see the hairline crack on the piers due to the fact a paint coating was applied to these piers in the past. The concrete pump support piers at Pump #5, at least three of them, show signs of anchor bolt concrete breakout cracking. At some pump support piers, the pump support leg steel base plate bears within one-half inch of the concrete support pier edge and the anchor bolt edge distances are four and one-half inches or less. The design of these concrete pump support piers need revisited based on required support of pump loads (vertical, shear and torsion loads along with proper anchor edge distances and embedment should be considered). Repairs will be needed to these pump bases.

The only structural steel framing at this elevation is grating and support framing over the center lower sump level shaft. The support framing has surface corrosion on both flanges and webs. The handrails and grating look to be in good condition with very minor surface corrosion.

08/23/2017
BUILDING- MAIN- Freud Sewage Station - Third Floor - 2nd down from top floor

08/23/2017
BUILDING- MAIN- Freud Sewage Station - Third Floor - 2nd down from top floor


BUILDING- MAIN- Freud Sewage Station - Third Floor - 2nd down from top floor
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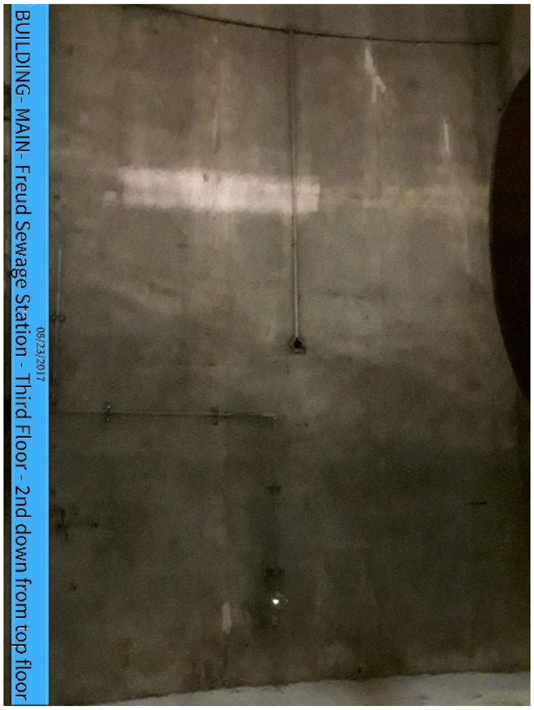
BUILDING- MAIN- Freud Sewage Station - Third Floor - 2nd down from top floor
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BUILDING- MAIN- Freud Sewage Station - Third Floor - 2nd down from top floor


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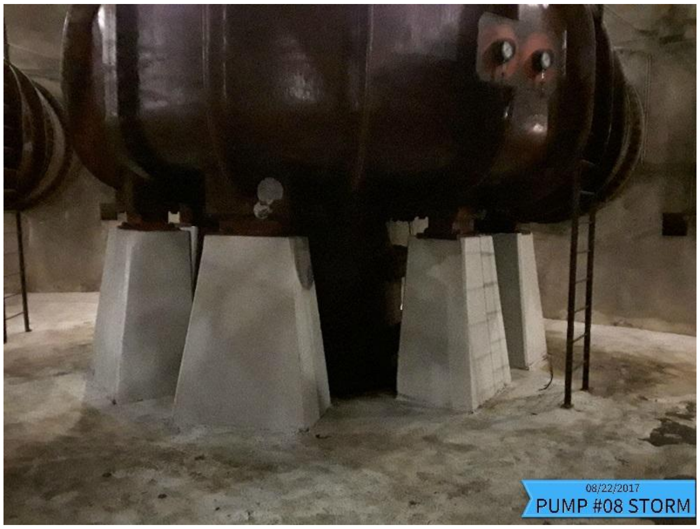
BUILDING- MAIN- Freud Sewage Station - Third Floor - 2nd down from top floor


08/22/2017
PUMP #08 STORM


08/23/2017
PUMP #05 STORM


08/23/2017
PUMP #05 STORM


08/23/2017
PUMP #06 STORM

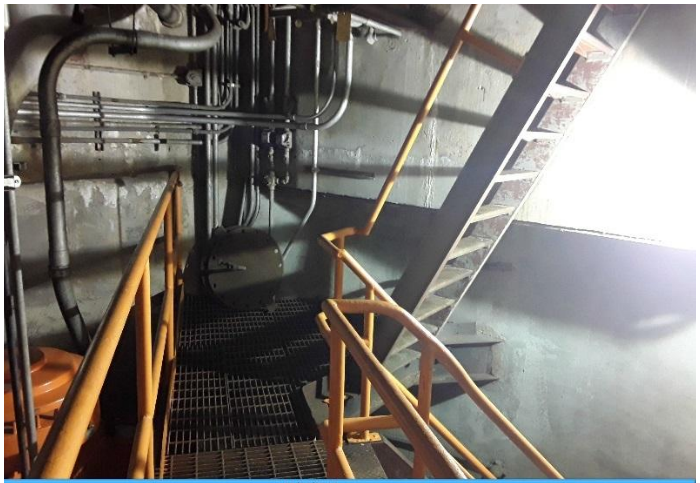

08/23/2017
PUMP #03 STORM

Lowest Level (Sump) and Substructure (4th Floor down from Top)

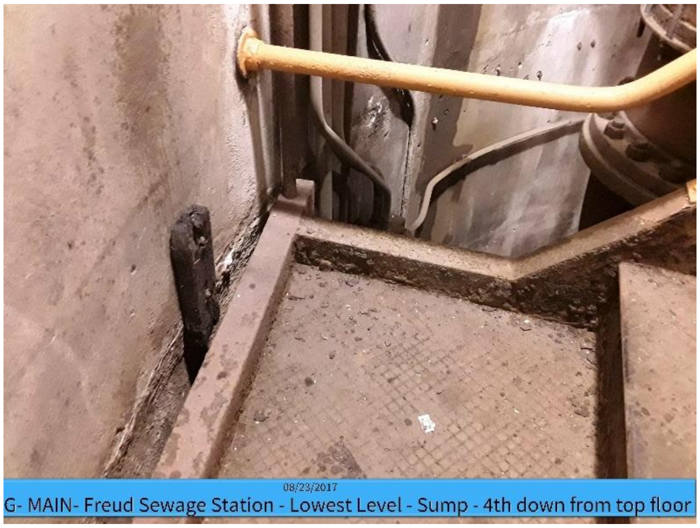
The perimeter reinforced concrete walls are in fair condition with numerous hairline cracks (with signs of active minor leakage and efflorescence), areas of concrete deterioration and spalls (on west wall and northwest corner), and numerous locations of exposed horizontal resteel in walls were observed. The walls of this lowest sump level are by far the poorest condition of any of the substructure walls observed in the Pump Station, and will require repairs in the future project.

The reinforced concrete floor is covered with debris and puddles of water and the lighting is very poor so it was very hard to observe the concrete floor surface.

The stair stringers, stair treads, intermediate walkway framing, and grating has significant surface corrosion. The handrail on the intermediate platform at the northwest end has lost its connection to the wall (connection corroded through). The upper and lower stairs to the intermediate platform are steep and narrow, and OHSA code requirements should be revisited to ensure stairs meet code.


08/23/2017
G- MAIN- Freud Sewage Station - Lowest Level - Sump - 4th down from top floor


08/23/2017
G- MAIN- Freud Sewage Station - Lowest Level - Sump - 4th down from top floor


08/23/2017
G- MAIN- Freud Sewage Station - Lowest Level - Sump - 4th down from top floor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G- MAIN- Freud Sewage Station - Lowest Level - Sump - 4th down from top floor

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G- MAIN- Freud Sewage Station - Lowest Level - Sump - 4th down from top floor

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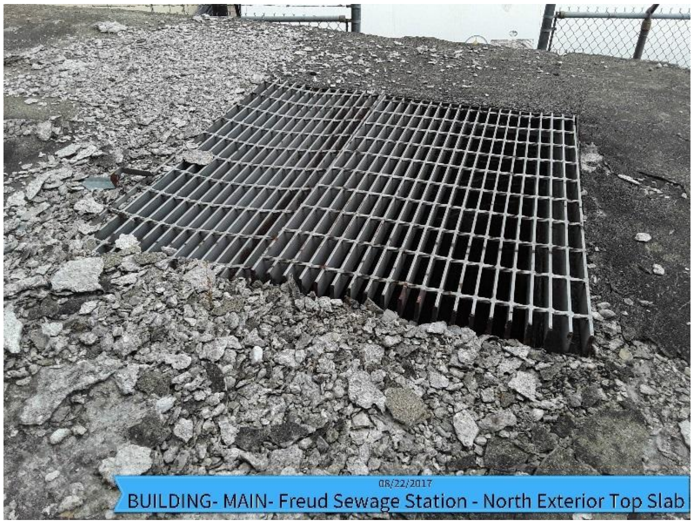
G- MAIN- Freud Sewage Station - Lowest Level - Sump - 4th down from top floor

08/23/2017

G- MAIN- Freud Sewage Station - Lowest Level - Sump - 4th down from top floor

North Exterior Top Slab

The north exterior top slab is an extension of the Pump Station top floor out over the perimeter flume. The western portions of the existing top slab are in good condition but the eastern portions are in very poor condition with significant concrete deterioration and spalling. With the current state of the eastern portion of the top slab, rain water is not draining off the slab but collecting and further deteriorating the concrete top slab. Significant concrete deterioration and spalls along with cracks showing signs of efflorescence were observed on the top slab edges at the top of the brick wall. The eastern portions of the top slab will need to be removed and replaced in the future project. The brick walls below the top slab are severely stained from the concrete and brick effloresce along with years of rainwater shedding off the top slab. All steel grating pieces on the north exterior top slab (over the flume) are deformed (some bearing bars showing signs of yielding) with cross bars broken and pose a potential safety concern due to loss of live load capacity and from tripping hazard standpoint. No stairs to access this slab exist. New stairs or a new platform (from the east or west exterior top slab) should be considered to provide access to the slab. Handrail along the edges of the top slab should be considered to prevent falls if access to this slab is needed.


08/22/2017
BUILDING- MAIN- Freud Sewage Station - North Exterior Top Slab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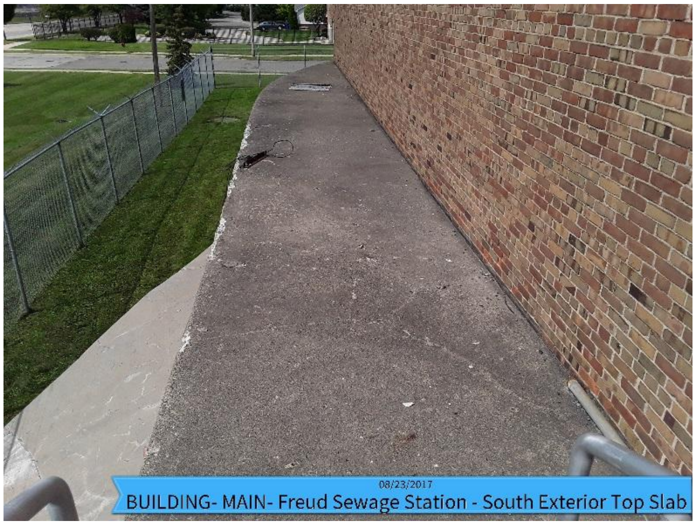
BUILDING- MAIN- Freud Sewage Station - North Exterior Top Slab


08/22/2017
BUILDING- MAIN- Freud Sewage Station - North Exterior Top Slab

South Exterior Top Slab

The south exterior top slab is approximately a 6-foot wide extension of the Pump Station top floor out over the perimeter flume. The existing top slab appears in good condition with only areas of concrete spall along a 6-foot stretch of the top slab edge. The brick walls below the top slab are stained from the concrete and brick efflorescence along with years of rainwater shedding off the top slab. The steel grating over the flume is deformed (some bearing bars showing signs of yielding) with cross bars broken and pose a potential safety concern due to loss of live load capacity and from tripping hazard standpoint. Some corrosion on steel lintels in the brick wall above windows was observed. No stairs to access this slab exist. Stairs from the eastern driveway to get up to this slab should be considered. Handrail along the edges of the top slab should be considered to prevent falls if access to this slab is needed.



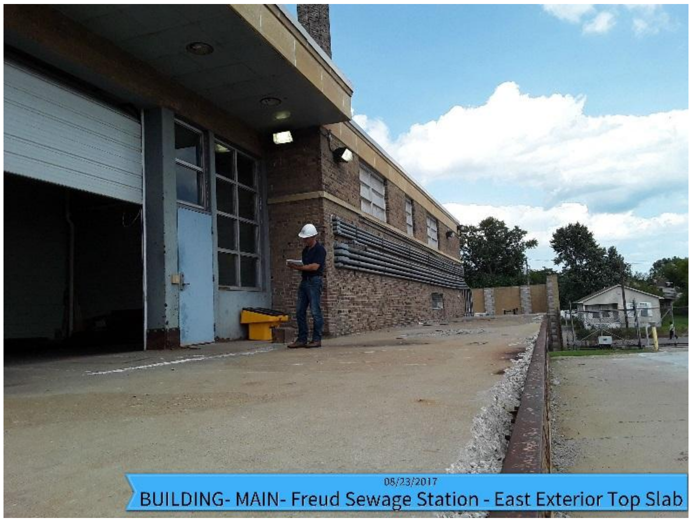
BUILDING- MAIN- Freud Sewage Station - South Exterior Top Slab

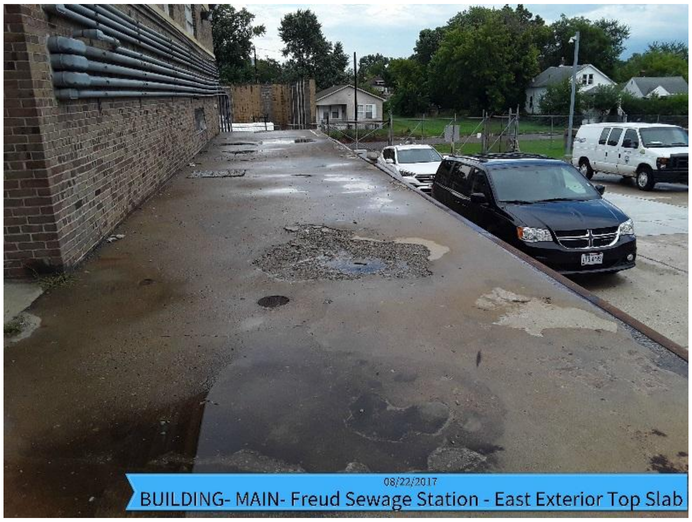
East Exterior Top Slab

The east exterior top slab is an extension of the pump station top floor out to the east side of the building to provide a loading dock down to the driveway. Approximately one-third of the top slab is in very poor condition with significant concrete deterioration and spalling. Just outside the entrance to the pump station, there is approximately a 16-square foot portion of top slab with significant concrete deterioration were the top two inches of concrete top slab has deteriorated to stone and gravel and exposed resteel can be observed (when stone and gravel is moved). Along the loading dock edge, the steel edge angle has significant surface corrosion and for large stretches of this angle the concrete slab edge has deteriorated so badly that the edge angle anchors have lost their embedment with the concrete top slab and the wall vertical dowels into the top slab are exposed. With the current state of the top slab, rain water is not draining off the slab but collecting and further deteriorating these substandard portions of the concrete top slab. Significant concrete deterioration and spalls along with cracks showing signs of efflorescence were observed on the top slab edges at the top of the brick wall. Portions of this top slab and the entire edge this top slab will need to be removed and replaced in the future project. The brick walls below the top slab are severely stained from the concrete and brick efflorescence along with steel edge angle corrosion and years of rainwater shedding off the top slab.

The steel grating is deformed (some bearing bars showing signs of yielding) with cross bars broken and pose a potential safety concern due to loss of live load capacity and from tripping hazard standpoint. Some corrosion on steel lintels in the brick wall above the windows was observed. Temporary wooden stairs with forward-sloping wooden stair treads are currently used as the main access to this east exterior top slab and pump station. Permanent aluminum or galvanized metal stairs and handrail, that are wider and code compliant, should be considered for proper access (and load carrying capacity of maintenance operations). Handrail is needed along the edges of the top slab to prevent falls. Removable side-mounted handrail should be considered in places to allow for better unloading and loading operations.


08/23/2017
BUILDING- MAIN- Freud Sewage Station - East Exterior Top Slab


08/23/2017
BUILDING- MAIN- Freud Sewage Station - East Exterior Top Slab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BUILDING- MAIN- Freud Sewage Station - East Exterior Top Slab


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BUILDING- MAIN- Freud Sewage Station - East Exterior Top Slab


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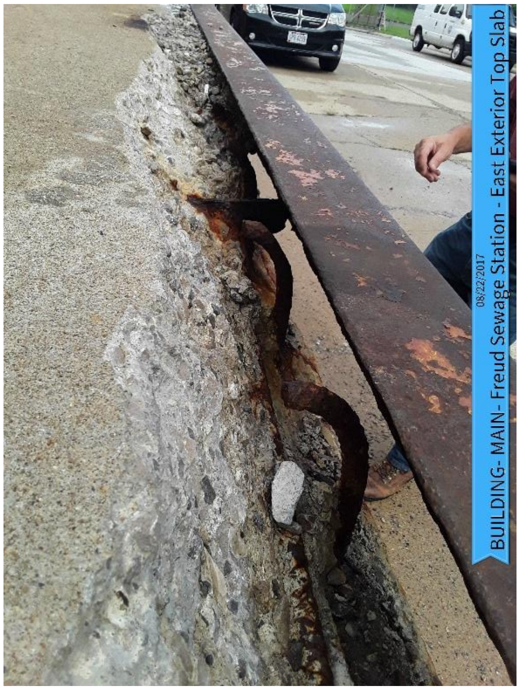
BUILDING- MAIN- Freud Sewage Station - East Exterior Top Slab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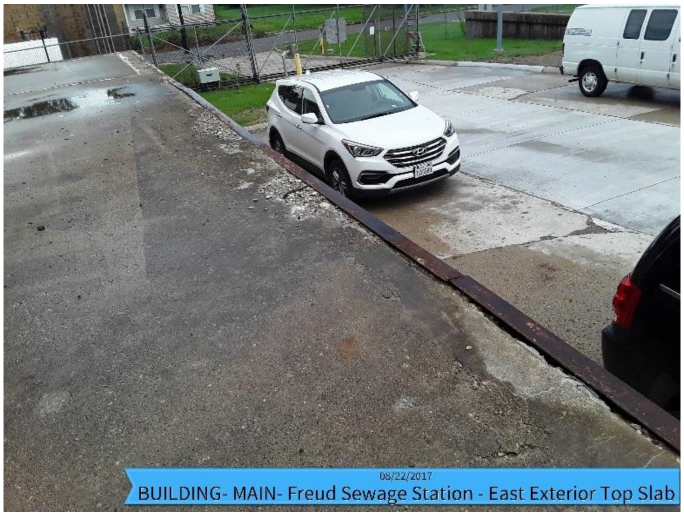
BUILDING- MAIN- Freud Sewage Station - East Exterior Top Slab


08/22/2017
BUILDING- MAIN- Freud Sewage Station - East Exterior Top Slab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BUILDING- MAIN- Freud Sewage Station - East Exterior Top Slab


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BUILDING- MAIN- Freud Sewage Station - East Exterior Top Slab


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BUILDING- MAIN- Freud Sewage Station - East Exterior Top Slab

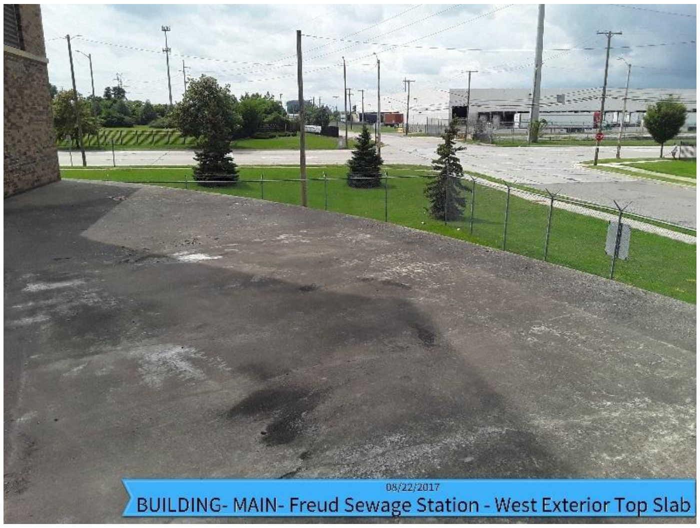

08/22/2017
BUILDING- MAIN- Freud Sewage Station - East Exterior Top Slab


08/22/2017
BUILDING- MAIN- Freud Sewage Station - East Exterior Top Slab

West Exterior Top Slab

The west exterior top slab is an extension of the Pump Station top floor out over the perimeter flume. The existing top slab for the most part appears to be in good condition with only areas of concrete spall along a 15-foot stretch of the top slab edge (at the top of the brick wall) and around the steel grating. The top slab seems flat and only has 1 floor drain just outside building's service door (southern portion of top slab has no floor drain), so not sure how well this top slab drains. The brick walls below the top slab are severely stained from the concrete and brick efflorescence along with years of rainwater shedding off the top slab. Floor tile installed outside the service door is broken or loose likely due to weather exposure, water retention and frequent freeze/thaw cycles.

The concrete stair treads are in fair condition with numerous cracks and efflorescence observed. Steel stair nosings have surface corrosion and some of the stair treads have warped up (embedment of steel nosing to concrete stair tread may have been compromised) and thus poses a potential safety concern (tripping hazard). The steel grating over the flume is deformed (some bearing bars showing signs of yielding) with cross bars broken and pose a potential safety concern due to loss of live load capacity and from tripping hazard standpoint. Handrail along the edges of the top slab should be provided to prevent falls (10 to 20-foot above grade).



08/22/2017

BUILDING- MAIN- Freud Sewage Station - West Exterior Top Slab

08/22/2017

BUILDING- MAIN- Freud Sewage Station - West Exterior Top Slab

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BUILDING- MAIN- Freud Sewage Station - West Exterior Top Slab

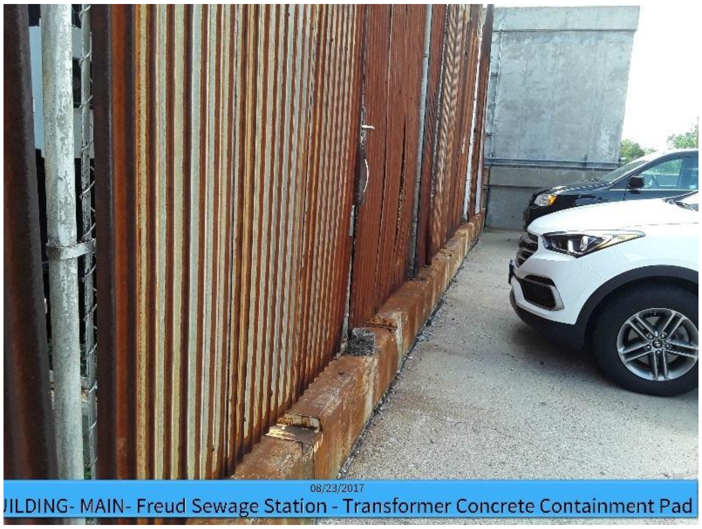
08/22/2017

BUILDING- MAIN- Freud Sewage Station - West Exterior Top Slab

Freud: Three Ancillary Structures

Transformer Containment Pad

The transformer containment pad consists of a concrete grade beams with embedded steel channels that the transformers bear on and a perimeter concrete curb with chain link fencing on two sides (backside of the East Site concrete retaining wall on other two sides). This was originally constructed along with the Pump Station in 1955. The existing concrete support grade beams under the transformer support legs appear in good shape with only minor cracks and spalls and the embedded steel channels in the grade beams have surface corrosion. The vertical concrete enclosure walls also appear to be in good condition. The chain link fence posts, metal panels and embedded steel channels are corroding and staining the concrete surfaces. The metal panels attached to the chain link fencing have presented safety concerns in the past because it provides more surface area for wind to act on and has ripped the fence gate portions off in a strong wind storm and struck parked vehicles. Containment of transformer fluids is not currently provided but should be considered.

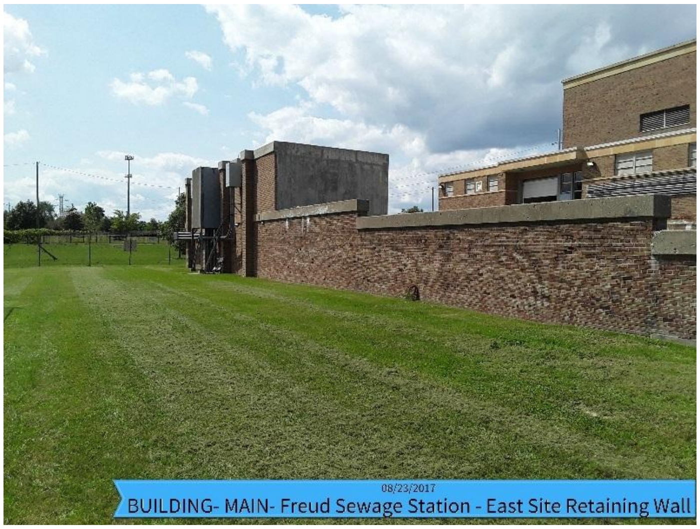


Generator and Diesel Fuel Storage Tank Pad and Perimeter Wall

Generators and diesel fuel storage tanks are supported from a concrete slab-on-grade that was constructed in 1999. A double-wythe CMU closure wall, with intermittently spaced vertical CMU support pilasters, is provided around three sides of the Generator and Diesel Fuel Storage Tank Pad area to offer protection and a privacy screen. The existing slab-on-grade appears in good condition with only minor water weathering where existing slab drains between electrical enclosures. The CMU closure walls, both split face (on exterior face) and CMU block backup wall are in good condition with only a couple of face cracks and one cutout location observed in CMU backup wall. The concrete slab-on-grade seems flat with its top surface eroded slightly to allow for water drainage between electrical enclosures. Standing water was observed on soil between edge of concrete slab and base of CMU closure walls.

East Site Retaining Wall

The east site retaining wall is a vertical cantilevered reinforced concrete retaining wall with a brick face on the side exposed to public view and a concrete cap at the top. The retaining wall was constructed at the same time as the Pump Station (1955) to help transition the site from the upper driveway on the backside to the lower grade on the front side of the retaining wall and to offer protection and hide the transformers from public view. The retaining wall appears to be in sound condition, with no signs of rotation or substantial cracking in the structural reinforced concrete portion of the retaining wall. The concrete cap at top of brick wall has weathered significantly in certain areas. Hairline cracks, with efflorescence, were observed in portions of deteriorated concrete cap edges, at brick wall control joints, and at changes of wall heights. Exposed resteel was observed in a few locations and signs of corrosion from resteel or steel wall anchors where found in other locations. Numerous cracks in the brick face at wall height transitions, abandoned brick wall anchors, brick wall face voids in two locations, and some weathering of the brick mortar joints (section loss of mortar joints) were observed. On the south side, slight brick wall movement was seen on each side of control joint with loss of filler material and sealant in the joint. Overall, the brick wall face is stained in some areas due to areas of efflorescence and steel corrosion. On the south side, the concrete flume encasement at-grade has a large amount of spider cracking with signs of efflorescence.


08/23/2017
BUILDING- MAIN- Freud Sewage Station - East Site Retaining Wall


08/23/2017
BUILDING- MAIN- Freud Sewage Station - East Site Retaining Wall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BUILDING- MAIN- Freud Sewage Station - East Site Retaining Wall


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BUILDING- MAIN- Freud Sewage Station - East Site Retaining Wall


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BUILDING- MAIN- Freud Sewage Station - East Site Retaining Wall


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BUILDING- MAIN- Freud Sewage Station - East Site Retaining Wall


08/23/2017
BUILDING- MAIN- Freud Sewage Station - East Site Retaining Wall

HVAC Condition Assessment – Freud and Conner Creek Pump Stations

The Conner Creek Pump Station consists of three main structures and seven ancillary structures. The three main structures consist of the Storm Water Pump Station (Main Building), Primary Switchgear Building, and Sanitary Pump Station. The seven ancillary structures include the Transformer Containment Pad, Regulator Chamber, Generator and Diesel Fuel Storage Pad, Gate Structure and Raised Stop Log Structure, Transfer Switch Electrical Enclosure, Surge Tank, and Backwater Gate Structure.

The Freud Pump Station consists of one main building which houses both the storm water and sanitary pumps, as well three ancillary structures. The three ancillary structures include the Transformer Containment Pad, Generator and Diesel Fuel Storage Tank Pad and Perimeter Wall, and East Site Retaining Wall.

Per NFPA 820, the Storm Water and Sanitary Pump Station Dry Wells for both Pump Stations require continuous ventilation at 6 air changes per hour. This will give the spaces an NEC Area Electrical Classification of Unclassified. Since the Dry Wells are adjacent to the Wet Wells, the ventilation system serving the Dry Wells shall provide positive pressure to the space.

A description of the HVAC and Plumbing equipment deficiencies associated with each building is provided below.

Conner Creek: Storm Water Pump Station

Heating System

The Storm Water Pump Station is provided with heat from a low-pressure steam system. Steam is distributed via piping to cast iron radiators located in the Motor Room that appear to be original to when the building was constructed. Condensate is returned to the boilers via a condensate return system. The two boilers are located in a lower level Boiler Room. One boiler appears to be non-operational, is very corroded, and has exceeded its service life expectancy. The other is operational, but has also reached its service life expectancy. The condensate return system is separate from the boilers. It consists of a condensate tank, pumps, piping, and controls. It has more than 50 percent corrosion on the piping and unit itself and has exceeded its service life expectancy. The cast iron radiators have been painted and appear in good condition on the exterior for their age. The steam and condensate piping in the Pump Room was painted and appeared in good condition on the exterior. Some of this piping had been replaced in 2001.

08/22/2017
BOILERS AND FURNACES- B-1

08/22/2017
BOILERS AND FURNACES- B-2

08/22/2017
CONENSATE PUMP RETURN SYSTEM FOR BOILERS

08/23/2017
TYPICAL STEAM RADIATOR STORM PS

The Boiler Room is heated by a natural gas fired unit heater controlled by a wall mounted thermostat. The unit has slight corrosion and has exceed its service life expectancy.

08/22/2017
GAS FIRED UNIT HEATER BOILER ROOM- STORM PS

Ventilation System

Ventilation for the Pump Room is provided by a natural gas direct fired make-up air handling unit located in the Boiler Room, three propeller type exhaust fans located in the sidewall of the Motor Room upper cupola, and four tube axial circulation fans located in the Pump Room. These units are all interlocked. 100% of outside air is brought in through a wall mounted intake louver and ducted down to the unit. Supply ductwork from the unit distributes air into the Pump Room along both sidewalls. Air migrates up to the Motor Room where it is exhausted through the three exhaust fans. The four tube axial circulation fans located in the Pump Room help to distribute the air within the space. The make-up air handling unit is controlled by a Hand-Off-Auto (HOA) switch, outdoor air sensor, and room space temperature and humidity sensors. A section of the supply ductwork from the make-up air handling unit is removed and lying on the floor. The outside air ductwork to the make-up air handling is corroded with some sections missing. The make-up air handling unit, exhaust fans, and circulation fans have exceeded their service life expectancy.

08/22/2017
MAKE UP AIR UNIT- MAU-1- STORM P.S.

08/23/2017
MAKE UP AIR UNIT- MAU-1- STORM P.S.

08/22/2017
MAKE UP AIR UNIT- MAU-1- STORM P.S.

08/23/2017
EXHAUST FAN EF-12 SEWAGE PS

08/23/2017
CIRCULATION FAN 1 SEWAGE PS

Conner Creek: Primary Switchgear Building

Heating System

The heating for the Primary Switchgear Building is provided by wall mounted electric unit heaters and electric radiant baseboard heaters throughout the facility. The unit heaters are controlled by wall mounted thermostats. The radiant baseboard heaters are controlled by integral thermostats. Each Restroom contains both a wall mounted electric unit heater and an electric radiant baseboard heater. The Janitors Room, Back Entrance Storage Room, and Basement are heated by the electric radiant baseboard heaters only. The Hallway and Switchgear Rooms are heated by only the wall mounted electric unit heaters. One of the unit heaters located in the Switchgear Room is missing the motor and fan blade. These units are approaching the end of their service life expectancy.

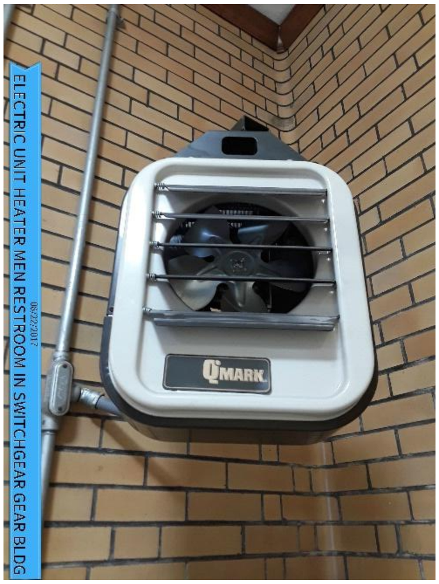

ELECTRIC UNIT HEATER 1 ELECTRICAL ROOM IN SWITCHGEAR GEAR BLDG
08/22/2017


ELECTRIC UNIT HEATER 2 ELECTRICAL ROOM IN SWITCHGEAR GEAR BLDG
08/22/2017


ELECTRIC UNIT HEATER HALLWAYIN SWITCHGEAR GEAR BLDG
08/22/2017

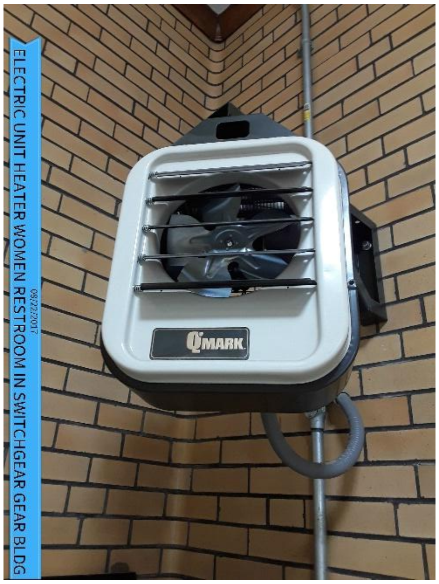

08/23/2017
ELECTRIC RADIANT HEATER BACK ENTRANCE IN SWITCHGEAR GEAR BLDG


08/23/2017
ELECTRIC RADIANT HEATER BASEMENT IN SWITCHGEAR GEAR BLDG



08/22/2017
ELECTRIC UNIT HEATER MEN RESTROOM IN SWITCHGEAR GEAR BLDG

08/22/2017
ELECTRIC RADIANT HEATER MEN RESTROOM IN SWITCHGEAR GEAR BLDG



08/22/2017
ELECTRIC UNIT HEATER WOMEN RESTROOM IN SWITCHGEAR GEAR BLDG

08/22/2017
ELECTRIC RADIANT HEATER WOMEN RESTROOM IN SWITCHGEAR GEAR BLDG

Ventilation System

Ventilation for the Primary Switchgear Building is provided by exhaust fans and a natural gas fired rooftop mounted 100% outside air make-up air handling unit. The exhaust fan that serves the Switchgear Room is a rooftop mounted centrifugal type fan. The fans that serve the Transformer Room, Battery Room, and Restrooms are ceiling mounted centrifugal type fans that are located between the ceiling and the roof deck. Air is exhausted from each of these spaces through ceiling mounted exhaust grilles via exhaust ductwork located in the space between the ceiling and the roof deck. This air is then discharged through gooseneck vents located on the roof. The make-up air handling unit distributes air through supply ductwork down to each space where it discharges at ceiling mounted supply diffusers. This supply ductwork is located in the space between the ceiling and the roof deck. The make-up air handling unit is controlled by an HOA switch, outdoor air sensor, and room space temperature and humidity sensors. The rooftop mounted centrifugal exhaust fan that serves the Switchgear Room is interlocked with the make-up air handling unit. The exhaust fans serving the Restrooms are interlocked with the room lighting controls. The Transformer Room exhaust fan is controlled by a humidity sensor, and the Battery Room exhaust fan is controlled by a start/stop switch and is set to operate continuously.

Domestic Water Heating System

An electric storage type water heater provides domestic hot water for the building. The water heater is located in the Basement of the facility. This unit is approaching the end of its service life expectancy.

Conner Creek: Sanitary Pump Station

Heating and Ventilation System

The Sanitary Pump Station Motor Room and lower levels down to the Pump Room are heated and ventilated by two indoor modular type air handling units. The air handling units are equipped with steam heating coils. Outside air is brought in through wall mounted intake louvers and ducted to each air handling unit. Outside and return air dampers modulate between 0 and 100% based on the temperature as sensed in the outside air ductwork. The air handling units have exceeded their service life expectancy.

There are two rooftop mounted centrifugal exhaust fans. One exhaust fan is ducted and the other is not. When the ducted exhaust fan serving the Pump Room Floor and Wet Well exhaust is energized via either a thermostat or humidistat, the air handling units return air dampers go to 0% and the outside air dampers go to 100%. During summer operation, the air handling units are de-energized. The ducted exhaust fan has exceeded its service life expectancy. The exhaust ductwork is corroded in many areas and is approaching its service life expectancy.

The non-ducted exhaust fan is interlocked with the wall mounted intake louver and provides ventilation for the Motor Room. The fan and intake louver are controlled by both a thermostat and humidistat. The wall mounted intake louver provides make-up air for the exhaust fan and is energized via either a thermostat or humidistat, a wall mounted intake louver is activated open to allow make-up air for the fan. The louver and exhaust fan have exceeded their service life expectancy.

Low pressure steam is provided by two steam boilers located in the Boiler Room of the Storm Water Pump Station. Steam is distributed via piping with condensate collected by a condensate return system located in the Dry Well. The condensate return system in the Dry Well sends condensate back to the condensate return system located in the Boiler Room of the Storm Water Pump Station. This condensate return system located in the Dry Well is separate from the boilers and consists of a condensate tank, pumps, piping, and controls. It has more than 50 percent corrosion on the piping and has exceeded its service life expectancy.

The Restroom of the facility has a wall mounted propeller type exhaust fan for ventilation and is interlocked and controlled by the room light switch. The exhaust fan has exceeded its service life expectancy.


08/23/2017
Sanitary Bldg. Exaust Fan EF-2


08/23/2017
EXHAUST FAN EF-1 SEWAGE PS


08/23/2017
EXHAUST FAN EF-1 SEWAGE PS


08/23/2017
EXHAUST FAN EF-1 SEWAGE PS


08/23/2017
WEST CONDENSATE PUMP SEWAGE PS


08/23/2017
EIXHAUST FAN SF-1 SSEWAGE PS

The Wet Well is ventilated intermittently by a utility type centrifugal fan located in the Motor Room. Supply air is distributed down to the Wet Well via ductwork that travels through the lower levels of the Dry Well. The supply ductwork is approaching its service life expectancy. This fan is operated by a manual switch and interlocked with the ducted rooftop exhaust fans. This unit has exceeded its service life expectancy.

Domestic Water Heating System

An electric storage type water heater provides domestic hot water for the building. The water heater is located in the Restroom of the facility. This unit has exceeded the end of its service life expectancy.

Freud Pump Station: Storm Water Pump and Motor Rooms

Heating System

The Storm Water Pump Station is provided with heat from a low-pressure steam system. Steam is distributed via piping to unit heaters located in and around the Motor Room area. These unit heaters are controlled by wall mounted thermostats. Condensate is returned to the boilers via a condensate return system. Two boilers located in the Boiler Room appear to be original to when the building was constructed in 1955. They are non-operational, very corroded, and have exceeded their service life expectancy. The condensate return system has exceeded its service life expectancy. Some of the steam unit heaters have been replaced but still have exceeded their service life expectancy. A total of three unit heaters appear original to when the building was constructed. These unit heaters have exceeded their service life expectancy as well.


08/22/2017
STM. UNIT HEATER- UH-3- MOTOR FLOOR


08/22/2017
STM. UNIT HEATER- UH-4- MOTOR FLOOR

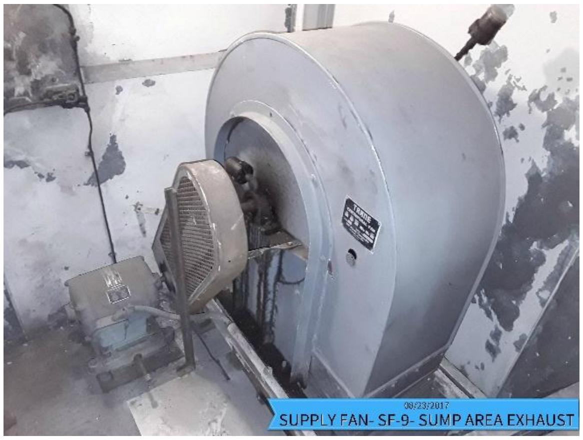

08/22/2017
STM. UNIT HEATER- UH-8- RECIEIVING ROOM

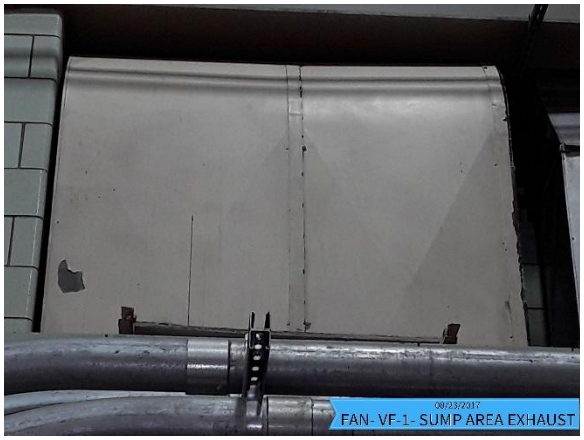

08/22/2017
STM. UNIT HEATER- UH-10- TOILET ROOM


08/22/2017
STM. UNIT HEATER- UH-12- EQUIPMENT ROOM

Ventilation System

The ventilation system for the Motor Room and the lower levels of the Dry Well down to the Pump Room is provided by two utility type centrifugal fans and one large utility type centrifugal exhaust fan. These fans are interlocked and run on a continuous basis. The two supply fans are each located in small fan rooms where outside air through a wall mounted intake louver is ducted down into the Rooms. From the Fan Rooms, the supply air is ducted down through the Dry Well to the lower levels terminating at the lower Pump Room. The supply air is tempered via electric duct heaters located in the supply ductwork. The exhaust air is ducted up through the Dry Well to the exhaust fan located in the Machine Room area where it is then ducted to a wall mounted exhaust louver and discharged from the building. These fans appear to be original to when the building was constructed in 1955. These fans have exceeded their service life expectancy. Both the supply and exhaust ductwork have reached their service life expectancy.





Domestic Water Heating

An electric storage type water heater provides domestic hot water for the building. The water heater is located in the Boiler Room of the facility. This unit has exceeded the end of its service life expectancy.

Freud Pump Station: Control, Switchgear, and Battery Rooms

Heating System

The Control and Switchgear Rooms are heated by wall mounted electric unit heaters, each controlled by wall mounted thermostats. The Battery Room is heated by an explosion proof wall mounted electric unit heater controlled by a wall mounted explosion proof thermostat. The units appear in good condition and are about halfway through their service life expectancy.

Ventilation Systems

The Battery Room is ventilated by a wall mounted intake louver and wall mounted propeller type exhaust fan. Motors for these units are explosion proof. The fan is operated by an HOA switch and controlled by a 24-hour programmable timer in the Auto mode. The units appear in good condition and are about halfway through their service life expectancy.


08/22/2017
FAN EXHAUST- BATTERY ROOM

Electrical Condition Assessment – Freud and Conner Creek Pump Stations

The Conner Creek Pump Station consists of three main structures and seven ancillary structures. The three main structures consist of the Storm Water Pump Station (Main Building), Primary Switchgear Building, and Sanitary Pump Station. The seven ancillary structures include the Transformer Containment Pad, Regulator Chamber, Generator and Diesel Fuel Storage Pad, Gate Structure and Raised Stop Log Structure, Transfer Switch Electrical Enclosure, Surge Tank, and Backwater Gate Structure.

The Freud Pump Station consists of one main building which houses both the storm water and sanitary pumps, as well three ancillary structures. The three ancillary structures include the Transformer Containment Pad, Generator and Diesel Fuel Storage Tank Pad and Perimeter Wall, and East Site Retaining Wall.

A description of the electrical equipment deficiencies associated with each building is provided below.

Conner Creek Pump Station: Electrical Distribution System Overview

The electrical system at this pump station consists of two 24 kV electrical services from Detroit Edison (DTE) which are sourced from two utility trunk lines (DTE Essex Trunk 501 and Essex Trunk 507). The two electrical services provide primary power to two outdoor, oil-filled, 10 MVA service transformers owned by GLWA. There are no GLWA-owned primary overcurrent protective devices at the 24 kV service entrances; each electrical service feeds directly to each service transformer. The only means of isolation is via manually operated primary switches installed integral to the top of each transformer.

The two service transformers are connected with a delta secondary, and therefore, there is no ground return path to each service transformer. However, the generator switchgear bus includes a 75 kVA grounding transformer which provides a reference to ground when the generator switchgear gen-utility tie is closed. The neutral-to-earth connection of this grounding transformer introduces ground reference for stabilizing and centering the 4.8 kV delta system around the ground reference point. The ground resistor also increases the zero sequence impedance of the generator system, which helps in limiting the magnitude of line-to-ground fault current on the emergency generator system. This grounding transformer has no effect on the electrical system when the gen-utility tie is open and the system is operating on normal utility power.

The 4.8 kV secondary from Transformer No. T1 (Essex Trunk 501) is brought into the primary switch house and terminated to a 4.8 kV switchgear lineup. The secondary from Transformer T2 (Essex Trunk 507) is routed to the outdoor generator switchgear, and then continues into the primary switch house.

The indoor switchgear line-up is configured in a main-tie-main arrangement. Under normal operation, the tie breaker is open, creating two isolated 4.8 kV bus systems.

This pump station has a total of four diesel-driven generator units. Each generator has a standby load rating of 1,850 kW (2,281 kVA). The 4.8 kV emergency generator switchgear is located in an outdoor switch house. The generator switchgear includes a main disconnect for 4.8 kV service from Transformer No. 2 (52-UM) and paralleling equipment to allow the generator system to be paralleled with this utility.

Two house transformers provide 480 volt power to two 480 VAC distribution panels (PDC-1 and PDC-2). Both panels are protected with 800A main circuit breakers which trip instantaneously when fault current exceeds 3,200 amperes. Modeling of arcing faults throughout the 480 VAC electrical system shows that 70 percent of arcing faults within this system can be cleared instantaneously by one of these two main 800A circuit breakers.

24 kV Service Transformers

Service transformers T1 and T2 were both originally manufactured by Westinghouse and installed when the pump station was constructed. The transformers have operated well beyond rated and expected life. Transformer T1 appears to have been refurbished in the last 8 years. Typical refurbishing services add another 10 to 20 years to the transformer life. The primary bushings recently failed on transformer T1 and have been replaced. The primary no-load switch on transformer T1 has non-functional indication on the position of the switch. There is a lack of transformer fault and overcurrent protection on the primary side of each transformer.

The transformers should be replaced to allow for another 40 to 50 years of reliable operation. Replacement should include installation of primary protection for the transformer. This should consist of a 27 kV or 35 kV rated vacuum circuit breaker in an outdoor-rated enclosure with programmable protective relaying specific to transformer protection. Protective relaying should isolate the transformer in the event of a transformer internal fault or utility power problem (ANSI 87 differential protection, ANSI 50 instantaneous fault protection, and ANSI 27 undervoltage protection, at a minimum).

2011 PHOTO

08/22/2017
T1-MAIN TRANSFORMER (10MVA)

08/22/2017
T2-MAIN TRANSFORMER (10MVA)

The two service transformers provide a floating delta secondary connection to the main switchgear. This type of system exposes the 4.8 kV system to potential overvoltage conditions in the event of an arcing phase-to-ground fault, where the arcing condition can cause a voltage multiplication with respect to ground. This type of fault can occur if an operating motor experiences a line-to-ground arcing fault on one of the motor windings, or if a surge arrestor begins to fail and begins flashing to ground. The result of the arcing condition can cause line-to-ground voltages to temporarily exceed 3 or more times the typical line-to-ground voltage.

A solution to this potential problem is to provide a derived neutral grounding system on the secondary side of each transformer. This involves adding a small three-phase wye-delta transformer (with high impedance neutral grounding on the primary side and shorted secondary delta windings) or a zig-zag transformer with high impedance grounding. Either solution creates an artificial ground which will hold the system voltage in place in the event of an arcing ground fault. A derived neutral grounding solution should be considered to eliminate potential damage to the station's electrical system and equipment.

4,800 Volt Generator Units

This pump station has a total of four diesel-driven generator units which were installed in 1999. The rated lifespan of these units is between 10,000 to 20,000 hours of operation. These units are only operated in the event of a loss of utility power or when exercised. The total usage on each engine-generator is under 2,000 hours over the last 17 years. With regular exercising, maintenance, and occasional repair, these units should provide another 40 years of operation.

4,800 Volt Generator Switchgear

The 4.8 kV generator switchgear was also installed in 1999 and consists of vacuum circuit breakers. The electrical switchgear is housed in an outdoor walk-in style enclosure. The switchgear has been well maintained and appears in good condition. This switchgear is expected to provide another 40 years of operation. The batteries are located in the first compartment and should be replaced as part of a regular maintenance schedule. Generator switchgear house transformer No. 1 is located outdoors. The equipment is in good condition but the enclosure has some surface corrosion. The corrosion can be controlled by applying a primer and paint manufactured specifically for rusting metal.

4,800 Volt Main Switchgear

The 4.8 kV main switchgear is located in the switchgear building and was installed in 2003. The switchgear consists of vacuum circuit breakers. The switchgear has been well maintained and appears in good condition. This switchgear is expected to provide another 40 years of operation. The batteries are located in a separate battery room and should be replaced as part of a regular maintenance schedule.

08/22/2017

BREAKER- H.S. TRANS. 1- 4160 VOLTS

08/22/2017

BATTERIES

Medium Voltage Motor Starters

The medium voltage motor starters are fused starters with vacuum contactors. All eight motor starters were replaced in 2003 and are in good condition. The motor starters are expected to provide another 40 years of operation.

08/22/2017

PUMP NO. 7 MV MOTOR STARTER

Storm Water Pump Motors

The station has six 2,300 HP and two 2,250 HP storm water pump motors. These medium voltage motors are synchronous, 200 rpm, 36-pole motors. The storm water pump motors are original as installed. It is understood that the storm water pumps/motors 1, 2, 3, and 4 were installed when the station was constructed; storm water pumps/motors 5 and 6 were installed in the 1930s; and storm water pumps/motors 7 and 8 were installed in the 1940s. While the motors are operating sufficiently, they are beyond the expected service life. New motors should be considered, especially if new pumps are provided with the new project.

08/22/2017

STORM PUMP NO. 2 - 4800V MOTOR

08/22/2017

STORM PUMP NO. 7 - 4800V MOTOR

Sanitary Pump Motors

The sanitary station has four medium voltage motors for sanitary pumps (Pumps No. 9, 10, 11, and 12). The motor horsepowers are 500 HP, 350 HP, 500 HP, and 200 HP respectively. The motor for Pump No. 9 had been removed for repair at the time of the field visit in August of 2017. The motors for pumps 10, 11, and 12 are 16-pole (450 rpm), 18-pole (400 rpm), and 14-pole (514 rpm) respectively. The existing motors are at the end of their expected service life. New motors should be considered, especially if new pumps are provided with the new project.

Low Voltage Distribution

The two 500 kVA house transformers were installed in 2003 to support the 480 VAC equipment. These are indoor, dry-type transformers and provide power to three 480 VAC distribution panels (PDC-1, PDC-2, and PDC-3). The station also includes six smaller dry type transformers which provide power to the station’s 120/208 VAC and 240 VAC panelboards. These transformers and panelboards were also installed in 2003. All transformers and panelboards are in good condition and are expected to provide another 40 years of operation.

Lighting Systems

The upper levels of the Conner Creek Pump Station are well lit with induction high-bay lighting fixtures. This type of fixture does not use a filament and has a rated life similar to LED fixtures (approximately 100,000 hours). The induction high-bay fixtures were installed within the last 10 years. The lighting replacement project included the Switchgear Building and the Sanitary Pump Station. Since the buildings are not occupied on a continuous basis, these lights are not used continuously and should provide another 20 to 30 years of useful life. The efficacy of the induction lamps is fairly high (approximately 95 lumens/watt). LED high bay fixtures provide efficacy values around 120 lumens/watt. Replacement of the induction lighting would not reduce lamp/light maintenance and would not provide a reasonable payback period based on higher efficacy. Supplemental LED lighting is recommended for some smaller rooms which were not included in the recent lighting retrofit.

The lower levels of the pump station still utilize the older incandescent style fixtures, although many of these have been replaced with compact fluorescent lamps. Lighting at these levels is not adequate and the fixtures provide low efficacy (14 lumens/watt for incandescent and 60 lumens/watt for compact fluorescent). The lighting at these lower levels should be replaced with more efficient LED lighting and the illumination levels should be increased to meet IES standards.

Field Instrumentation

Field instrumentation at this station appeared to be in good condition and functioning properly. The only exception was the Safetnet gas sensing system in the Sanitary Pump Station, which was not functional at the time of the visit, but was actively being repaired. Also, the hinge on the stainless steel gate control panel located near the rear of the property is broken and should be repaired.

Freud Pump Station: Electrical Distribution System Overview

The electrical system at the pump station consists of three 24 kV electrical services from Detroit Edison (Ludden 161, Porter 132, and Ludden 208). The three electrical services provide power to three GLWA-owned, 6,000/7,500 kVA transformers which step down the voltage from 24,000 VAC to 4,160 VAC. Each transformer includes an oil immersed isolation switch, but the switch is only rated to interrupt an unloaded transformer (10A magnetizing current interruption only). Service isolation is accomplished through Detroit Edison via utility switching.

The three service transformers provide ungrounded delta secondary service to the pump station. However, the generator switchgear bus includes a 75 kVA grounding transformer which provides a reference to ground when the generator switchgear gen-utility tie is closed. The neutral-to-earth connection of this grounding transformer introduces a ground reference for stabilizing and centering the 4.16 kV delta system around the ground reference point, but not when the system is operating on normal utility power.

The 4.16 kV secondary conductors from the two Ludden utility services (Ludden 161 and Ludden 208) are brought into the pump station and terminated directly to main circuit breakers on Bus #1 and Bus #3 respectively. The secondary conductors of transformer T-2 (Porter 132 utility service) are routed to the outdoor generator switchgear, and then continues into the indoor switchgear main circuit breaker on Bus #2.

The indoor switchgear line-up is configured in a 4-bus arrangement, with tie circuit breakers creating a looped tie between the four busses. Under normal operation, tie breakers 1-2, 2-3, and 4-1 are open, creating three isolated 4.16 kV bus systems which are fed from the three separate utility services. Bus 4 has no utility service, and Tie 3-4 is typically closed to provide service to this bus.

The 4.16 kV emergency generator switchgear is located in an outdoor switch house, and consists of 3-cycle vacuum breakers. The switchgear includes a main disconnect for intercepting the 4.16 kV service from Transformer No. 2 (52-UM), and paralleling equipment to allow the generator system to be paralleled with the Porter 132 utility. The generator switchgear is responsible for selecting the source of power (utility, generator, or both), and distributing this power to Bus #2 of the indoor switchgear.

This station does not have 480 VAC equipment. All low voltage equipment is sourced from the station's four 112.5 kVA, 4.16 kV – 120/208 VAC transformers.

24 kV Service Transformers

Service transformer T1 was originally manufactured by Standard Transformer and installed when the pump station was constructed in 1955. The transformer reached the end of its typical lifespan about 15 years ago. The transformer was refurbished in 2008 by Brandon and Clark Inc. Typical refurbishing services add another 10 to 20 years to the transformer life. The transformer should be replaced within the next decade to allow for another 40 to 50 years of reliable operation.


08/22/2017
MAIN TRANSFORMER T1 (6-7.5 MVA)


BRANDON & CLARK, INC.
TRANSFORMER DIVISION
LUBBOCK, TEXAS

THREE PHASE POWER TRANSFORMER 60 HERTZ

MANUFACTURER	STANDARD	SERIAL # 113301	
REPAIRED BY	BRANDON & CLARK	SERIAL # 272508	2008

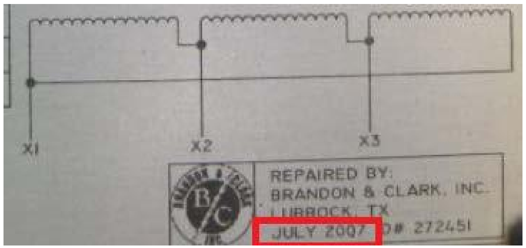
VOLTAGE RATING		24000/4160
OA RATING	6000 KVA	CONTINUOUS 55°C RISE SELF COOLED
FA RATING	7500 KVA	CONTINUOUS 55°C RISE FORCED AIR

IMPEDANCE VOLTS % AT 6000 KVA

BASIC IMPULSE INSULATION LEVELS (BIL)
HV 150
LV 75

Service transformer T2 was originally manufactured by Standard Transformer and also installed when the pump station was constructed in 1955. The transformer was repaired in 2007 by Brandon and Clark Inc. The transformer should be replaced within the next decade to allow for another 40 to 50 years of reliable operation.

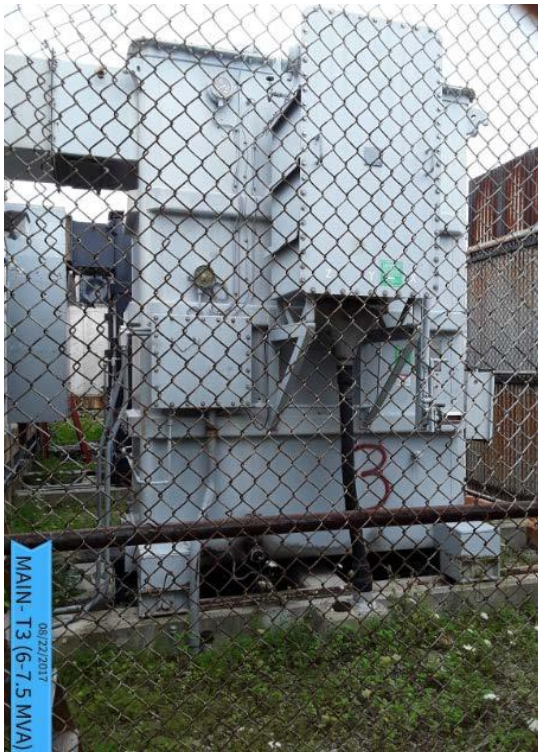

08/22/2017
MAIN- T2 (6-7.5 MVA)

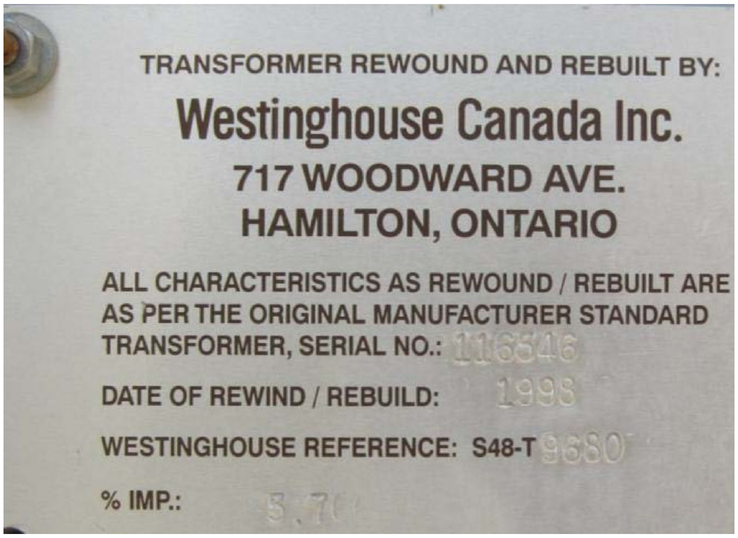


REPAIRED BY:
BRANDON & CLARK, INC.
LUBBOCK, TX
JULY 2007 # 272451

Service transformer T3 was originally manufactured by Standard Transformer and installed when the pump station was constructed in 1955. The transformer was rewound and rebuilt by Westinghouse Canada Inc in

1998. The refurbished transformer is approaching the rated 20 year life for a refurbished transformer and should be replaced soon with a new transformer.




TRANSFORMER REWOUND AND REBUILT BY:

Westinghouse Canada Inc.
717 WOODWARD AVE.
HAMILTON, ONTARIO

ALL CHARACTERISTICS AS REWOUND / REBUILT ARE AS PER THE ORIGINAL MANUFACTURER STANDARD TRANSFORMER, SERIAL NO.: 116546

DATE OF REWIND / REBUILD: 1998

WESTINGHOUSE REFERENCE: S48-T9680

% IMP.: 5.7

The three service transformers provide a floating delta secondary connection to the main switchgear. This type of system exposes the 4.16 kV system to potential overvoltage conditions in the event of an arcing phase-to-ground fault, where the arcing condition can cause a voltage multiplication with respect to ground. This type of fault can occur if an operating motor experiences a line-to-ground arcing fault on one of the motor windings or if a surge arrestor fails and begins flashing to ground. The result of the arcing condition can cause line-to-ground voltages to temporarily exceed 3 or more times the typical line-to-ground voltage. Occasional ground faults have been detected in the recent past by the ground fault sensing system provided on the medium voltage switchgear.

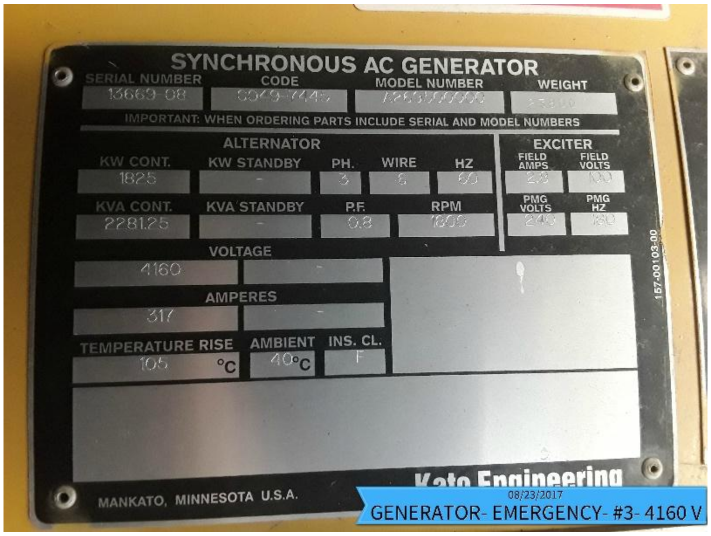
A solution to this potential problem is to provide a derived neutral grounding system on the secondary side of each transformer. This involves adding a small three-phase wye-delta transformer (with high impedance neutral grounding on the primary side and shorted secondary delta windings) or a zig-zag transformer with high impedance grounding. Either solution creates an artificial ground which will hold the system voltage in place in the event of an arcing ground fault. A derived neutral grounding solution should be considered to eliminate potential damage to the station's electrical system and equipment.

4,160 Volt Generator Units

This pump station has a total of four diesel-driven generator units which were installed in 1999. The rated lifespan of these units is between 10,000 to 20,000 hours of operation. These units are only operated in the event of a loss of utility power or when exercised. The total usage on each engine-generator is under 2,000 hours over the last 17 years. With regular exercising, maintenance, and occasional repair, these units should provide another 40 years of operation.

4,160 Volt Generator Switchgear

The 4.16 kV generator switchgear was also installed in 1999 and consists of vacuum circuit breakers. The electrical switchgear is housed in an outdoor walk-in style enclosure. The switchgear has been well maintained and appears in good condition. This switchgear is expected to provide another 40 years of operation. The batteries are located in the first compartment and should be replaced as part of a regular maintenance schedule. Generator switchgear house transformer No. 4 is located indoors and is in good condition.



4,160 Volt Main Switchgear

The 4.16 kV main switchgear was installed in 2007 and consists of vacuum circuit breakers. The switchgear has been well maintained and appears in good condition. This switchgear is expected to provide another 40 years of operation. The batteries are located in a separate battery room and should be replaced as part of a regular maintenance schedule. The dc power panel which distributes 125 vdc power appears to be the original panel from 1955. Although currently functional, replacement is recommended due to age and the critical nature associated with the function of the equipment that this panel supports.

Medium Voltage Motor Starters and Cubicles

The medium voltage motors are currently started by closing the 4.16 kV vacuum circuit breaker and synchronizing with the original 1955 motor field cubicles.   The age of these cubicles makes troubleshooting difficult, including repair or replacement of components. Medium voltage motor starters similar to those utilized in the Conner Creek Pump Station, including electronic synchronization, is recommended as a replacement for the current excitation and synchronization control system.

Storm Water Pump Motors

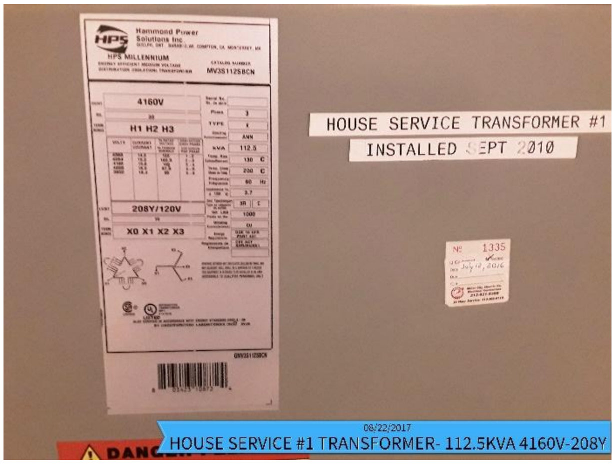
The station has eight 3,000 HP storm water pump motors. These medium voltage motors are synchronous, 225 rpm, 32-pole motors. The storm water pump motors are original as installed during the original pump station construction. While the motors are operating sufficiently, they are beyond the expected service life. New motors should be considered, especially if new pumps are provided with the new project.

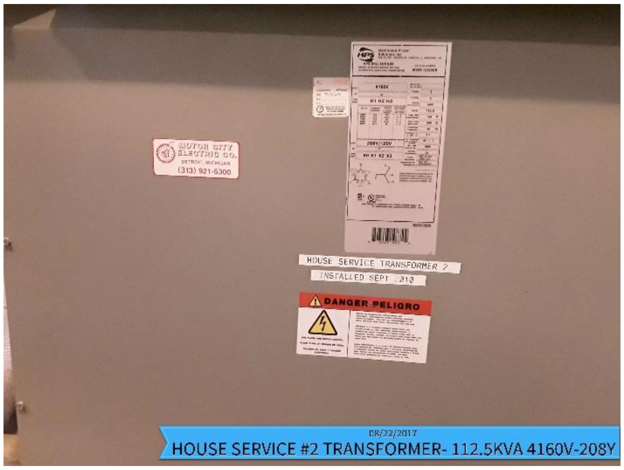
Sanitary Pump Motors

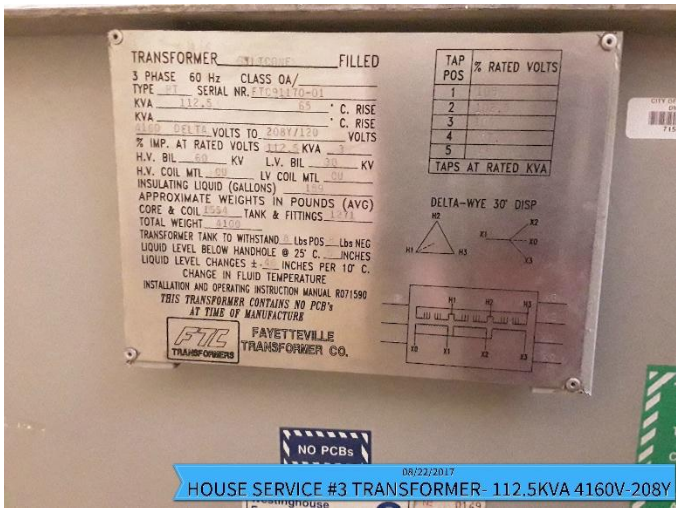
The sanitary pumps are driven with two 200HP medium voltage synchronous motors (Pumps No.9 and 10). The motors are located on the lowest level of the station and were originally used for station dewatering. New motors should be considered, especially if new pumps are provided with the new project.

Low Voltage Distribution

This station does not have 480 VAC. Station house power is distributed at the 208/120 VAC level via four 4160V-120/208V house transformers (including the generator house transformer, T-4). Three of these transformers are located in transformer room. House transformers T-1 and T-2 are dry type transformers and were recently replaced in 2010. These two transformers are expected to provide another 40 years of useful life. Transformer T-3 is a silicon liquid-filled transformer and appears to be installed after 1979 since the original nameplate includes a statement about being PCB-free (after PCBs were banned). The transformer may be approaching end-of-life and should be replaced within the next 10 years.







Many of the power distribution panelboards at this station date back to the 1950's. The age of the circuit breakers in these panels will make replacement difficult as the circuit breakers begin to fail. The following panelboards should be replaced:

- PP-1
- PP-2
- PP-3
- PP-5
- LP-3
- LP-4

Lighting Systems

The upper levels of the Freud Pump Station are well lit with induction high-bay lighting fixtures. This type of fixture does not use a filament and has a rated life similar to LED fixtures (approximately 100,000 hours). The induction high-bay fixtures were installed within the last 10 years. Since the building is not occupied on a continuous basis, these lights should provide another 20 to 30 years of useful life. The efficacy of the induction lamps is fairly high (approximately 95 lumens/watt). LED high bay fixtures provide efficacy values around 120 lumens/watt. Replacement of the induction lighting would not reduce lamp/light maintenance and would not provide a reasonable payback period based on higher efficacy. Supplemental LED lighting is recommended for some smaller rooms on the upper level which were not included in the recent lighting retrofit.

The lower levels of the pump station still utilize the older incandescent style fixtures, although many of these have been replaced with compact fluorescent lamps. Lighting at these levels is not adequate and the fixtures provide low efficacy (14 lumens/watt for incandescent and 60 lumens/watt for compact fluorescent). The illumination at these lower levels should be increased to meet IES standards. Replacement and new light fixtures should utilize the more efficient LED lights.

Field Instrumentation

Field instrumentation at this station appeared to be in good condition and functioning properly. The only exception was an Endress and Hauser FHB 20 wet well level sensor (LIT 803010), which appears to have been intentionally taken out of service. Several ultrasonic level monitors are located in the same vicinity of this non-functional level monitor.

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Appendix E

Freud and Conner Creek Pump Station Improvements Concept Alternatives Evaluation

Great Lakes Water Authority

FREUD AND CONNER CREEK PUMP STATION IMPROVEMENTS

Concept Alternatives Evaluation

November 2017

FREUD AND CONNER CREEK PUMP STATION IMPROVEMENTS

Concept Alternatives Evaluation

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DE000775.1203

Date:

November 22, 2017

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Technical Memorandum

Prepared for: Great Lakes Water Authority

Project Title: Freud and Conner Creek Pump Station Improvements

Project No.: CS-120

Technical Memorandum No. 2

Subject: Freud and Conner Creek Pump Station Improvements - Concept Alternatives Evaluation

Date: November 22, 2017

To: Ms. Mini Panicker, PE

From: Mr. Jeff Swartz, PE

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List of Abbreviations

AACE	Advancement of Cost Engineering International
AOR	allowable operating range
BEP	best efficiency point
BTU	British Thermal Unit
CC	Conner Creek
CCF	Hundred Cubic Feet
CFD	computational fluid dynamics
CSO	Combined Sewer Overflow
CMU	concrete masonry unit
DIP	Ductile Iron Pipe
DRI	Detroit River Interceptor
DWSD	Detroit Water and Sewerage Department
EL	Elevation – City of Detroit Datum
ft	feet
GLWA	Great Lakes Water Authority
HI	Hydraulic Institute
HTHV	High Temperature Heating and Ventilation
HVAC	Heating, Ventilation, and Cooling
HVAC	Heating, Ventilating, and Air Conditioning
IES	Illuminating Engineering Society
in	inches
kWh	Kilowatt-hour
MBTU	One Million British Thermal Unit
MDEQ	Michigan Department of Environmental Quality
mgd	million gallons per day
NPSHr	Net Positive Suction Head Required
O&M	Operation and Maintenance
POR	preferred operating range
PS	pump station
R&R	Replacement and Repair
RS	Raw Sewage
TM	Technical Memorandum
WTP	water treatment plant
WRRF	water resource recovery facility

Section 1: Introduction

1.1 Purpose

This Technical Memorandum 2 - Concept Alternatives Evaluation (TM2) is part of the CS-120 Freud and Conner Creek Pump Station Improvements Project. The purpose of this technical memorandum is to provide the following:

- Establish the new functional requirements for both the Freud and Conner Creek Pump Stations,
- Describe and compare the Freud and Conner Creek Pump Station improvement alternatives, and
- Provide recommendations for the improvements.

Many of the improvements described in the memorandum are derived from the findings of the Condition Assessment submitted to GLWA on October 13, 2017. Refer to the Condition Assessment Report for the basis of these recommended improvements.

A key component of this TM2 is to step back and analyze the entire system to answer questions regarding system operation and capacity. This evaluation, in addition to the condition assessment report, provides a road map of the improvements necessary at the Freud and Conner Creek Pump Stations to make them reliable, functional, and sustainable into the future, as well as safely maintaining operations during construction activities.

1.2 Pump Station History

The Freud and Conner Creek pumping systems are key components in relaying wastewater and storm water generated in the eastern portion of Detroit to the Fairview Sewage Pump Station, and ultimately, to the Detroit Water Resource Recovery Facility (WRRF). The operation of these facilities is critical to prevent flooding of stakeholders' premises, but they also protect the water quality in the Detroit River and ultimately the drinking water supply for Detroit. The conveyance system is very complex involving at least eight interceptors/sewers, multiple regulating structures, three large pump stations, and a CSO treatment system. The conveyance system has grown and been modified numerous times over the past 100-years with the last major improvement being the construction of the Conner Creek CSO Basin and Treatment Facility which was placed into operation in 2005.

In the past, many improvements made to the conveyance system were reactive improvements to address immediate issues. While these reactive improvements endeavored to review the operation of the entire system, in some instances, the immediate problem was corrected, but generated other issues with the overall operation of the conveyance system. The completion of the Conner Creek CSO Basin is an example of this effect. By all accounts, the vacuum priming system on the Conner storm water pumps worked effectively prior to the CSO basin being placed into operation. The impact of the CSO basin on the operation of the Conner storm water pumps was identified as a potential problem due to the Conner outfall being drained as a result of operation of the CSO facility. The solution was the construction of a low head dam in the Conner outfall to capture and retain a sufficient quantity of water to seal the Conner storm water pump's discharge siphon. This solution did not solve the primary concern (priming of the Conner storm water pumps) and caused a secondary issue with solids settling out upstream of the dam.

The Freud Pump Station (FPS) was constructed in the mid-1950s primarily to handle the overflows from the Conner Creek Pump Station (CCPS). When the capacity of the CCPS is exceeded, the East Jefferson Relief Sewer overflows to the Fox Creek and Ashland Relief Sewers. The original concept was for the FPS and the Fox Creek and Ashland Relief Sewers to store approximately 20 million gallons for return to the CCPS through the East Jefferson Relief sewer when the CCPS could handle the flow. The operation concept of Freud was changed when the Conner Creek CSO Facility was placed into operation. The change was made so that the Freud storm water pumps would fill up the Conner outfall, thereby facilitating the priming of the Conner storm water pumps.

The Conner Creek Pump Station was originally constructed in the late-1920s to handle the flows from the East and West Jefferson Relief Sewers. The CCPS consists of two distinct components, the sanitary pump station and the storm water pump station, along with the ancillary support appurtenances (emergency generators, switch house and backwater gates). Sanitary and low storm water flows are pumped by the sanitary pump station into the Detroit River Interceptor. The Sanitary Pump Station was constructed in the 1950s.

1.3 Current Conditions

A summary of the findings for the existing conditions at each station is included in the tables below for both the Freud Pump Station and Conner Creek Pump Station.

Table 1-1. Freud Pump Station - Summary of Existing Conditions Major Findings

Operations and Hydraulics Assessment • Insufficient Sanitary Pump Capacity • Sanitary Pumps operating beyond acceptable range • Undesirable Sanitary Pump Operating Conditions • Unacceptable Pump Suction Intake Conditions • Installation not compliant with HI Standards	**Process-Mechanical Assessment** • Inability to Isolate Wet Well for Storm and Sanitary Pumps • Excessive wear on Sanitary Pumps ○ Spare pumps are stored at the Pump station for replacements. ○ Each pump has a dedicated range and no installed redundancy is provided
Electrical Assessment • Aging Outdoor Service Transformers • Aging Motors • Poor Interior Lighting • Aging 125vdc Power Distribution System • Aging Back-Up Power System • Obsolete motor field cubicles	**Instrumentation Assessment** • Heavily Retrofitted Mimic/Control Panel • Aging Ovation PLC System
Architectural and Structural Assessment • Aging membrane roof, exterior doors, and windows • Brick tuckpointing and small brick patch repairs • Deteriorating tile flooring surface on top floor and exterior concrete stairs • Insufficient access stairs to loading dock/PS • Deteriorated exterior concrete flume and loading dock top slabs and slab edges, steel building column base at loading dock • Deficient concrete pump bases • Corroded interior and exterior gratings and platform and stair leading to lowest sump level • Corroded window and door lintels • Deteriorated concrete wall surfaces of lowest sump level	**HVAC and Plumbing Assessment** • All major HVAC equipment - end of useful service life • All major plumbing fixtures and equipment - end of useful service life
Civil Assessment • Poor Site Vehicle Access for large vehicles.	

Table 1-2. Conner Creek Pump Station - Summary of Existing Conditions Major Findings

Operations and Hydraulics Assessment • Insufficient Sanitary Pump Capacity ○ Standby capacity not provided for current flow ○ Poor suction hydraulics cause pump wear • Vacuum priming systems for Storm Pumps is complex and unreliable ○ Operators must be on site to operate vacuum priming system and start pumps • Installation not compliant with HI Standards	Process-Mechanical Assessment • Inability to isolate Wet Well for Storm Pumps • Desire to eliminate the Vacuum Priming System ○ Pump replacement will be required using a different pump style ○ Pump Station and piping modifications will be required
Electrical Assessment • Aging Outdoor Service Transformers • Aging Motors • Poor Interior Lighting • Aging Back-Up Power System	Instrumentation Assessment • Aging Ovation PLC System
Architectural and Structural Assessment • Aging membrane roof (Sanitary and Switchgear Buildings) • Aging gutters, exterior doors, and windows • Brick tuckpointing and small brick patch repairs • Deteriorated exterior concrete surge tank top slab • Corroded interior and exterior gratings • Corroded window and door lintels • Corroded steel crane runway beam of Storm PS • Corroded upper steel platform members of Backwater Gate Structure	HVAC and Plumbing Assessment • Need for replacement of all major HVAC equipment • Need for replacement of all major plumbing fixtures and equipment
Civil Assessment • Poor Site Vehicle Access outside gate and lack of parking for vehicles	

Section 2: Pump Facility Functional Requirements

Clearly defining the desired functional requirements for the improved facilities is critical to successful improvement of the pump stations. The functional requirements describe the required operational capabilities and the maintainability expectations. The functional requirements were developed based on review of current operating procedures, analysis of historic operations, and GLWA staff input for future operations and maintenance requirements. It should be noted that many of the requirements listed below are directly related to elements outlined in *Recommended Standards for Wastewater Facilities (2014 edition)*.

2.1 Freud Pump Station

2.1.1 Operational Requirements

The recommended operational functional requirements are as follows:

Proposed Firm Capacity – Provide 30 mgd firm Sanitary pumping capacity at a low wet well level (Elevation [EL.] 25-ft) with any pumping unit out of service. Provide 2,030 mgd firm Storm pumping capacity with any pumping unit out of service.

Wet Well Range – Provide firm capacity throughout the existing operating wet well range of EL. 25-ft to EL. 65-ft for the Sanitary Pumps, and EL. 45-ft to EL. 75-ft for the Storm Pumps, which provides some overlap between the Sanitary and Storm Pumps.

Pump Performance – Provide pumps that operate within their Preferred Operating Range (POR) throughout this normal range and within their Allowable Operating Range (AOR) for infrequent wet weather events.

Suction Intake Conditions – Meet Hydraulic Institute (HI) recommendations for suction intake conditions for normal operating conditions. Physical modelling is being completed by Clemson Engineering Hydraulics to evaluate the conditions for the existing wet wells, both for the Storm Pumps and the Sanitary Pumps to determine modifications that are beneficial to the pump suction conditions, specifically for the Sanitary Pumps.

Power Supply Redundancy – Provide a redundant power supply to support the pumping capacity.

2.1.2 Maintenance Requirements

The recommended maintenance functional requirements are as follows:

Isolation of Individual Sanitary Pump Units – Provide the ability to reliably and safely isolate or remove the individual pumping units for maintenance without impacting the performance of the other pumping units. The existing station layout provides isolation for the Sanitary Pumps, but not for the Storm Pumps.

Isolation of Wet Wells – Provide the ability to reliably and safely isolate the Pump Station wet well to allow maintenance. This is a criterion of GLWA, as there is currently no means to prevent flow from entering the station from the two 16-ft diameter sewers. In addition, the Sanitary Wet Well is contained within the Storm Wet Well, and there is no means to separate the two wet wells.

Equipment Removal Safety – Provide provisions to enhance removal of pumps, motors, and other major mechanical or electrical equipment. Individual pump and motor removal shall not interfere with continued operation of remaining pumps.

2.2 Conner Creek Pump Station

2.2.1 Operational Requirements

The recommended operational functional requirements are as follows:

Proposed Firm Capacity – Provide 184 mgd firm Sanitary pumping capacity (increased from existing) at a low wet well level (Elevation [EL.] 62-ft) with any pumping unit out of service. Provide 2,226 mgd firm Storm pumping capacity with any pumping unit out of service.

Wet Well Range – Provide firm capacity throughout the existing operating wet well range of EL. 59-ft to EL. 65-ft. for the Sanitary Pumps, and EL. 65-ft to EL. 79-ft for the Storm Pumps.

Pump Performance – Provide pumps that operate within their Preferred Operating Range (POR) throughout this normal range and within their Allowable Operating Range (AOR) for infrequent wet weather events.

Suction Intake Conditions – Meet Hydraulic Institute (HI) recommendations for suction intake conditions for normal operating conditions. Physical modelling is being completed by Clemson Engineering Hydraulics to evaluate the conditions for the existing wet wells, both for the Storm Pumps and the Sanitary Pumps to determine modifications that are beneficial to the pump suction conditions, specifically for the Sanitary Pumps.

Power Supply Redundancy – Provide a redundant power supply to support the firm pumping capacity.

Start-up Reliability / Ease-of-Operation – Provide pumping systems that can be reliably operated in remote-manual or remote-automatic mode. Pumping systems start-up shall not be reliant on vacuum priming systems.

2.2.2 Maintenance Requirements

The recommended maintenance functional requirements are as follows:

Isolation of Individual Sanitary Pump Units – Provide the ability to reliably and safely isolate or remove the individual pumping units for maintenance without impacting the performance of the other pumping units. The existing station layout provides isolation for the Sanitary Pumps, but not for the Storm Pumps.

Isolation of Wet Wells – Provide the ability to reliably and safely isolate the Pump Station wet wells to allow maintenance. This is a criterion of GLWA, as there is currently no means to prevent flow from entering the Storm Wet Well from the two 14-ft diameter sewers. The Sanitary Wet Well currently can be isolated.

Equipment Removal Safety – Provide provisions to facilitate removal of pumps, motors, and other major mechanical or electrical equipment. Individual pump and motor removal shall not interfere with continued operation of remaining pumps.

Section 3: Pumping Improvement Concept Alternatives Analysis

This section provides a description, analysis, and comparison of alternatives.

3.1 Alternatives Analysis Methodology

3.1.1 Methodology Overview

The Arcadis Team used a step-wise approach to developing and analyzing pumping concept alternatives for improvements to the Freud and Conner Creek Pump Stations. This approach was as follows:

- PS concept feasibility screening,
- Pump-type screening evaluation, and
- Alternatives development and comparison.

Alternatives development and comparison focused on achieving the functional requirements outlined above in Section 2.

3.1.2 Pump Station Concept Feasibility Screening

Numerous pump station concept alternatives were developed in the feasibility screening phase. Three alternatives were selected for further consideration; however, other concepts were developed and vetted. Some of the alternatives <u>not selected</u> for further consideration (screened-out) included:

Table 3-2. Pump Station Concept Feasibility Screening

Possible Feature	Cons/ Fatal Flaw
Conner PS Storm Pumps • **Different style of priming system**	• **Still presents a priming system that may be complex and/or difficult to maintain**
Conner PS Storm Wet Well • **Modify existing wet well to be deeper and more functional**	• **To maintain PS during construction would require essentially a new Conner Storm Station for "temporary" bypass**

3.1.3 Pump-Type Screening Evaluation

Based on knowledge of industry best practices and experience with other wastewater pump station design projects, the Project Team performed a screening evaluation of candidate pumping equipment types for use in the Freud and Conner Creek PS improvements. Table 3-1 below summarizes the screening evaluation conclusions. In brief, three pump-types were selected for further consideration: dry-pit vertical centrifugal, submersible non-clog centrifugal, and vertical axial flow column pumps.

Table 3-1. Pump-Type Screening Evaluation

Pumping Equipment Alternative		Advantages	Disadvantages	Comments/Conclusions
Dry-Pit Vertical Centrifugal Pump		• Easy access to motors and pumps for in-situ maintenance. • Robust construction well suited for solids handling. • Wide selection of products and performance curves.	• Requires deep dry-well adjacent to wet well. • Most complex facility; requires egress, HVAC, lighting, and equipment handling provisions.	• Good fit for rehabilitation of existing PS. • Selected for alternatives feasibility screening.
Submersible Non-Clog Centrifugal Pump		• No motor noise due to submergence. • Robust construction well suited for solids handling. • No external flushing water or oil/grease lube systems. • Very simple facility. • Wet-pit or dry-pit installation possible.	• Largest commercially available unit is approximately 40 mgd. • Numerous units needed for larger capacity PSs. • Wet-pit installation not readily accessible for inspection. May require maintenance at certified service centers.	• Wet-pit installation for new wet well would limit impact to residential neighborhood. • Selected for alternatives feasibility screening.
Vertical Axial Flow Column Pump		• Simple facility. Does not require dry-pit. • Does not require submersible motor. Easy access to motor. • Lower equipment cost.	• More prone to clogging. • Not well suited for solids handling (e.g. raw sewage). Common for storm water. • Requires above-ground building for motors. • Narrow POR, sensitive to intake conditions.	• Some potential, however, inferior to Non-Clog Solids Handling Vertical Column pumps. • Selected for alternatives feasibility screening.
Non-Clog Solids Handling Vertical Column Pump		• Robust construction purpose-built for wastewater solids-handling applications. • Simple facility. Does not require dry-pit. • Does not require submersible motor. Easy access to motor. • Capable of handling large solids. • Broad POR, excellent for variable speed operation.	• Access to pump bowl requires handling of motor and pump column. • Higher equipment cost. • Requires above-ground building for motors. • Large suction bell may not fit into existing wet well.	• Will not fit in existing Conner PS. • *Not selected for alternatives feasibility screening.*
Submersible Axial Flow Pump		• No motor noise due to submergence. • No external flushing water or oil/grease lube systems. • Very simple and secure facility.	• Not typically used for raw wastewater. Common for screened storm water. • Not readily accessible for inspection. • May require maintenance at certified service centers. • Narrow POR, sensitive to intake conditions.	• *Not selected for alternatives feasibility screening.*
Screw Pump		• Limited wet well size. • Can handle high solids loading.	• Very large concrete structure required. • Very high capital cost. • High potential for odors. • Large screw units are difficult to handle. • Most suitable for very low TDH applications.	• *Not selected for alternatives feasibility screening.*

3.2 Concept Alternatives Overview

Three conceptual categories were selected for further consideration. A brief description of each alternative is as follows:

- Alternative 1 – Minimum Improvements for Freud PS and Conner Creek PS.
  - Freud PS - This alternative includes the replacement of the two existing Sanitary Pumps with two submersible non-clog centrifugal pumps (30 mgd each) in the existing configuration to better cover the pumping range required. The pump station also requires isolation of the wet well which will be accomplished by constructing new junction shafts with stop gates on each of the 16-ft diameter sewers at the site along Freud Avenue.
  - Conner Creek PS - This alternative includes the addition of two new submersible Sanitary Pumps (40 mgd each) located in a new wet well on the site with connections to the existing Sanitary PS and 14-ft diameter sewers, as well as force mains to the existing Sanitary Discharge Box and the Storm Water Discharge structure (two layout options in figures). The pump station also requires isolation of the wet well which will be accomplished by constructing new junction shafts with stop gates on each of the 14-ft diameter sewers at the site. Elimination of the vacuum priming systems requires that the Storm Pumps be replaced with eight vertical column pumps installed through the existing openings in the pump room floor.
- Alternative 2 – Intermediate Improvements for Freud PS and New Conner Creek PS.
  - Freud PS - This alternative includes modification of the existing Sanitary Pumps to replace them with two Dewatering Pumps (30 mgd each) in the existing configuration. The pump station also requires isolation of the wet well which will be accomplished by constructing new junction shafts with stop gates on each of the 16-ft diameter sewers at the site along Freud Avenue. A new Sanitary Pump Station will be constructed on the north side of the site to house two new submersible non-clog Sanitary Pumps (30 mgd each). This will include 48-in diameter sewers from the Junction Shafts to the station, and two 36-in diameter force mains to the existing Discharge Chamber.
  - Conner Creek PS - This alternative includes construction of a new Conner Creek PS adjacent to the existing Conner Creek Pump Station, potentially to the west on a currently vacant parcel. The new station will include new stations for both Storm Pumps and Sanitary Pumps, with a divided wet well for the Storm pumps to allow half of the pumps to be isolated for maintenance. The Sanitary Pumps will be six new submersible non-clog pumps (40 mgd each) installed in a trench style wet well. The Storm Pumps will be twelve new vertical-column axial-flow pumps (200 mgd each, six in each wet well).
- Alternative 3 – New Combined Pump Station.
  - Freud PS & Conner PS - This alternative includes the construction of an entirely new PS adjacent to the existing Conner Creek Pump Station, potentially to the west on a currently vacant parcel. This will have a combined capacity to handle influent and effluent flows associated with both existing stations and deep enough to accept gravity flow from the existing Freud Pump Station by means of a new connecting tunnel. The concept for the new PS will include ten Storm Pumps and six Sanitary Pumps, as well as divided wet wells for both the sanitary and storm pumps to allow half of each group of pumps to be isolated for maintenance. This alternative effectively replaces the two existing stations with one new station.

3.3 Construction Cost Estimate Methodology

3.3.1 Class of Estimate

According to the Association for the Advancement of Cost Engineering International (AACE) criteria:

- A Class 5 estimate is defined as a Concept Screening Estimate.
    - Typically, project definition is from 0 to 2 percent complete.
    - Expected accuracy from -50 to +100 percent.
- A Class 4 estimate is defined as a Study or Feasibility Estimate.
    - Typically, project definition is from 1 to 15 percent complete.
    - Expected accuracy from -20 to +30 percent.

The alternatives presented in this report are still very conceptual in nature, but have been preliminarily evaluated for feasibility. Therefore, the estimates prepared for Alternatives 1, 2, and 3 are considered to be somewhere between a Class 4 and a Class 5 estimate. So, a range of uncertainty of -30 to +50 percent was applied to capital cost estimates for Alternatives 1, 2, and 3.

3.3.2 Cost Basis

The estimate was prepared using quantity take-offs, vendor quotes, and equipment pricing and construction costs from recent projects. Labor and Material construction cost data from RS Means was applied to the conceptual quantities available.

Alternatives 2 and 3 will likely require land acquisition, which introduces additional project complexity related to capital cost and construction schedule. Due to the uncertainty of associated costs, the Opinion of Probable Cost tables presented at the end of each alternative does not include dollars for land acquisition.

3.3.3 Estimate Markups

Contractor and other estimate markups are based on the following conventionally accepted values. The markups included for this evaluation are presented in Table 3-3.

Table 3-3. Estimate Markups

Item	Rate
Overhead and Profit	15%
Contractor General Conditions	12%
Contractor Startup, Training, O&M	
Building Risk, Liability, Auto Insurance	
Bonds and Insurance	
Escalation (3% per year – 3 years)	9%
Estimator's Contingency	-30 to +50%

3.4 Alternative 1: Minimum Improvements of Existing Pump Stations

3.4.1 Description – Alternative 1

The major construction elements of Alternative 1 are presented in the bulleted list below.

- Freud Pump Station Improvements
    - Civil-Site
        - New Junction Shaft for Stop Gate – Ashland Relief Sewer
        - New Junction Shaft for Stop Gate – Fox Creek Relief Sewer
        - Provide access drives for new Junction Shafts and modify fencing.
    - Process-Mechanical
        - Replace existing Sanitary Pumps (2 pumps, 30 mgd each) and piping
        - Rehabilitate existing storm pumps (8 pumps total)
    - HVAC/Plumbing
        - Replace second steam boiler
        - Replace condensate return system
        - Replace steam unit heaters
        - Replace exhaust and supply fans serving motor room and pump shaft
        - Replace electric water heater
    - Architectural
        - Exterior brick tuckpointing and small brick repair patches for the Main Building and site retaining wall
        - Replace upper and lower membrane roofs of Main Building
        - Replace tile on top floor surface (both inside and outside of building) with more durable top slab surface that can withstand material handling and maintenance operations
        - Repair exterior concrete stairs near the west exterior top slab
        - Provide handrail along the edges of all exterior concrete slabs; use removable handrail along the east exterior loading dock slab edge
        - Provide new permanent stair access for entry to Pump Station on east exterior loading dock
        - Replace existing personnel elevator
    - Structural
        - Repair structural steel column base at loading dock
        - Provide safety cage on ladder from lower to upper roof
        - Prepare and repaint exterior structural steel lintels
        - Inspect and service overhead bridge crane
        - Repair and rebuild crane runway beam stops and repair glazed CMU block wall
        - Install pull points for material handling operations from loading dock
        - Demo and repair portions of defective concrete top slabs on north and east exterior top slabs
        - Replace existing corroding and warping grating on all exterior top slabs (north, south, east and west)

        - Demo existing steel edge angle edge of east exterior loading dock and repair exterior concrete slab edges (on top of masonry walls below) on all exterior top slabs (north, south, east and west)
        - Injection grout concrete cracks in substructure walls
        - Demo and replace damaged concrete storm pump bases and anchor bolts
        - Replace grating above and prepare and repaint structural steel framing supporting grating over lowest sump level
        - Prepare and repaint structural steel walkway members, floor plates and stair treads leading down to lowest sump level. Replace all handrail and its connections to walls and walkway members.
        - Concrete surface repairs and injection grout of walls throughout the perimeter of the lowest sump level.
        - New concrete pad with containment curb for new transformers
    - Electrical
        - Replace Outdoor Service Transformers (3 transformers, 6/7.5 MVA each)
        - Replace motor field cubicles (8 total)
        - Replace indoor switchgear dc power distribution system
        - Replace and supplement lighting to meet IES recommended illumination levels.
    - I&C
        - Retrofit aging Ovation panel
        - Retrofit heavily reworked control/mimic panel
- Conner Creek Pump Station Improvements
    - Civil-Site
        - New Junction Shaft for Stop Gate – West Jefferson Interceptor
        - New Junction Shaft for Stop Gate – East Jefferson Interceptor
        - Modify drives to access Junction Shafts and modify site fencing
        - Add ne access drive to Pump Station and improve parking lot capacity
    - Process-Mechanical
        - Rehabilitation Sanitary Pumps (4 existing pumps)
        - Construct new Sanitary wet well and install two supplemental Sanitary Pumps (2 pumps, 40 mgd each) and piping
        - Replace Storm Pumps with new vertical column pumps (8 pumps, 317 mgd each)
    - HVAC/Plumbing
        - Conner Creek Storm Water Pump Station
            - Replace second steam boiler
            - Replace condensate return system
            - Install new outside air and supply ductwork to make-up air handling unit located in the Boiler Room
            - Replace the three exhaust fans located in the upper portion of the Strom Water Pump Station upper cupola
        - Conner Creek Sanitary Pump Station
            - Replace corroded exhaust ductwork

        - Replace condensate return system
        - Replace exhaust and supply fans
        - Replace electric water heater
    - Conner Creek Primary Switchgear Building
        - Replace one of the electric unit heaters located in the Electrical Room
        - Replace electric radiant baseboard heater located in the Basement
        - Replace rooftop mounted natural gas fired make-up air handling unit
        - Replace electric water heater
    - Conner Creek New Sanitary Pump Station
        - All new HVAC systems and controls
        - All new plumbing systems
- Architectural
    - General
        - Exterior brick tuckpointing and cast stone joint repairs on Storm and Sanitary Pump Stations and Switchgear Building
    - Storm Water Pump Station
        - New gutters and downspouts
        - New roof on low roof over connection of Sanitary and Storm Pump Station
    - Sanitary Pump Station
        - Ladder from upper roof to low roof over
        - Replace existing personnel elevator
    - Switchgear Building
        - New membrane roofing
    - Misc. Site Structures
        - Provide stair for access to the top of the surge tank

- Structural
    - Storm Pump Station
        - Prepare and repaint structural steel runway beams for bridge crane (also verify adequate capacity for replacement pump weights)
        - Inspect and service overhead bridge crane (also verify adequate capacity for replacement pumps)
        - New grating platform, on top of Storm Pumps, to access storm pump shafts
        - New access hatch doors on exterior concrete patio slab and caulk exterior concrete patio slab cracks
        - Repair/patch floor openings when vacuum priming systems are removed.
        - Demo old concrete bases and pour new concrete pump bases for new Storm pumps
    - Sanitary Pump Station
        - Inspect and service overhead bridge crane
        - Provide new grating on 3rd floor (1st floor up from basement – top of steel beam EL 68.00 from record drawings) where framing exists but no grating currently exists
        - Injection grout concrete cracks in substructure walls
    - Misc. Site Structures
        - New concrete pad with containment curb for new transformers

        - Caulk existing joints and cracks in generator containment slab and fix grading to remedy portions of slab being undermined
        - Demo and repair portions of defective concrete top slab on surge tank and replace existing corroding and warping access hatches and floor plates
        - Prepare and repaint structural steel upper platform framing beams at Backwater Gate Structure

- Electrical
    - Replace Outdoor Service Transformers (2 transformers, 10 MVA each)
    - Replace and supplement lighting to meet IES recommended illumination levels.
- I&C
    - Retrofit aging Ovation panel

Figure 3-1 shows the proposed layout for Alternative 1 at the Freud Pump Station.

Figure 3-2 illustrates the proposed site improvements at Conner Creek Pump Station Alternative 1A.

Figure 3-3 illustrates the proposed site improvements at Conner Creek Pump Station Alternative 1B.

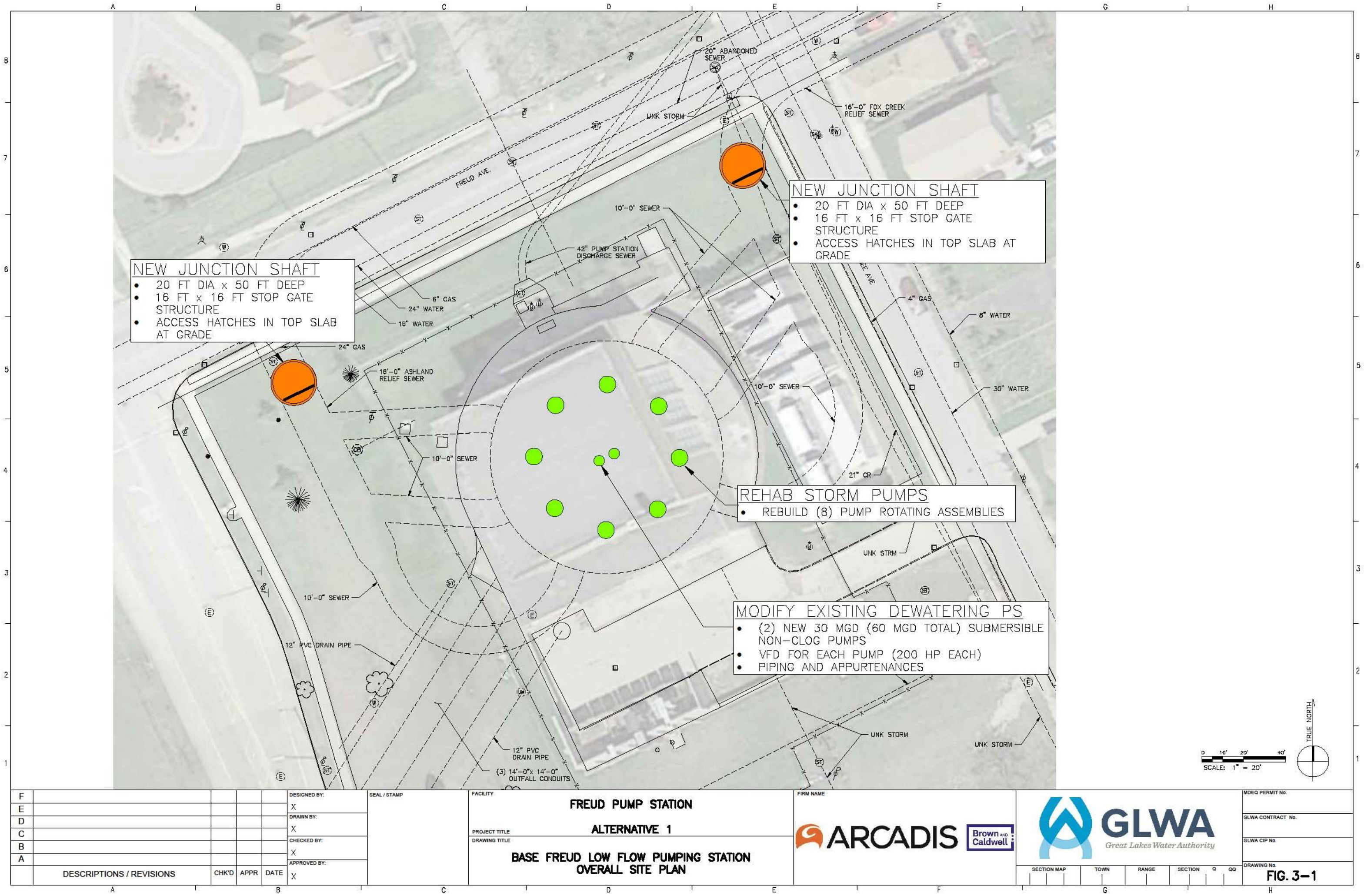
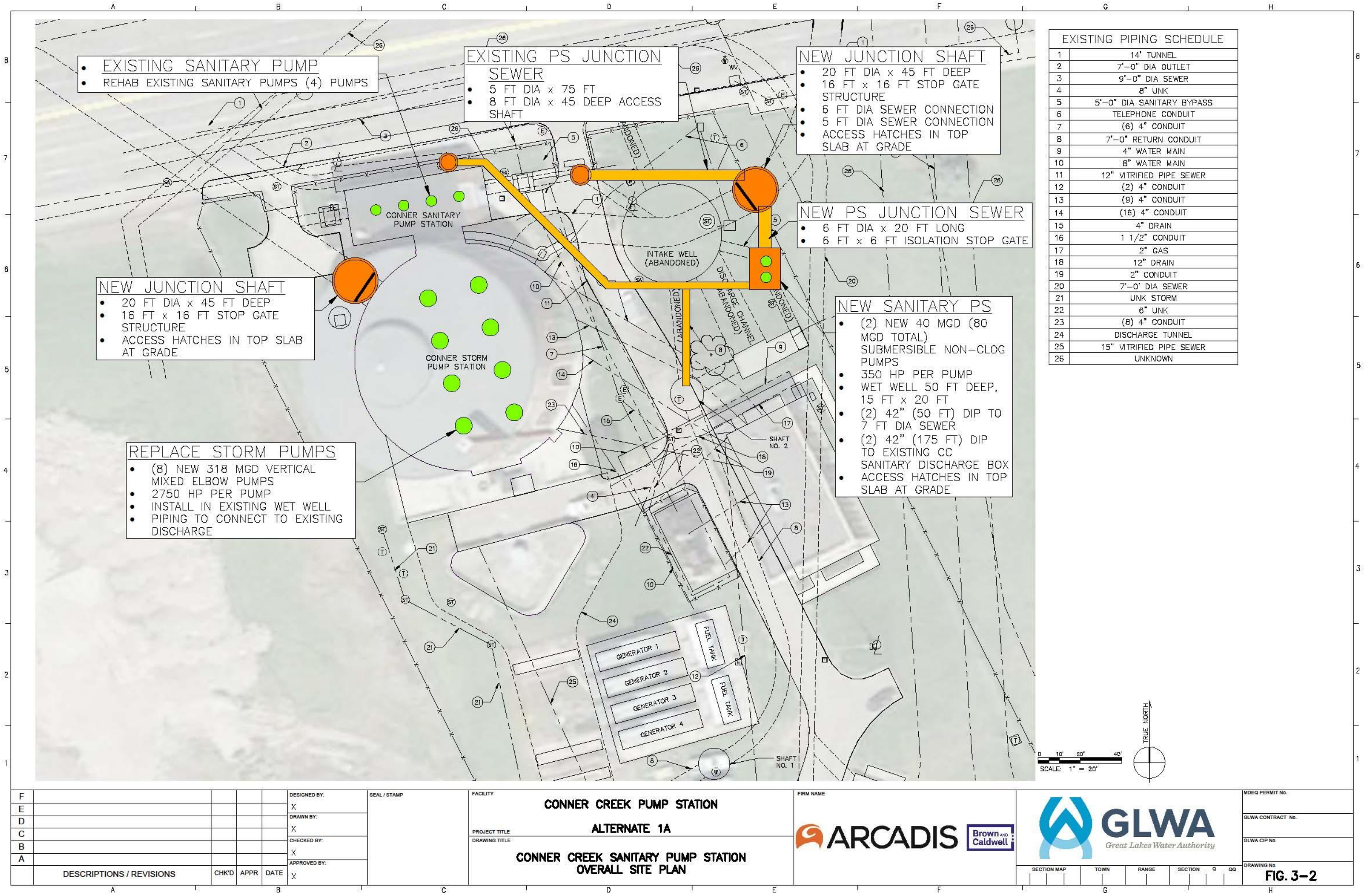
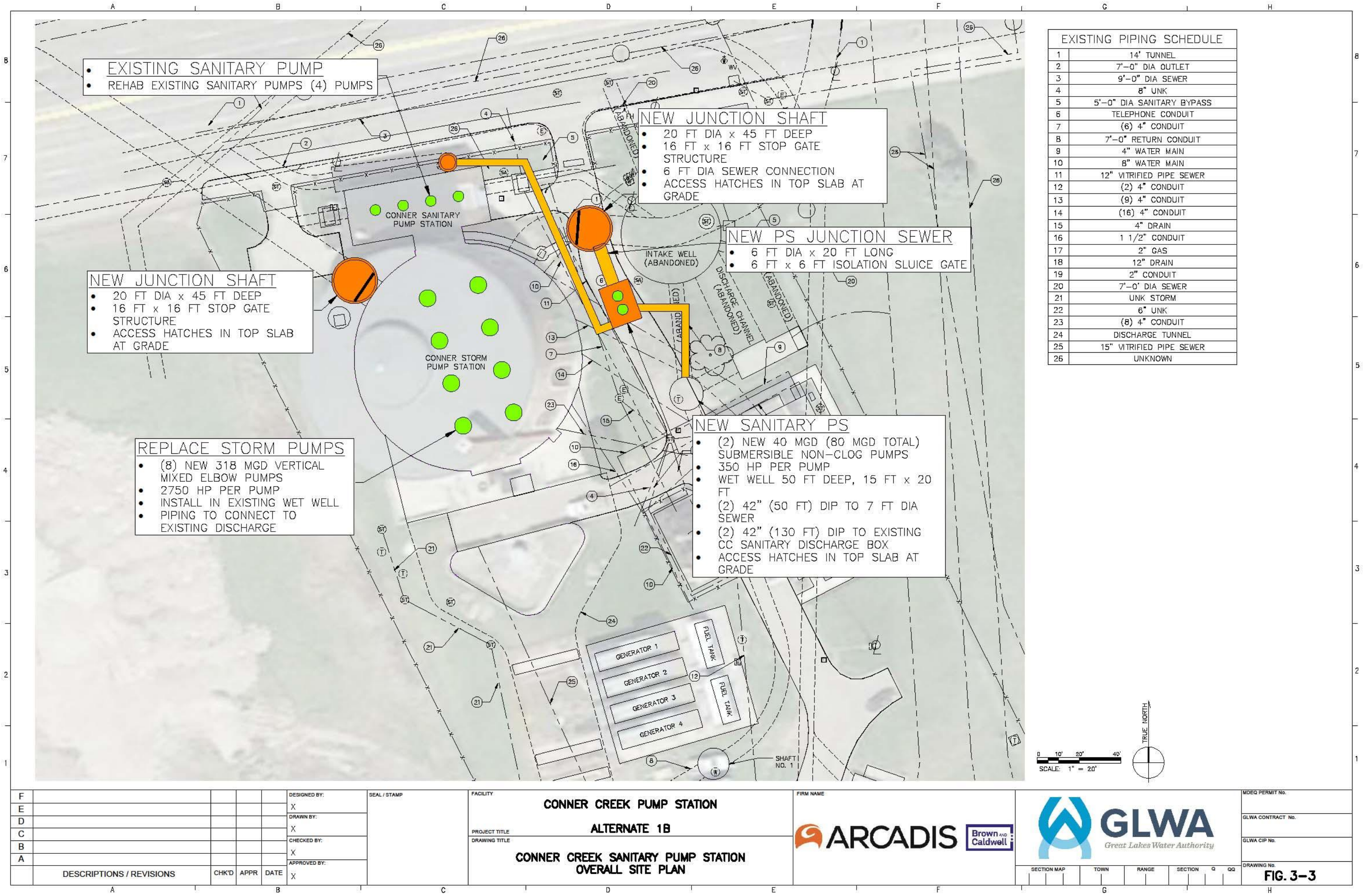


Figure 3-1. Alternative 1 - Freud Pump Station



EXISTING PIPING SCHEDULE	
1	14' TUNNEL
2	7'–0" DIA OUTLET
3	9'–0" DIA SEWER
4	8" UNK
5	5'–0" DIA SANITARY BYPASS
6	TELEPHONE CONDUIT
7	(6) 4" CONDUIT
8	7'–0" RETURN CONDUIT
9	4" WATER MAIN
10	8" WATER MAIN
11	12" VITRIFIED PIPE SEWER
12	(2) 4" CONDUIT
13	(9) 4" CONDUIT
14	(16) 4" CONDUIT
15	4" DRAIN
16	1 1/2" CONDUIT
17	2" GAS
18	12" DRAIN
19	2" CONDUIT
20	7'–0' DIA SEWER
21	UNK STORM
22	6" UNK
23	(8) 4" CONDUIT
24	DISCHARGE TUNNEL
25	15" VITRIFIED PIPE SEWER
26	UNKNOWN

Figure 3-2. Alternative 1A - Conner Creek Pump Station



EXISTING PIPING SCHEDULE

1	14' TUNNEL
2	7'-0" DIA OUTLET
3	9'-0" DIA SEWER
4	8" UNK
5	5'-0" DIA SANITARY BYPASS
6	TELEPHONE CONDUIT
7	(6) 4" CONDUIT
8	7'-0" RETURN CONDUIT
9	4" WATER MAIN
10	8" WATER MAIN
11	12" VITRIFIED PIPE SEWER
12	(2) 4" CONDUIT
13	(9) 4" CONDUIT
14	(16) 4" CONDUIT
15	4" DRAIN
16	1 1/2" CONDUIT
17	2" GAS
18	12" DRAIN
19	2" CONDUIT
20	7'-0' DIA SEWER
21	UNK STORM
22	6" UNK
23	(8) 4" CONDUIT
24	DISCHARGE TUNNEL
25	15" VITRIFIED PIPE SEWER
26	UNKNOWN

Figure 3-3. Alternative 1B - Conner Creek Pump Station

3.4.2 Analysis – Alternative 1

3.4.2.1 Discussion – Alternative 1

The main objective for Alternative 1 at both the Freud Station and the Conner Creek Station is to provide isolation for the wet wells and to firm up the Sanitary pumping capacity. In addition, the Conner Creek Station has the criteria to eliminate the vacuum priming systems, which requires that the Storm Pumps be replaced.

The Freud Station improvements include Junction Shafts for isolation of the wet well and replacement of the Sanitary Pumps to better suit the operating range and increase reliability.

The Conner Creek Station improvements include Junction Shafts for isolation of the Storm wet well and adding Sanitary Pump capacity with two additional pumps in a new wet well.

A disadvantage of this alternative is the risk and cost associated with maintaining pumping capacity during construction. It is anticipated that it is impractical to provide the full Storm Pump capacity with bypass pumping during construction due to the magnitude of the flows and poor access to install a temporary pumping system. Therefore, the proposed construction sequence below is based on upgrades to the Sanitary Pumps and diverting low flows to the Sanitary Pumps to allow work to be completed for the Junction Shafts at both stations and the Storm Pumps at Conner Creek. This will require an intermittent work schedule to complete the Junction Shafts and Stop Gates, as these will be in a “flow through” area when the Storm Pumps need to be operational.

Additionally, although maintainability of the Storm Pumps will be improved compared to the existing conditions, the existing wet well configuration would continue to provide no wet well redundancy. Wet well redundancy is a recommended industry best practice (*Recommended Standards for Wastewater Facilities*; 2014). Additionally, even with described improvements to the stations, these facilities are beyond their useful life and will likely require replacement within 40 years.

3.4.2.2 Constructability – Alternative 1

Freud Pump Station - Constructability challenges for this alternative include: maintaining pumping capacity during construction (need for bypass pumping), likelihood of unforeseen conditions, and providing adequate contractor laydown area. Bypass pumping will be required for Alternative 1, or some approach to allow construction in phases during dry periods to reduce the necessary bypass pumping capacity.

The likely sequence of construction for Alternative 1 is as follows:

1. Modify/replace the existing Dewatering Pumps to achieve the desired operating range,
2. Install the two new Junction Shafts to the extent possible without opening the 16-ft diameter sewers,
3. Cut out the sewers within the Junction Shafts to expose the flow,
4. Initiate temporary pumping for dry weather flow from the Junction Shafts to the Discharge Chamber,
5. Complete work in the Junction Shafts to install the stop gates and access for handling the gates,
6. Remove the temporary pumping.

Alternative 1 will present a challenging schedule, as all work is to be completed during low flow periods to allow the 16-ft sewers to remain open for high flow. This allows the Storm Pumps to remain on line and reduces the risk associated with bypass pumping for the full storm flow capacity. This limits work periods to dry weather when flows remain low and a weir in the Junction Shafts will provide a dry working area, although the bypass pumps would need to be secured or removed during high flow periods. Ongoing work in the Junction Shafts would require them to be cleaned as work started/stopped to continue construction until the stop gates and guides are completed.

Alternative 1 is anticipated to be contained on the existing Freud Station site, but will require the use of portions of the right-of-way for Freud Avenue and Tennessee Avenue during construction. The actual location of the existing 16-ft diameter sewers must be determined during design.

Conner Creek Pump Station - Constructability challenges for alternatives 1A and 1B include: maintaining pumping capacity during construction (need for bypass pumping), site constraints with existing infrastructure, likelihood of unforeseen conditions, and providing adequate contractor laydown area. Bypass pumping will be required for Alternatives 1A and 1B, or some approach to allow construction in phases during dry periods to reduce the necessary bypass pumping capacity.

The likely sequence of construction for Alternative 1A and 1B is as follows:

1. Modify/replace the existing Sanitary Pumps to achieve the desired operating range,
2. Install the two new Junction Shafts to the extent possible without opening the 14-ft diameter sewers, including stubs out for connections to the new Sanitary Station,
3. Install the new Sanitary Station, sewers, pumps, and discharge piping,
4. Put the new Sanitary Station into service to handle low flows in conjunction with the existing Sanitary Pumps,
5. Cut out the sewers within the Junction Shafts to expose the flow, and divert low flows to the existing and new Sanitary Stations,
6. Complete work in the Junction Shafts to install the stop gates and access for handling the gates,
7. Remove the diversion weirs to the Sanitary Stations.
8. During low flow periods, install Stop Gates and replace Storm Pumps individually to maintain station capacity. Coordination will be required to block floor openings any time a pump is removed to allow the Storm Pumps to be used during high flow periods.

Alternatives 1A and 1B will present a challenging schedule, as all work is to be completed during low flow periods to allow the 14-ft sewers to remain open for high flow. This allows the Storm Pumps to remain on line and reduces the risk associated with bypass pumping for the full storm flow capacity. This limits work periods to dry weather when flows remain low and a weir in the Junction Shafts will provide a dry working area. Ongoing work in the Junction Shafts would require them to be cleaned as work is started/stopped to continue construction until the stop gates and guides are completed.

Alternatives 1A and 1B will be contained on the existing Conner Creek Station site. The actual location of the existing sewers must be determined during design.

3.4.2.3 Construction Cost Estimate – Alternative 1

The opinion of probable construction cost is presented Table 3-4. Note that these costs include all estimate markups detailed above. The probable construction cost is bracketed with a lower and upper range also defined above.

Table 3-4. Opinion of Probable Construction Cost – Alternative 1

Estimate	Lower Range (-30%)	Probable Cost	Upper Range (+50%)
Probable Construction Cost	$41,700,000	$59,600,000	$89,400,000

- Alternative 1A and Alternative 1B are estimated to be approximately the same cost.

3.5 Alternative 2: Significant Improvements of Freud PS and New Conner Creek PS

3.5.1 Description – Alternative 2

The major construction elements of Alternative 2 are presented in the bulleted list below.

- Freud Pump Station Improvements
    - Civil-Site
        - New Junction Shaft for Stop Gate – Ashland Relief Sewer
        - New Junction Shaft for Stop Gate – Fox Creek Relief Sewer
        - Provide access drives for new Junction Shafts and modify fencing.
        - New Sanitary PS, connecting sewers and force mains
    - Process-Mechanical
        - Replace existing Dewatering Pumps (2 pumps, 30 mgd each) and piping
        - Rehabilitate existing storm pumps (8 pumps total)
        - New Sanitary Pumps (2 pumps, 30 mgd each)
    - HVAC/Plumbing
        - Replace all HVAC systems and controls
        - Replace all plumbing fixtures, equipment, and piping
    - Architectural
        - All the items listed in Alternative 1 and the following:
        - Exterior brick cleaning of Main Building and site retaining wall
        - Provide new stair to south exterior concrete slab.
        - Provide new platform or means of accessing west exterior concrete slab
    - Structural
        - All the items listed in Alternative 1 and the following:
        - Prepare and repaint portions of structural steel roof trusses and roof purlins that have experienced slight corrosion from past roof leaks
        - Prepare and repaint structural steel runway beams for bridge crane
        - Replace damaged grating pieces in 2nd and 3rd floors
        - Prepare and repaint portions of structural steel grating support beams on 2nd floor and 3rd floor
        - Install means of drainage along strip of soil between concrete slab and perimeter wall at northwest side of pad
    - Electrical
        - Replace Outdoor Service Transformers (3 transformers, 6/7.5 MVA each)
        - Replace standby generator units and medium voltage switchgear associated with generator system (2035 project)
        - Replace motor field cubicles (8 total)
        - Replace indoor switchgear dc power distribution system
        - Replace and supplement lighting to meet IES recommended illumination levels

    - I&C
        - Retrofit aging Ovation panel
        - Retrofit heavily reworked control/mimic panel
- Conner Creek Pump Station Improvements
    - Civil-Site
        - New Storm Pump Station with divided wet well and isolation stop gates
        - New Sanitary Pump Station with isolation gate
        - Provide access drives and fencing to access new facilities
        - Decommission and isolate portion of existing CC PS to be taken out of service
    - Process-Mechanical
        - Install connector pipe to existing 14-ft diameter sewers
        - Install new Junction Shaft to connect sewers to Storm and Sanitary wet wells
        - Install new Storm Pumps (12 pumps, 205 mgd each)
        - Install new Sanitary Pumps (6 pumps, 40 mgd each)
    - HVAC/Plumbing
        - All new HVAC systems and controls
        - All new plumbing systems
    - Architectural
        - No improvements to the Storm Pump Station
        - No improvements to the Sanitary Pump Station
        - Switchgear Building and Misc. Site Structures – All the items listed in Alternative 1 and the following:
            - Exterior brick cleaning of Switchgear Building
    - Structural
        - No improvements to the Storm Pump Station
        - No improvements to the Sanitary Pump Station
        - Switchgear Building and Misc. Site Structures – All the items listed in Alternative 1
    - Electrical
        - New medium voltage electrical distribution system, including service transformers, medium voltage transformers, and motor starters
        - New standby generator system, including medium voltage switchgear
        - New low voltage (600VAC and below) power distribution system
        - Indoor and outdoor lighting to meet IES recommended illumination levels
    - I&C
        - New SCADA system
        - New field instrumentation

Figure 3-4 illustrates the proposed site improvements for Alternative 2 at the Freud Pump Station.

Figure 3-5 illustrates the proposed new Conner Creek Pump Station Alternative 2.

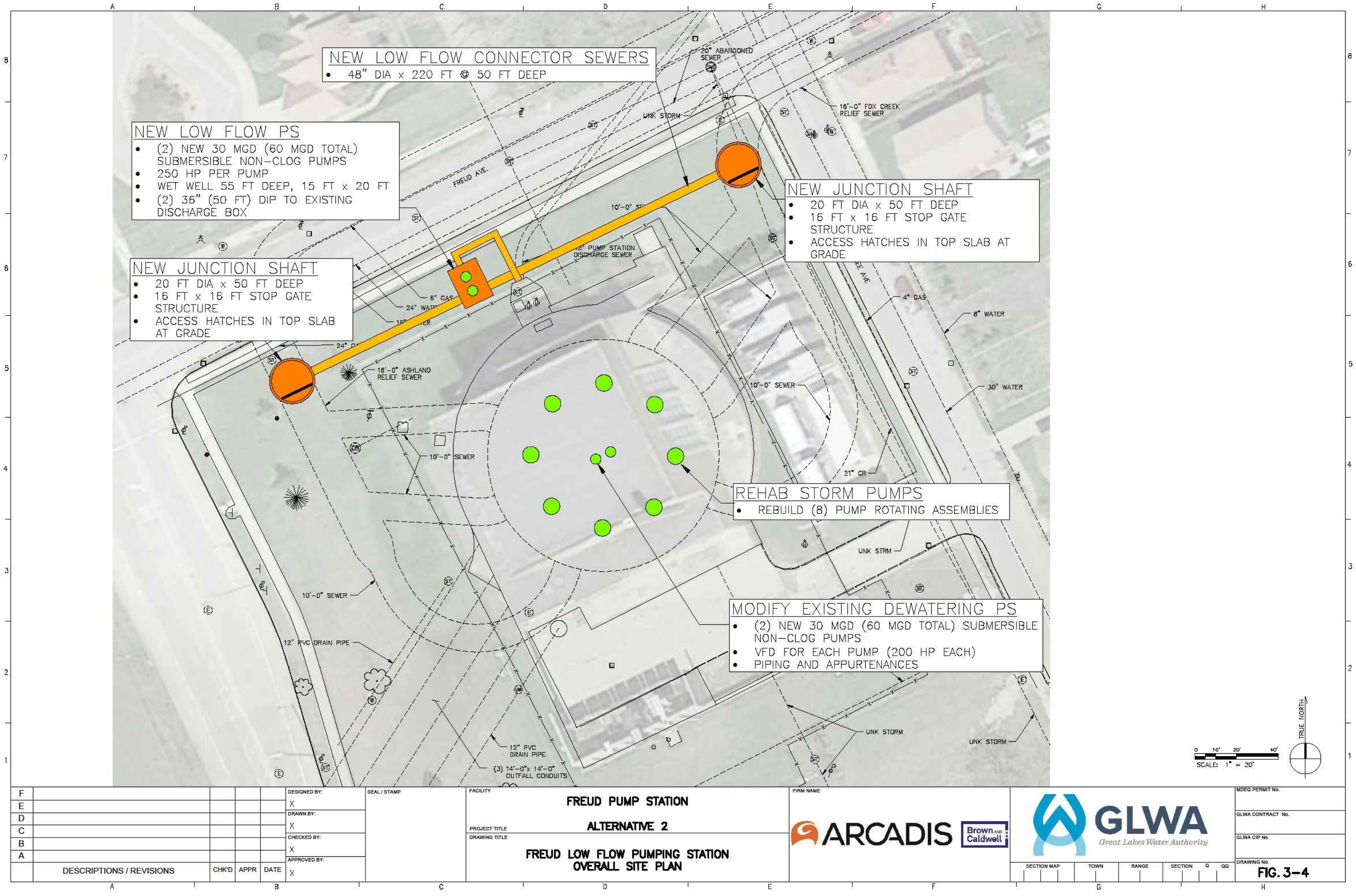
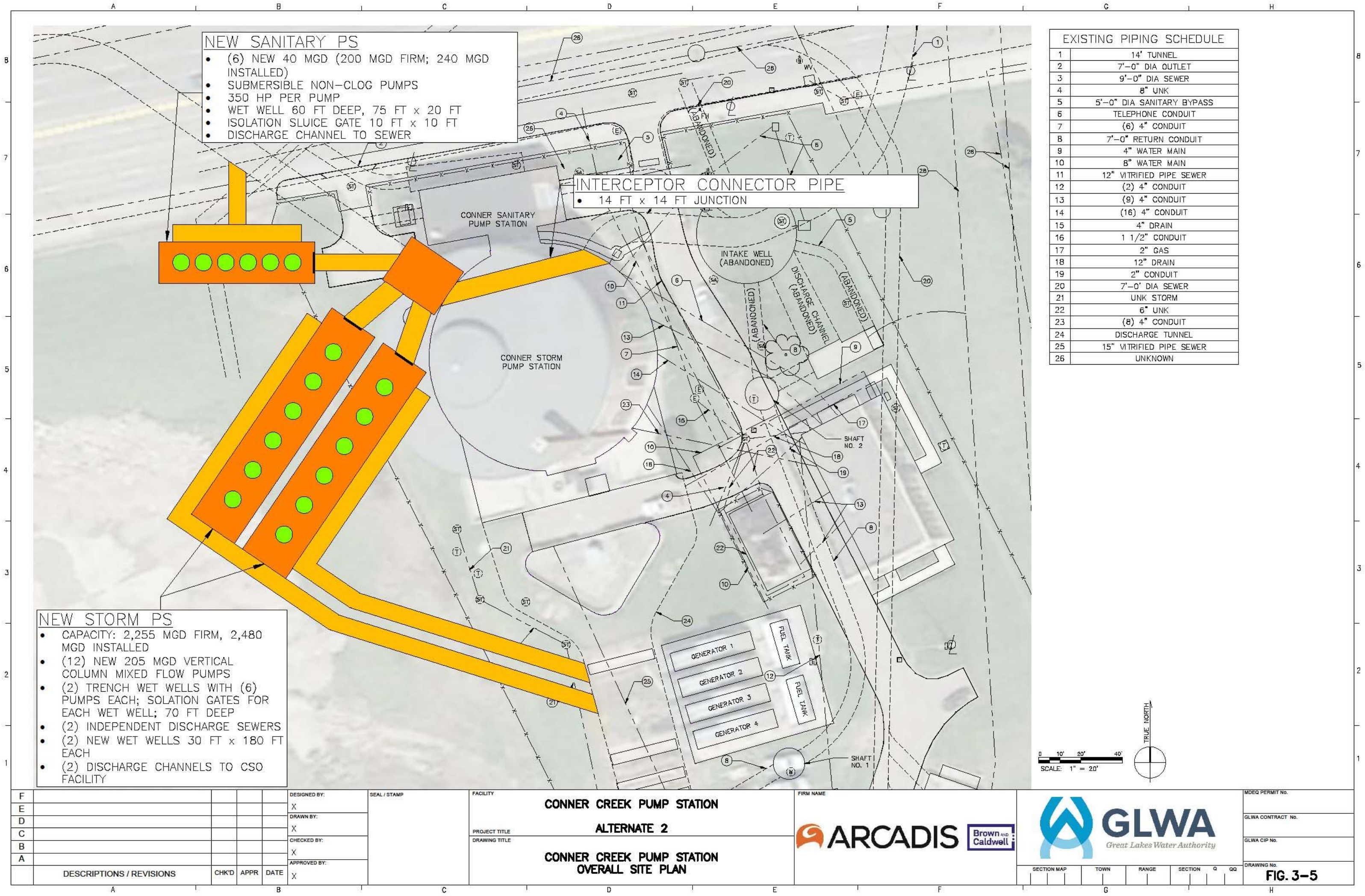


Figure 3-4. Alternative 2 - Freud Pump Station



NEW SANITARY PS

- (6) NEW 40 MGD (200 MGD FIRM; 240 MGD INSTALLED)
- SUBMERSIBLE NON–CLOG PUMPS
- 350 HP PER PUMP
- WET WELL 60 FT DEEP, 75 FT x 20 FT
- ISOLATION SLUICE GATE 10 FT x 10 FT
- DISCHARGE CHANNEL TO SEWER

INTERCEPTOR CONNECTOR PIPE

- 14 FT x 14 FT JUNCTION

NEW STORM PS

- CAPACITY: 2,255 MGD FIRM, 2,480 MGD INSTALLED
- (12) NEW 205 MGD VERTICAL COLUMN MIXED FLOW PUMPS
- (2) TRENCH WET WELLS WITH (6) PUMPS EACH; SOLATION GATES FOR EACH WET WELL; 70 FT DEEP
- (2) INDEPENDENT DISCHARGE SEWERS
- (2) NEW WET WELLS 30 FT x 180 FT EACH
- (2) DISCHARGE CHANNELS TO CSO FACILITY

EXISTING PIPING SCHEDULE	
1	14' TUNNEL
2	7'–0" DIA OUTLET
3	9'–0" DIA SEWER
4	8" UNK
5	5'–0" DIA SANITARY BYPASS
6	TELEPHONE CONDUIT
7	(6) 4" CONDUIT
8	7'–0" RETURN CONDUIT
9	4" WATER MAIN
10	8" WATER MAIN
11	12" VITRIFIED PIPE SEWER
12	(2) 4" CONDUIT
13	(9) 4" CONDUIT
14	(16) 4" CONDUIT
15	4" DRAIN
16	1 1/2" CONDUIT
17	2" GAS
18	12" DRAIN
19	2" CONDUIT
20	7'–0' DIA SEWER
21	UNK STORM
22	6" UNK
23	(8) 4" CONDUIT
24	DISCHARGE TUNNEL
25	15" VITRIFIED PIPE SEWER
26	UNKNOWN

Figure 3-5. Alternative 2 - Conner Creek Pump Station

3.5.2 Analysis – Alternative 2

3.5.2.1 Discussion – Alternative 2

The major differences between Alternative 2 and Alternative 1 are described as follows:

The Freud Station improvements are similar to Alternative 1, but adds a new Sanitary Station on the site to provide dedicated Sanitary Pumps in a new wet well that can be isolated for maintenance. This will allow the existing Dewatering Pumps to be dedicated for that purpose and sized for the required operating range.

The Conner Station improvements are more extensive as this is a replacement station with an increased Sanitary Pump capacity, and the same Storm Pump capacity which utilizes a deeper wet well to provide the proper submergence for new vertical mixed-flow pumps. This alternative requires the acquisition of new property near the Conner Creek Station. As result, there is some risk related to availability of a site and potential for delay related to property acquisition.

Similar to Alternative 1, the major benefits of this alternative are those associated with meeting functional requirements as described above. These include isolation of the wet wells, with a divided wet well at the new Conner Station, and isolation for the existing Freud Station, although it will still not have a divided wet well for redundancy (best practice).

Alternative 2 eliminates the risk related to maintaining pumping capacity during construction and electrical switchover by providing a full new permanent pumping facility prior to switchover from the existing Conner Creek Station. Property acquisition is required for the new PS site, laydown area and discharge conduits, tentatively to the west of the existing Conner Creek Station. As a result, there is some risk related to availability of a site and potential for delay related to property acquisition.

3.5.2.2 Constructability – Alternative 2

Freud Pump Station - Constructability challenges for this alternative are similar to Alternative 1, but with the addition of the new low flow Sanitary Pump Station. These include: maintaining pumping capacity during construction (need for bypass pumping), adding electrical gear for the new pumps, likelihood of unforeseen conditions, and providing adequate contractor laydown area. Limited bypass pumping can be provided by the new Sanitary Pumps for Alternative 2, to allow construction in phases during dry periods to reduce the necessary bypass pumping capacity.

The likely sequence of construction for Alternative 2 is as follows:

1. Replace the existing Dewatering Pumps to achieve the desired operating range,
2. Install the two new Junction Shafts to the extent possible without opening the 16-ft diameter sewers, including stubs out for connections to the new Sanitary Station,
3. Install the new Sanitary Station, sewers, pumps, and discharge piping,
4. Put the new Sanitary Station into service to handle low flows,
5. Cut out the sewers within the Junction Shafts to expose the flow, and divert low flows to the new Sanitary Station,
6. Complete work in the Junction Shafts to install the stop gates and access for handling the gates,
7. Remove the diversion weirs to the Sanitary Station.
8. Rehabilitate the Storm Pumps.

Alternative 2 will present a challenging schedule, as all work is to be completed during low flow periods to allow the 16-ft sewers to remain open for high flow. This allows the Storm Pumps to remain on line and reduces the risk associated with bypass pumping for the full storm flow capacity. This limits work periods to dry weather when flows remain low and a weir in the Junction Shafts will provide a dry working area. Ongoing work in the Junction Shafts would require them to be cleaned as work is started/stopped to continue construction until the stop gates and guides are completed.

Alternative 2 is expected to be contained on the existing Freud Station site, but will require the use of portions of the right-of-way for Freud Avenue and Tennessee Avenue during construction. The actual location of the existing sewers must be determined during design.

Conner Creek Pump Station - Constructability challenges for this alternative are different, as this is a new station to replace the existing Conner Creek Station. These include: acquiring adjacent property for the new station, adding electrical gear for the new pumps, likelihood of unforeseen conditions, and providing adequate contractor laydown area. Bypass pumping is not necessary as flow can be diverted from the existing station to the new station after it is on-line.

The likely sequence of construction for Alternative 2 is as follows:

1. Construct the new Conner Creek Station (shown on the parcel to the west of the existing station) with sewers and force mains to the existing discharge conduits,
2. Concurrently, construct a new Junction Shaft to connect the existing station, the new Sanitary Station, and the new Storm Station. Complete this structure without cutting through the wall into the existing station,
3. Cut out the wall to the existing station in the Junction Shaft to send flow to the new Conner Creek Station,
4. Install the Connector Pipe through the wet well of the existing station during low flow. Sanitary flow can be routed through the existing Sanitary Station during this period.
5. Decommission all of the existing Sanitary and Storm pumps and remove them from the stations.

Alternative 2 will constructed on a schedule that will be independent of current operations for the most part. Portions of the work will need to be completed during low flow periods to make connections to the new station and allow the 14-ft sewers to remain open for high flow. This allows high flows to be conveyed to the new station and reduces the risk associated with bypass pumping for the full storm flow capacity. This limits work periods to dry weather when flows remain low and are handled by the Sanitary Pumps. Ongoing work for the Connector Pipe in the existing station would require cleaning as work is started/stopped to continue construction until the stop gates and guides are completed.

Alternative 2 could be constructed on the adjacent parcel to the west of the existing Conner Creek Station. The actual location of the existing sewers must be determined during design.

3.5.2.3 Construction Cost Estimate – Alternative 2

The opinion of probable construction cost is presented Table 3-5. Note that these costs include all estimate markups detailed above. The probable construction cost is bracketed with a lower and upper range also defined above.

Table 3-5. Opinion of Probable Construction Cost – Alternative 2

Estimate	Lower Range (-30%)	Probable Cost	Upper Range (+50%)
Probable Construction Cost	$93,800,000	$134,100,000	$201,100,000

- Probable cost does not include land acquisition.

3.6 Alternative 3: New Combined Pump Station

3.6.1 Description – Alternative 3

The major construction elements of Alternative 3 are presented in the bulleted list below.

- New site location (tentatively west of existing CC PS)
- New wet well structures, two for storm pumps and two for sanitary pumps
- Connector from the existing CC PS to new Combined PS
- New 24-ft diameter connector sewer from Freud PS to new Combined PS
- New Storm Pumps (10 pumps, 475 mgd each)
- New Sanitary Pumps (6 pumps, 45 mgd each)
- Sluice gates and stop gates to isolate wet wells
- Civil work for drives, parking, fencing, and grading
- HVAC/Plumbing for pumping, operating, electrical, and office areas
- Architectural for new superstructure building
- Structural for new station and superstructure, equipment handling, and stairs
- Electrical for power, lighting, controls, and standby power
- I&C for monitoring and control of pumping and building systems

Figure 3-6, Figure 3-7, and Figure 3-8 provide an overview of the new combined pump station concept. It should be noted that is one of a few possible new pump station concepts.

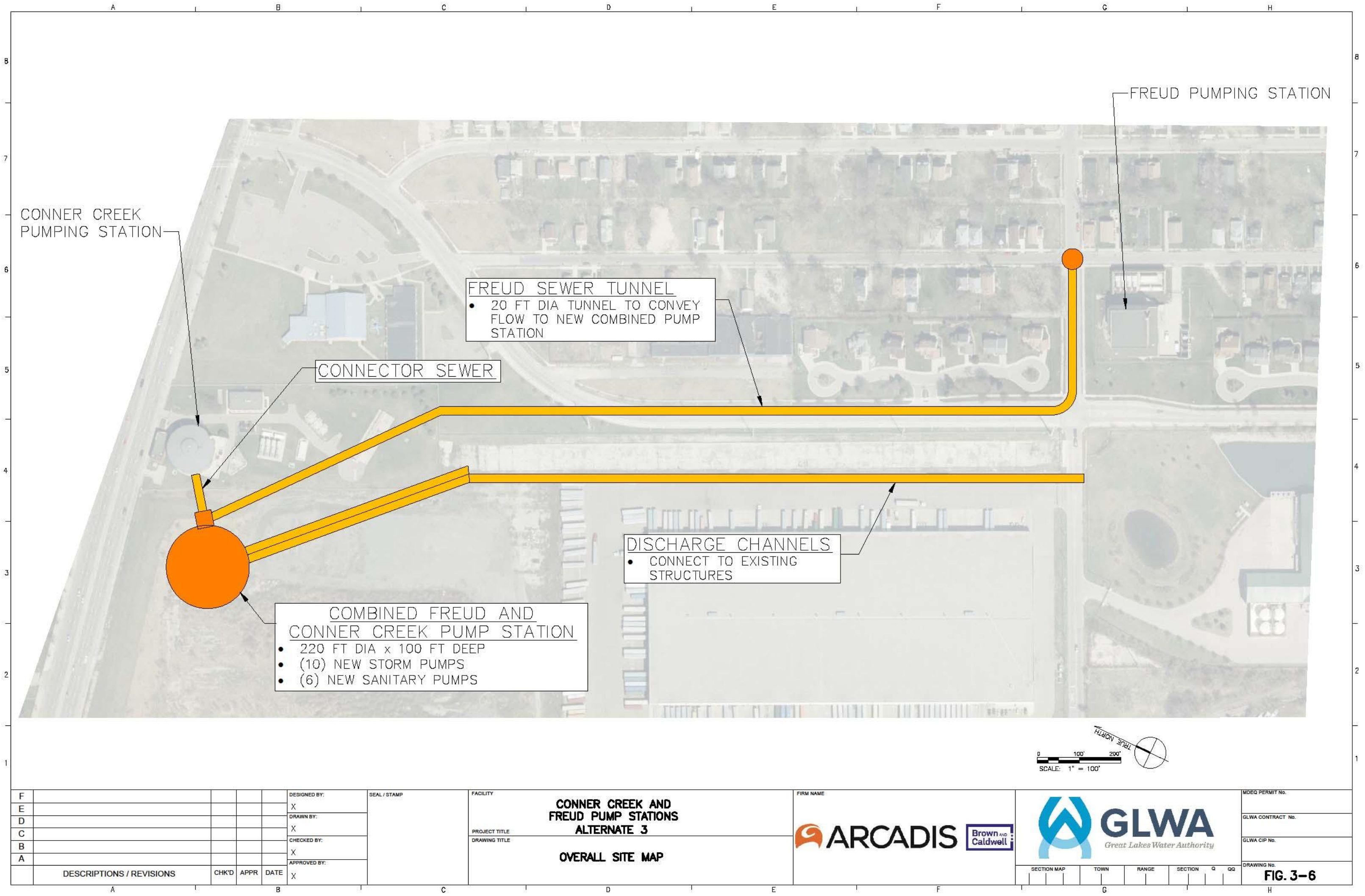


Figure 3-6. Alternative 3 – Combined Pump Station Site Plan

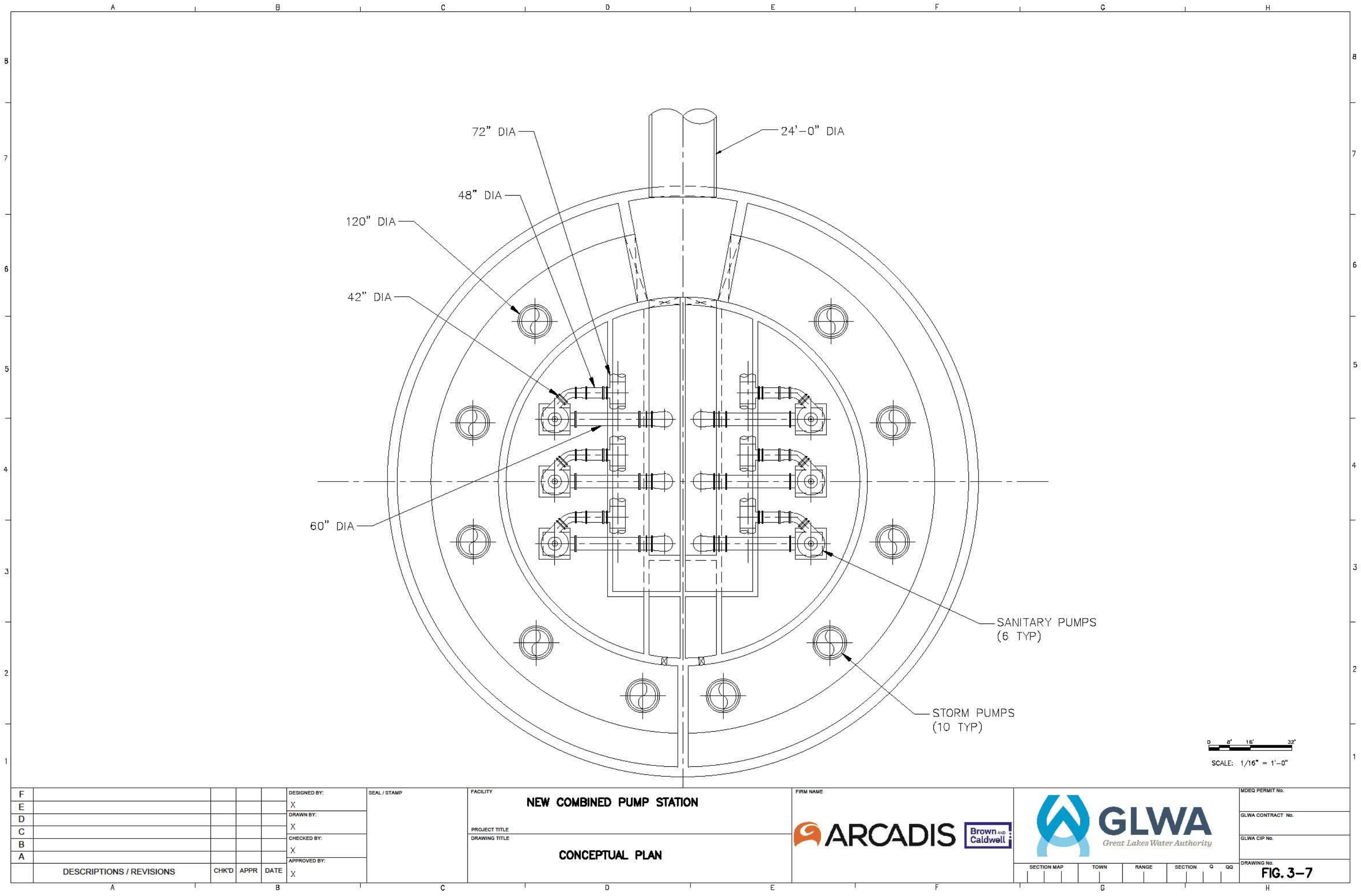


Figure 3-7. Alternative 3 – Combined Pump Station Pump Layout Plan

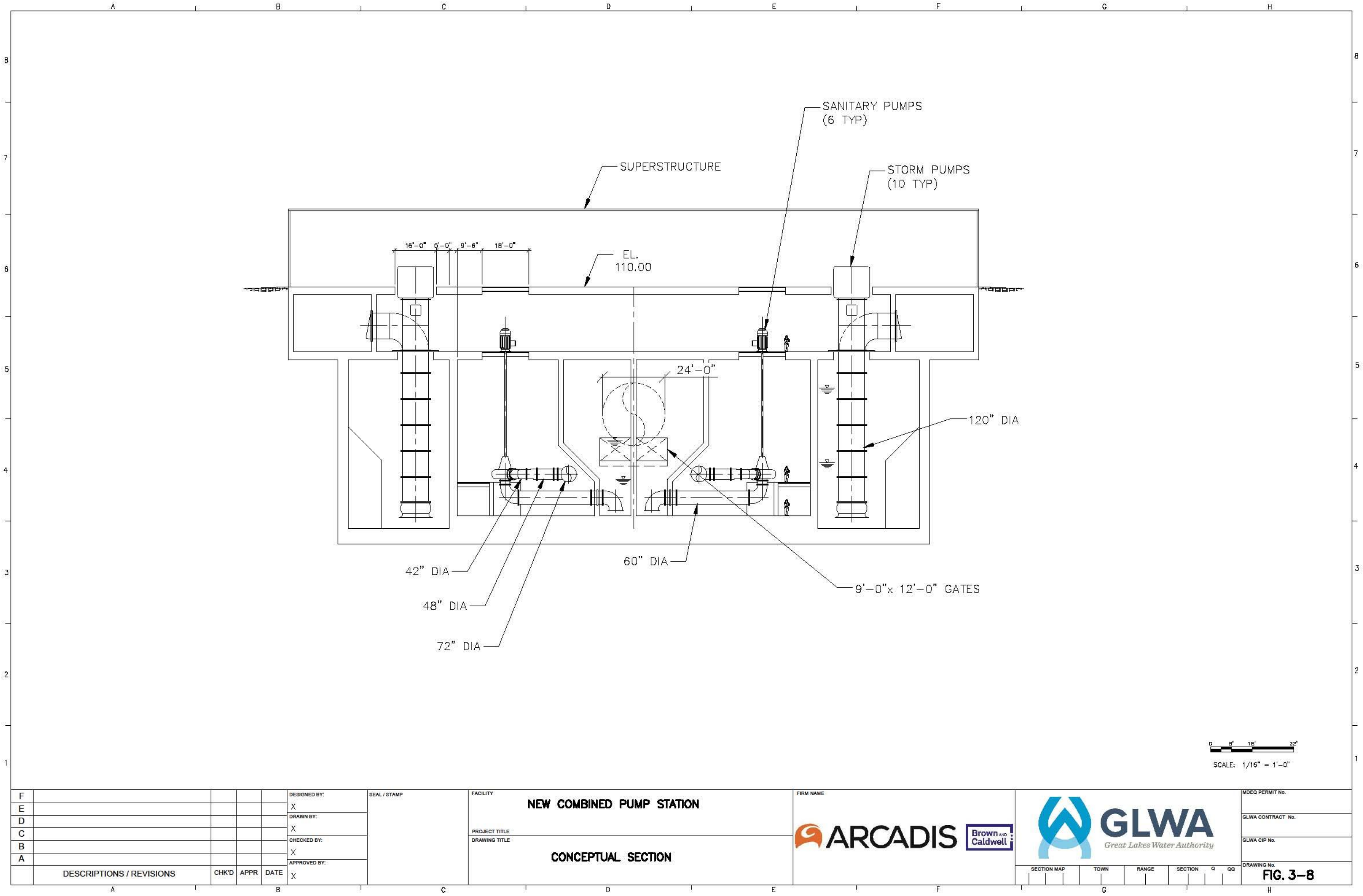


Figure 3-8. Alternative 3 – Combined Pump Station Section

3.6.2 Analysis – Alternative 3

3.6.2.1 Discussion – Alternative 3

The concept of constructing a new combined pump station to replace both Freud and Conner Creek was requested by GLWA for inclusion as an alternative due to limitations and present age of both the existing stations. The tentative location for a new station is on a vacant parcel immediately adjacent and west of the existing Conner Creek Station. Key issues include:

- The proposed location for a combined station is based on space availability adjacent to the existing Conner Creek Station, and the fact that the Freud Station is essentially "landlocked". This brings up the issue of conveying flow from both stations to one site and then discharging it to the Conner Creek CSO facility. This requires flow to be conveyed from the two existing 16-ft diameter sewers at the Freud Station through a new 24-ft diameter tunnel to the new station, and providing discharge channels to convey flow to the CSO facility. The existing discharge from the Conner Creek Station will carry half of the flow and a second parallel conduit will need to be constructed and connect south of Freud Avenue.
- Significant capital investment in 60 to 90+ year old structures is not common in the water/wastewater industry primarily due to a desire to manage risk. DWSD has benefited over the years from the robust construction techniques of the early-to-mid 1900's. Unfortunately, these old facilities also limit GLWA from fully realizing the operations and maintenance efficiencies of modern design practices. In short, a new pump station would position GLWA for continued operations for the next 50 to 100 years, whereas modifying the existing Freud and Conner Creek Pump Stations will result in a functioning facility in the near term but will continue to tie GLWA to the capital replacement cycle of old facilities (e.g. routine major re-investment).

3.6.2.2 Constructability – Alternative 3

Constructability challenges for all three alternatives include: maintaining pumping capacity during construction, ease of electrical switchover, likelihood of unforeseen conditions, and providing adequate contractor laydown area.

The likely sequence of construction for Alternative 3 is as follows:

1. Construct and equip new pump station (complete),
2. Construct new Junction Shaft to consolidate influent flow,
3. Construct new tunnel to convey flow from the Freud PS to the new Combined Station,
4. Construct new discharge channels from the new station to the CSO facility,
5. Perform influent/effluent tie-ins,
6. Begin operation of new PS

Alternative 3 involves deep excavation, tunneling, and tie-ins to existing facilities. Alternative 3 eliminates the risk related to maintaining pumping capacity during construction and electrical switchover by providing a full new permanent pumping facilities prior switchover from the existing Freud and Conner Creek Stations. Property acquisition is required for the new PS site, tunnel path and discharge conduits. Figure 3-6 shows new PS to the west of the existing Conner Creek Station. As result, there is some risk related to availability of a site and potential for delay related to property acquisition.

3.6.2.3 Construction Cost Estimate – Alternative 3

The opinion of probable construction cost is presented Table 3-6. Note that these costs include all estimate markups detailed above. The probable construction cost is bracketed with a lower and upper range also defined above.

Table 3-6. Opinion of Probable Construction Cost – Alternative 3

Estimate	Lower Range (-30%)	Probable Cost	Upper Range (+50%)
Probable Construction Cost	**$181,700,000**	**$259,600,000**	**$389,400,000**

- Probable cost does not include land acquisition.

Section 4: Discussion and Recommendations

The major construction elements, advantages, disadvantages, and capital cost for the alternatives are summarized in Table 4-1.

Table 4-1. Pump Station Alternatives Summary

Alternative 1 Minimum Improvements for Freud PS and Conner Creek PS	Alternative 2 Intermediate Improvements for Freud PS and New Conner Creek PS	Alternative 3 New Combined Pump Station
Major Construction Elements		
• Rehabilitation of Storm Pumps at Freud PS • New Dewatering Pumps (2 x 30 mgd) at Freud PS • New Storm Water Pumps (8 x 317 mgd) at Conner PS • Rehabilitation of existing Sanitary Pumps at Conner PS • New additional Sanitary Pumps (2 x 40 mgd) at Conner PS • Significant temporary bypass pumping • Significant constructability challenges to maintain PS operation during construction • New wet well isolation at both PS • Eliminate vacuum priming system at Conner PS	• Property acquisition (adjacent property) • Rehabilitation of Freud PS • New Sanitary Pump Station at Freud PS • New Sanitary (6 x 40 mgd) and Storm (12 x 200 mgd) PS at Conner with 2 wet wells • New wet well isolation at both PS • New connection piping at both PS	• Significant property acquisition • All new 4 bgd PS, 2 wet wells • 6 x 45 mgd Sanitary Pumps • 10 x 475 mgd Storm Pumps • New tunnel connection to influent sewers at existing Freud PS • New discharge channel (parallel existing discharge channel) to existing CSO • New wet well and junction chambers • Abandonment of Freud PS and Conner PS
Advantages		
• Lowest capital (initial) cost • Meets most functional requirements • Construction activities contained within existing property, plus right-of-way	• Meets all functional requirements • Improves operational reliability with new Sanitary Pump Station at Freud PS • Two wet wells at Conner PS increase redundancy, reliability, and maintainability • Eliminate expensive routine maintenance and O&M costs at 90+ year old Conner PS • Reduced bypass pumping / risk • Can take advantage of modern pumping equipment and PS design concepts at Conner PS	• Lowest long-term O&M • Can take full advantage of modern pumping equipment and PS design concepts • Most energy efficient option (pumping and facility) • Reduced temporary bypass pumping / lowest risk • Longest useful life for overall facility
Disadvantages		
• Risks/Limitations/Costs of existing Conner PS superstructure still exist • Least favorable match to functional needs	• Substantial Capital cost	• Highest Capital cost • Risk of tunneling construction near residential area
Cost		
• Capital Cost: $59.6M	• Capital Cost: $134.1M	• Capital Cost: $259.6M

A qualitative comparison of the alternatives related to their ability to meet the functional performance requirements described in Section 2 is presented as Table 4-2.

Table 4-2. Functional Requirements Qualitative Comparison

	Alt 1 – Minimum Improvements for Freud PS and Conner Creek PS	Alt 2 – Intermediate Improvements at Freud PS and New Conner Creek PS	Alt 3 – New Combined Pump Station
Operational Requirements (Freud PS / Conner PS)			
Firm Capacity	Good / Good	Good / Best	Best / Best
Wet Well Range	Good / Limited	Good/ Best	Best / Best
Pump Performance	Good / Good	Better	Best / Best
Suction Intake Conditions	Good / Limited	Good/ Best	Best / Best
Power Supply Redundancy	Good / Good	Good / Good	Good / Good
Maintenance Requirements (Freud PS / Conner PS)			
Pump Isolation	Limited	Better	Best
Wet Well Isolation	Good	Better	Best
Equipment Removal Safety	Limited	Better	Best

The Arcadis Team's recommended ranking of the three alternatives is presented here:

1) Alternative #2 – New Freud Sanitary PS and new Conner Creek PS – This alternative receives the highest ranking, as it satisfies most of the operational and maintenance requirements. Although this alternative is still tied to the aging Freud Pump Station, the Storm Pump configuration is acceptable and the addition of a new Sanitary Pump Station allows for improved isolation and maintenance. The new Conner Creek Pump Station achieves all of the requirements for divided (redundant) wet wells, improved pump isolation, and wet wells that are in compliance with HI Standards for proper pump suction hydraulics.

2) Alternative #3 - New Combined Pump Station – This alternative receives the second highest ranking because it does satisfy all of the operational and maintenance requirements, but at a significantly higher cost. Also, property acquisition, construction of the connecting tunnel between the pump stations, and the final construction is likely to take a significant amount of time to complete.

3) Alternative #1 – Rehabilitation of Existing PS Configuration – This alternative receives the lowest ranking due to the limited long-term benefits that it provides. While the primary objectives are met by providing isolation of the storm wet wells at both stations and elimination of the vacuum priming system at Conner Creek, there are other issues that remain. The Freud Pump Station still has the sanitary wet well within the storm wet well and this cannot be separately isolated. While the Conner Creek Storm Pumps can be replaced with vertical column pumps, these likely will not have sufficient submergence to meet the required Net Positive Suction Head (NPSHr), due to the existing configuration of the station and the limited depth available in the wet well. We believe that the NPSH requirements can be achieved at high wet well levels, but not for lower operating levels in the normal pumping range.

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Appendix F

Freud Pump Station Improvements, Basis of Design Report, August 2020

Great Lakes Water Authority

FREUD PUMP STATION IMPROVEMENTS

Project No. CS-120

Basis of Design Report

August 2020

FREUD PUMP STATION IMPROVEMENTS BASIS OF DESIGN REPORT

PROJECT NO. CS-120

Great Lakes Water Authority

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GLWA

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Our Ref.:
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Date:
August 2020

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VERSION

Revision No	Date	Description	By
1	08/31/20	For GLWA Review	FJS
2			
3			

Contents

FIGURES

APPENDICES

1 GENERAL

1.1 Project Purpose

The purpose of the Freud Pump Station Improvements Project is to make modifications and improvements to the pump station to protect the health, safety and welfare of residents served by improving operability, reliability, integrity, and maintainability.

Primary scope items include:

- Rehab of the storm water pumps including replacement of the pump rotating assembly, line shafts, and concrete pump supports.
- Design of a single isolation shaft with a 30 MGD firm sanitary capacity to manage dry weather flow conditions
- Installing new dewatering pumps inside the Freud Pump Station with an approximate 10.8 MGD firm capacity to be used solely as dewatering pumps between storm events
- Providing access to the Freud Pump wet well to allow draining, cleaning, inspections, and maintenance.

Additional scope items are detailed below.

1.2 Major Project Components

Major project components include:

- Rehabilitation of existing storm station.
    - Civil – Site improvements.
    - HVAC/Plumbing improvements
    - Architectural interior and exterior improvements.
    - Structural interior and exterior improvements.
    - Electrical improvements.
    - Instrumentation and Controls improvements.
- Rehabilitation of existing storm pumps, line shaft, steady bearings, and couplings
- Replacement of existing storm wet well dewatering pumps.
- Provide storm wet well isolation.
- Provide storm wet well access.
- Design of a 30 MGD sanitary pump station.

1.3 Wet Well Isolation Shaft Evaluation

Several options for the Freud Isolation Shaft were discussed in the Freud and Conner Creek Pump Station Improvements Concept Alternatives Evaluation report (November 2017) and during a meeting with the GLWA on May 28, 2020 (Freud & Conner Creek Pump Station Improvements Study & Design). At the request of the GLWA during the May 28, 2020 meeting, the single isolation shaft on Freud Street between Conner Street and Navahoe Street was selected. The Freud Isolation Shaft is described in the section below.

1.4 Site Datum and Flood Elevation

Survey control monuments within the boundaries of the Site have been established and are available for use. Horizontal datum is based on City of Detroit coordinate base. Vertical datum used is the Detroit Datum.

The 100-year flood elevation is EL 579.00 NAVD88 (EL 99.75 Detroit Datum) based on the FEMA NFIP firm map 26163C0302E (February 2, 2012). The Freud Pump Station is outside of the 100-year flood elevation.

1.5 Reference Drawings

Key drawings provided from GLWA are as follows:

- Fox Creek District Freud Storm Water Pumping Station Super Structure (June 1952)
- Ashland Relief Sewer drawings pages 1-26 (August 1958)
- Freud Sewage Pumping Station (January 1993)

1.6 Safety Provisions

Provisions for fall protection at the Freud Isolation Shaft and wet well access entry points will be incorporated into the design. Any new access hatches will be provided with fall protection grating just beneath the hatch or removable railing around openings. Ladder safety posts will be included with all ladders and mounting sleeves for a man rated davit and hoist will be provided at each ladder.

2 FIELD STUDY

2.1 Geotechnical

Key elements of the Freud project require excavation for the Freud Isolation Shaft and the construction of structures. Historic geotechnical information provided a base line for conceptual design of the isolation shafts discussed below. In addition, it will serve as the basis for additional geotechnical field sampling and data collection. These geotechnical data will be used to provide design criteria for the stabilization of excavation (SOE) for the isolation shaft, the liner of the isolation shaft and necessary site structures. The following tasks will be completed as part of and resulting from the geotechnical field study:

- Finalize review of historic geotechnical data and layout a subsurface exploration program to provide design criteria for the SOE, the isolation shaft liner, and the other structures for the project.
- Complete a Geotechnical Data Report (GDR) that will present the results of the subsurface exploration program. The GDR will include
  - Test Boring Logs

  - In-situ test data
  - Groundwater observation wells and vibrating wire piezometer data
  - Laboratory test results
  - Soil Classification system to be used for interpretation of the subsurface materials
- Completion of a Geotechnical Interpretive Memoranda that will interpret the geotechnical data and provide risk discussions and guidance for the specifications and contracting documents for the geotechnical work.
- Finalize design criteria for the design elements impacted by geotechnical data
- Finalize necessary design and contract documents

2.2 Site Surveying

Initial site survey and topographic survey were completed by Nederveld Inc. (Ann Arbor, Michigan) on May 11 – 15, 2020 and are described in the subsequent sections.

Site Surveying

Site survey was completed to establish a site and topographic survey of the project area outlined in red on Figure 1 that included the following information that will be used in the Freud Pump Station Improvements design:

- Physical topographic survey with one (1) foot contours for the area of interest (AOI) shown in Figure 1.
- Obtained available right-of-way, easement, property and section corner information from Local and State agencies.
  - Property lines and right-of-ways were added to the topographic survey to produce the base map.
  - Property deed was not available online so the Wayne County Register of Deeds was contacted to search its records. After searching for 669 Tennessee and 12300 Freud, no documents could be found showing transfer of the current parcel to the City of Detroit.
- Sent out survey notification and coordinated with utility companies to locate underground utilities in field and to obtain utility plans.
- Provided utility mapping and connectivity between structures.
- Site survey was completed to obtain the following information to generate a survey drawing that will be used in the detail design:
  - All located utilities
  - Storm sewers, including invert, crown (exterior top of pipe) and rim elevations and type of pipe (including outfall structures).
  - Sanitary sewers, including invert, crown (exterior top of pipe), and rim elevation and type of pipe (including outfall structures)
  - Building limits on the Freud property including the pump station, electrical transformers, loading docks, driveway, generators and generator enclosure
  - Fence lines
  - Tree groups
  - Individual trees

  - Edges of pavement for all streets and sidewalks within the survey limits.
  - Limits of existing channel banks and bottom of channel.
  - Location and elevations of onsite benchmarks.
  - Property limits including the existing right-of-way.
  - Existing easements
- Provide survey data in electronic format including graphical representation of structure information (rim elevation, structure down, inverts, structure dimensions, connected pipe material, connected pipe diameter, and connected pipe direction).
- All elevations were obtained using the North American Vertical Datum of 1988 (NAVD88) coordinate system and then was converted to the City of Detroit vertical datum.

Within the RED Boundary:
- TOPO Survey
- Utility Locate
- Survey all located utilities.
- Storm and Sanitary Sewer: invert, crown and rim elevations.
- Property boundary survey.
- Locate trees, individual and groups.
- Building limits as described in Section 1.e.iv.

Figure 1: Survey Area of Interest

Topographic Surveying

Topographic Field Survey was completed to establish site and topographic survey of the AOI outlined in RED shown on Figure 1 and following information was included:

- Existing utilities on site including rim and invert elevation of storm, sanitary and water.
- Limits of all existing structures and buildings.
- Fence lines
- Edge of pavement (all types).

2.3 Utility Locate

Prior to the site survey and topographic survey activities as described in Section 2.2, the Michigan One-Call system (MISSDIG) was contacted to mark all the utilities within the AOI outlined in red shown on Figure 1.

In addition to MISSDIG marking utilities, a private utility locator (Underground Detective, Cincinnati, Ohio) was contracted and completed the following:

- Marked all private utilities in the AOI and adjacent areas as depicted on Figure 2.
  - The private utility locator used ground penetrating radar and electromagnetic locating equipment to locate utilities.
- All utilities that were located were marked and then surveyed.

Figure 2: Private Utility Locate Area of Interest

The completed topographic survey and surveyed utilities are depicted on drawings C-01 and C-02 (Appendix A).

2.4 Wet Well Inspection

GLWA reports the Freud Pump Station wet well has not been inspected since it was constructed in the 1950's. Inspection of the wet well is planned as part of this construction project. Work will need to be performed during low flow period(s) when the storm pumps are not needed. Since there is currently very limited access to the wet well, inspection work is likely to be performed after the wet well access improvements are complete and the new sanitary pumps are operational in the new Freud Isolation Shaft (see sections below). This would allow for the wet well to be pressure washed and cleaned for a more thorough inspection of concrete surfaces. Although the condition of the wet well is unknown, the construction cost estimate includes concrete repairs base on assumed quantities.

2.5 Wet Well Access

Access Through Abandoned Inlet Sewer/Valve Actuator

This would likely require a roof hatch to allow use of a crane to move equipment in and out of the wet well. Access to the roof will be needed. In addition, a wall needs to be constructed to isolate the space from the main pump motor room. The largest practical floor opening, and roof opening will be provided, based on limitations of the current structure. The current floor opening (Figure 3) would be modified and enlarged to allow access to the wet well. Providing a man door from the outside of the station will also be required to allow maintenance personnel access through a dedicated exterior entrance, along with a roll-up door to handle tools and equipment. It would also allow access for small equipment without needing to be lifted to the roof. The roof hatch will be located over the floor opening to provide a path for a crane to lower equipment down into the wet well. A preliminary wet well access building section and layout has been in included on drawings M-08 and M-10, respectively (Appendix A).

Figure 3: Existing Floor Hatch

Access hatch behind Pump Motor 4

This option utilizes the existing hatch through the motor floor located behind Pump Motor 4. Using this hatch to access the wet well presents room classification concerns for the main motor room. Although original drawings show a ladder from the hatch to the wet well, the condition of the ladder is unknown. The size of the existing hatch (approximately 3-feet by 3-feet) limits equipment from being lowered into the wet well. It would also be very difficult and messy to remove grit and debris from this hatch through the motor room to the exterior of the building.

Access from outside the pump station

This option would require construction of a isolation shaft on the exterior of the pump station. This shaft will likely be on the south side of the station providing entry to the wet well below the abandoned 10-foot diameter inlet sewer. This abandoned 10-foot diameter inlet sewer opening, at the outer caisson wall of the pump station, has a centerline at elevation 35.00. This would require the isolation shaft on the exterior of the pump station to go at least 80 feet below the surface to enter the wet well floor at elevation 20.00. The structural integrity of the outer caisson wall, if a isolation shaft is excavated next to it, is something that will need to be investigated before this option is executed. The wet well access shaft would be installed approximately 50 feet south of the Freud Pump Station. The two structures would have to be connected via a tunnel. The connection of the two structures would require coring through the almost 7-foot-thick outer caisson concrete wall. Some major design challenges and increased cost implications would entail the diameter of the wet well access shaft, the installation of the access shaft, potential relocation of the Freud Pump Station transformers, structurally supporting the new connection of the two structures, and preventing the accumulation of grit, sludge, debris in the tunnel that connects to wet well access shaft to the Freud Pump Station.

2.6 Influent Piping Inspection

Previous inspections of the Ashland and Fox Creek (referred to as Mack Sewer in the reports) Relief Sewers were completed by Inland Waters Pollution Control, Inc. (Detroit, Michigan) in 2016 and 2019. The final reports of the sewer inspections have been included in Appendix B and will be reviewed during the design. If further inspections are required for the Freud Pump Station Improvements, a separate proposal will be provided to the GLWA.

2.7 Stormwater Wet Well Physical Model

Clemson Engineering Hydraulics, Inc. (CEH) conducted a physical hydraulic model study [Freud Stormwater Pump Intake Structure Physical Hydraulic Model Study, Final Report (Rev 2), February 2018) of the Great Lakes Water Authority’s Freud storm water pump intake structure.

The objectives of the study were as follows:

- Evaluate the performance of the intake structure to determine if any potential problems may exist with the approach flow hydraulics that may adversely impact the performance of the pumps.
- If necessary, develop modifications to the design or implement corrective measures that would mitigate or eliminate problems associated with the adverse approach flow.
- Test and document the approach flow conditions in the sump with the final recommended modifications in place.

Based on the report, CEH recommended that a floor cone be installed under each pump and suction tubes/shroud on the ceiling under each of the pumps. Four vanes should also be installed in the suction tubes/shrouds. There are significant challenges and risks in constructing these flow conditioning devices in a wet well that cannot be taken out of service. Access is limited and all components would need to be assembled in the wet well and temporarily supported until installation is complete. Temporary supports and construction materials in the wet well could be dislodged during a storm event and damage the storm pumps. Based on the construction complexity, operational risk and flooding risk during construction, the proposed flow conditioning devices are not included in the Freud Pump Station Improvements design. Furthermore, the current stormwater pumps do not appear to be negatively affected by the lack of the floor cones and suction tubes/shrouds. GLWA recently replaced the original rotating assemblies in stormwater pumps 5 and 8 under GLWA-CON-109. The original rotating assemblies were put into service over 60 years ago and were just replaced.

2.8 Stormwater Pump Vibration Analysis

Based on observations made by the GLWA during the operation of several stormwater pump simultaneously, the Freud Pump Station appears to experience excessive vibration. It is unclear if the vibration is due to a structural or mechanical issue with the stormwater pumps, motors, line shaft alignment, or impeller imbalance.

Following the completion of the stormwater pump upgrades (described in more detail in the sections below) a vibration analysis of the stormwater pumps can be completed to assist in determining the extent of the issue. One of the main objectives of a vibration analysis would be to determine if the vibration levels of the pumps and building are acceptable versus acceptance criteria in ANSI/Hydraulic Institute Standards. Since the stormwater pumps operate infrequently due to water levels in the wet well based on the duration and intensity of storms, a vibration analysis would be conducted over a certain length of time. The vibration analysis could be carried out in multiple phases based on the limited information and occurrences of the observed excessive vibration. Stormwater pump vibration analysis was not included in the original concept construction cost estimate.

2.9 Motor Testing

The station has eight 3,000 HP storm water pump motors. These medium voltage motors are synchronous, 225 rpm, 32-pole motors. The storm water pump motors are original motors as installed during the 1955 pump station construction. The motors for the stormwater pumps are currently started by closing the 4.16 kV vacuum circuit breaker and synchronizing with the original 1955 motor field cubicles. The age and condition of these cubicles has caused problems with motor starting and synchronization.

A demonstration of the Freud Pump Station motors and pumps was conducted in March of 2017, which included momentary starting of all pumps. The purpose of the demonstration was to allow representatives of LGC Global, DES Services, Rockwell Automation, and PCI to observe operations, collect data and identify findings. The demonstration showed that all eight stormwater motors were able to start and synchronize within 4 seconds. However, visual observations and inspection showed a significant number of deficiencies and irregularities with the exciter cabinets. As a result of this demonstration, new Allen Bradley exciter cabinets have been purchased and are currently being installed for each motor. This project assumes that all testing associated with the new exciter cabinet will be completed as part of the exciter cabinet replacement project. This includes testing rotor field insulation and conducting testing to find the appropriate field ampere setting.

Although the motors are old, they have very little operational time. An overall replacement would be cost-intensive and is not part of this project. Motor feeder and motor insulation testing is recommended to confirm the insulation integrity of the motor windings and motor feeder conductors.

2.10 Hazardous Material Testing

As part of the Freud Pump Station improvements, select equipment will either be removed or renovated. As such, an environmental assessment for these items to identify regulated materials and ACM to aid in planning for proper management, handling and disposal in accordance with federal and state regulations during the work will be completed but not until approximate 50% design phase. As such, a cost estimate for the hazardous material testing has not been included with this submittal.

The survey is generally expected to include development of a Health and Safety Plan, conducting an ACM survey, building material sampling, paint chip sampling and inventory of universal wastes/regulated building materials.

3 DEMOLITION

As part of the Freud Pump Station Improvements, various pieces of equipment will need to be removed. The following major items are summarized below (but not limited to):

- Pumps
    - Stormwater water pumps as described in Section 7.1.
        - Rotating assemblies and pump bearings
        - Drive shaft bearings (babbitt bearings to ball bearings) and possibly the drive shaft.
        - Pump casing concrete pedestals
    - Dewatering and sanitary pumps (9 and 10). The existing pumps will be replaced with new dewatering pumps as described in Section 7.2.
- Dewatering and Sanitary Pump discharge valves
    - Approximately seven different valves associated with the existing dewatering and sanitary pumps will be upgraded as described in Section 7.4.
- The existing toilet room will be demolished in order to construct the wet well access room (see drawing D-1 and D-2 in Appendix A).
- Electrical conduits that are currently installed on the south wall of the Freud Pump Station. Prior to the installation of the roll-up and man door to the new wet well access room, these conduits will need to be removed and rerouted (see drawing D-1 and D-2 in Appendix A).

4 CIVIL

4.1 Freud Isolation Shaft Location and Design Criteria

Freud Isolation Shaft Location

The Freud isolation shaft will be located upstream of the current Freud PS at the location shown on Drawing C-3 and C-4 (Appendix C). At the request of the GLWA following a meeting with Arcadis and BC, the decision to proceed with a single isolation shaft was determined. One shaft will be constructed over both tunnels simultaneously and will contain the isolation gates for each tunnel and a new sanitary pumping station. The road will need to be relocated as shown in the figures. The final alignment of the roadway will be determined later in the design in collaboration with the City of Detroit and GLWA.

Freud Isolation Shaft Design Criteria

The Freud Isolation Shaft will meet the following design criteria and constraints:

- Installed around the active tunnels which will need to remain in service during construction.
- Final shaft to be watertight to prevent groundwater from entering the sewer system.
- The shaft to be accessible by GLWA from the surface to allow maintenance of equipment, gates, etc. in the shaft.
- The location of the Stabilization of Excavation (SOE) will not interfere with structures or foundation of existing structures.
- The SOE and shaft will be vertical to the extent practical
- The SOE and shaft to be designed to control known site conditions:
    - High groundwater table
    - Known heaving subsurface conditions
- The SOE to be reinforced to reduce post construction issues.

These criteria and the data collected during the geotechnical investigation will be used to create a performance specification for the SOE. Multiple methodologies exist for completing the SOE. The performance specification will exclude methods that do not meet the constraints and have a high risk of failure while allowing multiple viable SOE options.

4.2 Utility Relocate Plans

Existing water, storm sewer, sanitary sewer, overhead electric, gas and communication utilities that conflict with the new Freud isolation shaft and appurtenances will be relocated. The following design criteria and constraints apply:

- Utilities will be designed and relocated to provide comparable service to the existing utility service.
- Water, Storm Sewer, and Sanitary Sewer utilities will be designed to meet the Jurisdiction Having Authorities (JHA) design standards for each utility as part of the detailed design.
- Overhead Electric, Gas and Communications utilities relocation plans will be designed and constructed by the owner of the utility as part of the construction contract. Utility owners will be provided with utility corridors to relocate the utilities within.
- Utilities will remain in-service except to provide tie over to reduce impact to those fed by each utility.
- Utilities will be relocated at the beginning of the construction to protect the utilities during the project.

4.3 Freud Street Relocation

The Freud Isolation Shaft road alignments shown in Drawings C-3 and C-4 (Appendix C) deflect Freud Street around the shaft. Preliminary discussions with Detroit Public Works (DPW) indicated that a permanent street closure of Freud Street is not viable. Freud Street is the main east west route for residents in this area. In addition, DPW prefers that Freud Street remain in the current location with the road passing over the top of the isolation shaft. However, this would result in vehicular traffic over the proposed sanitary pumps and isolation gates in the current design and would require road closures for equipment removal and installation. Discussions and coordination with DPW continue and will impact the specific road relocation plan during detailed design. The roadway design criteria are as follows:

- Roadway Posted Speed Limit: 25 mph per the Southeast Michigan Council of Governments (SEMCOG) roadway information website. In conversation with DPW, they indicated that the posted speed limit is 30 mph
- Roadway Design Speed: 5 mph more than the posted speed limit per DPW
- Roadway Design vehicle: DPW to provide input
- Roadway Type: Asphalt with curb and gutter
- Roadway width: Replace per existing width
- Right-of-way (ROW) width: 60-feet
- Roadway relocation or deflection will also require the relocation or deflection of the ROW to accommodate the roadway and relocated utilities.

4.4 Property Acquisition

As noted above, the proposed Freud Isolation Shaft is in Freud Street between Connor and Navahoe Streets and the facility requirements extend into the adjacent properties with surface support structures. GLWA will acquire property to relocate the road right-of-way and to place the surface support structures needed for the design.

GLWA has started the process with the owners and stake holders and will continue to pursue property as needed for the facility.

4.5 Sanitary Pump Station Sewer Connection

The new Freud Isolation Shaft will contain a sanitary pump station. The existing Freud PS connection to the sanitary sewer is located at the intersection of Tennessee and Freud streets. The new sanitary pump station sewer will be designed to flow to the existing sewer connection.

4.6 Grading Plans

In general, the grading at the Freud Pumping Station site will remain the same except grading along the west side of the existing station near the outlet channel. This location will be regraded to reduce the standing water that occurs in this location and is currently pumped to a nearby storm drain.

New structures will be graded away from the structures to prevent drainage issues.

4.7 Drainage Plans

Drainage at the site will not be changed except for the area west of the current Freud Pump Station. This area collects stormwater during storm events that is being pumped with a temporary system. An evaluation of this area and possible locations to drain this area will be completed during detailed design. The following design criteria and constraints will be implemented:

- Gravity drainage is desired.
- Drain to the north away from the cul-de-sac to the south.
- Minimize increasing runoff to the extent practicable.

4.8 Erosion and Sedimentation Control Plans

Erosion and sedimentation will be controlled throughout the project area. JHA input will be utilized to finalize the design. The design criteria and constraints are as follows:

- Protect existing storm drains from the impacts of construction during rain events.
- Minimize exposed soils to reduce erosion and sediment.
- Minimize tracked mud and sediment leaving site.
- Control dust during dry periods.

5 STRUCTURAL

5.1 Sanitary Pump Station and Freud Isolation Shaft

Utilize the geotechnical information to design an isolation shaft to house a new sanitary pump station and isolation gates. The new station will have the following design criteria and constraints:

- The SOE will not provide structural support for the isolation shaft.
- The SOE will not be fully watertight.
- The isolation shaft must be watertight to the extent practicable to reduce groundwater infiltration.
- Control buoyancy to prevent uplift of the inner shaft and damage to the existing tunnels.
- The isolation shaft cover will be designed to allow maintenance equipment loading over the top.
- The isolation shaft cover must be removable or have removable access hatches to remove the gates and pumps as needed.
- The isolation gates will be mounted to new concrete and can be removed by crane if the gates are stuck and allow for cleaning out large debris that gets caught in the shaft.
- The invert of the new shaft will be below the existing tunnel inverts.
- The isolation shaft will be round.

5.2 Superstructure Improvements

The Freud Pump Station Main Building houses both the Storm Water and Sanitary pumps and has 5 floors starting at the top floor (approximately 5 feet above grade on South exterior side and 10 feet above grade on the North exterior side) down to the lowest sump level (approximately 83 feet below the top floor). The Freud Pump Station Main Building was constructed in 1955.

5.3 Steel Lintels

Existing steel lintel at Louver opening or window opening show rust and existing coating is peeled off (Figure 4). The steel lintel shall be cleaned (sand blasting) and re-coated per coating spec.

Figure 4: Existing Steel Lintel

5.4 Bridge Crane

The Main Building has a 20-ton overhead bridge crane that runs along runway beams on the North and South walls (Figure 5). GLWA staff commented the crane strains to lift heavy pump components but does still work. GLWA staff requested the crane be inspected and serviced if needed during the upcoming project.

Figure 5: Existing Bridge Crane

5.5 Loading Dock

A temporary steel column base repair as shown in Figure 6 was observed at the overhead door adjacent to the South exterior top slab (loading dock). A more permanent repair for this steel column base is needed. The damaged steel column base shall be removed and new steel column shall be added.

Figure 6: Existing Damaged Column Base

5.6 Foundations and Base Plates

Sanitary Pump Bases

The existing dewatering and sanitary pumps are located at the lowest level in the station. There is minor corrosion at the steel supports. The reinforced concrete floor needs to be checked for condition.

Figure 7: Existing Sanitary Pump

Sanitary Motor Bases

There are two sanitary pumps/motors. New motors shall be considered. The existing motors are close coupled with the pumps. Further field inspection is required.

Figure 8: Existing Sanitary Motor

Storm Pump Bases

The concrete pump support piers are in poor condition (the concrete pump support piers at Pump #5 are deficient). Ninety percent of all concrete pump support piers (6 piers per pump) show signs of concrete cold joints four inches down from the top of the support pier that may have been from original construction. A horizontal hairline crack is also found around all four sides of these concrete pump support piers at this cold joint level. The concrete pump support piers at Pump #5, at least three of them, show signs of anchor bolt concrete breakout cracking. At some pump support piers, the pump support leg steel base plate bears within one-half inch of the concrete support pier edge and the anchor bolt edge distances are four and one-half inches or less. The design of these concrete pump support piers needs to be revisited based on required support of pump loads (vertical, shear and torsion load along with proper anchor edge distances and embedment should be considered). Repairs will be needed to these pump bases. The existing concrete pump support piers shall be removed and new concrete pump support piers shall be provided with epoxy base grout. Existing plan of storm pump layout (ES-01) is attached in Appendix A.

Figure 9: Existing Damaged Concrete Support Pier

Storm Pump Motor Bases

There are 8 existing pumps/motors at pumping station. The existing Storm Pump motors are located at the 1st floor elevation and motor are supported by concrete encased steel beams. The embedded steel wide flange framing beams embedded in the concrete floor look to have minimal surface corrosion on them. Existing plan of Motor base layout (ES-02) is attached in Appendix A.

Figure 10: Existing 1st Floor Photo

Transformer Foundations

The transformer containment pad consists of a concrete grade beams with embedded steel channels that the transformers bear on and a perimeter concrete curb with chain link fencing on two sides (backside of the South Site concrete retaining wall on other two sides). This was originally constructed along with the Pump Station in 1955. The existing concrete support grade beams under the transformer support legs appear in good shape with only minor cracks and spalls and the embedded steel channels in the grade beams have surface corrosion. The spalling concrete shall be removed and the area to be patched with concrete mortar per concrete repair spec. The concrete cracks shall be repaired with epoxy injection grout. The corrosion on the existing embedded steel channels shall be cleaned and re-coated per coating spec.

Figure 11: Existing Transformer Foundation

West Site Retaining Wall

The West site retaining wall is a vertical cantilevered reinforced concrete retaining wall with a brick face on the side exposed to public view and a concrete cap at the top.

On the West side, the concrete flume encasement at-grade has a large amount of spider cracking with signs of efflorescence. The concrete cracks shall be repaired with epoxy injection grout.

Figure 12: Existing South Site Retaining Wall

Top Slab Concrete (design repairs to exterior spalled concrete)

East Exterior Top Slab

The East exterior top slab is an extension of the Pump Station top floor out over the perimeter flume**.** The Northern portions of the existing top slab are in good condition but the Southern portions are in very poor condition with significant concrete deterioration and spalling. With the current state of the Southern portion of the top slab, rain water is not draining off the slab but collecting and further deteriorating the concrete top slab. Significant concrete deterioration and spalls along with cracks showing signs of efflorescence were observed on the top slab edges at the top of the brick wall. The deteriorating and spalling concrete shall be removed and the area to be patched with concrete mortar per concrete repair spec.

Figure 13: Existing East Exterior Top Slab

All steel grating pieces on the East exterior top slab (over the flume) are deformed (some bearing bars showing signs of yielding) with cross bars broken and pose a potential safety concern due to loss of live load capacity and from tripping hazard standpoint. No stairs to access this slab exist. The damaged steel grating shall be replaced to new steel grating.

West Exterior Top Slab

The steel grating over the flume is deformed (some bearing bars showing signs of yielding) with cross bars broken and pose a potential safety concern due to loss of live load capacity and from tripping hazard standpoint. The damaged steel grating shall be replaced to new steel grating.

Figure 14: Existing West Exterior Top Slab

South Exterior Top Slab

The South exterior top slab is an extension of the pump station top floor out to the South side of the building to provide a loading dock down to the driveway. Approximately one-third of the top slab is in very poor condition with significant concrete deterioration and spalling. Just outside the entrance to the pump station, there is approximately a 16-square foot portion of top slab with significant concrete deterioration were the top two inches of concrete top slab has deteriorated to stone and gravel and exposed resteel can be observed (when stone and gravel is moved). Along the loading dock edge, the steel edge angle has significant surface corrosion and for large stretches of this angle the concrete slab edge has deteriorated so badly that the edge angle anchors have lost their embedment with the concrete top slab and the wall vertical dowels into the top slab are exposed. With the current state of the top slab, rain water is not draining off the slab but collecting and further deteriorating these substandard portions of the concrete top slab. Significant concrete deterioration and spalls along with cracks showing signs of efflorescence were observed on the top slab edges at the top of the brick wall. The deteriorating and spalling concrete will be removed and the area patched with concrete mortar per concrete repair spec. A new edge angle will be provided. Due to heavy usage of deicing material during wintertime, it is recommended to provide a protective coating at repaired and existing concrete slab.

The steel grating is deformed (some bearing bars showing signs of yielding) with cross bars broken and pose a potential safety concern due to loss of live load capacity and from tripping hazard standpoint. The damaged steel grating will be replaced with new steel grating.

Temporary wooden stairs with forward-sloping wooden stair treads are currently used as the main access to this South exterior top slab and the pumping station. The existing wooden stair shall be replaced with permanent aluminum stairs with aluminum handrails as the main access to this South exterior top slab and the pump station. Railing shall be provided along the edge of the top slab and removable side-mounted railing shall be considered in places to allow for better unloading and loading operations.

Figure 15: Existing South Exterior Top Slab

North Exterior Top Slab

The North exterior top slab is an extension of the Pump Station top floor out over the perimeter flume. The existing top slab for the most part appears to be in good condition with only areas of concrete spall along a 15-foot stretch of the top slab edge (at the top of the brick wall) and around the steel grating. The spalling concrete shall be removed and the area to be patched with concrete mortar per concrete repair spec.

Floor tile installed outside the service door is broken or loose likely due to weather exposure, water retention and frequent freeze/thaw cycles. Floor tile shall be replaced per Architectural details.

Steel stair nosing have surface corrosion and some of the stair treads have warped up (embedment of steel nosing to concrete stair tread may have been compromised) and thus poses a potential safety concern (tripping hazard). The existing stair nosing will be removed and new aluminum stair nosing will be installed.

The steel grating over the flume is deformed (some bearing bars showing signs of yielding) with cross bars broken and pose a potential safety concern due to loss of live load capacity and from tripping hazard standpoint. Handrail along the edges of the top slab should be provided to prevent falls (approximately 10 foot above grade). The damaged steel grating will be replaced with new steel grating. Aluminum Handrail will be provided around the edges of the top slab.

Figure 16: Existing North Exterior Top Slab

Building 1st Floor slab

The top slab of the pump station has tile flooring and the underside of the slab looks to be in good condition. The embedded steel wide flange framing beams embedded in the concrete floor look to have minimal surface corrosion on them.

Substructure Improvements

Bar Grating

The damaged existing bar grating shall be replaced with new bar grating and painting on bar grating shall be matched to existing grating.

Steel Frame Coating

The steel surface corrosion was observed on the existing structural steel framing. The corrosion on steel surfaces shall be cleaned and re-coated per coating spec. The re-coating shall be matched to the existing coating.

Drainage Along Slab and Perimeter Wall

The perimeter reinforced concrete caisson walls at 2nd and 3rd floor down from top are in good condition with numerous hairline cracks and signs of past minor leakage (efflorescence) of the walls observed. Hairline cracks or minor leakage cracks (non-structural crack) shall be repaired with hydrophobic polyurethane grout crack injection.

The perimeter reinforced concrete wall at 4th floor down from top are in fair condition with numerous hairline cracks (with sign of active minor leakage and efflorescence), area of concrete deterioration and spalls (on North wall and Northeast corner), and numerous locations of exposed horizontal resteel in walls were observed. The walls of this lowest sump level are by far the poorest condition of any of the substructure walls observed in the Pump station. The hairline cracks and minor leakage crack shall be repaired with hydrophobic polyurethane grout crack injection. The deteriorating and spalling concrete shall be repaired per concrete repair spec. The unsound concrete shall be removed and repair mortar be applied to spalling area.

Stair and Walkway

The stair stringers, stair treads, intermediate walkway framing, and grating at 4th floor down from top has significant surface corrosion. The handrail on the intermediate platform at the Northeast end has lost its connection to the wall (connection corroded through). The upper and lower stairs to the intermediate platform are steep and narrow, and OHSA code requirements should be revisited to ensure stairs meet code. The steel surface with corrosion shall be cleaned and re-coated per coating specs. The handrail shall be connected properly to the wall. The steep and narrow stair shall be checked per OHSA code, if necessary, it will be replaced with new stairs.

5.6 Materials of Construction

Concrete

- Compressive strength @ 28 days:
    - Cast-in-place concrete: 4500 psi
    - Precast concrete: 5000 psi
    - Lean concrete: 2000 psi
- Cement: Type I or II Cement per ASTM C150
- Aggregate: ¾″ max typ., except 1″ max for foundations and concrete greater than 12″ thick
- Reinforcement:
    - ASTM A615, Grade 60, Deformed

Structural Brick Masonry

- Concrete block: ASTM C90, Normal Weight
- Specified prism compressive strength: f'm=1500 psi
- Mortar: ASTM C270, Type S
- Grout: ASTM C476, course grout with 2,000 psi, 28-day compressive strength
- Reinforcing: ASTM A615, Grade 60, Deformed

Steel

- Wide flange and WT shapes: ASTM A992, Fy = 50 ksi
- Channels and angles: ASTM A36.
- Plates: ASTM A36 (Type 316L stainless steel in corrosive areas)
- Hollow structural sections: ASTM A500, Grade B, Fy=46 ksi
- Pipe sections: ASTM A53, Type E or S, Grade B, Fy = 35 ksi

- Bolted steel connections: A325 (Type 1) bearing bolts, galvanized, fully tensioned typical at steel framing connections in non-corrosive areas
- Welding structural steel: E70XX low hydrogen electrodes, operators AWS qualified

Stainless Steel

- Bars & shapes: (annealed): ASTM A276
- Plate: ASTM A480/A 666
    - Type 316, (Type 304 for architectural uses) Fy = 30 ksi.
    - Type 316L, (Type 304L for architectural uses) Fy = 25 ksi (required where subject to welding)
- Bolted connections (1/4-in. to 5/8-in.): ASTM A 593/A 594, Condition CW, match type of stainless steel connected (Fu = 100 ksi, Fy = 65 ksi).
- Bolted connections (3/4-in. to 1 ½-in.): ASTM A 593/A 594, Condition CW, match type of stainless steel connected (Fu = 85 ksi, Fy = 45 ksi).

Aluminium

- Structural shapes: 6061-T6 per ASTM B308
- Bolts: Stainless steel Type 316 for aluminum framing connections
- Guardrails and handrails: 6061-T6 or 6063-T6 per ASTM B241
- Floor and cover plates: 6061-T6 per ASTM B209
- Grating: 6061-T6 per ASTM B221
- Contact with concrete: Coat aluminum with heavy coat of bituminous paint

Concrete Anchorage

- Type 316 stainless steel: at all submerged, buried, and corrosive areas
- ASTM F1554, Grade 55, galvanized at covered, non-corrosive areas
- High strength anchor bolts (if needed): Stainless steel ASTM A193, Grade B8M Class 2, AISI Type 316
- Concrete Anchors (set in hardened concrete): Shall be adhesive or wedge type.
- Adhesive anchors required at all submerged or buried locations and where subject to vibration. Not to be used where high temperatures (> 140˚F) are possible.

Structural Concrete Repair and Expansion Joint Products

- Repair mortar: a two-component polymer-modified, Portland cement, fast-setting, trowel-grade mortar.
    - Min compressive strength at one day: 2,000 psi
    - Min compressive strength at 28 days: 6,000 psi
    - Min Bond Strength at 28 days: 1,800 psi
- Repair of Exposed Reinforcing Steel

    - Two components: an initial application of corrosion inhibitor and subsequent application of protective slurry mortar
- Crack injection Materials
    - Structural Crack Repair System: Epoxy injection, low-viscosity, high-modulus moisture insensitive type.
    - Non-Structural Crack Repair System: Hydrophobic Polyurethane Chemical Grout
- Expansion Joint Repair System
    - Two components: an epoxy resin adhesive and hypalon sheeting

5.7 Design Criteria

Codes and Standards

The following codes will be used for the final design for this project.

- 2015 International Building Code (IBC) with Local Amendments and 2015 Michigan Building Code
- ASCE 7-10 – Minimum Design Loads for Buildings and Other Structures
- ACI 318-14 – Building Code Requirement for Structural Concrete
- ACI 350-06 – Code Requirements for Environmental Engineering Concrete Structures
- ACI 350.3-06 – Seismic Design of Liquid-Containing Concrete Structures
- ACI 530-13 – Building Code Requirements for Masonry Structures
- AISC 341-10—Seismic Provisions for Structural Steel Buildings
- AISC 360-10 Steel Construction Manual – 14th Edition
- Aluminum Design Manual, 2015 Edition
- AWS Welding Codes, Latest Editions
- AASHTO Standard Specification for Highway Bridges, Latest Edition.

Dead Loads

Dead loads used in the calculations shall consist of only permanent dead load, defined as weight of the structural member, weight of material of construction incorporated into the buildings to be supported permanently by the structural members, weight of partitions, and weight of permanent building mechanical service equipment. Weight of process equipment shall be considered a live load.
Typical dead load allowance for lighting and sprinkler piping unless noted otherwise: 5 psf
Note that process piping, conduit and cable tray loads are accounted for in the superimposed dead load section.
Material Densities:

Steel:	490 pcf
Aluminum:	168 pcf
Water:	62.4 pcf
Sludge:	65.5 pcf
Reinforced Concrete:	150 pcf
Concrete Masonry:	135 pcf (normal weight CMU)

- Clay Masonry: 120 pcf
- Compacted Soil: 120 pcf

Superimposed Dead Loads

Superimposed dead load (SDL) shall consist of an allowance for process piping, conduit and cable tray loads.

- Roofs (except electrical and control rooms): 10 psf
- Electrical and control room roofs: 30 psf
- Process area elevated concrete floor (unless noted otherwise): 50 psf
- Elevated grating floors: 20 psf
- Equipment platforms, walkways/catwalks: 20 psf

Live Loads

Live loads are loads produced by the use and occupancy of the building, and include process equipment loads and associated concrete pads. Equipment loads and pads do not have to be independently accounted for if they do not exceed the uniform design live load.

- Roofs: 20 psf
- Roof HVAC mechanical equipment areas: 150 psf
- Warehouse area slab-on-grade 1000 psf
- Process area slab-on-grade: 400 psf
- Material storage area slab-on-grade: 400 psf
- Non-process area slab-on-grade: 100 psf
- Office and lobby area: 100 psf
- Office file/records area: 125 psf
- Laboratory: 125 psf
- Electrical and control room floor: 250 psf
- HVAC mechanical room floor: 150 psf
- Process area elevated concrete floor: 300 psf
- Elevated grating floors: 100 psf (foot traffic only)
- Stairs, landings and exit ways: 100 psf
- Equipment platforms, walkways/catwalks 100 psf (other than exit ways):
- Truck access areas: AASHTO HL93 loading
    - Use AASHTO Standard Specification for highway bridges for impact forces due to moving wheel loads.
- Monorails:
    - Vertical 25% of lifted load
    - Transverse 2% of lifted load
    - Longitudinal 10% of lifted load
- Bridge cranes (pendant operated):

  - Vertical 15% of crane and load
  - Transverse 20% of trolley and load
  - Longitudinal 10% of maximum operating wheel loads
- Bridge cranes (cab operated):
  - Vertical 25% of crane and load
  - Transverse 20% of trolley and load
  - Longitudinal 10% of maximum operating wheel loads
- Hangers supporting floors and platforms: 33% of live and dead load

Snow Loads

- Ground snow load, pg: 20 psf
- Minimum roof snow load: [xx] psf
- Exposure: C
- Snow Importance Factor, Is: 1.1
- Risk Category: III

All roof structures and building frames shall be adequately designed for the required snow loads. Due consideration shall be given to drifting and the possible formation of ice dams resulting in ponding of water on uninsulated roofs.

Wind Loads

- Ultimate wind speed: 120 mph
- Basic wind speed 93 mph
- Exposure: C
- Risk Category: III

Seismic Loads

- 0.2 Sec. Mapped Spectral Response, Ss: 0.102 g
- 1.0 Sec. Mapped Spectral Response, S1: 0.045 g
- Site class: D
- 0.2 Sec. Design Spectral Response, SDS: 0.108 g
- 1.0 Sec. Design Spectral Response, SD1: 0.073 g
- Seismic Importance Factor, Ie: 1.25
- Seismic Design Category: B

Liquid Loads

Liquid holding basin walls shall be designed for the following load combinations:

- Normal operating level without backfill (Leak Test Condition).
- Overtopping condition without backfill (Liquid Level at top of basin walls).
- Backfill with flood level ground water with tank empty (Maintenance Condition and Floatation Stability Check Condition).

- For multi-cell tank, consider any tank cell empty or full in any combination with or without backfill.

Safety Factors

A safety factor of 1.5 should be used to resist overturning and sliding.
Safety factor against buoyant uplift shall be a minimum of 1.25 for 100-year flood elevation and 1.10 for maximum flood elevation.
Resistance to uplift includes the dead weight of the structure and the column of soil above the footing extension. The submerged weight of soil should be used below the water table. Use of side friction between soil and structure to resist buoyant uplift should be avoided.

Seismic Design of Non-Structural Components

Non-structural components refer to architectural, process related mechanical, mechanical (HVAC, plumbing, fire protection), electrical and instrumentation equipment and appurtenances. A term called the seismic design category is a classification assigned to a structure based on its use and severity of the design earthquake ground motion at the site. Depending on the seismic design categories (A-F) assigned to the structures, the building code provides specific requirements for bracing non-structural components in the structures. As part of this project the seismic design categories of new and existing buildings requiring work will be determined based on site accelerations assigned in the code, building use and site geotechnical data. Seismic design of non-structural components will be incorporated into the project in accordance with the building code requirements based on site specific geotechnical and building usage category information gathered during design.

Architectural Components

Level of seismic design required for architectural components:

- Seismic design category B = Required only if Ip = 1.5

Mechanical and Electrical Components

Level of seismic design required for mechanical and electrical components:

- Seismic design category A and B = None

Component Importance Factor

Based on ASCE 7-10, the importance factor (Ip) assigned to non-structural component is as follows

Fire protection sprinkler systems:	Ip = 1.5
Components which contain hazardous toxic material:	Ip = 1.5
Components inside or attached to a Risk Category IV structure:	Ip = 1.5
All other components:	Ip = 1.0

5.8 Geotechnical Information

Refer to the Historical Geotechnical Report for a conceptual design of the Freud Isolation Shaft and Section 2.1 for additional information. A Geotechnical report for a complete description of the site subsurface conditions and geotechnical recommendations shall be provided as part of design.

Geotechnical Design Criteria

- Shallow Footings:
    - Individual footing allowable bearing pressure: NA
    - Continuous footing allowable bearing pressure: NA
    - Soil friction coefficient resisting sliding at foundations: NA
    - Modulus of subgrade reaction for concrete floor slabs-on-grade: NA
    - Modulus of subgrade reaction for large area mat slabs: NA
- Piles (12” diameter concrete filed pipe piles):
    - Compression capacity: 100 tons (allowable load)
    - Tension capacity: 30 tons (allowable load)
    - Lateral capacity: 4 tons (allowable load)

Lateral Earth Pressure

- Active pressures: NA
- At-rest pressures (equivalent fluid earth pressure): recommended for the design
    - 65 psf/ft above the perched water table elevation
    - 95 psf/ft below the perched water table.
- Passive pressures: NA
- Surcharge pressures, unless otherwise shown, use a minimum of 2 feet of earth for walls where vehicular loads come within H/2 of the wall. Contact the geotechnical engineer for the surcharge pressure from large cranes located next to facilities to remove equipment.

Frost Depth

All foundations for buildings and other structures supporting settlement sensitive equipment shall extend below the frost line or be supported on non-frost susceptible structural fill down to the frost line.

- Frost line for foundations: 42 inches

Groundwater Elevations

- Design groundwater elevation: 100 ft
- 100-year flood elevation: 579 ft (NAVD 88) from Flood Insurance Rat Map (26163C0302E), Area of 0.2% annual chance Flood. City of Detroit datum = 579-479.25 = 99.75 ft

6 ARCHITECTURAL

6.1 Applicable Codes and Standards

The design and construction of the building architectural works will comply with applicable local, state, federal, and international jurisdictional agencies and regulations including but not limited to:

- Michigan Building Code (MBC) – 2015 will be followed as applicable for this type of facility.
- Michigan Energy Code – 2015 will be followed as applicable for this type of facility.
- Per MBC 1103.2.9 Equipment Spaces, water or sewage facilities are exempted from accessibility requirements; however, building design will follow the ADA requirements as far as practical.

6.2 Design Considerations

The Freud Pump Station was constructed in 1955 and is structurally sound (see section on structural) but is in need of window and exterior and interior finish replacements.

Building Components

Exterior Walls – Exterior Side

- The exterior masonry brick is in overall good condition from the main floor level and above. Below the main floor level, there is, in certain areas, efflorescence in addition to deteriorating concrete and rusting metal. Cleaning, tucking, pointing repair work of masonry and mortar as well as cleaning and repairs/replacement of concrete and/or metal support work will be completed. For bidding purposes, include 20% of exterior wall surface areas for tucking, pointing, or repair work. This will be addressed as part of the base bid.

Exterior Walls – Interior Side

- Overall, the glazed masonry on the interior side of the exterior walls is in good condition. No repair or replacement is included in this scope, except as required where damage occurs as a result of the work.

Interior walls

- At the room being repurposed into the wet well access location a new wall will be provided at the north interior wall to close off this area from the rest of the facility. The existing walls creating the existing toilet room will be removed.

Windows

- On the main level (above ground), the formerly existing window glass was replaced with an opaque, flexible material to abate issues involving vandalism. In order to reintroduce natural daylight into the main room of this pump station, the current design will remove the top two portions of the north and east windows and frames and replace with either vandal-resistant translucent wall systems (example, Kalwall), or clear vision glazing. Window operability is not desired and will not be included, unless specifically called out otherwise on architectural drawings.

Doors

- No door replacement is included as part of this scope of work.
- If it is decided to replace a door or doors as part of this work, insulated FRP (fiber reinforced plastic) or insulated aluminum doors are recommended.
- At the room being repurposed into the wet well access location, a new door will be provided at the south exterior wall.
- Note: At the main entrance, the exterior overhead door and personnel door and window assembly (second row, left) have been modified over the years. It may be desirable to propose a redesign of this entryway, replacing both doors and the windows to provide a more functional configuration for current use.

Roof

- No roof replacement is included as part of this scope of work.
- No roof drain replacement is included as part of this scope of work.
- At the room being repurposed into the wet well access location a new roof access hatch will be provided to lift materials into the wet well.

Flooring

- The existing quarry tile in most of the building areas is in good condition. However the quarry tile on the exterior of the north part of the building has experienced significant damage and in some areas has detached from the subfloor completely and will require removal, grinding and cleaning, and replacement with a new terrazzo-type poured flooring. This is also the case in the loading dock area (on the motor floor around the motors). Currently the tile that is existing cracks when heavy loads are moved across it when replacing the dewatering pumps rotating assembly. The damaged tiles in the whole area will be removed; the subfloor ground, cleaned, and repaired as required; and a terrazzo-type floor will be poured to infill the area where the flooring was removed.
- Note: It is likely that if the existing skid will continue to be used in the future to move the pumps, any new flooring will eventually be damaged, regardless of metal tracks. Arcadis can help investigate alternative equipment moving options such as air pallets, which utilize compressed air.

Restroom

- The existing toilet room will be removed in its entirety, including the interior partition walls. The existing space will be repurposed into a Wet Well Access Area that will only be accessible from outside the building. A new toilet room will be provided which will include a single toilet, a urinal, a lavatory, and an emergency shower. The preliminary suggested location for the new toilet room is the existing storage room.

Elevator

- The existing elevator is not functioning and must be replaced. An investigation will take place to determine whether the existing elevator shaft is large enough to accommodate an elevator that meets current minimum code requirements for moving personnel between floors.

Stairs

- The existing exterior stairway up to the loading dock is not code compliant and will be replaced in its entirety along with code-compliant handrails and guardrails.
- Note: If general accessibility into the building is warranted or desired, a ramp can be designed and installed along with the new stair

Freud Isolation Shaft Control Building

- A new 30’-0” x 30’-0” building will be constructed at the Freud Isolation Shaft on Freud Street between Conner Street and Navahoe Street. The building will be comprised of an unfinished concrete slab floor, split-face concrete masonry unit walls to 14’-0” above finished floor, and a sloped standing seam metal roof. There will be one 10’-0” wide by 10’-0” high overhead door and a standard 3’-0” wide by 7’-0” swing door. There will be no windows. The building will not be occupied, will not have a toilet room, and will not be conditioned.

Exterior Roof Ladder

- The current roof ladder leading to the upper roof (Figure 17) does not meet code, it will be removed and replaced with a code compliant ladder. The ladder shall include a fall protection system consisting of a vertical rigid track carrier rail securely and permanently attached to ladder, over which travels a sleeve to harness belt can be attached.

Figure 17: Existing Ladder

7 PROCESS MECHANICAL

7.1 Stormwater Pumps

The rotating assemblies in storm water pumps 1, 2, 3, 4, 6 and 7 will be replaced during this portion of work. Six (6) of the eight (8) Worthington 72” MC-1 vertical volute pumps will be upgraded with new rotating assemblies with a new bearing frame to incorporate grease lubrication versus the current oil lubrication system. GLWA replaced the rotating assemblies in storm water pumps 5 and 8 in 2019 under GLWA Contract No. GLWA-CON-109 between the GLWA and Lakeshore Global Corporation (Detroit, Michigan). Rotating assemblies and associated components will be supplied by Flowserve Corporation.

Specific equipment and accessories that will be replaced include, but not limited to are the following:

- Flowserve Model 72MC-1 stage centrifugal rotating assembly
- Stainless steel impeller, fitted with stainless steel wear ring
- Carbon steel pump shaft with stainless steel sleeve
- Cast iron upper casing head with stainless steel wear ring
- Cast iron stuffing box
- Cast iron bearing housing
- Flowserve standard enamel coating on the bearing frame, stuffing box head, and stuffing box
- Warranty for twelve (12) months from start-up

In addition to upgrading the rotating assemblies, the existing 13 ½“ diameter line shaft and babbitt style sleeve bearings (Figure 18) will be replaced with the following equipment:

- New 13 ½” diameter line shaft
- Roller bearings with grease fittings
- Steady bearing housing

- Line shaft couplings

The upgraded rotating assembly (and associated accessories), line shaft, steady bearings, and shaft couplings will be replaced based on the current GLWA schedule for stormwater pump upgrades.

Figure 18: Existing Stormwater Pump Steady Bearing Assembly

7.2 Dewatering Pumps (Pumps 9 and 10)

The existing dewatering and sanitary pumps (Pump 9 and Pump 10, respectively), were initially installed to function as dewatering pumps for the stormwater wet well but are now dedicated pumps to handle dry weather flow from the Fox Creek and Ashland Relief Sewers. The O&M Manual (Operation and Maintenance Manual, Freud Sewage Pump Station, January 1993) indicates Pump 9 is rated for 15,750 gpm at 36 feet TDH and Pump 10 is rated for 9,000 gpm at 57 feet TDH. As a verification of the hydraulics based on the operating levels of the wet well as noted in the O&M Manual (Pump 9 operates between 45 feet and 65 feet, and Pump 10 operates between 25 feet and 45 feet), Arcadis completed hydraulic calculations to verify Pumps 9 and 10 are sized properly to operate in the ranges mentioned. Figure 19 depicts the operating range of the stormwater, sanitary, and dewatering pumps as presented in the Freud and Conner Creek Pump Station Improvements Study and Design Technical Memorandum No. 1 (October 2017).

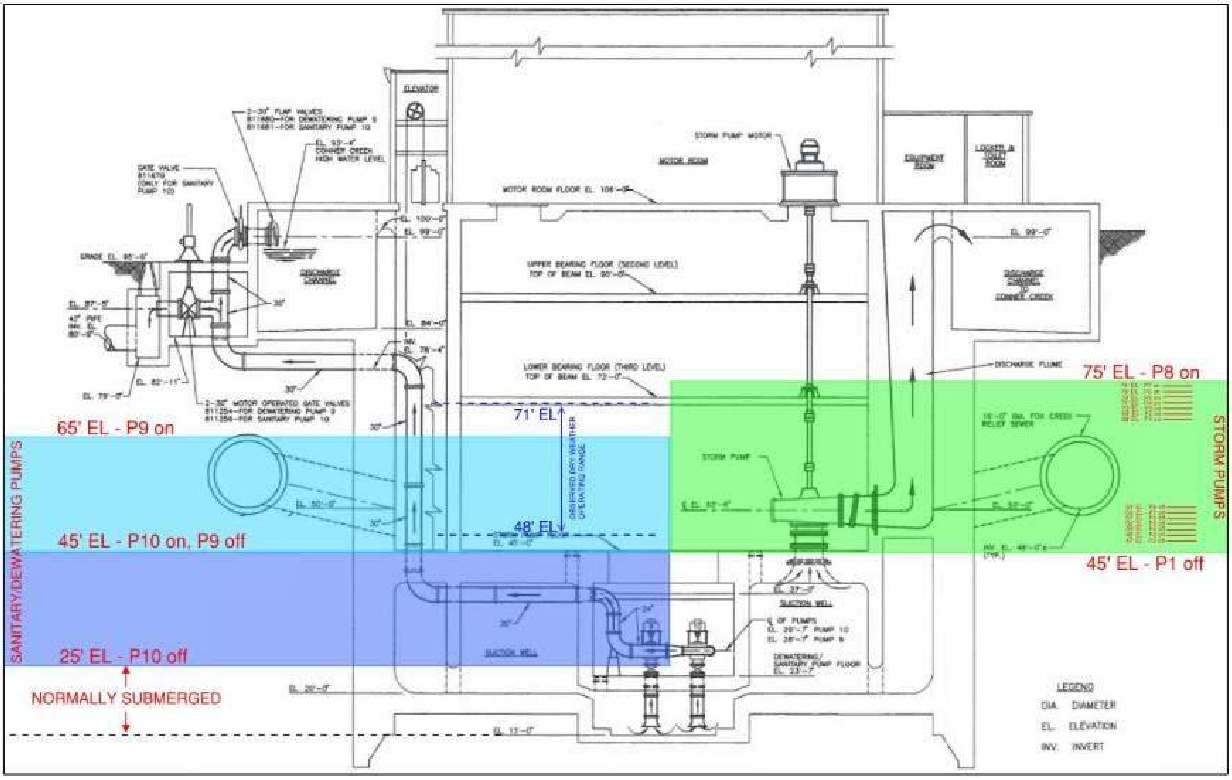

Figure 19: Freud Pump Station Wet Well Control Levels and Observed Dry Weather Operating Range

Based on the hydraulic calculations, Pump 9 has a calculated minimum and maximum accumulated head at approximately 47 feet and 67 feet, respectively indicating the pump design criteria targets the middle value of the accumulated calculated head. Similarly, Pump 10 has a calculated minimum and maximum accumulated head at approximately 27 feet and 47 feet, respectively, again indicating the pump design criteria targets the middle value of the accumulated calculated head. It appears both Pumps 9 and 10 operate within their allowable operating range but will see decreased performance when operating outside this range. As noted in the O&M Manual, Pump 9 and Pump 10 are not supposed to operate in parallel because the combined flow rate would exceed the hydraulic capacity of the receiving 42-inch sewer pipe that connects to Tennessee Ave. Furthermore, as discussed in the Freud and Conner Creek Pump Station Improvements Study and Design Technical Memorandum No. 1 (October 2017), the observed dry weather operating range was noted to be between 48 feet and 71 feet. Currently Pumps 9 and 10 are not operating as intended with the original design criteria.

As part of the Freud Pump Station Improvements, a separate isolation shaft will be constructed to enable isolation of the stormwater wet well and to handle the dry weather flow that is currently entering the pump station wet well. Once the new isolation shaft is operational, Pumps 9 and 10 in the existing Freud Pump Station will no longer pump dry weather flow. Pumps 9 and 10 will return to the original function to dewater the stormwater wet well following wet weather storm events or to dewater the wet well prior to access for maintenance and/or inspections. At the request of the GLWA, the existing dewatering and sanitary pumps (Pumps 9 and 10) will be replaced with two of the same pumps and if possible smaller frame size for ease of maintenance and/or replacement. The new design criteria for Pumps 9 and 10 will be operating the stormwater wet well between 25 feet to 55 feet and being able to dewater the stormwater wet well within a 10-hour period. The new dewatering pumps (Pump 9 and 10) will be rated for an average of 7,500 gpm over the accumulated minimum and maximum head range of 33 feet and 63 feet, respectively.

Following a meeting the GLWA (August 7, 2020), the new dewatering pumps will be vertical dry pit submersible pumps sized appropriately based on the new design criteria. The new dewatering pumps 9 and 10 will be the same model and a third pump could be provided as a common shelf spare. As depicted in Figures 20 and 21, the new dewatering pumps will be installed in the vertical orientation to maximize the floor area and the existing knife gate valves will be replaced with plug valves. The existing 24-inch floor openings will be reused and failed leaded joint will be addressed to stop leaks from entering the dewatering pump floor room.

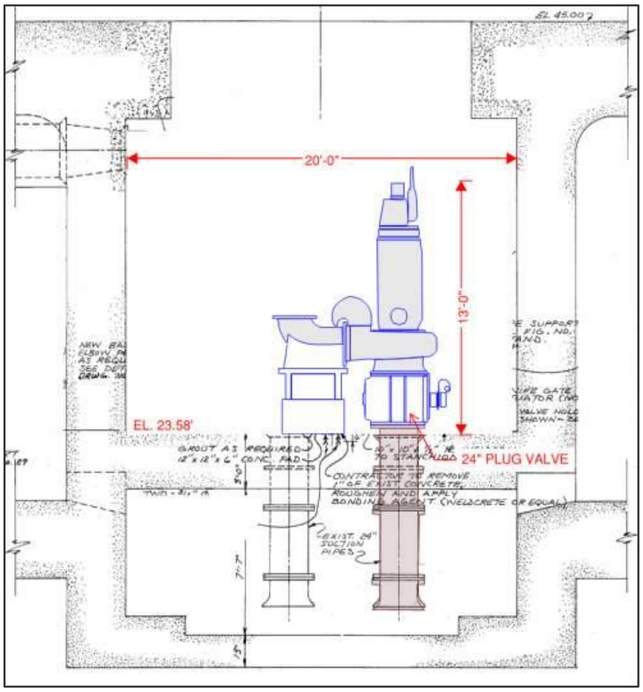

Figure 20: Vertical Dry Pit Submersible Pump

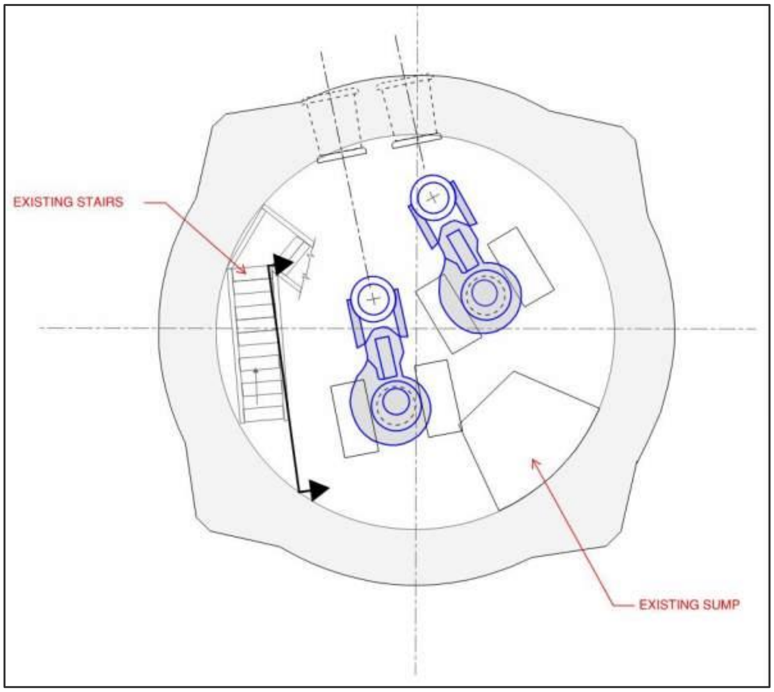

Figure 21: Plan View of Vertical Dry Pit Submersible Pumps 9 and 10

7.3 Dewatering Pump Discharge Piping

The dewatering pump discharge piping is currently cast in concrete through the storm pump wet well and are located against the ceiling, or on the bottom side of the pump floor. Some level of inspection is needed to determine the integrity of the existing piping.

7.4 Valve Replacement

Currently there are seven (7) valves that were identified in the Freud and Conner Creek Pump Station Improvements Condition Assessment Report (October, 2017). These valves will be replaced as part of the Freud Pump Station Improvements design and are listed in the sections below.

Pump Influent Knife Gate Valves

The two existing sanitary pump influent valves (Figures 22 and 23) are located below the existing sanitary pumps and are a knife gate style valve. These have a significant amount of corrosion and one of the operator supports is delaminating due to the corrosion. The electric actuator for gate #10 has been removed and a handwheel has been installed on the gear operator. As mentioned in Section 7.2 (Dewatering Pumps), the existing knife gate valves will be replaced with new plug valves to isolate the pumps and reduce the amount of floor space that is currently being utilized.

Figure 22: Existing Sanitary Pump Influent Gate Valve

Figure 23: Existing Sanitary Pump Influent Gate Valve

Discharge Flap Gates

Two flap gates are installed in the discharge channel on the outside of the station (Figures 24 and 25). These are in fair condition with corrosion on both the gates and the hardware.

Figure 24: Existing Pump 9 Flap Gate

Figure 25: Existing Pump 10 Flap Gate

Overflow Gate Valve

The Overflow Gate is located on the discharge for the existing sanitary pump #10 and is an enclosed knife gate type (Figure 26). Corrosion of the valve is minimal, but there is peeling paint exposing what is likely the factory paint underneath. The valve stem and operator are in good condition.

Figure 26: Existing Pump 10 Overflow Gate Valve to the Discharge Channel

Discharge Gate Valves

The two Sanitary Discharge Gates (Figures 27 and 28) are gate valves installed in a pit outside the station along the fence. The gate valves and associated piping have significant corrosion due to moisture in the pit. The valve operators and electric actuators are of an older style and have multiple layers of paint that is peeling in some areas. It is not known if these actuators are functional.

Figure 27: Existing Pump 9 and 10 Discharge Gate Valve

Figure 28: Existing Pump 9 and 10 Discharge Gate Valve

7.5 Sump Pumps

There are three (3) submersible sump pumps installed in the lowest level of the station (two installed in the floor sump and a third which is sitting on the dewatering pump floor). All three submersible sump pumps and discharge piping will be replaced under the Freud Pump Station Improvements design.

7.6 Seal Water System

The existing seal water system consists of a break tank and fill valve assembly (Figure 29). The seal water system will be evaluated during the design following the selection of the dewatering pumps, and stormwater pump upgrades. A water demand analysis will be completed, and the seal water system will be upgraded if the system is undersized.

Figure 29: Seal Water System Break Tank

7.7 Pump Station Wet Well Isolation

The current Freud Pump Station cannot be isolated to stop influent flow from the Ashland and Fox Creek Relief Sewers. The station was not built with isolation gates or other structures to allow isolation of the wet well. As mentioned previously, isolation of the Freud Pump Station will provide a safe means of cleaning, inspection, and maintenance.

This project will install isolation gates for the station and separate the dry weather sanitary flow from the storm water flow. The team evaluated locating isolation gates on the two deep influent sewers on the Freud Pump Station property. The evaluation indicated that this would require multiple deep shafts that would not be contained on the property. Therefore, the isolation gates will be located in one isolation shaft that spans both deep sewers up the street from the existing station as shown on Drawing C-3 and C-4 (Appendix C).

The dry weather/sanitary flow will be captured and pumped at this location to the allow isolation during dry weather flow and to separate the dewatering pumps in the current station from needing to pump sanitary flow. The pumped dry weather flow would be routed to a discharge chamber and then routed via gravity to the sanitary manhole on Tennessee Ave.

Station Isolation will be installed at each existing 16-ft tunnel (Ashland and Fox Creek Relief Sewers) to provide full wet well isolation at the Freud Pump Station as indicated. The isolation will have the following design criteria and constraints:

- Fully isolate the wet well
- Ability to be submerged to full depth of the tunnel. Overflow will be provided for higher depths of submergence
- Removable by a crane if stuck in the closed position.
- Constructed while the Freud Pump Station is operational without being damaged during high flow events that will occur during construction.
- The gates will be easy to operate and maintain due to minimal usage during the year.

Initial discussions with GLWA indicate that GLWA desires to have geared and actuated gates for isolation to simplify operations. Operated gates require maintenance, exercising and continual power to ensure the ability the gates will operate when needed. However, stop logs or stop plates may meet the criteria as well. The decision about the types of gates will be made during the detailed design.

Dry Weather Flow

During dry weather flow conditions, flow in the Ashland and Fox Creek Relief Sewers would be diverted to the trench style sump in the isolation shaft. Flows from the relief sewer will be routed to the sump from a diversion dam constructed within the 16-foot diameter relief sewers. The flow will enter the isolation shaft through a sluice gate installed off the side of each of the relief sewers (see drawings in Appendix A). The diversion dam will be designed to route the dry weather flow from the relief sewers into the Freud Isolation Shaft sump. From there the dry weather flow will be pumped from the trench and routed to the discharge channel. Flow will be routed to the manhole on Tennessee Ave. via a new gravity sewer. At the request of the GLWA, the dry weather flow pumps have been designed to a firm capacity of 30 MGD. Preliminary hydraulic calculations have been completed to assist with a pump selection.

The Freud Isolation Shaft sump will contain approximately six (6) submersible pumps (three rows of two pumps) installed on a rail system for ease of removing from the isolation shaft for maintenance and/or replacement. The discharge piping will be installed up through the first level of the isolation shaft where the piping will enter the discharge chamber on the west side of the structure. Check valves will be installed on each of the discharge pipes to avoid flow from entering the discharge piping when certain pumps are not operating.

Grit Management

Grit that passes through the Ashland and Fox Creek Relief Sewers during wet weather conditions will enter the Freud Isolation Shaft and will need to be removed. The removal of this grit will help minimize unnecessary abrasion and wear of the sanitary pumps during dry weather flow conditions. A few options of a grit management system will be further evaluated during the design phase and will include:

- A flushing system that uses pressurized water jets installed in the isolation shaft to resuspend the grit following wet weather events. The resuspended grit will then be removed by the dry weather flow pumps and routed to the discharge channel.
- Flushing buckets or water retention system on the east face of the structure. The water collection system would fill during wet weather events and be held in place until the system returns to dry weather flow conditions. When needed, the flushing system would be engaged to assist in resuspending the grit and removed by the sanitary pumps.

Protection Against Clogging

Ten States Standards for Wastewater (2014) recommends bar racks to protect pumps from clogging and damage in combined wastewater applications. At GLWA's request, bar racks are not planned at this installation. To mitigate this risk, special provisions will be included in the proposed sanitary pumps to clean the impellers and pass large solids.

Operations During Wet Weather Events

During wet weather events the flow through the Ashland and Fox Creek Relief Sewers will be managed at the Freud Pump Station. The diversion gates on the side of the two 16-foot diameter sewers used during dry weather flow conditions to route water into the Freud Isolation Shaft will be closed.

7.8 Maintaining Pump Station Operation During Construction

The Freud Pump Station is required to maintain operation during construction as it is a critical component of the sewer and stormwater system on the east side of Detroit along the river to prevent flooding. Due to the criticality of this element, the sequencing of construction may be dictated to the contractor for key elements to meet this requirement. Section 14 below provides the beginning of the construction sequencing discussion

8 HVAC

8.1 Design Criteria

The HVAC system will comply with the following standards and codes:

- 2015 Michigan Mechanical Code
- 2015 Michigan Energy Code
- 2020 NFPA 820 Standard for Fire Protection in Wastewater Treatment and Collection Facilities
- ASHRAE Fundamentals Handbook
- SMACNA HVAC Duct Construction Standards- Metal and Flexible

8.2 Steam Heating System

The Storm Water Pump Station is served by an existing low-pressure steam system with a boiler inside the building. This boiler was recently replaced due to its condition. Two original, non-operational boilers located in the Boiler Room were removed from the building completely. Steam distribution piping and insulation will be fully replaced. Schedule 40 black steel will be utilized with fiberglass insulation and PVC jacketing.

8.3 Condensate Return System

The condensate return system has exceeded its service life expectancy and will be completely replaced. New condensate return piping will be comprised of Schedule 80 black steel with fiberglass insulation and PVC jacketing. A new duplex condensate return pump with receiver tank will be installed to ensure the steam condensate effectively returns to the boiler. Condensate return piping will be pitched to drain back to the condensate receiver tank. Discharge piping from the condensate pumps will be routed to the boiler. Due to the pressurized nature of the discharge piping, there will be flexibility in routing pipe from the pumps to the boiler.

8.4 Steam Unit Heaters

All existing steam unit heaters will be replaced throughout the facility due to either their condition or age and expected reliability. Unit heaters will utilize a horizontal configuration with internal propeller fan and bottom condensate return piping connection. Float and thermostatic steam traps will prevent unused steam from entering the condensate return system.

8.5 Electric Unit Heaters

The Control and Switchgear Rooms are currently heated by existing wall mounted electric unit heaters, each controlled by wall mounted thermostats. The Battery Room is heated by an explosion proof wall mounted electric unit heater, controlled by a wall mounted explosion proof thermostat. These unit heaters will remain, as they appear to be in good condition and are about halfway through their service life expectancy.

8.6 Ventilation

Per NFPA 820, the Storm Water and Sanitary Pump Station Dry Well requires continuous ventilation at 6 air changes per hour. This will give the spaces an NEC Area Electrical Classification of Unclassified. Since the Dry Wells are adjacent to the Wet Well, the ventilation system serving the Dry Wells shall provide positive pressure to the space. The Wet Well will remain unventilated.

8.7 Supply/Exhaust Fans

The ventilation system for the Motor Room and the lower levels will be replaced. The Dry Well is open to the Pump Room below and will be supplied ventilation air via two utility set centrifugal fans and one utility set centrifugal exhaust fan. These fans will operate on a continuous basis.

The current supply fan configuration includes one fan located in a fan room and a second fan located outside this room. The unit outside the fan room will be located in the proposed Wet Well Access Room requiring it to carry an explosion proof rating. Restroom adjacent to this fan room will be demolished, allowing for accessible space for the fan. The second supply fan is inside the fan room and is not in a room that will carry any sort of rating. Outside air will be provided through wall-mounted intake louvers and ducted to the fans. From the supply fans, the supply air will be ducted down through the Dry Well to the lower levels, terminating at the lower Pump Room. The supply air will be tempered via electric duct heaters located in the supply ductwork.

Exhaust air will be pulled up from the Dry Well to the exhaust fan located in the Machine Room area. The exhaust fan discharge will be ducted to a wall mounted exhaust louver and discharged from the building.

The Battery Room is ventilated by an existing wall-mounted intake louver and wall-mounted propeller type exhaust fan. Motors for these units are explosion proof. The fan is operated by an HOA switch and controlled by a 24-hour programmable timer in the Auto mode. The louver and fan will remain in their current arrangement and operation as they appear to be in good condition and are about halfway through their service life expectancy.

9 PLUMBING

9.1 Lavatory/Water Closets/Shower

The existing restroom will be removed. A new restroom will be installed in the building, with a new lavatory and water closet. A lavatory will be wall-mounted ceramic with single lever manual faucets. A water closet will be floor-mounted manual flush valve type. Either a shower or an emergency shower will be installed.

9.2 Wall Faucets/Hose Bibbs

Wall faucets and hose bibbs will be provided in locations convenient for use throughout the facility. Wall faucets will be located on the exterior of the building, spaced to allow a hose to reach the midway point between two faucets, while hose bibbs will be located on the interior of the space, as needed.

9.3 Water Heater

An existing electric storage type water heater will be replaced with new insta-hot electric hot water heaters at the point of use (restroom lavatories). This will eliminate the need to maintain a tank of hot water for a relatively low level of occupancy.

9.4 Domestic Water Piping

Domestic water service will be fully replaced in the building. A new reduced pressure zone backflow preventer will be installed at the service entrance into the building, with copper piping distributed throughout the facility.

9.5 Sanitary Drain, Waste & Vent Piping

Sanitary drain waste & vent piping will be constructed of cast iron unless GLWA prefers PVC. Piping will be routed out of the pump station to an existing sanitary main. Coordination with site civil will be performed to ensure proper connection while avoiding electrical utilities.

10 ELECTRICAL

10.1 Power Distribution System Overview

The electrical system at the pump station currently has three 24 kV electrical services from Detroit Edison (Ludden 161, Porter 132, and Ludden 208). The three electrical services provide power to three GLWA-owned, 6,000/7,500 kVA transformers which step down the voltage from 24,000 VAC to 4,160 VAC. Each transformer includes an oil immersed isolation switch, but the switch is only rated to interrupt an unloaded transformer (10A magnetizing current interruption only). Service isolation is accomplished through Detroit Edison via utility switching.

The three service transformers provide ungrounded delta secondary service to the pump station. However, the generator switchgear bus includes a 75 kVA grounding transformer which provides a reference to ground when the generator switchgear gen-utility tie is closed. The neutral-to-earth connection of this grounding transformer introduces a ground reference for stabilizing and centering the 4.16 kV delta system around the ground reference point, but not when the system is operating on normal utility power.

The 4.16 kV secondary conductors from the two Ludden utility services (Ludden 161 and Ludden 208) are brought into the pump station and terminated directly to main circuit breakers on Bus #1 and Bus #3 respectively. The secondary conductors of transformer T-2 (Porter 132 utility service) are routed to the outdoor generator switchgear, and then continues into the indoor switchgear main circuit breaker on Bus #2.

The indoor switchgear line-up is configured in a 4-bus arrangement, with tie circuit breakers creating a looped tie between the four busses. Under normal operation, tie breakers 1-2, 2-3, and 4-1 are open, creating three isolated 4.16 kV bus systems which are fed from the three separate utility services. Bus 4 has no utility service, and Tie 3-4 is typically closed to provide service to this bus.

The 4.16 kV emergency generator switchgear is located in an outdoor switch house, and consists of 3-cycle vacuum breakers. The switchgear includes a main disconnect for intercepting the 4.16 kV service from Transformer No. 2 (52-UM), and paralleling equipment to allow the generator system to be paralleled with the Porter 132 utility. The generator switchgear is responsible for selecting the source of power (utility, generator, or both), and distributing this power to Bus #2 of the indoor switchgear.

This station does not have 480 VAC equipment. All low voltage equipment is sourced from the station's four 112.5 kVA, 4.16 kV – 120/208 VAC transformers.

10.2 Medium Voltage Transformers

The three existing service transformers are all original, dating back to 1955 when the pump station was constructed. Transformers T1 and T2 were refurbished in 2008, providing an additional life expectancy of 10 to 20 years. Transformer T3 was refurbished and rewound in 1998. The three transformers have all operated well beyond expected life and will be replaced with new transformers. The redundancy of the electrical services allows the replacement of these transformers in a phased approach so that utility power can be maintained to the station throughout construction.

New transformers will be liquid-filled distribution substation style transformers constructed in accordance with ANSI C57.12.00 and ANSI C57.12.36. Connections to the primary and secondary side will be cabled rather than bussed, to match the existing methods of transformer connection. The dielectric fluid will be Envirotemp FR3 or equivalent natural ester based dielectric fluid which is environmentally friendly, provides a high flash/fire point and is recognized as "less-flammable" in accordance with Section 450.23 of the NEC.

Each transformer will include no-load tap changers to adjust secondary voltage +/- 5 percent from nominal voltage. The existing voltage at the pumping station is currently set at 4% to 5% above the 4.16 kV nominal voltage, with measurements of 4,300VAC to 4,400VAC noted during the original field visit in 2017, and as noted in the equipment demonstration in May of 2017. The reason behind this tap change will need to be investigated during design, including electrical system modeling to identify potential voltage drop issues during motor starting.

The following existing deficiencies will be corrected with the replacement transformers:

Replace Floating Delta Secondary

The existing transformers provide a floating delta secondary connection to the main switchgear. This type of system exposes the 4.16 kV system to potential overvoltage conditions in the event of an arcing phase-to-ground fault, where the arcing condition can cause a voltage multiplication with respect to ground. This type of fault can occur if an operating motor experiences a line-to-ground arcing fault on one of the motor windings or if a surge arrestor fails and begins flashing to ground. The result of the arcing condition can cause line-to-ground voltages to temporarily exceed 3 or more times the typical line-to-ground voltage. Occasional ground faults have been detected in the recent past by the ground fault sensing system provided on the medium voltage switchgear.

The new design will correct this problem by evaluating and implementing one of the solutions below:

- Preferred Option: Replace wye-delta transformers with delta-wye transformers

This option involves replacing each wye-delta transformer with a new transformer that has a 24kV delta winding configuration on the primary side and a 4,160Y/2,400V wye secondary winding. The transformer replacement process will need to be guarded to prevent accidental paralleling of transformer secondaries since the delta-wye secondary on the new transformers will have a 60 degree phase shift from the existing wye-delta transformer windings. This anti-paralleling protection is already in place in the form of electrical permissive interlocking. However, selective unracking of circuit breakers is suggested to provide a second degree of isolation during the period of time that delta and wye secondary connections are simultaneously present within the electrical distribution system.

Transformers with delta-connected primary windings and transformers with wye-connected primary windings can both be supported from the 24kV primary distribution system. However, some utility companies have strict policies on which type of connection can be utilized on their power distribution lines. This solution will need to be coordinated with Detroit Edison prior to being implemented.

- Alternative Approach: Provide grounding transformers on delta secondary

  If a wye primary connection is required by Detroit Edison, secondary grounding can be provided by using a delta secondary winding and providing a derived neutral grounding system on the secondary side of each transformer. This involves adding a small three-phase wye-delta transformer (with high impedance neutral grounding on the primary side and shorted secondary delta windings) or a zig-zag transformer with high impedance grounding. Either solution creates an artificial ground which will hold the system voltage in place in the event of an arcing ground fault.

- Alternative Approach: Provide wye-wye transformers

  This approach is not recommended. Transformers with wye-wye configuration have historically presented problems associated with overvoltage conditions under light loading conditions. These three transformers will be lightly loaded the majority of the time. The wye-wye connection also presents complications in dealing with triplen harmonics and presents potential ferroresonance issues. There are solutions available to mitigate these issues, such as using embedded tertiary windings or using a 5-legged transformer core. However, one of the first two alternatives described above should provide an available solution for the replacement transformers.

Primary Overcurrent Protection

The existing transformers do not include a primary overcurrent device or a means to disconnect and separate a loaded transformer from the utility. Overcurrent protection and disconnect of these primary lines is required by the National Electrical Code. The non-compliance with NEC 230, Part VIII is a result of a previous City-owned PLD utility which was subsequently purchased by Detroit Edison. New renovations to the utility services will require compliance with Part VIII of NEC 230.

Isolation of the transformer primaries is currently accomplished via an oil isolation switch which is mounted to the transformer casing. However, the isolation switch is not rated to break a loaded transformer. Each switch is only rated to interrupt the magnetizing current of an unloaded transformer.

Isolation of primary power to each transformer currently requires coordination with Detroit Edison. Primary protection also relies on upstream Detroit Edison protective devices. The design should provide a means of allowing GLWA to isolate and provide protection for their own transformers.

To rectify this issue, new outdoor medium-voltage switchgear will be installed, consisting of 27kV-rated vacuum circuit breakers. The new switchgear will provide primary protection for the new transformers in addition to utilizing other transformer protection methods.

Limit Ground-Fault Energy

Each transformer will be able to deliver approximately 100 MVA of secondary fault energy. Historically, approximately 70 percent of faults on electrical distribution systems are associated with line-to-ground faults. The available line-to-ground fault current on a grounded wye system can be very destructive and measures should be taken to limit the amount of energy that is dissipated into a single line-to-ground fault.

The existing 4.16kV floating delta secondary connection inherently protects against single line-to-ground faults by allowing the system to operate during the ground fault. In the event of a ground fault, the faulted phase immediately assumes ground potential, and the remaining two phases (which have a normal potential of 2.4kV to ground) are elevated to 4.16kV to ground. The system can continue to operate in this manner until the ground fault is identified. Repairs can be made to correct the ground fault during dry weather periods.

Although this type of system may sound ideal, most line-to-ground faults are not solidly connected faults, but rather, momentary arcing faults. Therefore, the entire secondary 4.16kV power distribution system may be able to continue operating, but overvoltage transient conditions which could be present from an arcing fault can damage the station equipment that this system supplies.

The use of floating delta systems has largely been replaced with low-resistance neutral grounding systems. A low resistance grounding system limits the ground fault current to low levels (typically 200A or less), thereby eliminating the explosive damage in the area of the line-to-ground fault. The neutral resistor also limits the fault current on the medium voltage cable sheaths, preventing thermal damage to the distribution cables in the event of a line-to-ground fault.

Unlike the floating delta system, a low resistance grounded system is not able to operate continuously until the ground fault is corrected. The time duration of the fault is limited by the thermal rating of the grounding resistor and this time duration is typically less than 10 seconds. However, the electrical distribution system for the Freud Pumping Station consists of a fully-redundant design. If any portion of the electrical distribution system should experience a line-to-ground fault, then that portion of the electrical distribution system can be removed and isolated within the 10 second allotted time frame, allowing the remainder of the station to continue operating.

Note that selective coordination and removal of a ground fault condition requires monitoring of the ground current on all feeders. One could argue that a floating delta connection could continue to be used if overvoltage (ANSI 59) protection were incorporated to accomplish a similar objective. However, in the event of an arcing fault, the entire 4.16 kV system experiences the transient overvoltage and there is no method of determining the location of the ground fault and isolating it.

The design will be based on using a 24 ohm neutral grounding resistor with 10 second rating, allowing a maximum of 100A on the grounding system in the event of a line-to-ground fault on the 4.16kV secondary distribution system. The ground fault current returning to the transformer neutral could be split into parallel return paths since the three service transformers share a common equipment grounding system.

Transformer Differential Protection

The existing transformers do not have detection or protection against a fault which occurs internal to the transformer. The method of protection used for protection of internal transformer faults is "differential protection" (ANSI 87 Protection). The concept behind transformer differential protection is to use current transformers to measure the current entering and leaving the transformer. If a significant amount of power entering the transformer is not equal to the power leaving the transformer, then the difference must be due to destructive internal fault energy.

Differential protection relies on the ability to isolate the transformer primary when an internal fault is detected. The present system has no primary fault-break device to accomplish this. The new primary switchgear will allow this protective function to be added and implemented.

The placement of the secondary current transformers in this differential system will determine the zone of protection that the differential protection will cover. If a new set of secondary CTs is included in the transformer secondary compartment, the zone of protection will cover the transformer primary feeder and internal faults to the transformer. If the secondary CTs are placed at the main breaker of the existing switchgear systems, then this protection will also cover the secondary conductors into the switchgear.

Transformer Supplemental Protection Systems

Each new transformer will be provided with the following supplemental transformer discrete monitoring systems:

- Dielectric fluid level gauge with low level alarm contact
- Dielectric fluid temperature gauge with high temp alarm contact
- Tank Vacuum/Pressure gauge with low pressure alarm contact

Grounding Resistor Protection System

In the event of a line-to-ground fault, the neutral grounding resistor will only be able to withstand up to 10 seconds of operation before overheating. The grounding resistor system on each transformer will include a 100:5 current transformer which will continuously monitor the current returning to the transformer neutral. An ANSI 50/51G ground fault protective relay in the new primary switchgear will trip the primary circuit breaker within this 10 second period. Some intentional delay should be incorporated to allow downstream protective devices to clear and isolate the fault. This downstream ground fault protection system currently does not exist in the existing 4.16 kV switchgear and will need to be added.

Grounding transformers will be placed in the same enclosed space as the transformer that it pertains to. Grounding resistors will be elevated with protected terminals since the neutral connection can be elevated to 2,400VAC during a ground fault condition.

Transformer Guarding and Fencing

The existing transformers are protected with concrete walls on three sides of the service transformer area. The concrete walls are approximately 20 feet tall. The front access to the transformers is protected with sheet steel and fencing. The sheet steel is also approximately 20 feet high and has been damaged in the past from high wind loads. A 20-foot high by 4-foot wide section of sheet steel can be subject to 1,000 lbs of surface pressure in a 70 mph wind gust. The overall guarding and protection methods used for the service transformer area will be reviewed with the project structural engineer to identify needed improvements.

10.2 Medium Voltage Primary Switchgear

The new 27kV rated primary switchgear will consist of three independent 27kV metal-clad sections in a lineup (one per service transformer). The general arrangement will consist of a vacuum circuit breaker in the lower compartment of the vertical section and protective relaying placed in the upper compartment of the switchgear. Switchgear will be the draw-out type with all electrical terminations made in the rear of the switchgear lineup. The switchgear will be ordered in an outdoor housing and set on a new concrete pad, similar in style to the outdoor switchgear housing used on the standby generator system. The preferred location for this new switchgear is adjacent to the east side of the service transformers in order to minimize the length of primary cable between the switchgear and the transformers. The existing 24k feeders are presently brought to the property underground and terminated directly to the transformer primary oil switches. Splicing is likely the most practical approach for extending the existing services to the new primary switchgear.

The interrupt rating of the primary switchgear will need to meet the available fault current present on the utility system. The existing available three-phase bolted fault current values on each utility service is as follows:

Ludden 161 Service (Transformer T-1): 3,324A symmetrical (138 short circuit MVA)

Porter 132 Service (Transformer T-2): 3,749A symmetrical (156 short circuit MVA)

Ludden 208 Service (Transformer T-3): 4,955A symmetrical (206 short circuit MVA)

Circuit breakers will be 1,200A frame vacuum circuit breakers, 750 MVA class, rated for 27kV maximum voltage and with a 3-cycle interrupting time. Interrupt ratings will be 16 kA symmetrical (3 second rating) and 43kA closing and latching. Surge arrestors will be included on the line side of each circuit breaker for dissipation of transient energy off the incoming utility lines.

The upper section of each primary circuit breaker cabinet will contain the following protective metering and power monitoring devices:

- Digital power monitors for display and measurement of voltage, current, kW, kVA, and kVAR.
- ANSI 50/51 - Protective Relaying: Overcurrent and fault protection of the transformer primary feeder and transformer primary winding.
- ANSI 87 - Differential Relaying: Protection of internal faults within the transformer
- ANSI 50/51G - Protection against ground faults

- ANSI 86 - Lockout relay

The switchgear lineup will need to include current transformers on each circuit breaker and potential transformers on the line side of each circuit breaker. Additional cabinets will also be required to support Detroit Edison current transformers, potential transformers, and metering devices. Space requirements will need to be coordinated with Detroit Edison.

The switchgear house will include an HVAC environmental control system, factory lighting (LED), and service receptacles. A 120/208V house service feeder will be brought to the switchgear house from the pumping station or from the generator switchgear to provide internal house power. This will avoid having the house power dependent upon any particular service transformer. A 125vdc battery system and dc power distribution panel will also be provided for the breaker control system.

Raceway systems for communication and monitoring of the switchgear will need to be added between the pumping station and the switchgear house. The new monitoring signals will need to be integrated into the existing Ovation monitoring system.

10.3 Existing 4.16kV Switchgear

The 4.16 kV indoor main switchgear was installed in 2007 and consists of vacuum circuit breakers. The switchgear has been well maintained and will continue to be used. The existing protective relays meet the phase fault and overcurrent protection system needs for the station. However, the switchgear does not include ground fault protection on the outgoing feeders since the present secondary voltages consist of an ungrounded floating delta systems. ANSI 50/51G will need to be added to each outgoing feeder to allow for selective detection of a ground fault on the individual feeders. This will allow for a ground fault on an individual feeder to be quickly isolated from the system, leaving the remainder of the power distribution system intact.

The existing batteries are located in a separate battery room and are replaced as part of a regular maintenance schedule. Improvements to the battery system will not be part of this project. However, the dc power panel which distributes 125 vdc power appear to be the original panel from 1955. Although currently functional, replacement is recommended due to age and the critical nature associated with the function of the equipment that this panel supports. These panels will be replaced.

The existing ground detection system provided on each of the main circuit breakers can remain in place since the behavior of the system voltage on a low resistance grounding system will be similar to the behavior of a floating secondary system.

Undervoltage detection and related power transfer schemes will remain in place and will not need to be modified.

10.4 Existing 4.16kV Generator Switchgear

The 4.16 kV generator switchgear was installed in 1999 and consists of vacuum circuit breakers. The electrical switchgear is housed in an outdoor walk-in style enclosure. The switchgear is in good condition and will not be modified as part of this project.

10.5 Existing 4.16kV Generator Units

The pump station has a total of four outdoor diesel-driven generator units which were installed in 1999. The rated lifespan of these units is between 10,000 to 20,000 hours of operation. These units are only operated in the event of a loss of utility power or when exercised. The total usage on each engine-generator is under 2,000 hours over the last 17 years and can continue to be used. Replacement of these units will not be a part of this project. However, the outdoor enclosures which house the generators have some minor deficiencies. Repair of enclosures will be identified and discussed for inclusion into the construction project.

10.6 Storm Pump Synchronous Motors

The station has eight 3,000 HP storm water pump motors. These medium voltage motors are synchronous, 225 rpm, 32-pole motors. The storm water pump motors are original as installed during the original pump station construction. The motors for the stormwater pumps are currently started by closing the 4.16 kV vacuum circuit breaker and synchronizing with the original 1955 motor field cubicles. The age and condition of these cubicles has caused problems with motor starting and synchronization.

A demonstration of the Freud Pumping Station motors and pumps was conducted in March of 2017, which included momentary starting of all pumps. The purpose of the demonstration was to allow representatives of LGC Global, DES Services, Rockwell Automation, and PCI to observe operations, collect data and identify findings. The demonstration showed that all eight stormwater motors were able to start and synchronize within 4 seconds. However, visual observations and inspection showed a significant number of deficiencies and irregularities with the exciter cabinets. As a result of this demonstration, new Allen Bradley exciter cabinets have been purchased and are currently being installed for each motor. This project assumes that the out-of-sync protection systems, 208V, three-phase motor stator heater contactors and controls, and local E-stop pushbuttons have been incorporated into this exciter replacement project. Exciter cabinet modifications are not anticipated to be part of this project.

Although the motors are old, they are rarely used and are functional. An overall replacement would be cost-intensive and is not part of this project. Motor feeder and motor insulation testing will be incorporated as part of the project to provide confirmation the insulation integrity of the motor windings and motor feeder conductors. If recent insulation testing has been performed and insulation integrity has been confirmed, then this can be omitted from the project.

An Eaton MP-3000 multifunction motor protection relay and a Basler 87 motor differential protection relay was provided for each stormwater pump motor in 2008 as part of the switchgear replacement project. These protective systems will not need to be modified.

Each motor also includes a temperature monitoring system which monitors bearing temperatures and motor winding temperatures. The existing motor thermal protections systems were found to be nonfunctional during the March 2017 field demonstration. Therefore, the entire thermal protection system was replaced as part of a change order to the GLWA-CON-109 project in May of 2018. This design project assumes that this replacement system has been installed, tested, and is now operational.

An existing surge capacitor and arrestor is provided at each motor for transient protection. These systems will remain in place and will not be modified or replaced as part of this project.

The cooling water solenoid for each stormwater pump motor are controlled by the circuit breaker closing circuit and will not need to be modified as a result of the exciter replacements.

10.7 Dewatering and Sanitary Pump Induction Motors

The two dewatering and sanitary pumps are driven with two 200HP medium voltage induction motors (Pumps No.9 and 10). The motors are located on the lowest level of the station and were originally used for station dewatering. The pumps were recently rebuilt in 2017. Based on conditional assessments, the motors were in good condition and were reinstalled on the rebuilt pump assemblies. Replacement or rework of these motors is not part of this project.

10.8 Low Voltage Power Distribution

This station does not have a 480 VAC distribution system. Station house power is distributed at the 208/120 VAC level via four 4160V-120/208V house transformers (including the generator house transformer, T-4). Three of these transformers are located in the transformer room. House transformers T-1 and T-2 are dry type transformers and were recently replaced in 2010. Transformer T-3 is a silicon liquid-filled transformer and appears to be installed after 1979 since the original nameplate includes a statement about being PCB-free (after PCBs were banned). This transformer will be replaced with a dry-type transformer.

Many of the power distribution panelboards at this station date back to the 1950's. The age of the circuit breakers in these panels make replacement difficult as the circuit breakers begin to fail. The following 208Y/120V panelboards will be replaced under this project:

- PP-1
- PP-2
- PP-3
- PP-5
- LP-3
- LP-4

10.9 Lighting

Interior Lighting

The upper levels of the Freud Pump Station are well lit with induction high-bay lighting fixtures. This type of fixture does not use a filament and has a rated life similar to LED fixtures (approximately 100,000 hours). The induction high-bay fixtures were installed within the last 10 years. Since the building is not occupied on a continuous basis, these lights should provide another 20 to 30 years of useful life. The efficacy of the induction lamps is fairly high (approximately 95 lumens/watt). LED high bay fixtures provide efficacy values around 120 lumens/watt. Replacement of the induction lighting would not reduce lamp/light maintenance and would not provide a reasonable payback period based on higher efficacy. Supplemental LED lighting will be provided for some smaller rooms on the upper level which were not included in the previous lighting retrofit.

The lower levels of the pump station still utilize the older incandescent style fixtures, although many of these have been replaced with compact fluorescent lamps. Lighting at these levels is not adequate and the fixtures provide low efficacy (14 lumens/watt for incandescent and 60 lumens/watt for compact fluorescent). The illumination at these lower levels will be increased to meet IES standards. Replacement and new light fixtures will utilize the more efficient LED lights.

New lighting will utilize 4000 to 4500 kelvin temperature.

Exterior Site Lighting

Four existing wall pack units are installed on the south side of the building for illumination of the parking area. Three additional recessed light fixtures are in the overhang area of the loading dock. The wall pack fixtures are functional, but the age and type of fixture is not known. The kelvin temperature of the lights suggest that they are metal halide or LED. The wall-pack units will be evaluated for replacement based on the type, age, and condition of the lights. The recessed lights over the loading dock were in need of replacement during the 2017 assessment and will be replaced with LED fixtures. New lighting will utilize 4000 to 4500 kelvin temperature.

10.10 New Sanitary Pumps and Isolation Gates

Several alternatives have been presented for the location of a new sanitary lift station and associated isolation gates. These alternatives include locating the isolation shafts and equipment on the same property as the Freud Pumping Station or locating the isolation shafts and equipment one and a half blocks east of the Freud Pumping Station.

The design for the isolation gates is expected to utilize motorized actuators with horsepower ratings not exceeding 15 HP. The new sanitary pumps will be designed to handle 30 MGD flow rates, suggesting an operating load of approximately 1,000 kVA with two pumps operating (third pump is spare). Pump motors are expected to be induction motors in the range of 500HP or less (the existing sanitary/dewatering pumps are 200 HP, constant speed operation). The use of variable or constant speed control methods will be determined as design progresses.

If the isolation shafts and sanitary pumps are located on the same property as the Freud Pumping Station, the station can be fed from the existing 4.16kV switchgear via a new 4.16kV-480V step-down transformer. The existing switchgear has an equipped space to add a new circuit breaker to the Bus 1 line-up to support this load. However, redundancy on the power supply is needed for the new electrical loads. If an additional standby generator unit is dedicated to this structure, a single utility supply can be provided. If the new electrical load is small enough to allow operation under the existing standby power system, then two separate feeders will be needed to support the new electrical loads.

The existing 4.16kV switchgear only has space for one new circuit breaker and the available space within the station does not allow for expansion to any of the four 4.16kV bus sections. If a second feeder is needed, the feeder circuit breaker that services house transformers T-2 and T-3 could be utilized to feed a 4.16kV-480V transformer for the station, with house transformers T-2 and T-3 sub-fed from the 480V system.

If the isolation shaft and sanitary pumps are located off the property, it is likely that the station cannot be served from the Freud Pumping Station, and that a separate 480V utility service will be needed. In this case, a dedicated standby generator unit would serve as the backup power source for the station.

Based on a meeting Arcadis and Brown and Caldwell (BC) had with the GLWA (May 28, 2020), a decision was made to proceed with a single isolation shaft located on Freud Street between Conner Street and Navahoe Street. The station will require a separate 480Y/277V utility feed to a new building located over the isolation shaft location. The station will not include standby power as part of this design, but provisions should be included to easily add standby power in a later project.

10.11 Internal Wet Well Access Modifications

This project will include modifications to the southern portion of the building to allow for an interior wet well access room with a new exterior door. This new space will be a classified area. Interior access to this new space will be eliminated. The existing space, which currently houses level monitoring and a sluice gate actuator, will be combined with the space currently used for a restroom area. This will require a new restroom area to be created within the station. The space will include an overhead skylight or roof access and lighting will need to be designed to avoid impeding the removable overhead access area. Nine exterior conduits from the generator system to the station are installed on the exterior south wall of the building. These raceways will need to be reworked and relocated so that they do not impede the new exterior entrance to this space.

Currently, the southeast corner of the station (storage room) appears to be the most likely space to accommodate the relocated restroom area. There are several electrical panels in this space which will require relocation (Panel PP-5 and boiler-related electrical panels).

10.12 Modifications to Restricted Passage

There are currently seven 4-inch rigid galvanized steel raceway systems which pass through the space between the overhead entrance door and the pump room area. These conduits impede the ability to move large equipment in and out of the pumping station. The conduit systems consist of medium voltage motor feeders to the 3,000 HP motors for pumps P1, P3, P5, P7, P9, and P10. The seventh conduit is utilized for carrying current transformer wiring systems for motor differential protection. Rework of the raceway systems will result in a lengthening of the overall raceway path. Existing motor feeders will need to be removed and new motor feeders will need to be installed in order to avoid splicing.

10 INSTRUMENTATION & CONTROLS

11.1 Operator Control Board

The overall functionality of the operator control board will be reviewed as part of the design to identify modifications and repairs. Anticipated modifications consist of the following:

- Removal of rheostat and pilot light for synchronization of the eight stormwater pumps. These items are expected to no longer be required with the new Allen-Bradley exciters.

- Review of analog style AC and DC ammeters, voltmeters, and power factor meters and their usefulness. The field demonstration conducted in 2107 showed that six of the eight power factor meters were not functional, four of the eight voltmeters were not functional, and one of the eight stator ammeters was not functional. All DC field ammeters were functional, but it is not clear if these ammeters will be incorporated into the exciter replacement project. A considerable amount of inaccuracy was found between the measured field amperes and the displayed field amperes on the existing analog meters.
- The existing 10-window Panalarm annunciator panel is not functional and should be removed or replaced.
- The existing emergency stop pushbutton at the control console requires clear identification as to the intended function. The pushbuttons integrate with existing ANSI 43 timed restart control logic and it is not clear if the E-stops are intended to stop the entire station.
- Temperature alarm switches may need to be modified or removed in order to integrate with the new temperature monitoring system that was installed as part of a change order to the GLWA-CON-109 project in May of 2018.
- Space heater pilot lights may need to be replaced or modified to integrate with the new exciter cabinets.
- Service transformer pilot lights and switches may need to be modified to accommodate the protection systems provided with the new service transformers.

11.2 Level

Field instrumentation at this station was all functioning properly during the 2017 field assessment. The instrumentation will be revisited during design. At this time, improvements or replacements are not anticipated.

11.3 Temperature

The existing motor thermal protections systems were found to be nonfunctional during the March 2017 field demonstration. Therefore, the entire thermal protection system was replaced as part of a change order to the GLWA-CON-109 project in May of 2018. This design project assumes that this replacement system has been installed, tested, and is now operational. The new temperature monitoring system will be reviewed to identify if additional integration is needed with the operator control board.

11.4 Vibration

Operational staff have noted that the station exhibits a concerning amount of vibration when multiple stormwater pumps are operating. The station currently does not have vibration monitoring on the pumps and motors. A continuous (analog) vibration monitoring system will be considered as part of this design. A continuous monitoring system will provide the ability to historically track motor and pump vibration on a bidirectional (X-Y) axis system in order to establish a baseline for each pump and motor, and also to provide a comparison between pump/motor assemblies. The system can be integrated into the Ovation system to provide alarming and shutdown setpoints for the individual pump/motor assemblies. Alarm and shutdown setpoints are typically momentary inhibited or adjusted during a pump start-up event since higher vibrations during startup can result in false alarms or shutdowns.

12 DRAWINGS, SPECIFICATIONS, AND CONSTRUCTION COST ESTIMATE

A preliminary set of drawings for this BOD Report, a list of projected specifications, and a construction cost estimate are included in Appendix A, D, and E respectively. A set of Contract Drawings will be completed during the Freud Pump Station Improvement design.

13 CONSTRUCTION WORK SEQUENCE

13.1 Freud Pump Station Improvements – Work Sequence

The work sequence to install the improvements at the pump station will require a great deal of coordination, considering that the station will also need to remain in operation to convey both sanitary and wet weather flows when necessary. To start conversation on this, the major components are outlined below with thoughts on the order and other considerations.

Freud Isolation Shaft Construction

- Freud St. closure and realignment
- Demolition and reroute utilities to clear the shaft site
- Stabilize shaft excavation (maintain tunnels though excavation)
- Excavate the shaft
- Cast the interior shaft walls and bottom (maintain tunnels through structure)
- Install shaft interior structure:
    - Sanitary wet well
    - Isolation gate risers around and over tunnels
    - Structural framing
- Open tunnels and install isolation gates and guides
- Gates are long lead items – Submittals 4 weeks after PO and shipment 36 weeks afterwards
- Install top slab of shaft
- Complete site work and service building

Freud Isolation Shaft Sanitary Pumps

- Install pump base elbows, discharge piping and guide rails (coordinate with temporary pumping)
- Tunnel diversion gates to the sanitary wet well (coordinate with temporary pumping)
- Install discharge force main (coordinate with temporary pumping)
- Install electrical service and electrical equipment (coordinate with temporary pumping)
- Install pumps and connect electrical and SCADA

Storm Pumps

- New pump rotating assemblies are a long lead item
    - Submittals 14 weeks after PO and shipment 47 weeks after release to factory
- Sequence pumps for rehab/replacement, only one out of service at any time
- Remove pump and drive shaft
- Replace existing drive shaft Babbitt sleeve bearings with greased roller bearings
    - Submittals 14 weeks after PO and shipment 60 weeks after release to factory
- Replace pump concrete support piers
- Rehab pump volute and reinstall on new piers
- Install new/rehabilitated rotating assembly
- Replace pump drive shaft and upgraded bearing assemblies
- Complete any required motor testing and maintenance
- Complete pump start-up and testing

Dewatering Pumps

- Start installation after sanitary/temporary pumping is in place
- Provide isolation for storm wet well and pump down wet well
- Remove existing pumps, one at a time, from floor casting to discharge casting in wall
- Repair connection at floor casting (leaking lead joint)
- Install new suction valve and pump
- Install discharge piping to existing wall casting
- Complete pump start-up and testing

Freud Pump Station Wet Well Access

- Install new toilet room in the existing storage closet
- Remove existing toilet room and walls
- Close off existing room from inside access
- Install roll up and man door
- Enlarge existing floor opening
- Ventilation modifications
- Install roof hatch access
- Remove existing gate and gate operator

Freud Pump Station Wet Well

- During dry weather flow period(s)
- Cleaning and inspection of wet well
- Concrete surface repairs (assumed quantity)

13.2 Temporary Sewer Bypass During Construction

Currently, flow data in the Ashland and Fox Creek Sewers is not available. However, GLWA is currently installing new flow meters which are expected to be operational by late August 2020. Once this data is available and provided by GLWA, bypass pumping will be evaluated during the design. As such, a cost estimate for the temporary bypass pumping has not been included with this submittal.

Facilitating construction of the Freud Pump Station components may require temporary pumping with a capacity greater than the sanitary pumping capacity of 30 MGD included in the design. This may allow fewer interruptions during the construction and provide for pumping of minor wet weather events without the storm pumps being on-line and keeping the storm wet well isolated, but this will require further review. One concept for this is to provide pumps that are larger than the sanitary pumps being designed for permanent use but installing them in the new sanitary wet well in the isolation shaft. These could be similar pumps, but with a higher capacity and horsepower that will still fit in the locations for the permanent pumps and utilizing the same discharge piping and guide rails. Temporary discharge piping would be needed to connect the temporary pumps to the storm pump discharge channel.

Several concepts are currently under consideration to provide temporary bypasses or pumping, including:

- Temporary diversion of flow from one tunnel to the other to allow installation of the isolation gates.
- Diversion of flows upstream of the new Freud Isolation Shaft where practical during low flow periods.
- Installation of a force main from the new Freud Isolation Shaft to the stormwater discharge channels of the Freud Pump Station.
- Use of the current sanitary discharge location at Tennessee Street to capture dry weather flows and allow work to be completed in the Storm Wet Well, as outlined in the Work Sequence above.

APPENDIX A

Design Drawings

GREAT LAKES WATER AUTHORITY

CONTRACT NO. GLWA CS-120

FREUD PUMP STATION IMPROVEMENTS

ENGINEERS

ARCADIS

607 SHELBY STREET, SUITE 400
DETROIT, MICHIGAN 48226

Brown AND Caldwell

100 WEST BIG BEAVER ROAD, SUITE 200
TROY, MICHIGAN 48084

GLWA BOARD OF DIRECTORS

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Brian Baker, Director
Gary A. Brown, Director
Freman Hendrix, Director

GLWA STAFF

Sue McCormick
Chief Executive Officer
Cheryl Porter
Chief Operating Officer, Water & Field Services
Grant Gartrell, P.E.
Director of Engineering, Water Operations
Biren Saparia
Manager of Water and Field Services

BASIS OF DESIGN DRAWINGS

NOT FOR CONSTRUCTION
AUGUST 2020

DRAWING INDEX

Dwg No.	
TOTAL	
	GENERAL
G-00	COVER SHEET
G-01	INDEX OF DRAWINGS
G-02	LEGEND, ABBREVITIONS, AND GENERAL NOTES
G-03	LAYOUT
	DEMOLITION
	FREUD PUMPING STATION
D-01	WET WELL ACCESS PLAN DEMOLITION
D-02	DEMOLITION PHOTOS
	CIVIL
	FREUD PUMPING STATION
C-01	SITE SURVEY 1 OF 2
C-02	SITE SURVEY 2 OF 2
	ARCHITECTURAL
	FREUD PUMPING STATION
A-01	FLOOR PLAN

Dwg No.	
	STRUCTURAL
	FREUD STORM WATER PUMPING STATION
ES-01	EXISTING PUMP PEDESTALS - PLAN AND DETAILS
ES-02	EXISTING MOTOR FLOOR FRAMING PLAN
	SANITARY PUMPING STATION AND STATION ISOLATION SHAFT
S-01	FOUNDATION PLAN @ EL. 53.50
S-02	THIRD LEVEL PLAN @ EL. 65.25
S-03	SECOND LEVEL PLAN @ EL. 74.00
S-04	FIRST LEVEL PLAN @ EL. 83.00
S-05	TOP PLAN @ EL. 95.00
S-06	SECTION 1
S-07	SECTION 2
S-08	SECTION 3
S-09	SECTION 4
S-10	SECTION 5
	PROCESS MECHANICAL
M-01	PLANS
M-02	PLANS
M-03	PLANS
M-04	SECTIONS
M-05	
M-06	SECTIONS
M-07	EXISTING FLOOR PLAN
M-08	BUILDING SECTION
M-09	BUILDING SECTION - WEST
M-10	WET WELL ACCESS FLOOR PLAN

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SEAL / STAMP

FACILITY
FREUD PUMP STATION
PROJECT TITLE
FREUD PUMP STATION IMPROVEMENTS
DRAWING TITLE
INDEX OF DRAWINGS

FIRM NAME

SECTION MAP	TOWN	RANGE	SECTION	Q	QQ

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GLWA CONTRACT No. -
GLWA CIP No. -
DRAWING No. G-01
GENERAL

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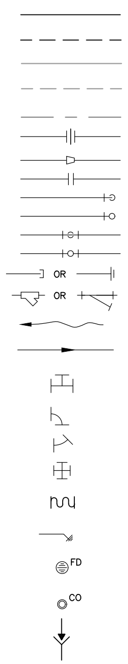
SYMBOLS:

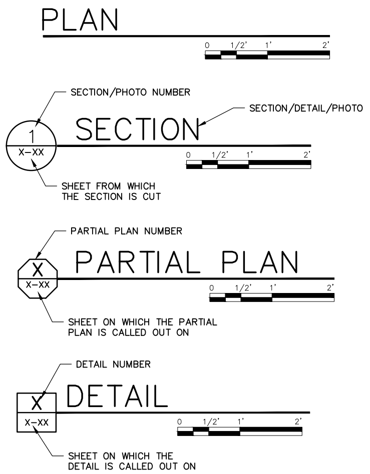
- AIR RELEASE VALVE (AR)
- AIR/VACUUM VALVE (AV)
COMBINATION AIR VALVE (CA)
- BALL VALVE (BA), NORMALLY OPEN
- BALL VALVE (BA), NORMALLY CLOSED
- BALL CHECK VALVE (BC)
- BUTTERFLY VALVE (BV)
- BUTTERFLY DAMPER (BD)
- CHECK VALVE (CH)
- DUCK BILL CHECK VALVE (DB)
- ANTI–SIPHON VALVE (ASV)
- DIAPHRAGM VALVE (DV)
- SUCTION FOOT VALVE (FV)
- THREE–WAY PLUG VALVE (TW)
- FOUR–WAY VALVE (FW)
- GLOBE VALVE (GL)
- GATE VALVE (GV)
- VACUUM BREAKER (VB)
- AUTOMATIC PRESSURE REDUCING VALVES (PR)
- AUTOMATIC PRESSURE SUSTAINING VALVES (PS)
- ECCENTRIC PLUG VALVE (PV)
- RELIEF VALVE (RV)
- SOLENOID VALVE (SV)
  - FO=FAIL OPEN
  - FC=FAIL CLOSED

LEGEND:



- NEW EQUIPMENT, PIPING, STRUCTURE, ETC
- NEW BURIED EQUIPMENT, PIPING, STRUCTURE, ETC
- EXISTING EQUIPMENT, PIPING, STRUCTURE, ETC
- EXISTING BURIED EQUIPMENT, PIPING, STRUCTURE, ETC
- CENTERLINE
- UNION
- REDUCER
- TRANSITION
- PIPING ELBOW, 90° TURNED DOWN
- PIPING ELBOW, 90° TURNED UP
- PIPING TEE, OUTLET TURNED DOWN
- PIPING TEE, OUTLET TURNED UP
- PLUG OR CAP
- STRAINER
- DRAINAGE FLOW ARROW
- PROPOSED PIPING WITH DIRECTION OF FLOW
- TEE
- 90° BEND
- 45° BEND
- CROSS
- FLEX CONNECTION
- HOSE BIBB
- FLOOR DRAIN OR AREA DRAIN
- CLEANOUT
- DRAIN

TITLE MARKERS



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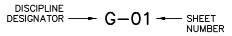

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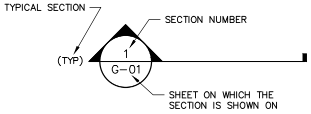

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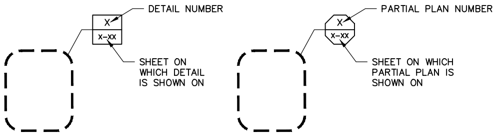

GENERAL NOTES:

1. THESE NOTES ARE GENERAL AND SUPPLEMENTAL TO THE BIDDING/ CONTRACT DOCUMENTS. THESE NOTES APPLY TO THE ENTIRE PROJECT UNLESS MODIFIED OR NOTED OTHERWISE IN THE BIDDING/ CONTRACT DOCUMENTS.
2. THE SYMBOLS AND ABBREVIATIONS LIST ON THIS SHEET IS A COMPREHENSIVE STANDARD GUIDE INTENDED FOR GENERAL USE ON ALL PROJECTS. THEREFORE NOT ALL THE SYMBOLS AND ABBREVIATIONS CONTAINED IN THIS LIST ARE NECESSARILY USED ON THIS PARTICULAR PROJECT AND SHOULD BE USED FOR CLARIFICATION ONLY. ADDITIONAL ABBREVIATIONS AND SYMBOLS ARE SHOWN AND IDENTIFIED WHERE NECESSARY WITHIN THE BIDDING/ CONTRACT DOCUMENTS.

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FACILITY
FREUD PUMP STATION
PROJECT TITLE
FREUD PUMP STATION IMPROVEMENTS
DRAWING TITLE
LEGEND, ABBREVIATIONS, AND
GENERAL NOTES

FIRM NAME
ARCADIS
Brown AND Caldwell
GLWA
Great Lakes Water Authority

SECTION MAP | TOWN | RANGE | SECTION | Q | QQ

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GLWA CIP No. -
DRAWING No. G-02
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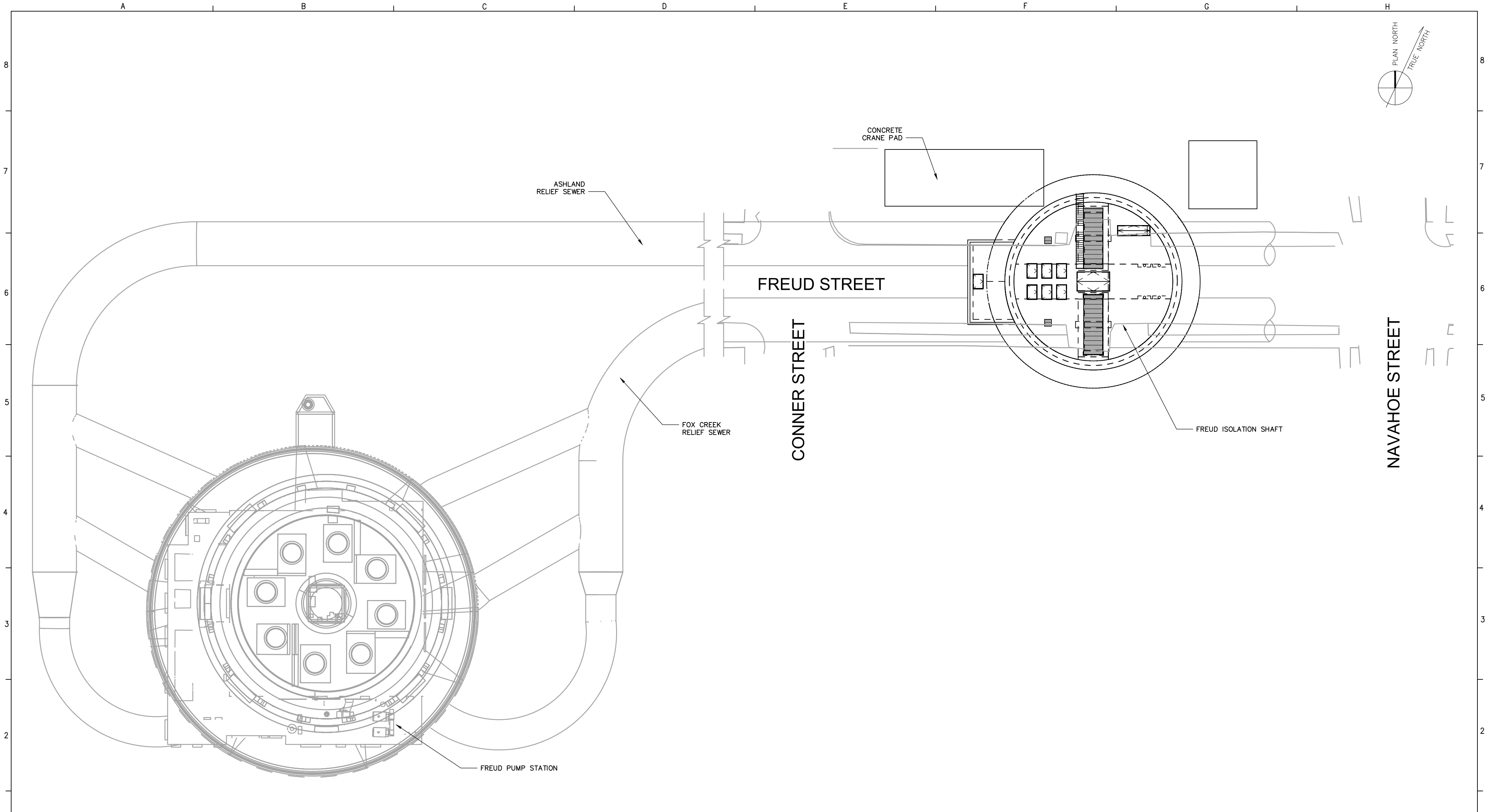

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PROJECT TITLE
FREUD PUMP STATION IMPROVEMENTS
DRAWING TITLE
LAYOUT

FIRM NAME
ARCADIS
Brown AND Caldwell

GLWA
Great Lakes Water Authority

SECTION MAP	TOWN	RANGE	SECTION	Q	QQ

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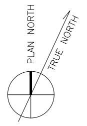

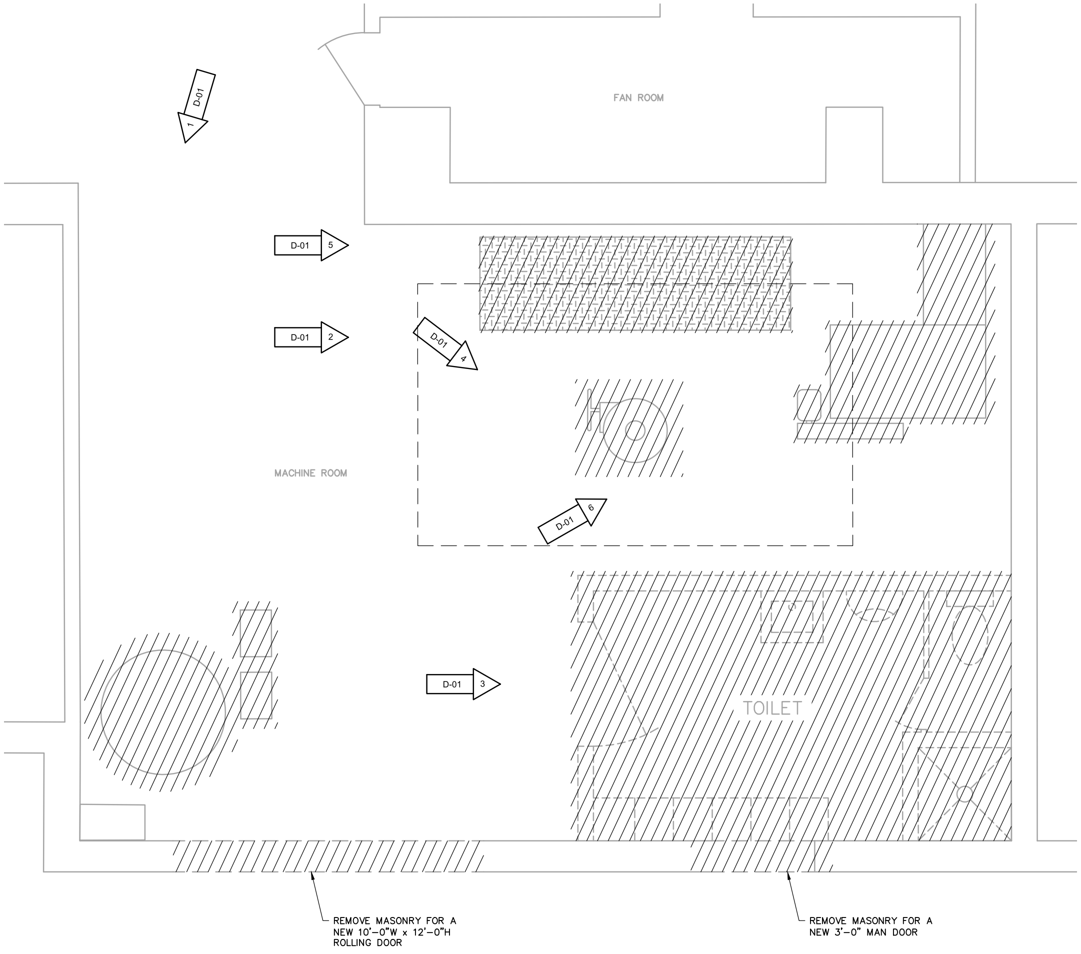

REMOVE MASONRY FOR A NEW 10'-0"W x 12'-0"H ROLLING DOOR

REMOVE MASONRY FOR A NEW 3'-0" MAN DOOR

WET WELL ACCESS PLAN DEMOLITION

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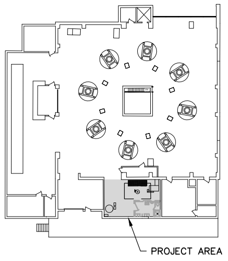

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FACILITY
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PROJECT TITLE
FREUD PUMP STATION IMPROVEMENTS
DRAWING TITLE
WET WELL ACCESS PLAN DEMOLITION

FIRM NAME
ARCADIS Brown AND Caldwell

GLWA Great Lakes Water Authority

SECTION MAP | TOWN | RANGE | SECTION | Q | QQ

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GLWA CIP No. -
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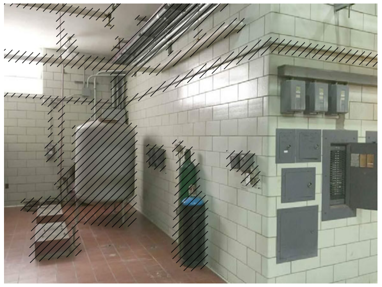

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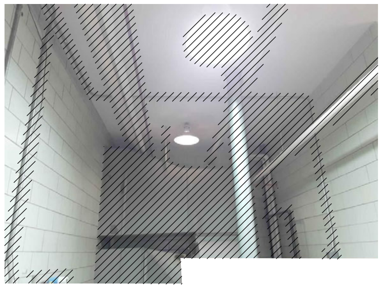

PHOTO 2

PHOTO 3

PHOTO 4

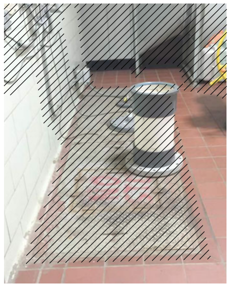

PHOTO 5

PHOTO 6

PHOTO 7

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FACILITY
FREUD PUMP STATION
PROJECT TITLE
FREUD PUMP STATION IMPROVEMENTS
DRAWING TITLE
DEMOLITION PHOTOS

FIRM NAME
ARCADIS
Brown AND Caldwell

GLWA
Great Lakes Water Authority

SECTION MAP	TOWN	RANGE	SECTION	Q	QQ

MDEQ PERMIT No. -
GLWA CONTRACT No. -
GLWA CIP No. -
DRAWING No. D-02
DEMOLITION

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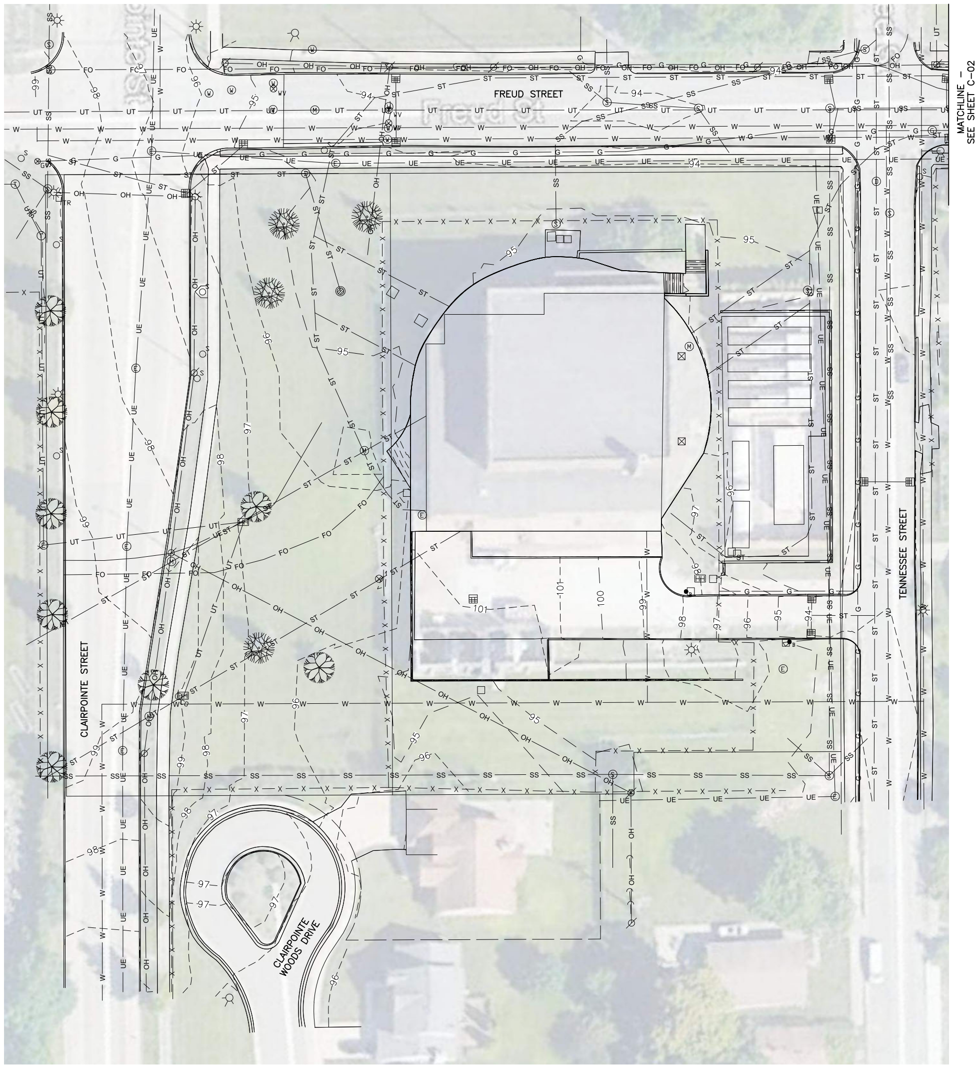
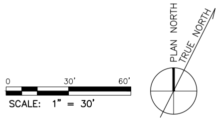


GENERAL NOTES:

1. SURVEY INFORMATION SHOWN HEREIN IS FROM A TOPOGRAPHIC SURVEY CONDUCTED BY NEDERVELD INC., DATED 07/13/2020.
2. ALL COORDINATES SHOWN ARE BASED ON CITY OF DETROIT COORDINATES. FOR VERTICAL CONTROL, ADD 479.25 TO CONVERT FROM CITY OF DETROIT DATUM TO NAVD88.
3. BASED ON FEMA NFIP FIRM MAP 26163C0302E, DATED FEBRUARY 2, 2012, THE SITE IS LOCATED WITHIN FLOOD ZONE X (0.2% OR LESS ANNUAL CHANCE FLOOD HAZARD).



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SEAL / STAMP

FACILITY
FREUD PUMP STATION
SURVEY CONTROL

PROJECT TITLE
DRAWING TITLE
FREUD PUMP STATION
SITE SURVEY 1 OF 2

FIRM NAME
ARCADIS
Brown AND Caldwell

GLWA
Great Lakes Water Authority

SECTION MAP | TOWN | RANGE | SECTION | Q | QQ

MDEQ PERMIT No.
GLWA CONTRACT No.
GLWA CIP No.
DRAWING No.
C–01

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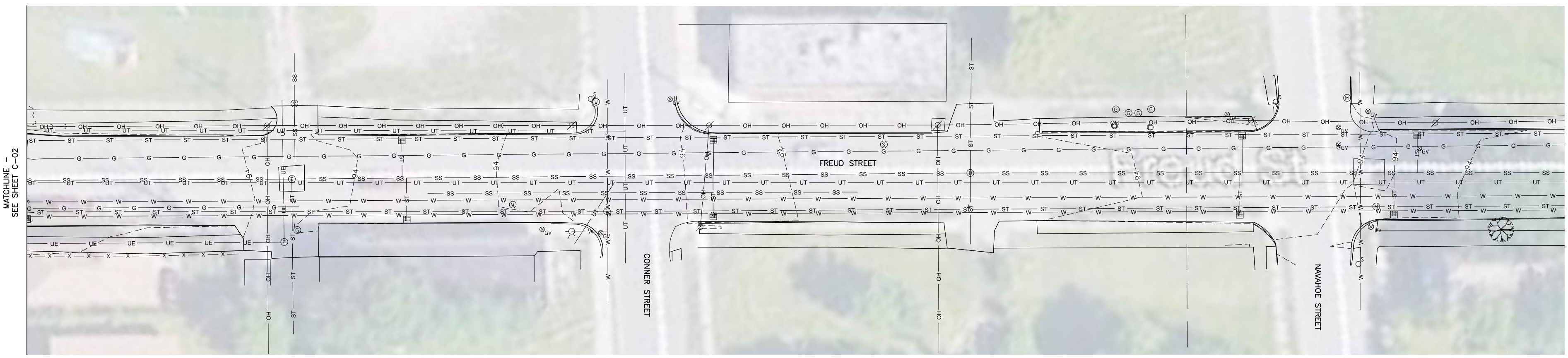

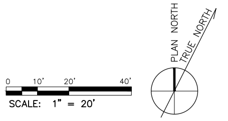

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FACILITY

FREUD PUMP STATION
SURVEY CONTROL

PROJECT TITLE

DRAWING TITLE

FREUD PUMP STATION
SITE SURVEY 2 OF 2

FIRM NAME

ARCADIS

Brown AND Caldwell

GLWA
Great Lakes Water Authority

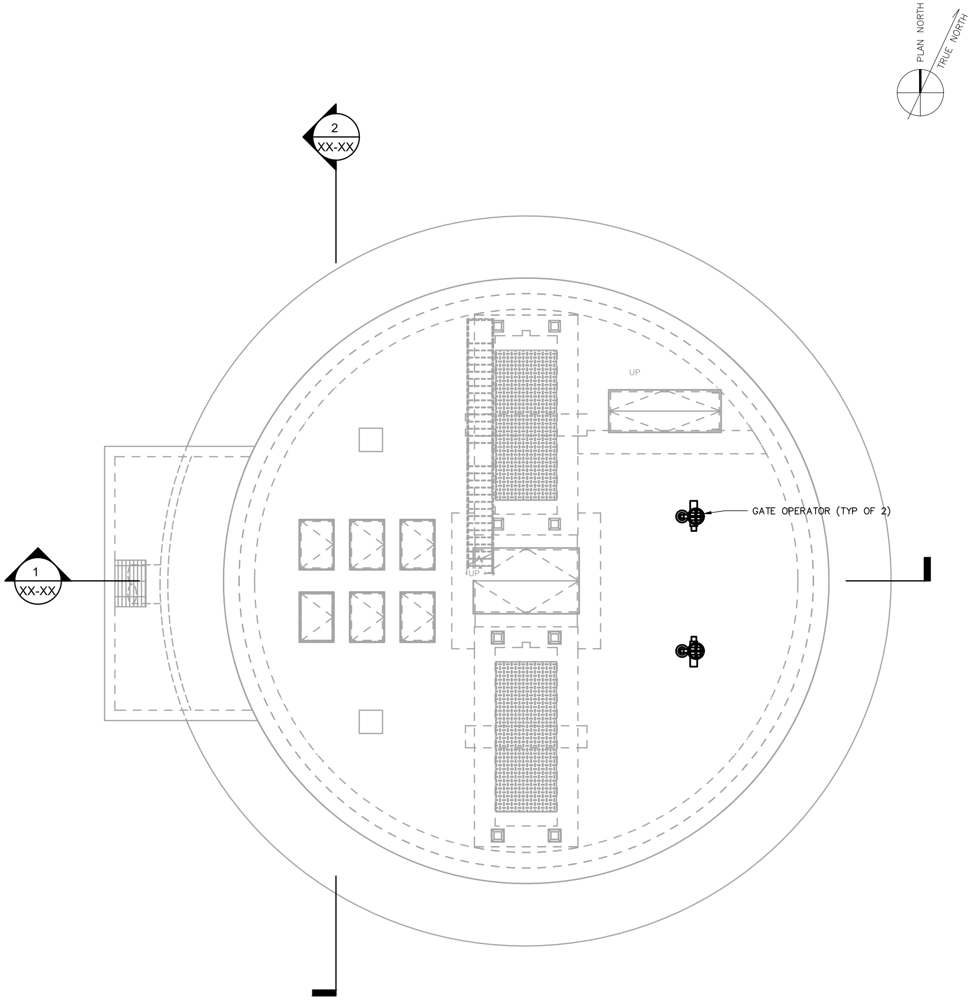
SECTION MAP	TOWN	RANGE	SECTION	Q	QQ

MDEQ PERMIT No.

GLWA CONTRACT No.

GLWA CIP No.

DRAWING No.
C–02



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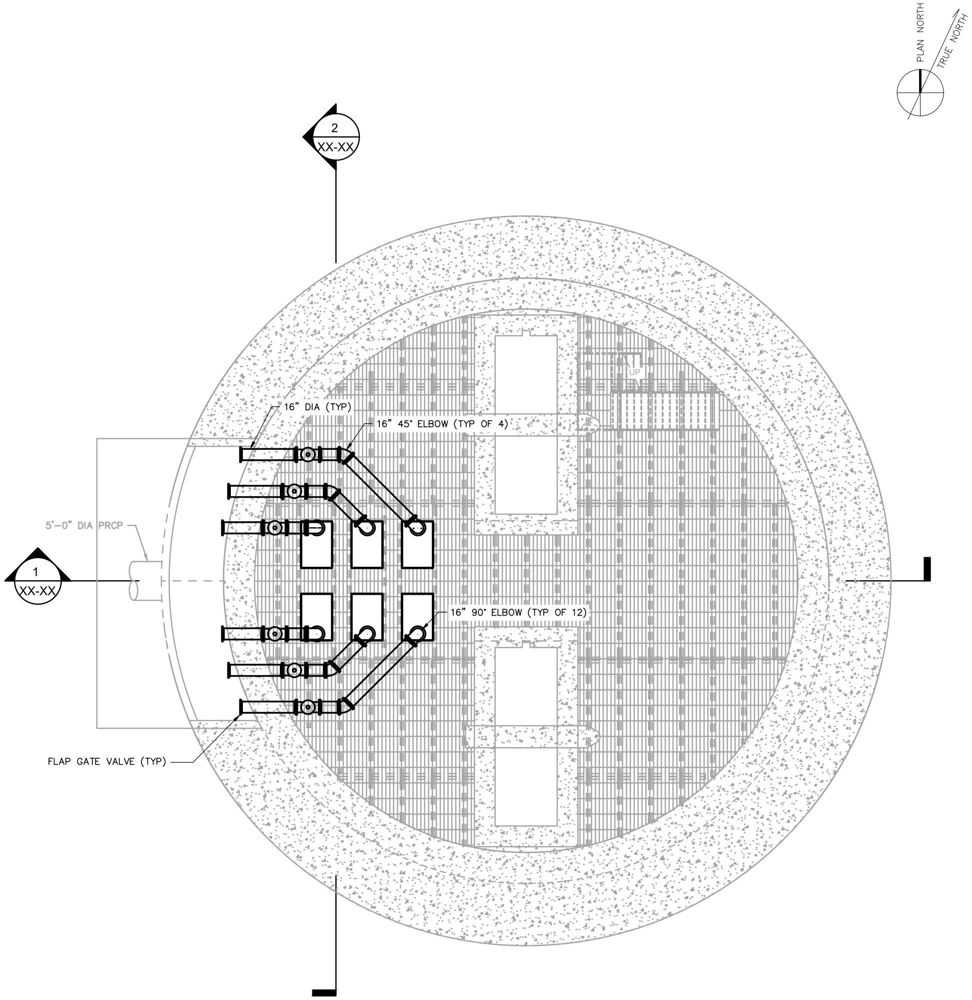

PLAN AT EL. 83.00

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APPROVED BY: -

SEAL / STAMP

FACILITY
FREUD PUMP STATION
PROJECT TITLE
FREUD PUMP STATION IMPROVEMENTS
DRAWING TITLE
PLANS

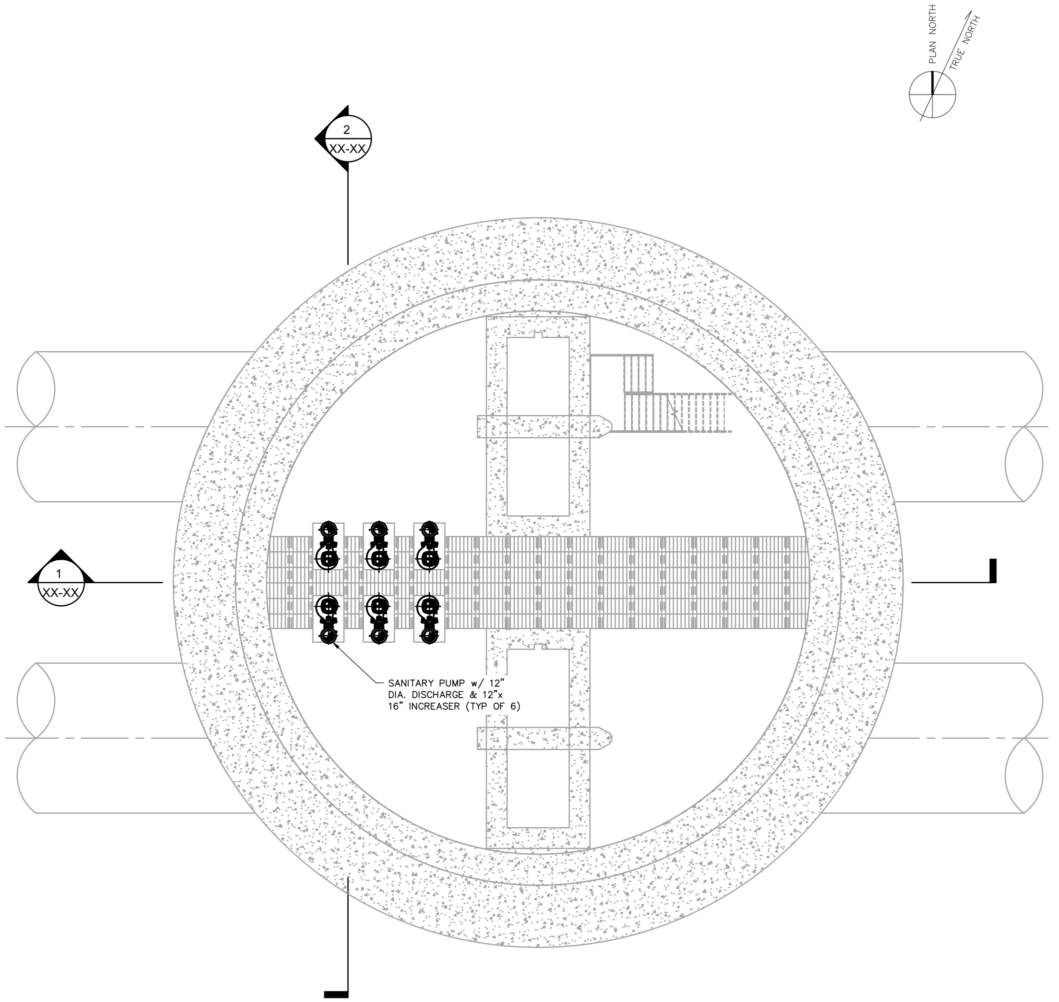
FIRM NAME
ARCADIS
Brown AND Caldwell

GLWA
Great Lakes Water Authority

SECTION MAP | TOWN | RANGE | SECTION | Q | QQ

MDEQ PERMIT No. -
GLWA CONTRACT No. -
GLWA CIP No. -
DRAWING No. M-01
MECHANICAL

User:TMUELLER Spec:AUS-NCSMOD File:C:\USERS\TMUELLER\BIM 360\ARCADIS\ANA - 30010353 - DETROIT MI - FREUD PUMP STATION REHABILITATION\PROJECT FILES\0_WIP\MECH\M-01.DWG Scale:1:1 SavedDate:8/31/2020 Time:14:14 Plot Date: Mueller, Tim; 8/31/2020; 14:20 ; Layout:LAYOUT1



PLAN AT EL. 62.00

1/8"=1'-0"

	DESCRIPTIONS / REVISIONS	CHK'D	APPR	DATE
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DESIGNED BY: -
DRAWN BY: -
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APPROVED BY: -

SEAL / STAMP

FACILITY
FREUD PUMP STATION
PROJECT TITLE
FREUD PUMP STATION IMPROVEMENTS
DRAWING TITLE
PLANS

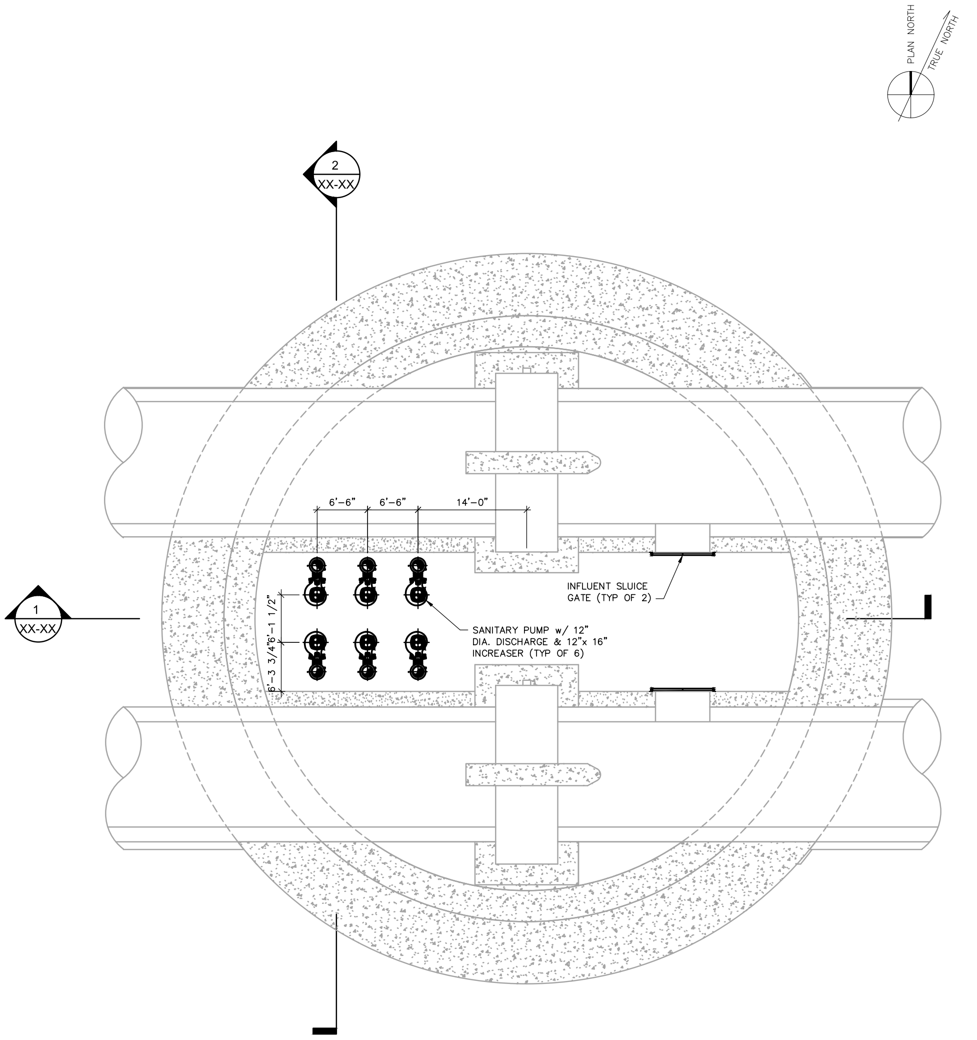
FIRM NAME
ARCADIS
Brown AND Caldwell

GLWA
Great Lakes Water Authority

SECTION MAP | TOWN | RANGE | SECTION | Q | QQ

MDEQ PERMIT No. -
GLWA CONTRACT No. -
GLWA CIP No. -
DRAWING No. M-02
MECHANICAL

User:TMUELLER Spec:AUS-NCSMOD File:C:\USERS\TMUELLER\BIM 360\ARCADIS\ANA - 30010353 - DETROIT MI - FREUD PUMP STATION REHABILITATION\PROJECT FILES\0_WIP\MECH\M-02.DWG Scale:1:1 SavedDate:8/27/2020 Time:15:15 Plot Date: Mueller, Tim; 8/31/2020; 12:04 ; Layout:LAYOUT1



PLAN AT EL. 53.50

1/8"=1'-0"

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	DESCRIPTIONS / REVISIONS	CHK'D	APPR	DATE

DESIGNED BY: -
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SEAL / STAMP

FACILITY
FREUD PUMP STATION
PROJECT TITLE
FREUD PUMP STATION IMPROVEMENTS
DRAWING TITLE
PLANS

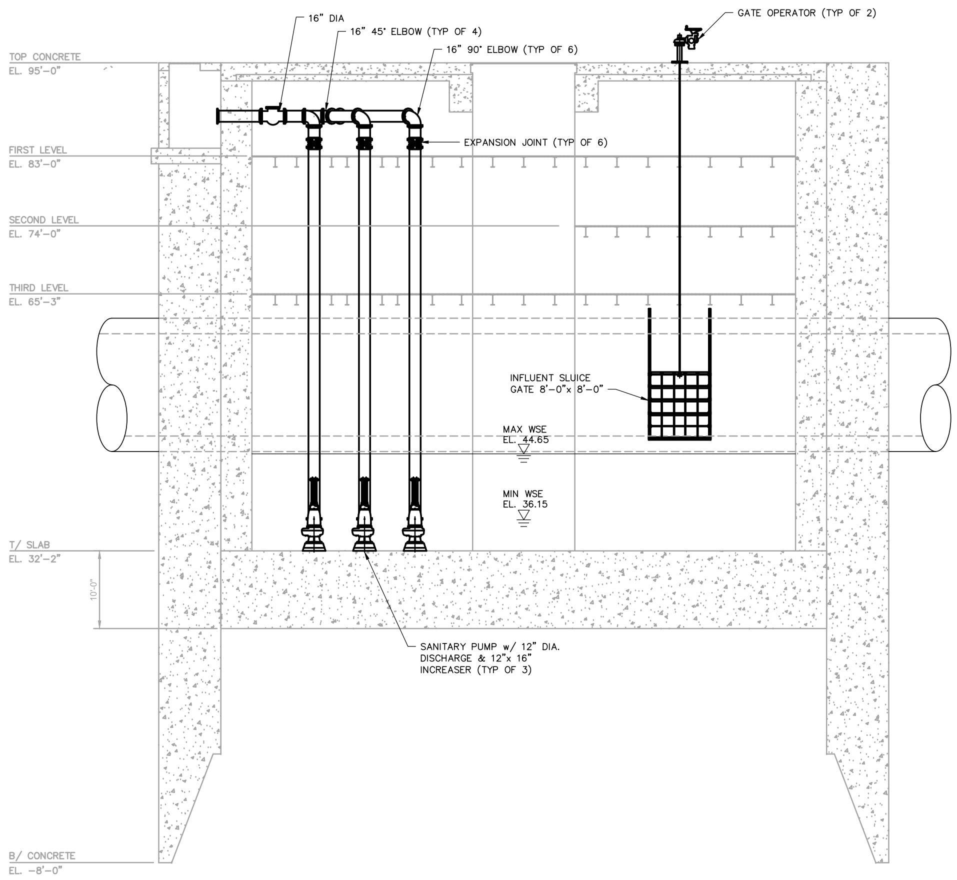
FIRM NAME
ARCADIS
Brown AND Caldwell

GLWA
Great Lakes Water Authority

SECTION MAP | TOWN | RANGE | SECTION | Q | QQ

MDEQ PERMIT No. -
GLWA CONTRACT No. -
GLWA CIP No. -
DRAWING No.
M-03
MECHANICAL

User:TMUELLER Spec:AUS-NCSMOD File:C:\USERS\TMUELLER\BIM 360\ARCADIS\ANA - 30010353 - DETROIT MI - FREUD PUMP STATION REHABILITATION\PROJECT FILES\0_WIP\MECH\M-03.DWG Scale:1:1 SavedDate:8/31/2020 Time:11:52 Plot Date: Mueller, Tim; 8/31/2020; 12:02 ; Layout:LAYOUT1



1 XX–XX **SECTION**

1/8"=1'-0" 8 4 0 8

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SEAL / STAMP

FACILITY
FREUD PUMP STATION
PROJECT TITLE
FREUD PUMP STATION IMPROVEMENTS
DRAWING TITLE
SECTIONS

FIRM NAME
ARCADIS
Brown AND Caldwell

GLWA
Great Lakes Water Authority

SECTION MAP	TOWN	RANGE	SECTION	Q	QQ

MDEQ PERMIT No. -
GLWA CONTRACT No. -
GLWA CIP No. -
DRAWING No. M-04
MECHANICAL

User:TMUELLER Spec:AUS–NCSMOD File:C:\USERS\TMUELLER\BIM 360\ARCADIS\ANA – 30010353 – DETROIT MI – FREUD PUMP STATION REHABILITATION\PROJECT FILES\0_WIP\MECH\M–04.DWG Scale:1:1 SavedDate:8/31/2020 Time:13:59 Plot Date: Mueller, Tim; 8/31/2020; 14:00 ; Layout:LAYOUT1

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	DESCRIPTIONS / REVISIONS	CHK'D	APPR	DATE

DESIGNED BY: -

DRAWN BY: -

CHECKED BY: -

APPROVED BY: -

SEAL / STAMP

FACILITY

FREUD PUMP STATION

PROJECT TITLE

FREUD PUMP STATION IMPROVEMENTS

DRAWING TITLE

SECTIONS

FIRM NAME

ARCADIS

Brown AND Caldwell

GLWA Great Lakes Water Authority

SECTION MAP	TOWN	RANGE	SECTION	Q	QQ

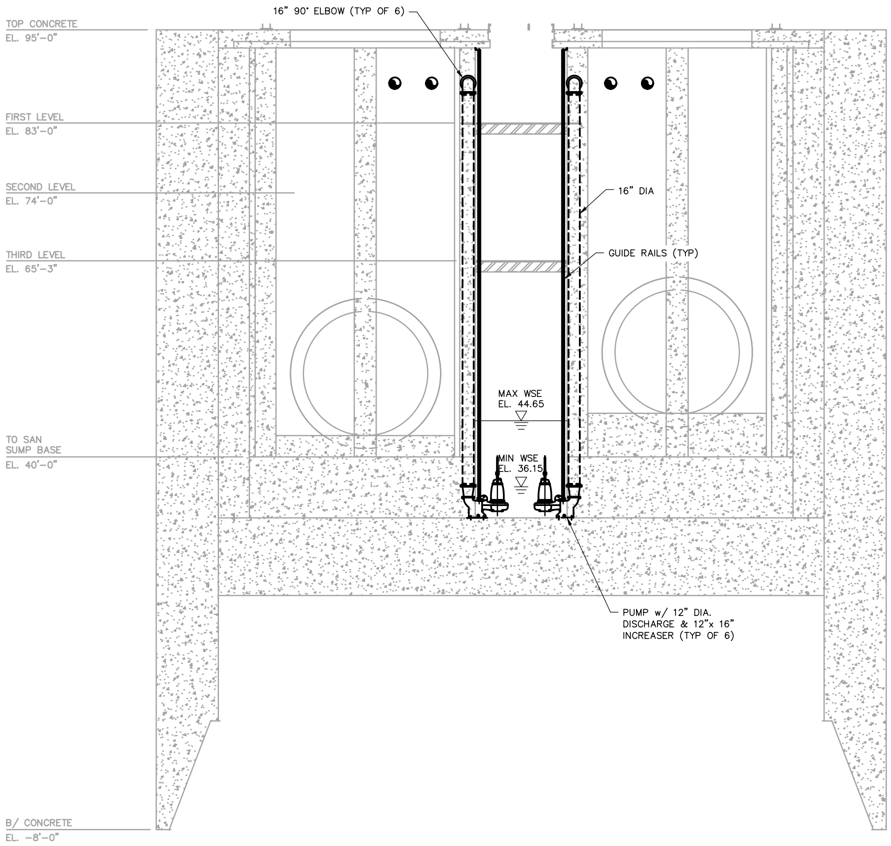
MDEQ PERMIT No. -

GLWA CONTRACT No. -

GLWA CIP No. -

DRAWING No. M-05

MECHANICAL



2 SECTION
XX-XX

1/8"=1'-0"

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	DESCRIPTIONS / REVISIONS	CHK'D	APPR	DATE

DESIGNED BY: -
DRAWN BY: -
CHECKED BY: -
APPROVED BY: -

SEAL / STAMP

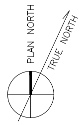
FACILITY
FREUD PUMP STATION
PROJECT TITLE
FREUD PUMP STATION IMPROVEMENTS
DRAWING TITLE
SECTIONS

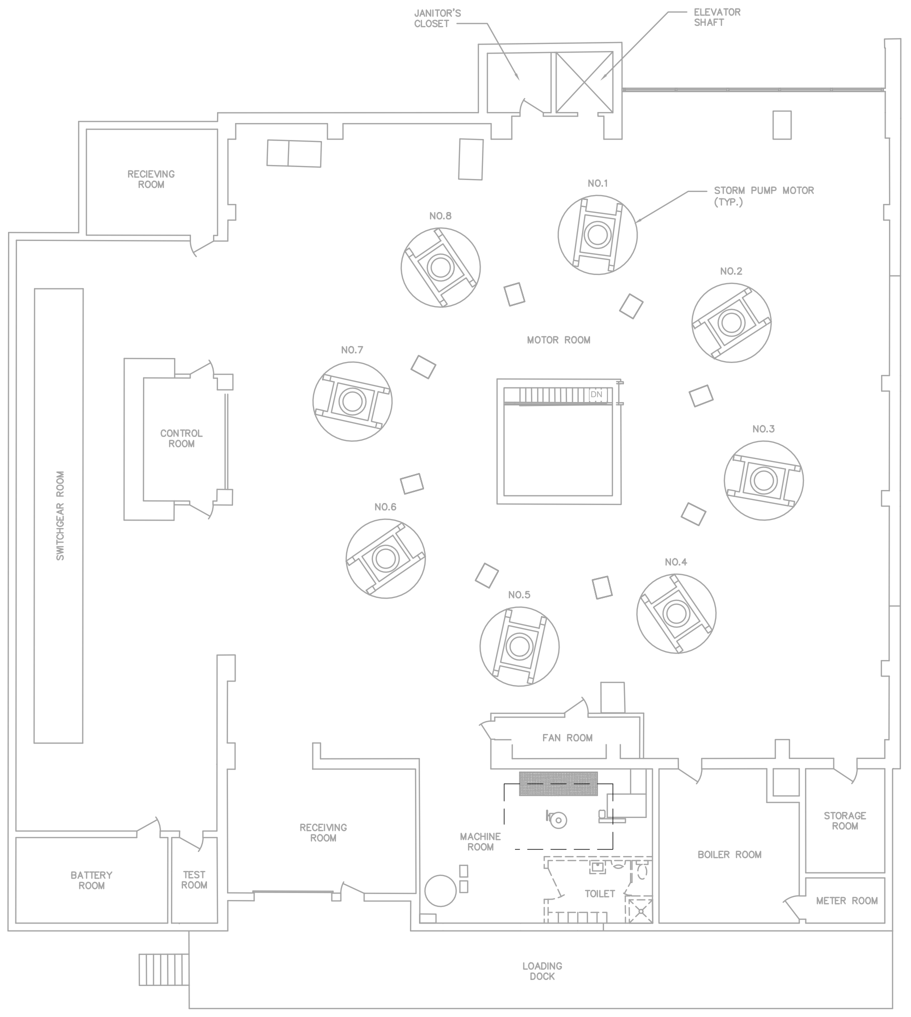
FIRM NAME
ARCADIS
Brown AND Caldwell

GLWA
Great Lakes Water Authority

SECTION MAP | TOWN | RANGE | SECTION | Q | QQ

MDEQ PERMIT No. -
GLWA CONTRACT No. -
GLWA CIP No. -
DRAWING No.
M-06
MECHANICAL





EXISTING FLOOR PLAN

1/8"=1'-0" 8 4 0 8

F				
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	DESCRIPTIONS / REVISIONS	CHK'D	APPR	DATE

DESIGNED BY: -
DRAWN BY: -
CHECKED BY: -
APPROVED BY: -

SEAL / STAMP

FACILITY
FREUD PUMP STATION
PROJECT TITLE
FREUD PUMP STATION IMPROVEMENTS
DRAWING TITLE
EXISTING FLOOR PLAN

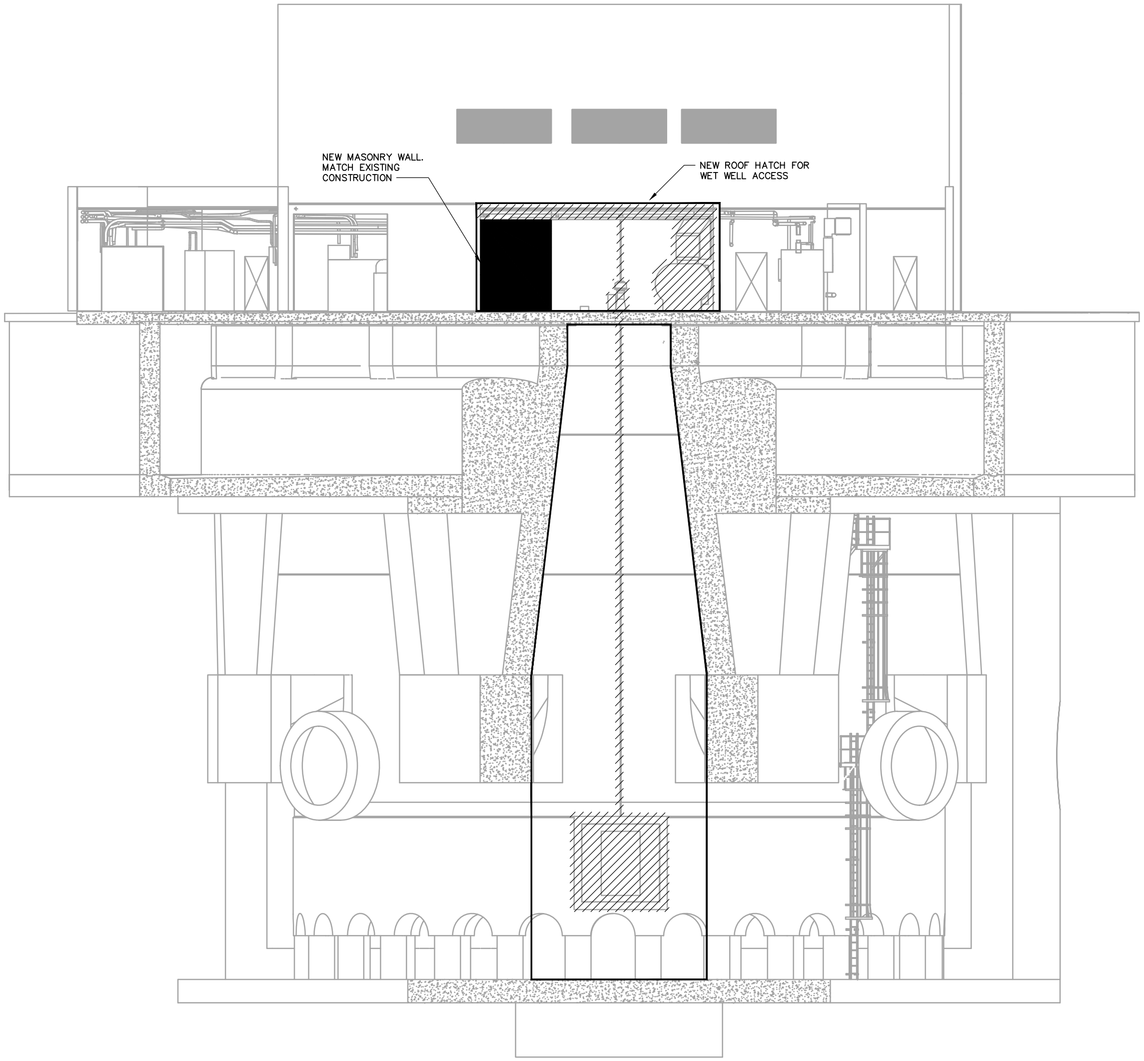
FIRM NAME
ARCADIS
Brown AND Caldwell

GLWA
Great Lakes Water Authority

SECTION MAP	TOWN	RANGE	SECTION	Q	QQ

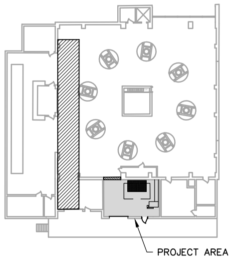
MDEQ PERMIT No. -
GLWA CONTRACT No. -
GLWA CIP No. -
DRAWING No. M-07
GENERAL

User:DEWYER Spec:AUS-NCSMOD File:C:\USERS\JFOGLE\BIM 360\ARCADIS\ANA - 30010353 - DETROIT MI - FREUD PUMP STATION REHABILITATION\PROJECT FILES\0_WIP\MECH\M-07.DWG Scale:1:1 SavedDate:8/4/2020 Time:15:25 Plot Date: Fogle, Jeff; 8/26/2020; 15:19 ; Layout:LAYOUT1



BUILDING SECTION

1/8"=1'-0"



KEY PLAN

		CHK'D	APPR	DATE
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	DESCRIPTIONS / REVISIONS	CHK'D	APPR	DATE

DESIGNED BY: -
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CHECKED BY: -
APPROVED BY: -

SEAL / STAMP

FACILITY
FREUD PUMP STATION
PROJECT TITLE
FREUD PUMP STATION IMPROVEMENTS
DRAWING TITLE
BUILDING SECTION

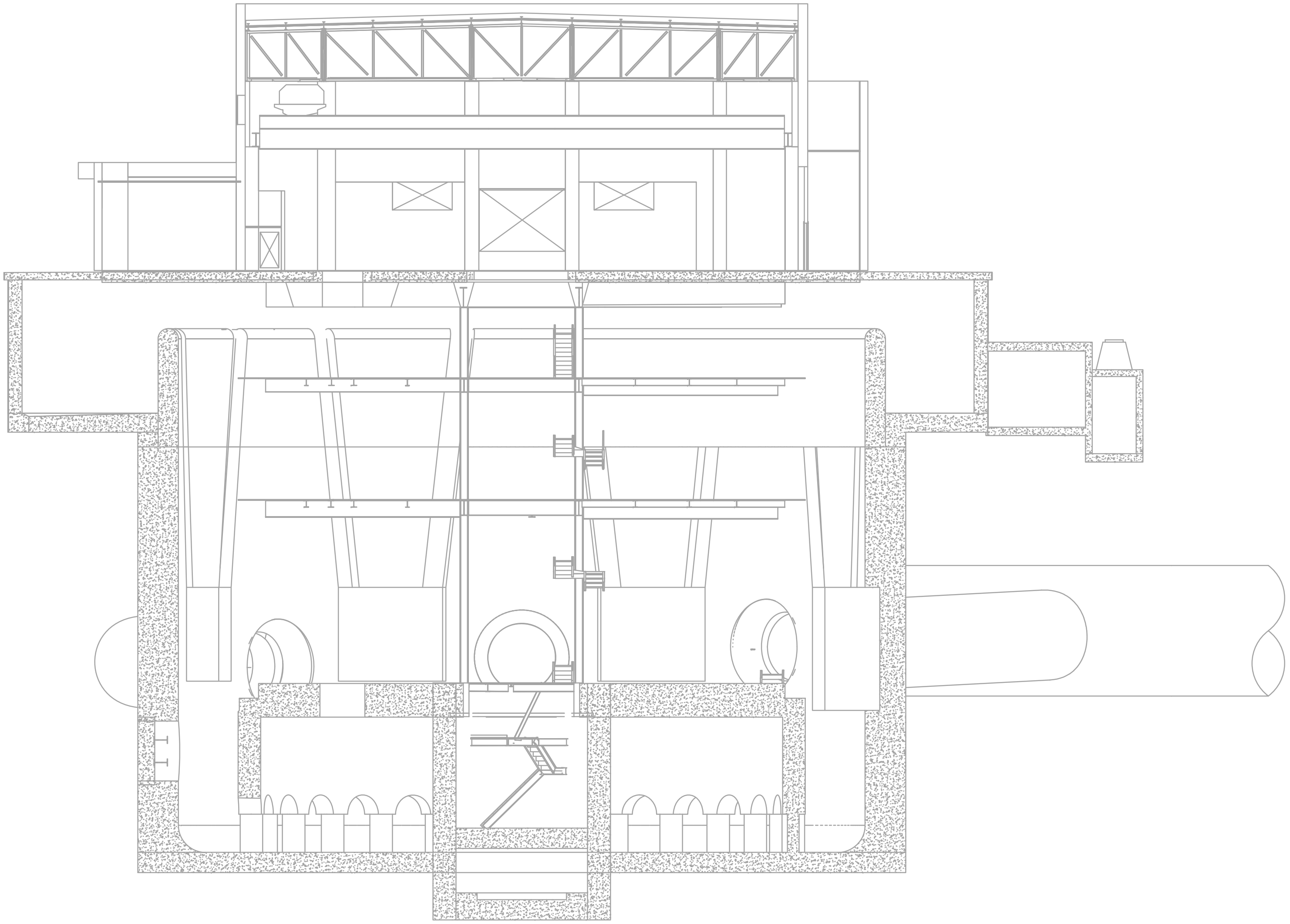
FIRM NAME
ARCADIS
Brown AND Caldwell

GLWA
Great Lakes Water Authority

SECTION MAP
TOWN
RANGE
SECTION
Q
QQ

MDEQ PERMIT No. -
GLWA CONTRACT No. -
GLWA CIP No. -
DRAWING No.
M-08
GENERAL

User:DEWYER Spec:AUS-NCSMOD File:C:\USERS\JFOGLE\BIM 360\ARCADIS\ANA - 30010353 - DETROIT MI - FREUD PUMP STATION REHABILITATION\PROJECT FILES\0_WIP\MECH\M-08.DWG Scale:1:1 SavedDate:8/5/2020 Time:17:05 Plot Date: Fogle, Jeff; 8/26/2020; 15:19 ; Layout:LAYOUT1



BUILDING SECTION – WEST

1/8"=1'-0"

	DESCRIPTIONS / REVISIONS	CHK'D	APPR	DATE
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DESIGNED BY: -

DRAWN BY: -

CHECKED BY: -

APPROVED BY: -

SEAL / STAMP

FACILITY

FREUD PUMP STATION

PROJECT TITLE

FREUD PUMP STATION IMPROVEMENTS

DRAWING TITLE

BUILDING SECTION - WEST

FIRM NAME

ARCADIS

Brown AND Caldwell

GLWA

Great Lakes Water Authority

MDEQ PERMIT No. -

GLWA CONTRACT No. -

GLWA CIP No. -

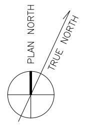
SECTION MAP	TOWN	RANGE	SECTION	Q	QQ

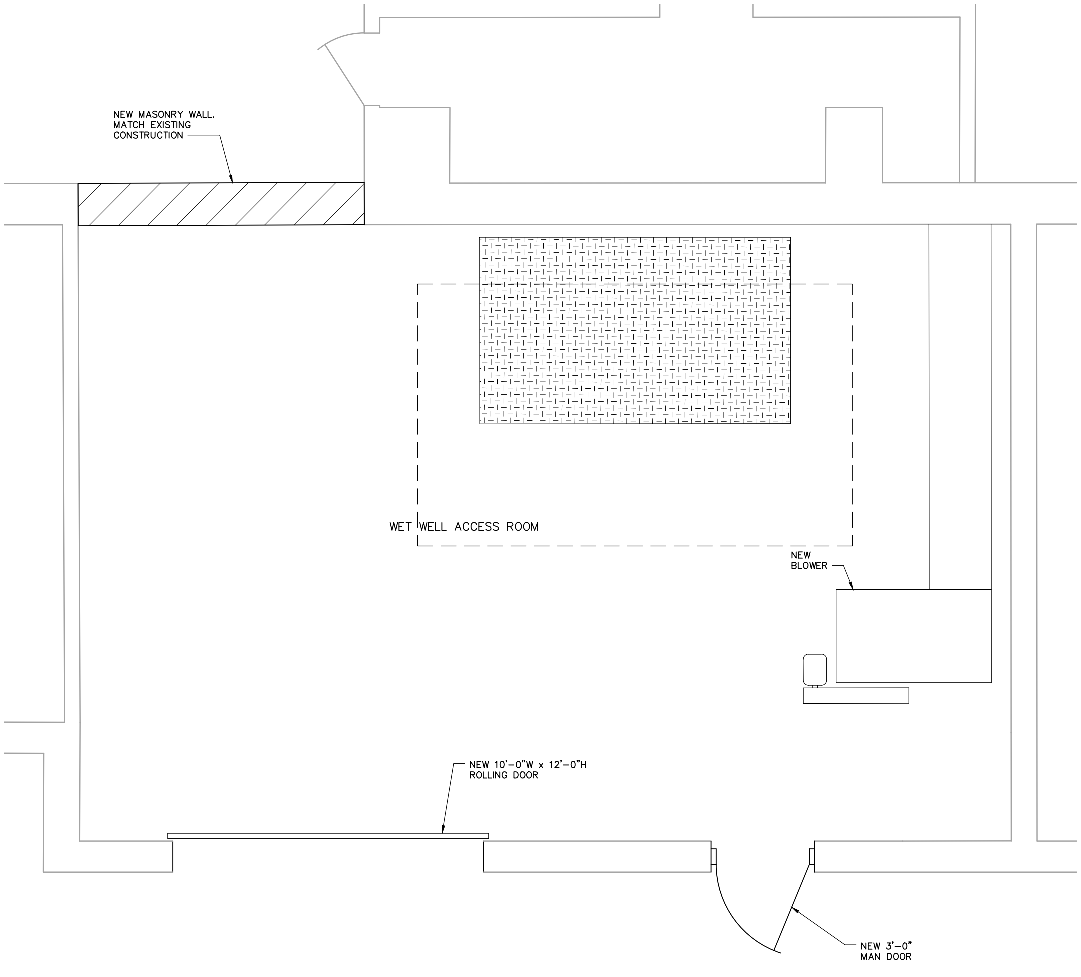
DRAWING No.

M-09

GENERAL

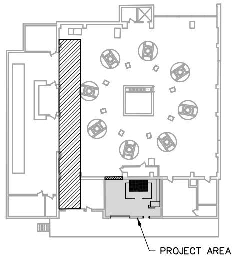
User:DEWYER Spec:AUS-NCSMOD File:C:\USERS\JFOGLE\BIM 360\ARCADIS\ANA - 30010353 - DETROIT MI - FREUD PUMP STATION REHABILITATION\PROJECT FILES\0_WIP\MECH\M-09.DWG Scale:1:1 SavedDate:7/31/2020 Time:08:55 Plot Date: Fogle, Jeff; 8/26/2020; 15:18 ; Layout:LAYOUT1





FLOOR PLAN

1/2"=1'-0"



KEY PLAN

	DESCRIPTIONS / REVISIONS	CHK'D	APPR	DATE
F				
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DESIGNED BY: -
DRAWN BY: -
CHECKED BY: -
APPROVED BY: -

SEAL / STAMP

FACILITY
FREUD PUMP STATION
PROJECT TITLE
FREUD PUMP STATION IMPROVEMENTS
DRAWING TITLE
WET WELL ACCESS FLOOR PLAN

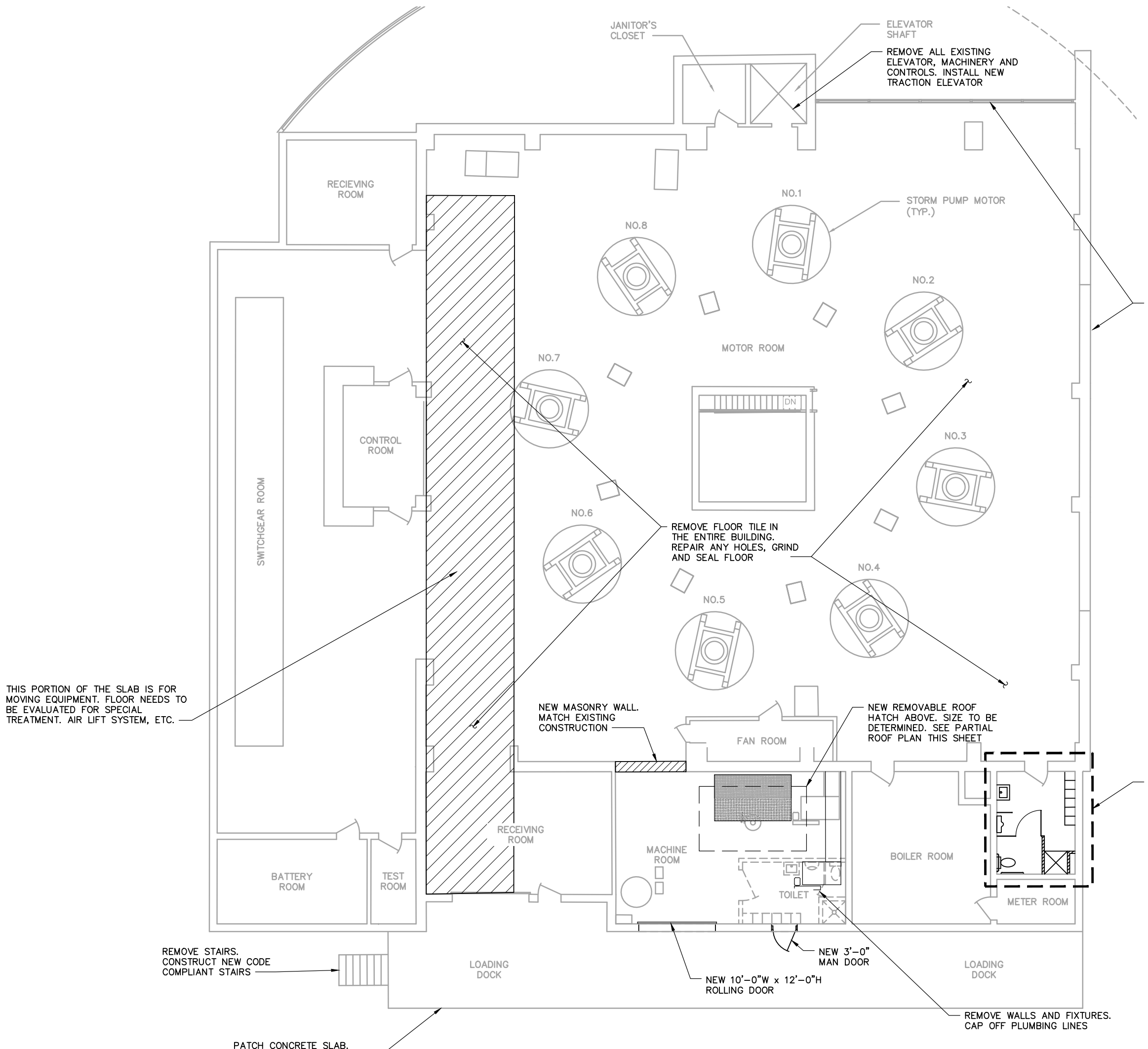
FIRM NAME
ARCADIS
Brown AND Caldwell

GLWA
Great Lakes Water Authority

SECTION MAP	TOWN	RANGE	SECTION	Q	QQ

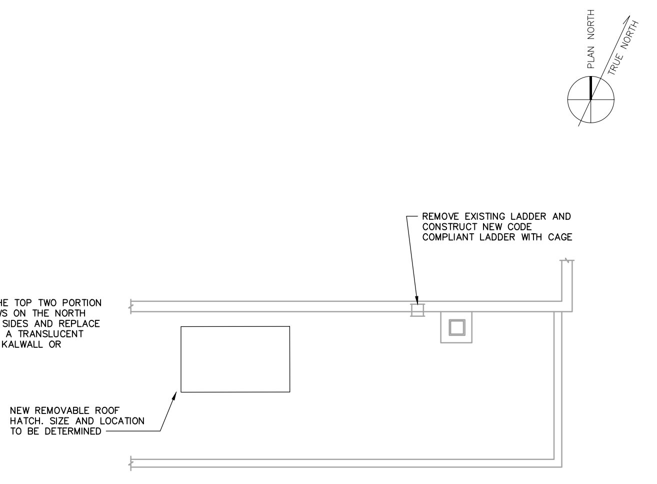
MDEQ PERMIT No. -
GLWA CONTRACT No. -
GLWA CIP No. -
DRAWING No.
M-10
GENERAL

User:JFOGLE Spec:AUS-NCSMOD File:C:\USERS\JFOGLE\BIM 360\ARCADIS\ANA - 30010353 - DETROIT MI - FREUD PUMP STATION REHABILITATION\PROJECT FILES\0_WIP\MECH\M-10.DWG Scale:1:1 SavedDate:8/25/2020 Time:09:14 Plot Date: Fogle, Jeff; 8/26/2020; 15:17 ; Layout:LAYOUT1



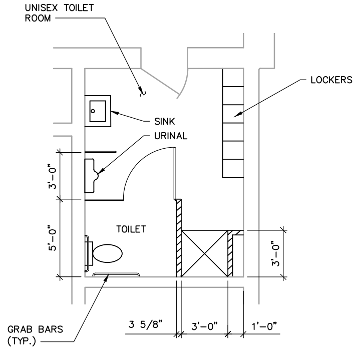
FLOOR PLAN

1/8"=1'-0" 8 4 0 8



PARTIAL ROOF PLAN

SCALE: 1/8" = 1'-0" 0 4' 8' 16'



ENLARGED PARTIAL PLAN

SCALE: 1/2" = 1'-0" 0 1' 2' 4'

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DESCRIPTIONS / REVISIONS	CHK'D	APPR	DATE	

DESIGNED BY: -

DRAWN BY: -

CHECKED BY: -

APPROVED BY: -

SEAL / STAMP

FACILITY

FREUD PUMP STATION

PROJECT TITLE

FREUD PUMP STATION IMPROVEMENTS

DRAWING TITLE

FLOOR PLAN

FIRM NAME

ARCADIS

Brown AND Caldwell

GLWA

Great Lakes Water Authority

SECTION MAP	TOWN	RANGE	SECTION	Q	QQ

MDEQ PERMIT No. -

GLWA CONTRACT No. -

GLWA CIP No. -

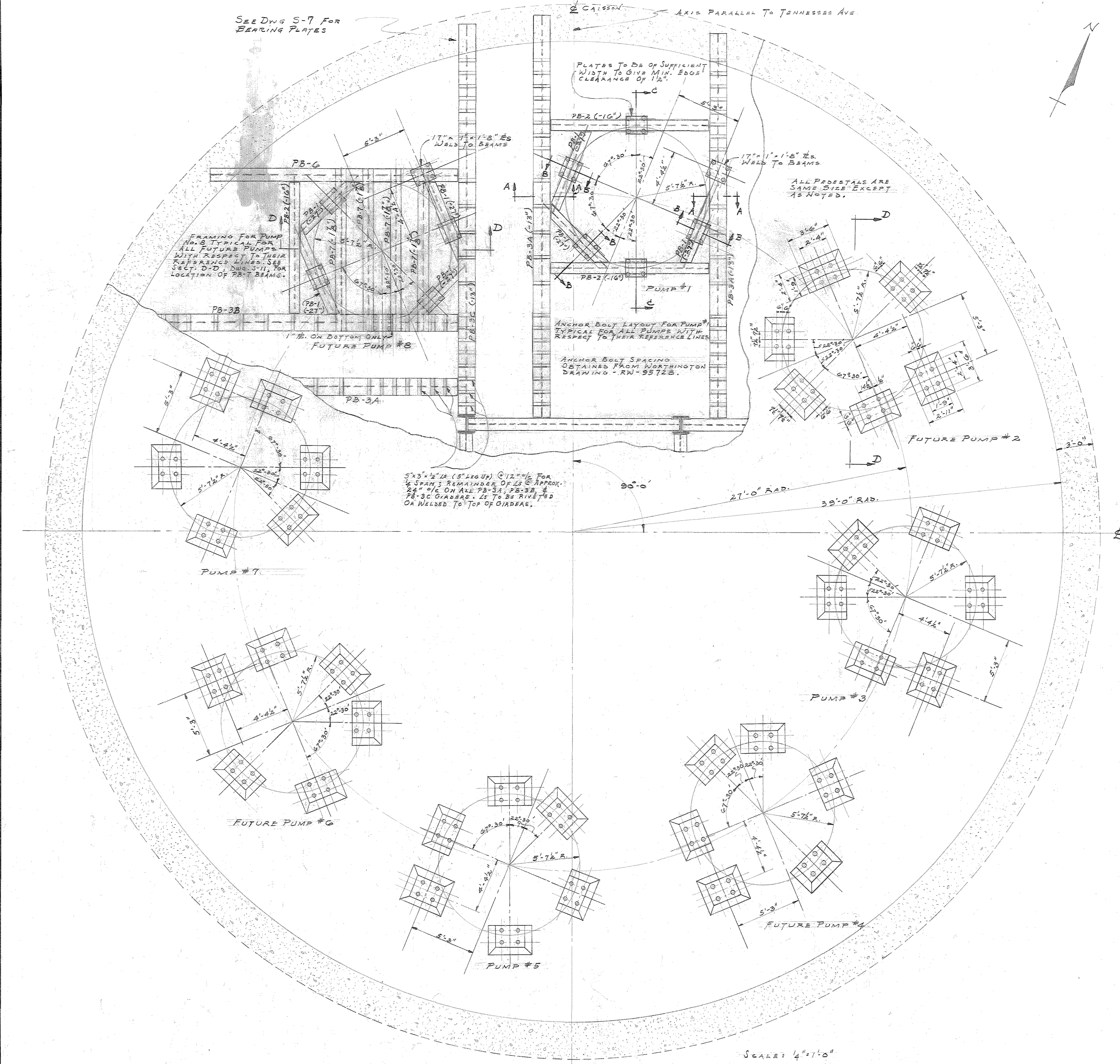
DRAWING No.

A-01

GENERAL

Copy ck. by Currie 6/19/52

M F 1057



SEE DWG S-7 FOR BEARING PLATES

PLATES TO BE OF SUFFICIENT WIDTH TO GIVE MIN. EDGE CLEARANCE OF 1½".

17" × 1" × 1'-8" ℔s WELD TO BEAMS

17" × 1" × 1'-8" ℔s. WELD TO BEAMS

ALL PEDESTALS ARE SAME SIZE EXCEPT AS NOTED.

FRAMING FOR PUMP NO. 8 TYPICAL FOR ALL FUTURE PUMPS WITH RESPECT TO THEIR REFERENCE LINES. SEE SECT. D-D, DWG. S-11, FOR LOCATION OF PB-7 BEAMS.

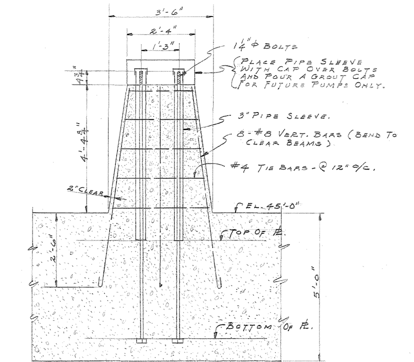
1" ℔. ON BOTTOM ONLY

ANCHOR BOLT LAYOUT FOR PUMP #1 TYPICAL FOR ALL PUMPS WITH RESPECT TO THEIR REFERENCE LINES.

ANCHOR BOLT SPACING OBTAINED FROM WORTHINGTON DRAWING - RW-95728.

5" × 3" × ½" Ls (5" LEG UP) @ 12" o/c FOR ¼ SPAN; REMAINDER OF Ls @ APPROX. 24" o/c ON ALL PB-3A, PB-3B, & PB-3C GIRDERS. Ls TO BE RIVETED OR WELDED TO TOP OF GIRDERS.

SCALE: ¼" = 1'-0"



1¼"⌀ BOLTS

PLACE PIPE SLEEVE WITH CAP OVER BOLTS AND POUR A GROUT CAP FOR FUTURE PUMPS ONLY.

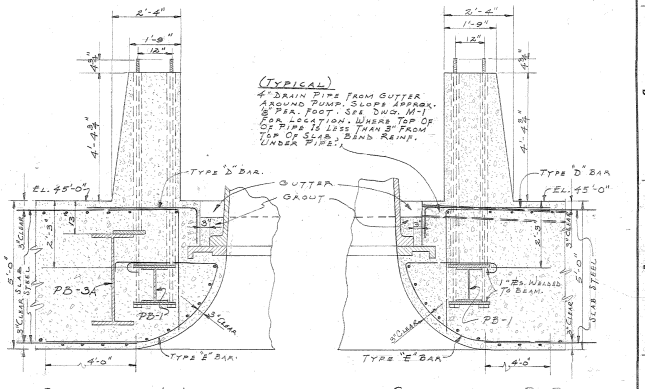
3" PIPE SLEEVE.

8-#8 VERT. BARS (BEND TO CLEAR BEAMS)

#4 TIE BARS - @ 12" o/c.

SECTION THRU TYPICAL PEDESTAL

SCALE ½" = 1'-0"



(TYPICAL)
4" DRAIN PIPE FROM GUTTER AROUND PUMP. SLOPE APPROX. ⅛" PER. FOOT. SEE DWG. M-1 FOR LOCATION. WHERE TOP OF OF PIPE IS LESS THAN 3" FROM TOP OF SLAB, BEND REINF. UNDER PIPE.

SECTION-A-A

SCALE ½" = 1'-0"

SECTION B-B

SCALE ½" = 1'-0"

NOTE: SEE DWG. S-11 FOR SECTS. C-C & D-D.
MINUS ELEVS. SHOWN, ARE FROM EL. 45'-0"

COOR'D	DESCRIPTION	DR'N	CK'D	AP'V'D	DATE

REVISIONS LOCATED BY COORDINATES ON SHEET

REFERENCE DRAWINGS

DESIGNED BY F. J. Currie
DRAWN BY F. J. Currie
TRACED BY P. Gross
CHECKED BY E. Mitchell

APPROVED: [illegible]
ARCHITECTURAL ENGINEER
M. [illegible]
ASSISTANT CITY ENGINEER
G. R. Thompson
CITY ENGINEER

CITY OF DETROIT
DEPARTMENT OF PUBLIC WORKS
CITY ENGINEERS OFFICE
FOR
THE DEPARTMENT OF PUBLIC WORKS

FOX CREEK DISTRICT
FREUD STORM WATER PUMPING STATION
SUB-STRUCTURE

PUMP PEDESTALS - PLAN & DETAILS

SCALE AS NOTED

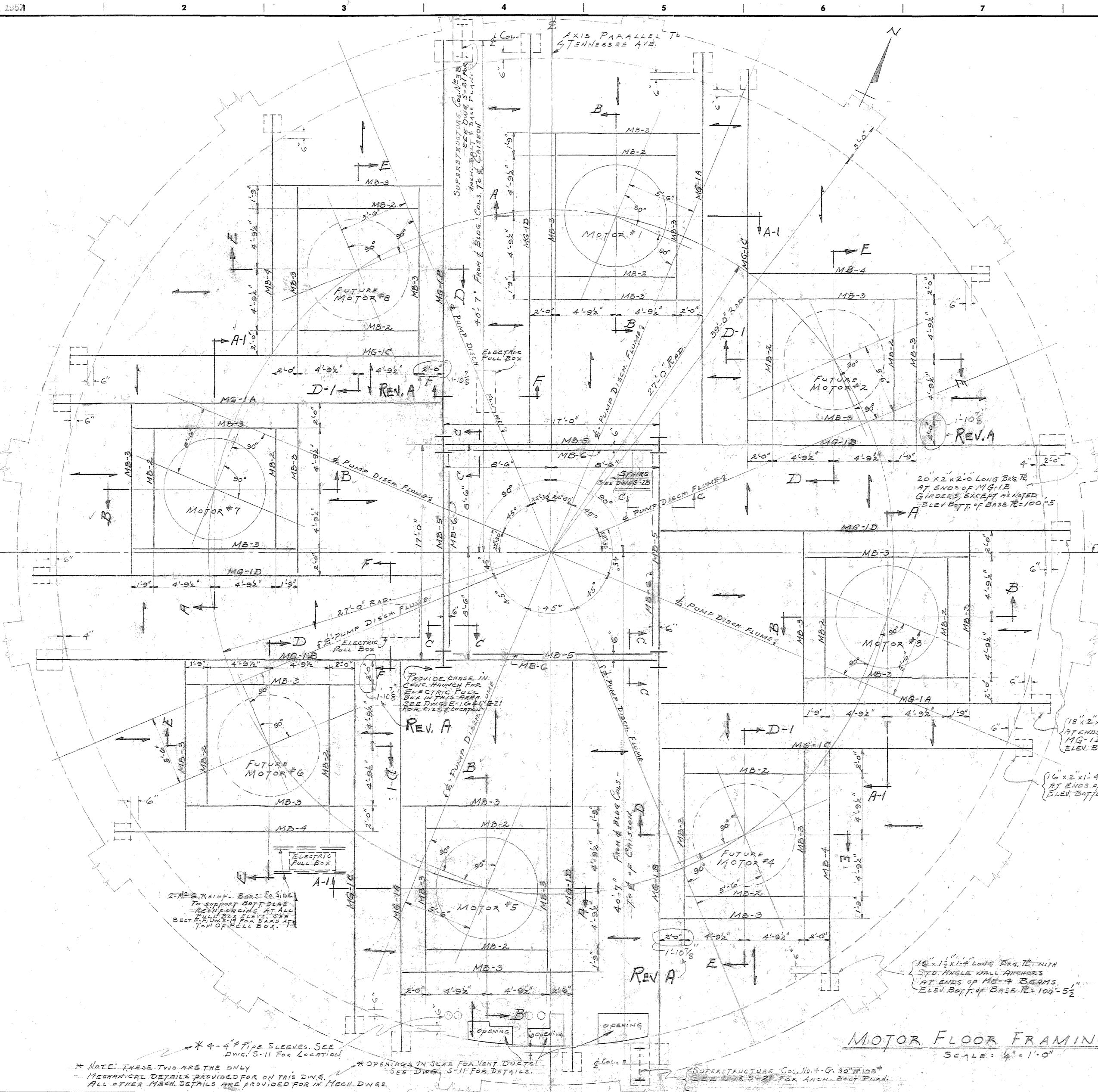
? S-8 AX

SHEET 8 OF 39 SHEETS
CONTRACT No. PW-1071-B2
DRWG No. S-8
DATE JUNE 1952

67-IV-B2

2SD - 2/29/52
City Ck. Currie 6/20/52

M F 1951



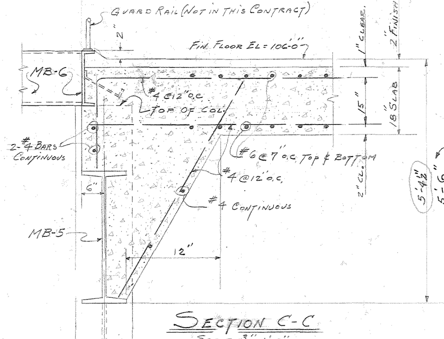
MOTOR FLOOR FRAMING PLAN (AT ELEV. 106'-0")

SCALE: ¼" = 1'-0"

* NOTE: THESE TWO ARE THE ONLY MECHANICAL DETAILS PROVIDED FOR ON THIS DWG. ALL OTHER MECH. DETAILS ARE PROVIDED FOR IN MECH. DWGS.

FRAMING SCHEDULE

MARK	SIZE	REACTIONS	REMARKS
MG-1A	46½" PL GIRDER	COL. END = 124K WALL END = 124K	SEE TYPICAL DETAIL DWG. S-20
MG-1B	ditto	COL. END = 356K WALL END = 190K	" "
MG-1C	ditto	COL. END = 91K WALL END = 148K	" "
MG-1D	ditto	BOTH ENDS = 160K.	" " "
MB-2	18" WF 64	BOTH ENDS = 21.5K	
MB-3	24" WF 76	BOTH ENDS = 54K	
MB-4	30" WF 108	COL. END = 40K WALL END = 58K	
MB-5	36" WF 150	COL. ENDS = 90.5K & 63.5K	
MB-6	15" [33.9		SEE SECT. C-C BELOW



SECTION C-C

SCALE: ¾" = 1'-0"

NOTES:

MOTOR FLOOR BEAMS DESIGNED FOR MAX. L.L. DEFLECTION OF 0.04".

ELEVATIONS OF TOPS OF ALL GIRDERS & BEAMS ARE OBTAINABLE FROM SECTIONS A-A, B-B, C-C, & D-D.

FOR TYPICAL DETAIL OF PL. GIRDERS & SPECIAL CONNECTIONS SEE DWG. S-20.

LENGTH OF GIRDERS & BEAMS RUNNING INTO CONCRETE MUST AGREE WITH FIELD MEASUREMENTS.

SECTIONS A, A-1, B, D, D-1, E & F-F ARE GIVEN ON DWG. S-19.

ALL BEARING PLATES TO BE SET ON A MIN. OF 2" OF GROUT.

SEE DWG. S-21 FOR LOCATION OF MOTOR BASE ANCHOR BOLT LAYOUT.

⟷ INDICATES DIRECTION OF MAIN REINF. STEEL (#6 BARS @ 7" o.c.) TOP & BOTTOM OF 18" FLOOR SLAB. TEMP. STEEL = #4 BARS @ 12" o.c.

EXTEND REINFORCING BARS SUPPORTED BY 3'-0" WALL TO WITHIN 6" OF OUTER EDGE.

SEE DWG. S-19 FOR FRAMING AROUND ELECTRICAL PULL BOXES IN 18" CONCRETE FLOOR SLAB.

FOR BALANCE OF REINF. STEEL SEE SECTIONS.

CONTINUE #6 BARS IN 18" CONC. FLOOR SLAB 30" BEYOND THE ℄ OF BEAM WHERE DIRECTION OF THESE BARS CHANGES.

LOCATION OF GIRDERS NOT GIVEN TO BE COMPUTED FROM GIVEN ANGULAR LOCATION OF MOTORS.

SECT. F-F SHOWN ON DWG. S-19.

SEE DWG. S-21 FOR SUPERSTRUCTURE COLUMN ANCHOR BOLTS AND POCKET PLAN INCLUDED IN CONTR. PW-1071-B2.

ALL MOTOR FLOOR SLABS DESIGNED FOR A LIVE LOAD OF 500 #/□'.

USE MECHANICAL DWGS. IN CONJUNCTION WITH STRUCTURAL DWGS. FOR LOCATION & SIZES OF PIPES & SLEEVES, EXCEPT AS NOTED.

COOR'D		DESCRIPTION	DR'N	CK'D	AP'VD	DATE
D-8	B	CHANGED DIM. FROM 5'-4½" TO 5'-6"	F.J.C.		EM	12-1-52
C-7, G-5 E-5, C-4	A	CHANGE DIM. FROM 2'-0" TO 1'-10⅞"	F.J.C.	RGT	RGT	9/26/52

REVISIONS LOCATED BY COORDINATES ON SHEET

REFERENCE DRAWINGS

DESIGNED BY Currie
DRAWN BY Currie
TRACED BY S.P. Gross
CHECKED BY E. Mitchell

APPROVED: R.G. Gibson
ARCHITECTURAL ENGINEER
M. Marquardt
ASSISTANT CITY ENGINEER
S.R. Thompson
CITY ENGINEER

CITY OF DETROIT
DEPARTMENT OF PUBLIC WORKS
CITY ENGINEERS OFFICE
FOR
THE DEPARTMENT OF PUBLIC WORKS

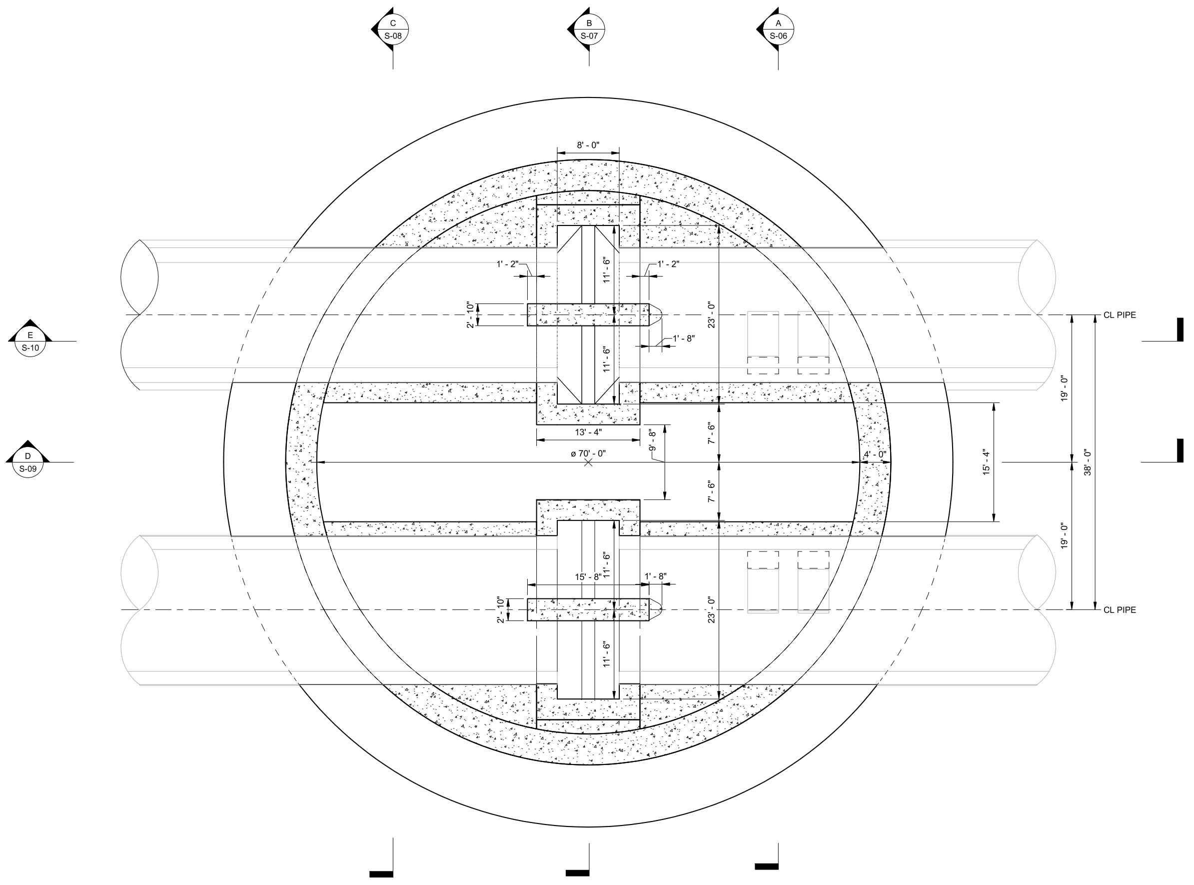
FOX CREEK DISTRICT
FREUD STORM WATER PUMPING STATION
SUB-STRUCTURE

MOTOR FLOOR FRAMING PLAN

SCALE AS NOTED

SHEET 17 OF 39 SHEETS
CONTRACT No. PW-1071-B2
DRWG NO. S-17
DATE JUNE 1952

67III B2



PLAN @ EL 53.50

SCALE: 1/8" = 1'-0"

ARCADIS

LEGAL ENTITY:
ARCADIS U.S., INC.

CONSULTANTS

SEALS

Project Status

GREAT LAKES WATER
AUTHORITY

FREUD PUMP
STATION
REHABILITATION 1

ARCADIS PROJ. NO. 30047523

NO.	DATE	ISSUED FOR	BY

DATE: Issue Date
PROJECT NO.: 30047523
FILE NAME:
DESIGNED BY: K. PARK
DRAWN BY: R. BLUMENSHINE
CHECKED BY: Checker

SHEET TITLE

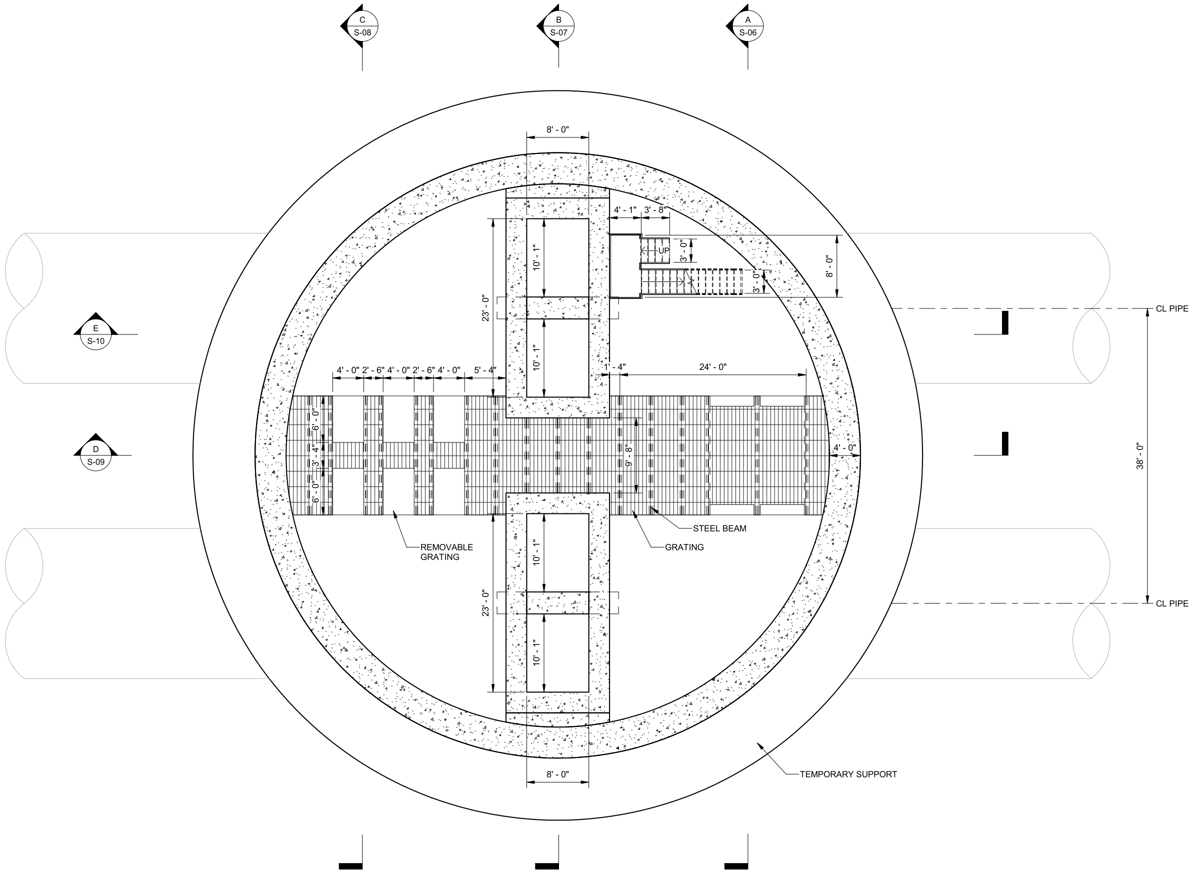
STRUCTURAL

FOUNDATION PLAN @
EL 53.50

SCALE: 1/8" = 1'-0"

S-01

SHEET ______ OF ______



PLAN @ EL 65.25

SCALE: 1/8" = 1'-0"

ARCADIS

LEGAL ENTITY:
ARCADIS U.S., INC.

CONSULTANTS

SEALS

Project Status

GREAT LAKES WATER
AUTHORITY

FREUD PUMP
STATION
REHABILITATION 1

ARCADIS PROJ. NO. 30047523

NO.	DATE	ISSUED FOR	BY

DATE: Issue Date
PROJECT NO.: 30047523
FILE NAME:
DESIGNED BY: K. PARK
DRAWN BY: R. BLUMENSHINE
CHECKED BY: Checker

SHEET TITLE

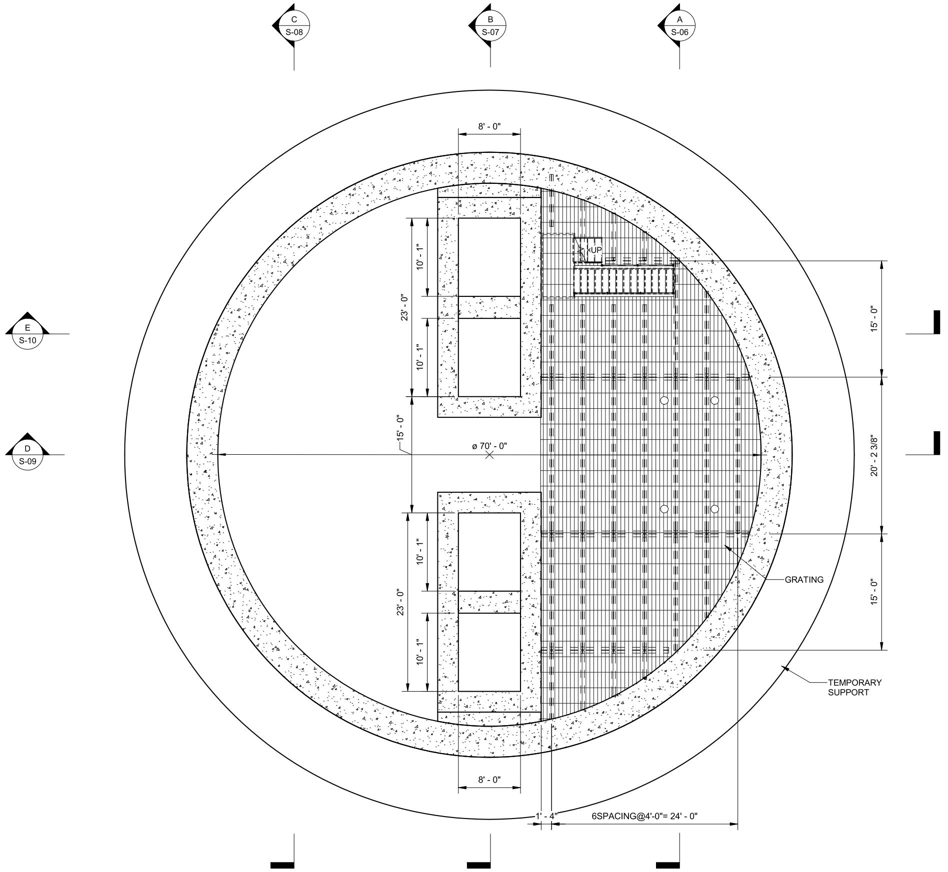
STRUCTURAL

THIRD LEVEL PLAN @
EL 65.25

SCALE: 1/8" = 1'-0"

S-02

SHEET ________ OF ________



PLAN @ EL 74.00

SCALE: 1/8" = 1'-0" 0' 4' 8' 16'

ARCADIS

LEGAL ENTITY:
ARCADIS U.S., INC.

CONSULTANTS

SEALS

Project Status

GREAT LAKES WATER
AUTHORITY

FREUD PUMP
STATION
REHABILITATION 1

ARCADIS PROJ. NO. 30047523

NO.	DATE	ISSUED FOR	BY

DATE: Issue Date
PROJECT NO.: 30047523
FILE NAME:
DESIGNED BY: K. PARK
DRAWN BY: R. BLUMENSHINE
CHECKED BY: Checker

SHEET TITLE

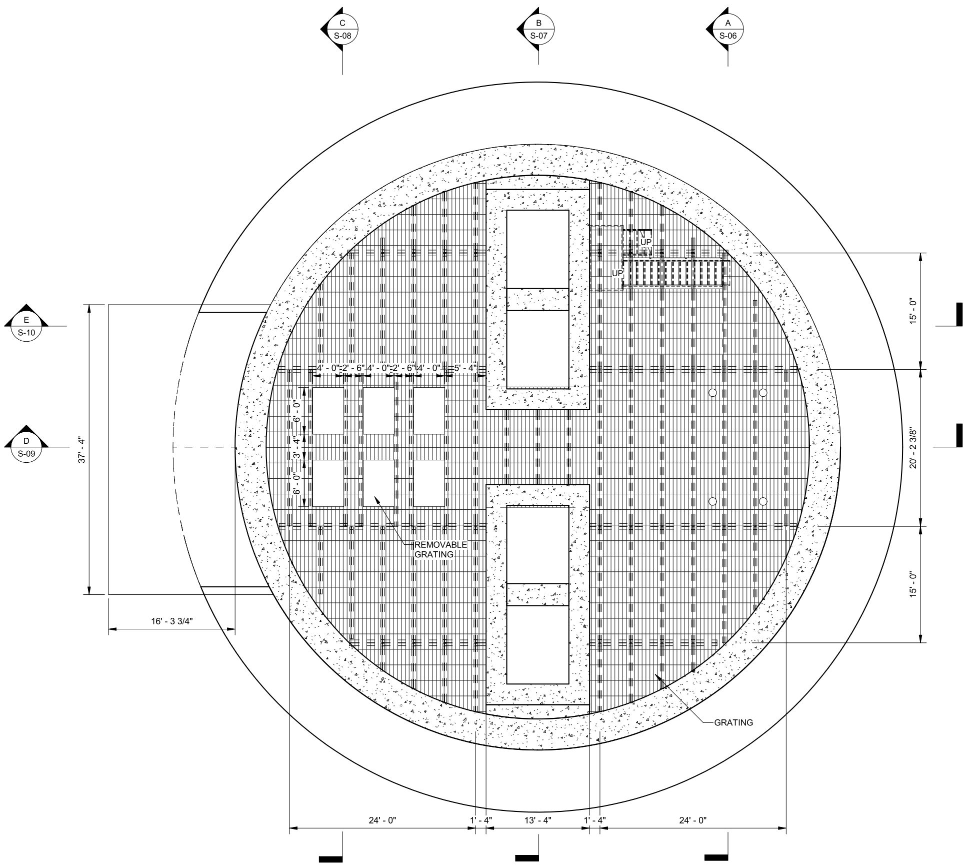
STRUCTURAL

SECOND LEVEL PLAN
@ EL 74.00

SCALE: 1/8" = 1'-0"

S-03

SHEET ________ OF ________



PLAN @ EL 83.00

SCALE: 1/8" = 1'-0"

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LEGAL ENTITY:
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CONSULTANTS

SEALS

Project Status

GREAT LAKES WATER
AUTHORITY

FREUD PUMP
STATION
REHABILITATION 1

ARCADIS PROJ. NO. 30047523

NO.	DATE	ISSUED FOR	BY

DATE: Issue Date
PROJECT NO.: 30047523
FILE NAME:
DESIGNED BY: K. PARK
DRAWN BY: R. BLUMENSHINE
CHECKED BY: Checker

SHEET TITLE

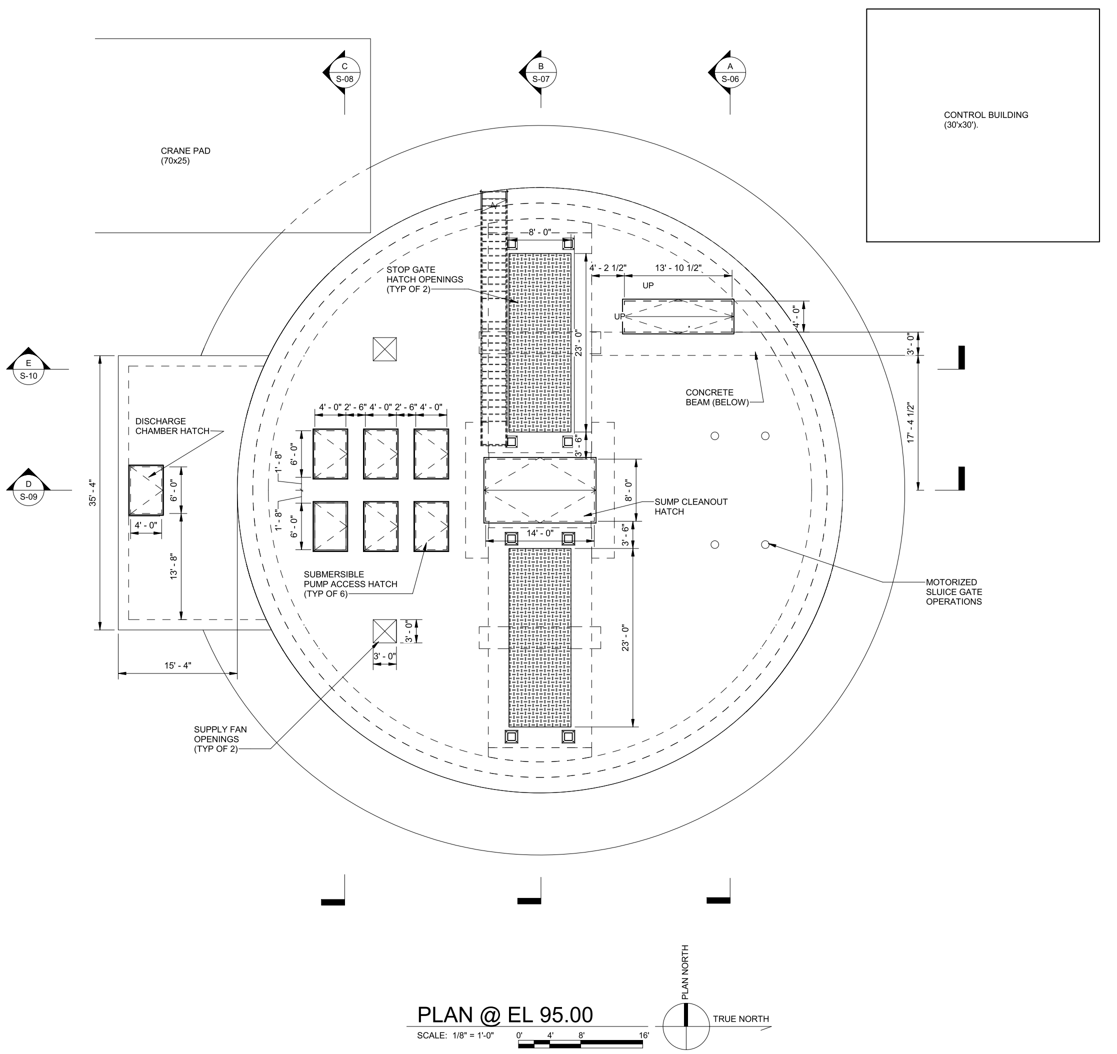
STRUCTURAL

FIRST LEVEL PLAN @
EL 83.00

SCALE: 1/8" = 1'-0"

S-04

SHEET ________ OF ________



PLAN @ EL 95.00

SCALE: 1/8" = 1'-0"

ARCADIS

LEGAL ENTITY:
ARCADIS U.S., INC.

CONSULTANTS

SEALS

Project Status

GREAT LAKES WATER
AUTHORITY

FREUD PUMP
STATION
REHABILITATION 1

ARCADIS PROJ. NO. 30047523

NO.	DATE	ISSUED FOR	BY

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DATE: Issue Date
PROJECT NO.: 30047523
FILE NAME:
DESIGNED BY: K. PARK
DRAWN BY: R. BLUMENSHINE
CHECKED BY: Checker

SHEET TITLE

STRUCTURAL

TOP PLAN @ EL 95.00

SCALE: 1/8" = 1'-0"

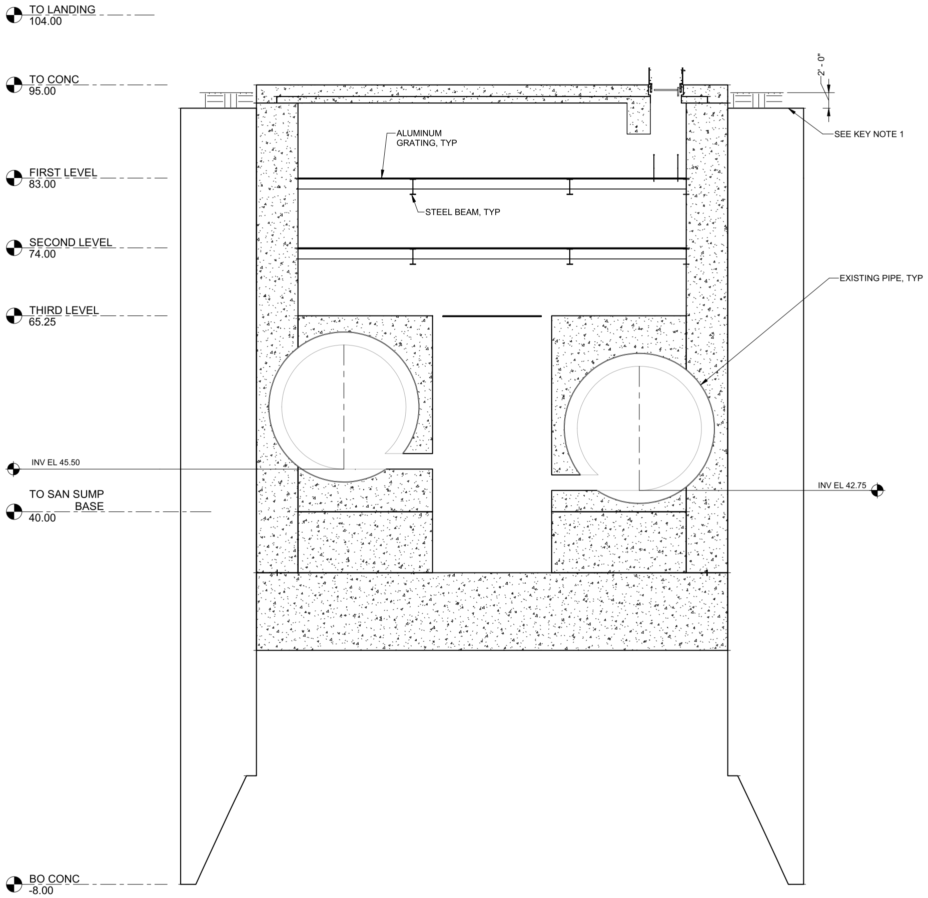
S-05

SHEET ______ OF ______

8/24/2020 5:32:49 PM BIM 360://ANA - 30010353 - Detroit MI - Freud Pump Station Rehabilitation/S-3D-SFT.rvt

KEY NOTES

1. TOP OF TEMPORARY SUPPORT SHALL BE CUT BELOW 2'-0" FINISH GRADE AFTER COMPLETION OF PERMANENT STRUCTURE.



A
S-01
SECTION
SCALE: 1/8" = 1'-0"

ARCADIS

LEGAL ENTITY:
ARCADIS U.S., INC.

CONSULTANTS

SEALS

Project Status

GREAT LAKES WATER AUTHORITY

FREUD PUMP STATION REHABILITATION 1

ARCADIS PROJ. NO. 30047523

NO.	DATE	ISSUED FOR	BY

DATE: Issue Date
PROJECT NO.: 30047523
FILE NAME:
DESIGNED BY: K. PARK
DRAWN BY: R. BLUMENSHINE
CHECKED BY: Checker

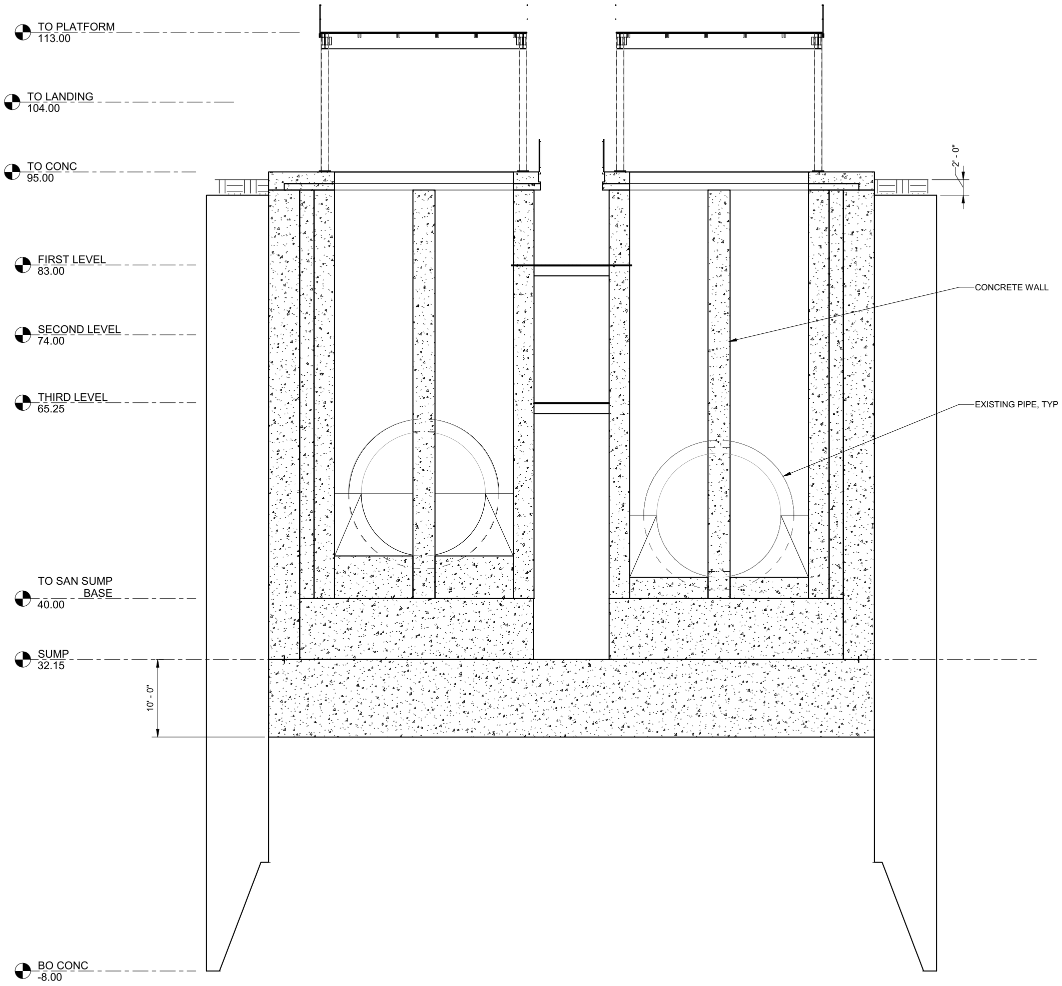
SHEET TITLE
STRUCTURAL

SECTION 1

SCALE: 1/8" = 1'-0"

S-06

SHEET ____ OF ____



B
S-01
SECTION
SCALE: 1/8" = 1'-0"

ARCADIS

LEGAL ENTITY:
ARCADIS U.S., INC.

CONSULTANTS

SEALS

Project Status

GREAT LAKES WATER
AUTHORITY

FREUD PUMP
STATION
REHABILITATION 1

ARCADIS PROJ. NO. 30047523

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DATE: Issue Date
PROJECT NO.: 30047523
FILE NAME:
DESIGNED BY: K. PARK
DRAWN BY: R. BLUMENSHINE
CHECKED BY: Checker

SHEET TITLE

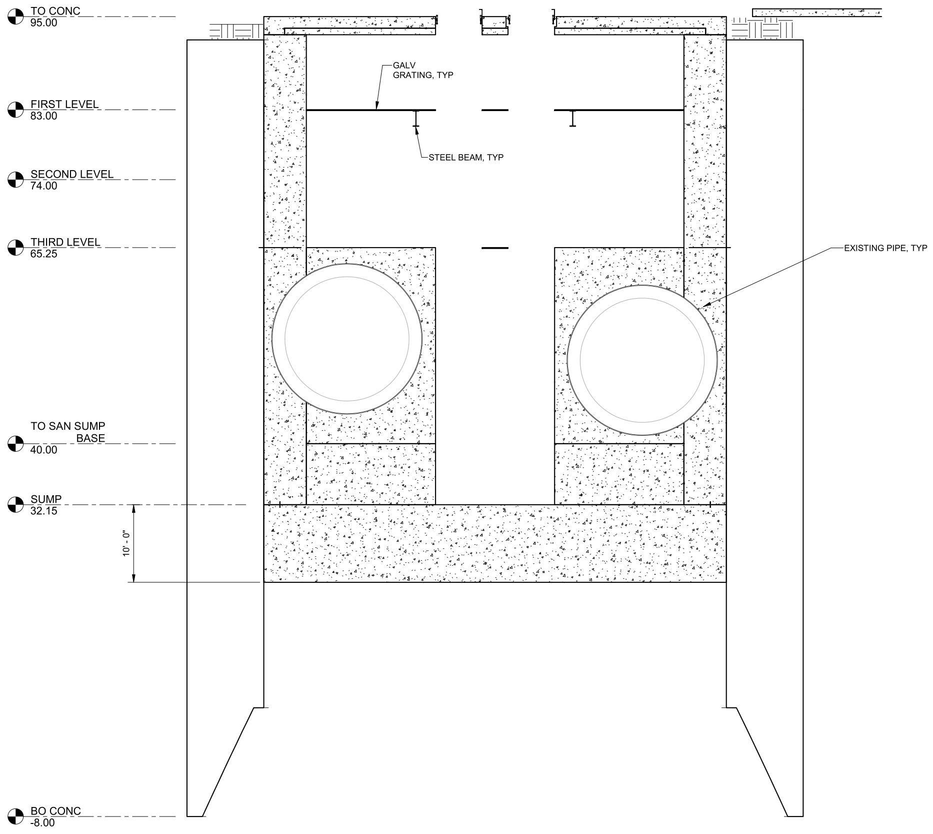
STRUCTURAL

SECTION 2

SCALE: 1/8" = 1'-0"

S-07

SHEET ______ OF ______



C
S-01
SECTION
SCALE: 1/8" = 1'-0"

ARCADIS

LEGAL ENTITY:
ARCADIS U.S., INC.

CONSULTANTS

SEALS

Project Status

GREAT LAKES WATER
AUTHORITY

FREUD PUMP
STATION
REHABILITATION 1

ARCADIS PROJ. NO. 30047523

NO.	DATE	ISSUED FOR	BY

DATE: Issue Date
PROJECT NO.: 30047523
FILE NAME:
DESIGNED BY: K. PARK
DRAWN BY: R. BLUMENSHINE
CHECKED BY: Checker

SHEET TITLE

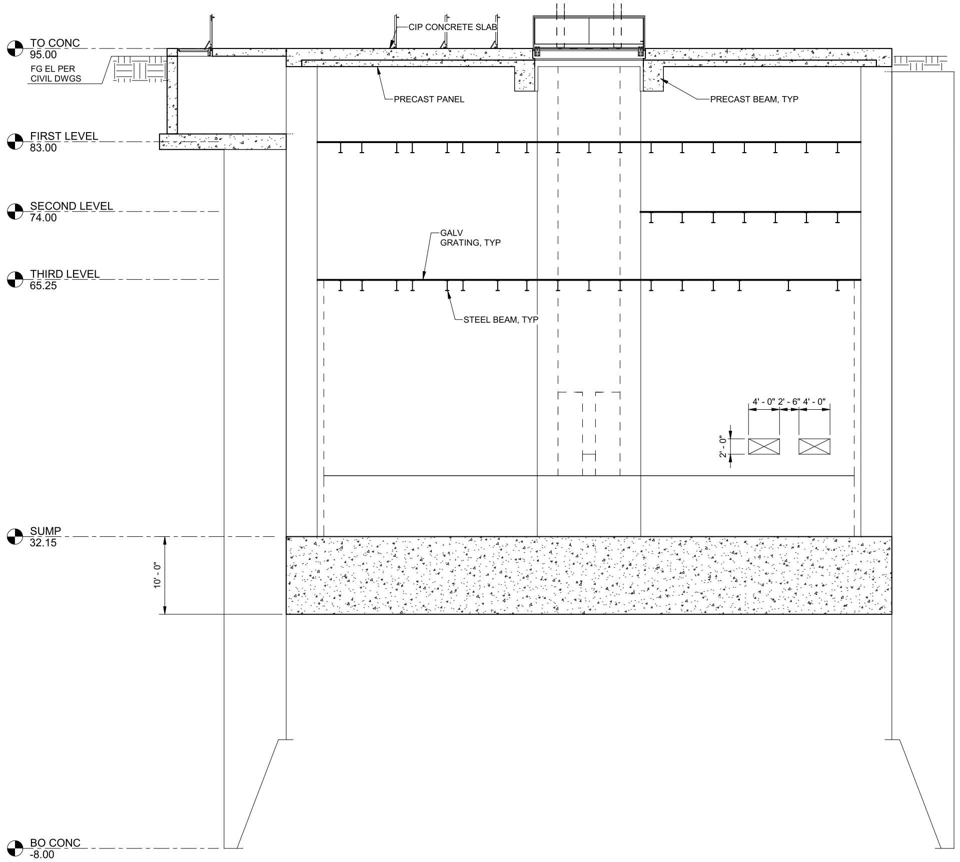
STRUCTURAL

SECTION 3

SCALE: 1/8" = 1'-0"

S-08

SHEET ______ OF ______



D
S-01
SECTION
SCALE: 1/8" = 1'-0"

ARCADIS

LEGAL ENTITY:
ARCADIS U.S., INC.

CONSULTANTS

SEALS

Project Status

GREAT LAKES WATER
AUTHORITY

FREUD PUMP
STATION
REHABILITATION 1

ARCADIS PROJ. NO. 30047523

NO.	DATE	ISSUED FOR	BY

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DATE: Issue Date
PROJECT NO.: 30047523
FILE NAME:
DESIGNED BY: K. PARK
DRAWN BY: R. BLUMENSHINE
CHECKED BY: Checker

SHEET TITLE

STRUCTURAL

SECTION 4

SCALE: 1/8" = 1'-0"

S-09

SHEET ____ OF ____

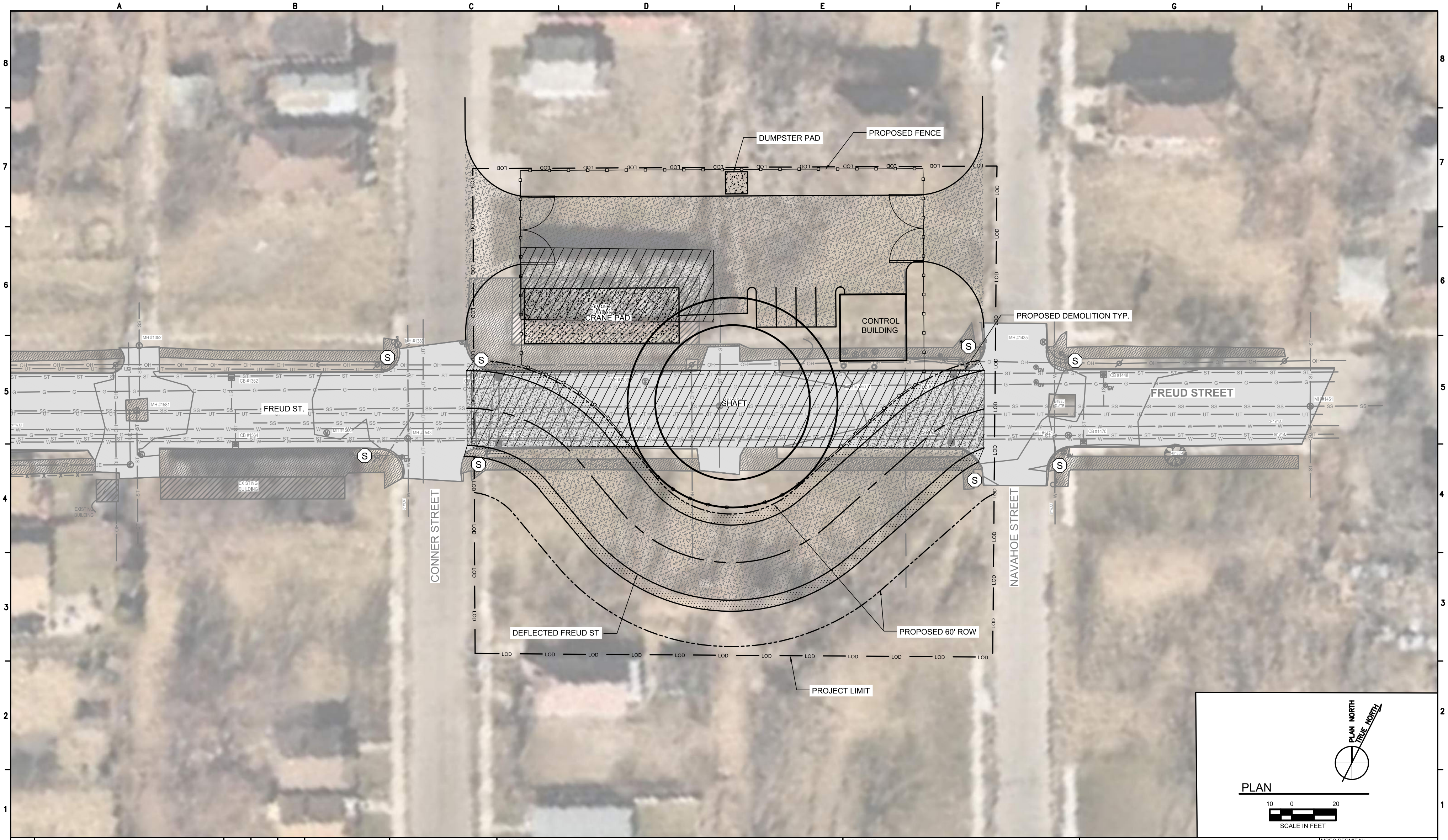
8/24/2020 5:32:51 PM BIM 360://ANA - 30010353 - Detroit MI - Freud Pump Station Rehabilitation/S-3D-SFT.rvt

APPENDIX B

Ashland and Fox Creek Relief Sewer Inspection Report

APPENDIX C

Freud Street Relocation Options



		CHK'D	APPR	DATE
F				
E				
D				
C				
B				
A				
	DESCRIPTIONS / REVISIONS	CHK'D	APPR	DATE

DESIGNED BY: X. ZHANG
DRAWN BY: R. JAMES
CHECKED BY: J. O'NEILL
APPROVED BY:

SEAL / STAMP

FACILITY

GLWA CONTRACT NO. CS-120
CONNER CREEK AND FREUD PUMP
STATION IMPROVEMENTS

PROJECT TITLE

DRAWING TITLE

CONCEPTUAL SITE LAYOUT OPTION 2D-1

FIRM NAME

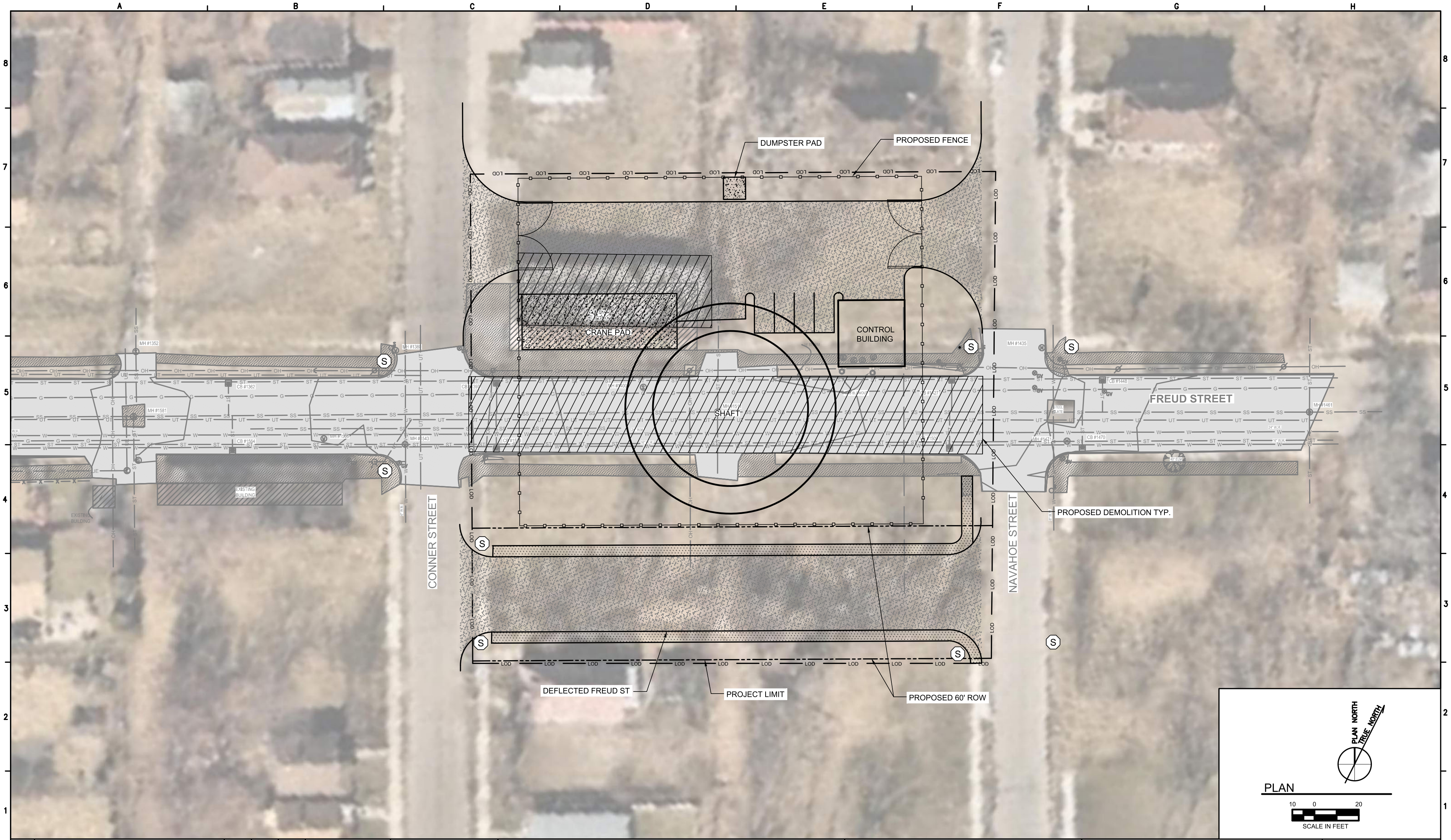
ARCADIS

Brown AND Caldwell

GLWA
Great Lakes Water Authority

SECTION MAP	TOWN	RANGE	SECTION	Q	QQ

MDEQ PERMIT No.
GLWA CONTRACT No.
GLWA CIP No.
DRAWING No. C-3



F				
E				
D				
C				
B				
A				
	DESCRIPTIONS / REVISIONS	CHK'D	APPR	DATE

DESIGNED BY: X. ZHANG
DRAWN BY: R. JAMES
CHECKED BY: J. O'NEILL
APPROVED BY:

SEAL / STAMP

FACILITY

GLWA CONTRACT NO. CS-120
CONNER CREEK AND FREUD PUMP
STATION IMPROVEMENTS

PROJECT TITLE

DRAWING TITLE

CONCEPTUAL SITE LAYOUT OPTION 2D-2

FIRM NAME

ARCADIS

Brown AND Caldwell

GLWA
Great Lakes Water Authority

SECTION MAP	TOWN	RANGE	SECTION	Q	QQ

MDEQ PERMIT No.
GLWA CONTRACT No.
GLWA CIP No.
DRAWING No. C-4

APPENDIX D

Specifications – Table of Contents

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INTRODUCTORY INFORMATION

BIDDING REQUIREMENTS

CONTRACTING REQUIREMENTS

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DIVISION 02 – EXISTING CONDITIONS

DIVISION 03 – CONCRETE

DIVISION 04 – MASONRY

DIVISION 05 – METALS

DIVISION 06 – WOOD, PLASTICS AND COMPOSITES

DIVISION 07 – THERMAL AND MOISTURE PROTECTION

DIVISION 08 – OPENINGS

DIVISION 09 – FINISHES

DIVISION 10 – SPECIALTIES

DIVISION 11 – EQUIPMENT (NOT USED)

DIVISION 12 – FURNISHINGS (NOT USED)

DIVISION 13 – SPECIAL CONSTRUCTION (NOT USED)

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DIVISION 46 – WATER AND WASTEWATER EQUIPMENT (NOT USED)

APPENDIX E

Construction Cost Estimate

ENGINEER'S OPINION OF CONSTRUCTION COST

PROJECT: Freud Pump Station Improvements **DATE:** 08/31/20
LOCATION: Detroit, MI **PROJECT NO.:** CS-120
BASIS FOR ESTIMATE: [ ] CONCEPTUAL [X] PRELIMINARY [ ] FINAL
WORK: Freud Pump Station Improvements and Freud Isolation Shaft

ITEM NO.	DESCRIPTION		AMOUNT	Percent of Subtotal
	Division 01-General Requirements		**$131,000**	0.3%
	Division 02-Existing Conditions		**$435,000**	1.0%
	Division 03-Concrete		**$8,750,000**	20.1%
	Division 04-Masonry		**$54,000**	0.1%
	Division 05-Metals		**$108,000**	0.2%
	Division 06-Wood, Plastics, & Composites		**$2,000**	0.0%
	Division 07-Thermal & Moisture Protection		**$77,000**	0.2%
	Division 08-Openings		**$62,000**	0.1%
	Division 09-Finishes		**$60,000**	0.1%
	Division 10-Specialties		**$1,000**	0.0%
	Division 11-Equipment		**$0**	0.0%
	Division 12-Furnishings		**$0**	0.0%
	Division 14-Conveying Equipment		**$190,000**	0.4%
	Division 21-Fire Suppression		**$0**	0.0%
	Division 22-Plumbing		**$0**	0.0%
	Division 23-Heating, Ventilating, & Air Conditioning (HVAC)		**$0**	0.0%
	Division 26-Electrical		**$2,922,000**	6.7%
	Division 27-Communications		**$0**	0.0%
	Division 28-Electronic Safety & Security		**$80,000**	0.2%
	Division 31-Earthwork		**$14,600,000**	33.6%
	Division 32-Exterior Improvements		**$731,000**	1.7%
	Division 33-Utilities		**$2,715,000**	6.2%
	Division 40-Process Integration		**$2,360,000**	5.4%
	Division 41-Material Processing & Handling Equipment		**$0**	0.0%
	Division 43-Process Gas & Liquid Handling, Purification, & Storage Equipment		**$10,165,000**	23.4%
	Division 44-Pollution & Waste Control Equipment		**$0**	0.0%
	SUBTOTAL		**$43,443,000**	100.0%
	SUBTOTAL with 25% Contingency		**$54,303,750**	
	Contractor General Conditions	**15%**	**$6,516,450**	
	Start-up, Training, O&M **Building Risks, Liability, Auto Insurance** **Bonds & Insurance**	**12%**	**$5,995,134**	
	Escalation (3 years at 3%)	**9%**	**$5,035,913**	
				Rounded Report #
	Total		**$71,851,247**	**$71,900,000**

This Engineer's Opinion of Construction Costs is provided based on available information and the engineer's experience and qualifications and represents their best judgment as a design professional familiar with the construction industry. The engineer has no control over the costs of labor, materials, equipment, or over the contractor's methods of determining prices or over competitive bidding or market conditions. The engineer cannot and does not guarantee that proposals, bids or construction cost will not vary from this estimate.

Arcadis of Michigan, LLC.

607 Shelby Street

Suite 400

Detroit, Michigan 48226

Tel 313 965 8436

Fax 248 994 2241

www.arcadis.com

Appendix G

Disadvantaged Community Status Determination Worksheet

MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

DISADVANTAGED COMMUNITY STATUS DETERMINATION WORKSHEET

The following data is required from each municipality to assess the disadvantaged community status. Please provide the necessary information and return to:

Mark Conradi
Water Infrastructure Financing Section
Finance Division
conradim@michigan.gov

Please contact Mark Conradi (conradim@michigan.gov) with any questions on the completion of the form.

Please check the box this determination is for:

DWSRF ☐

CWSRF ☐

Total amount of anticipated debt for the proposed project, if applicable.

Annual payments on the existing debt for the system.

Total operation, maintenance, and replacement expenses for the system on an annual basis.

Number of residential equivalent users (REUs) in the system.

For determinations made using anticipated debt, a final determination will be made based upon the awarded loan amount.

If you need this information in an alternate format, contact EGLE-Accessibility@Michigan.gov or call 800-662-9278.

EGLE does not discriminate on the basis of race, sex, religion, age, national origin, color, marital status, disability, political beliefs, height, weight, genetic information, or sexual orientation in the administration of any of its programs or activities, and prohibits intimidation and retaliation, as required by applicable laws and regulations. Questions or concerns should be directed to the Nondiscrimination Compliance Coordinator at EGLE-NondiscriminationCC@Michigan.gov or 517-249-0906.

This form and its contents are subject to the Freedom of Information Act and may be released to the public.

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607 Shelby Street, Suite 400
Detroit
Michigan 48226
Phone: 313 694 8436
www.arcadis.com

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