EXHIBIT # 8.1

Noise Impact Study
McKinnon Creek Pumphouse

April 2016

LAKE FOREST PARK WATER DISTRICT

Lake Forest Park Water District
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EXHIBIT # 8.2

1. Background and Introduction

Lake Forest Park Water District is relocating and improving the McKinnon Creek well field pumphouse. The new facility proposed at #18460 47th Ave. will serve as control center for well pumps and also will house 4 – 25hp "transfer„ pumps which lift water from the "Low„ zone reservoir to the "High„ zone steel standpipe. Note that the 3rd and 4th pumps are proposed for emergency and redundancy only, and will not be used in routine operation.

The proposed facility (and the existing pumphouse) is abutted to the east and west by a suburban residential neighborhood. Of particular interest is noise expected from operation of the proposed pumphouse and how this may impact neighboring residences compared with the existing pumphouse which is located in the McKinnon Creek wellfield about 90 feet to the north and west.

Field sampling of ambient noise levels was conducted near the existing and proposed pumphouse locations. Expected noise levels for the new pumphouse were established based on published data (and field sampling) for similar water pumping facilities. Lake Forest Park Municipal Code is referenced for allowable levels of noise and relevant exemptions. In addition, a similarly sized pump station operated by Northshore Utility District was visited and readings of noise were recorded for reference.

Calculations of expected noise from all sources are compared with the observed in order to accurately predict noise from the proposed McKinnon Creek pumphouse.

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2. FIELD SAMPLING

Field sampling was carried out in June 2014 and April 2016 to determine noise levels in three locations as described here:

- Existing wooden pumphouse at McKinnon Creek both ambient and with pumps running
- East property boundary of 18460 47th Place which is the proposed location of McKinnon Creek pumphouse. Spot samples were taken and ambient noise was logged every 30 seconds for one week.
- Northshore Utility District sewage Lift Station #14

Table 2-1 below lists the results of noise samples measured near the existing wooden above grade pumphouse at McKinnon Creek. The samples were taken on separate occasions and with different instruments as indicated. Noise of the operating pump(s) was noticeably audible above ambient noise at all distances. The sample data reveal a very close correlation between each instrument and over both sample dates with exception of a single sample – ambient noise at 50ft measured in 2014 was considerably below other ambient samples and was rejected. Sample values are averaged below and reveal that noise from the existing above grade wood pumphouse would likely exceed allowable levels of 45 DB_A night as described in LFPMC 8.24.050 if the pumphouse was within 50 feet of the property boundary.

Distance from pumps, ft	**Noise Level, dB_A** 6/10/2014 6:00pm	**Noise Level dB_A** 4/7/2016 3:00pm		**Avg. Noise dB_A**	**Notes:** Sampling at existing McKinnon Creek Pumphouse - Instrument height 3ft - dBA frequency weighting - "fast" 125ms response
	EXTECH#H D600 data logger	**EXTECH #407730**	**EXTECH #407732**	**AVG. ALL SAMPLES**	**SAMPLING SCENARIO**
5	n/a	43.9	43.4	43.6	Inside existing pumphouse, ambient, *pumps off*
	82	80.2	82.7	81.6	Inside existing pumphouse, *one 25-hp pump running*
	94	91.3	93.4	92.9	Inside existing pumphouse, *two 25-hp pumps running*
10	n/a	45.9	45.1	45.5	Outside East wall existing pumphouse, *ambient, pumps off*
	51	50.2	50.6	50.6	Outside East wall existing pumphouse, *one pump running*
	60	57.4	59.8	59.1	Outside East wall existing pumphouse, *two pumps running*
25	42	43.0	42.5	42.5	Outside East wall existing pumphouse, *ambient, pumps off*
	46	47.6	48.0	47.2	Outside East wall existing pumphouse, *one pump running*
	53	53.1	55.1	53.7	Outside East wall existing pumphouse, *two pumps running*
50	(30)*	40.5	42.6	41.5	Outside East wall existing pumphouse, *ambient, pumps off*
	46	43.0	45.4	44.8	Outside East wall existing pumphouse, *one pump running*
	51	50.5	50.5	50.7	Outside East wall existing pumphouse, *two pumps running* *reading questionable, removed from average

Table 2-1 Existing McKinnon Cr. Pumphouse

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Table 2-2 below summarizes spot samples of ambient noise taken at a single point along the east property boundary of #18460 47th Place. The proposed pumphouse location is approximately 50 feet from either property boundary.

Ambient Noise Level dB_A 4/7/2016 2:41pm			**Avg. Noise** dB_A	**Notes:** Sampling at proposed McKinnon Creek Pumphouse site (#18460 46th PL) - Instrument height 3ft - dBA frequency weighting - "fast" 125ms response - Instruments calibrated with Extech #407722 at $94dB_A$
EXTECH# HD600 data logger	**EXTECH #407730**	**EXTECH #407732**	**AVG. ALL**	**SAMPLING SCENARIO**
46.0	42.8	40.6	43.1	Reading #1
45.9	41.2	45.7	44.3	Reading #2
45.6	44.4	42.6	44.2	Reading #3
45.8	**42.8**	**43.0**	**43.9**	**AVERAGE ALL READINGS**

Table 2-2 Ambient noise at #18460 47th PL

The ambient noise readings show remarkable correlation between samples. There was an average of $3dB_A$ offset between the Extech HD600 and the other two instruments but this is considered acceptable and within error limits of the instruments.

Table 2-3 below summarizes noise readings that were taken at Northshore Utility District (NUD) Lift Station #14 in Kirkland, WA. This sewage pump station was selected for reference because of the below grade concrete basement design which is similar to the proposed McKinnon Creek pumphouse and because horsepower is similar.

Distance from pumps, ft	**Noise Level,** dB_A	**Notes: Sampling at NUD Lift Station #14 on 118th Ave. NE** (sampling 6/11/2014 at 1:30pm using EXTECH #HD600)
0 (20 ft above pumps)	21 72	Pumps "OFF" standing on upper deck inside pumphouse Pumps "ON" standing on upper deck inside pumphouse *No sound baffling in pumphouse.*
10	54* 54*	Pumps "OFF" standing outside pumphouse, on 88th Ave. Pumps "ON" standing outside pumphouse, on 88th Ave. **Note: no sound of pumps could be heard, but there were aircraft noises that raised ambient noise level.*
50	40 – 54*	Pumps "ON" readings taken at around 2:00pm. No pump sound noticeable.

Table 2-3 Reference NUD Pump Facility

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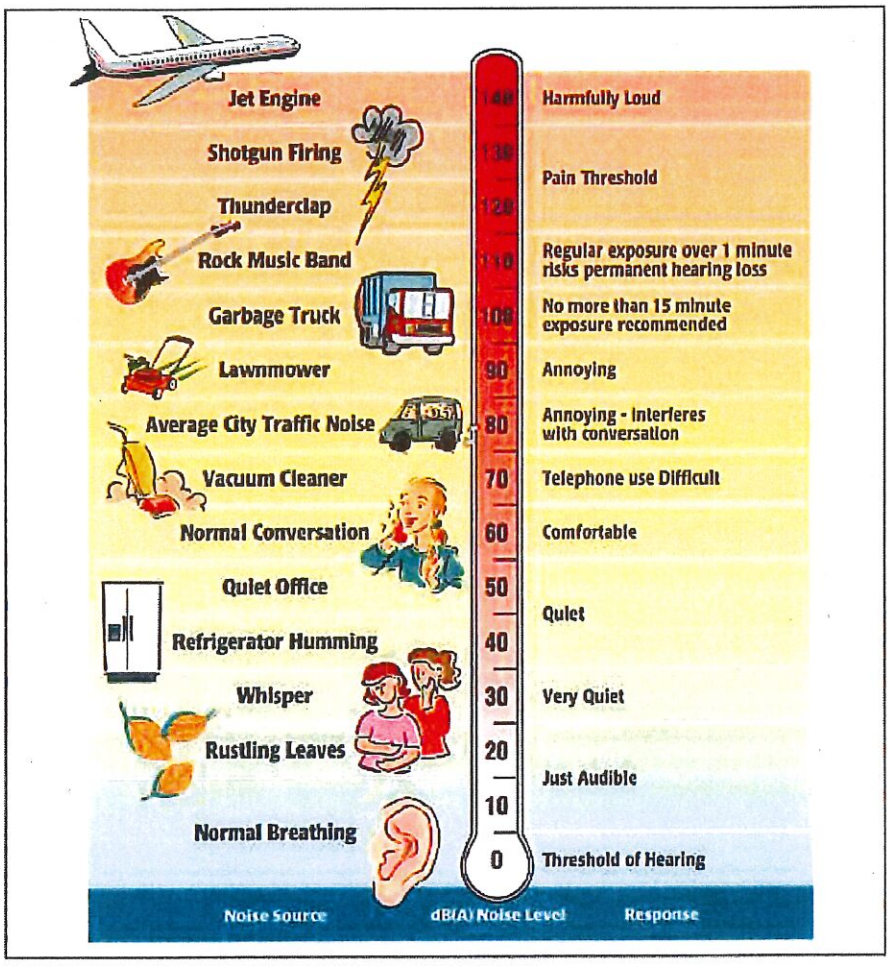
Figure 2-1 (below) illustrates sound levels from various sources for comparison of the data.



SOURCE: Melville C. Branch and R. Dale Beland, *Outdoor Noise in the Metropolitan Environment*, 1970
Environmental Protection Agency, *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety* (EPA/ONAC 550/9-74-004), March 1974

Figure 2-0-1 Comparative Sound Sources

Ambient noise levels were also recorded with the Extech HD600 data logger over a one week period at the site of the proposed McKinnon Creek pumphouse to benchmark the "status quo,, condition and better understand the possible impact of noise from the proposed pumphouse facility. Samples were recorded and date stamped every 30seconds. In addition, an audio recorder was placed with the data logger over the same period to allow identification of noise sources.

Figure 2-2 below summarizes ambient noise levels from this sampling. From the data we observe diurnal fluctuation of peak noise events between 5pm and midnight due to overhead aircraft. These flights are intermittent, and occur while the average noise is lowest. There are also peaks in noise for several hours in the morning, mostly due to bird songs. These sounds raise the hourly average ambient noise level considerably but are not considered nuisance.

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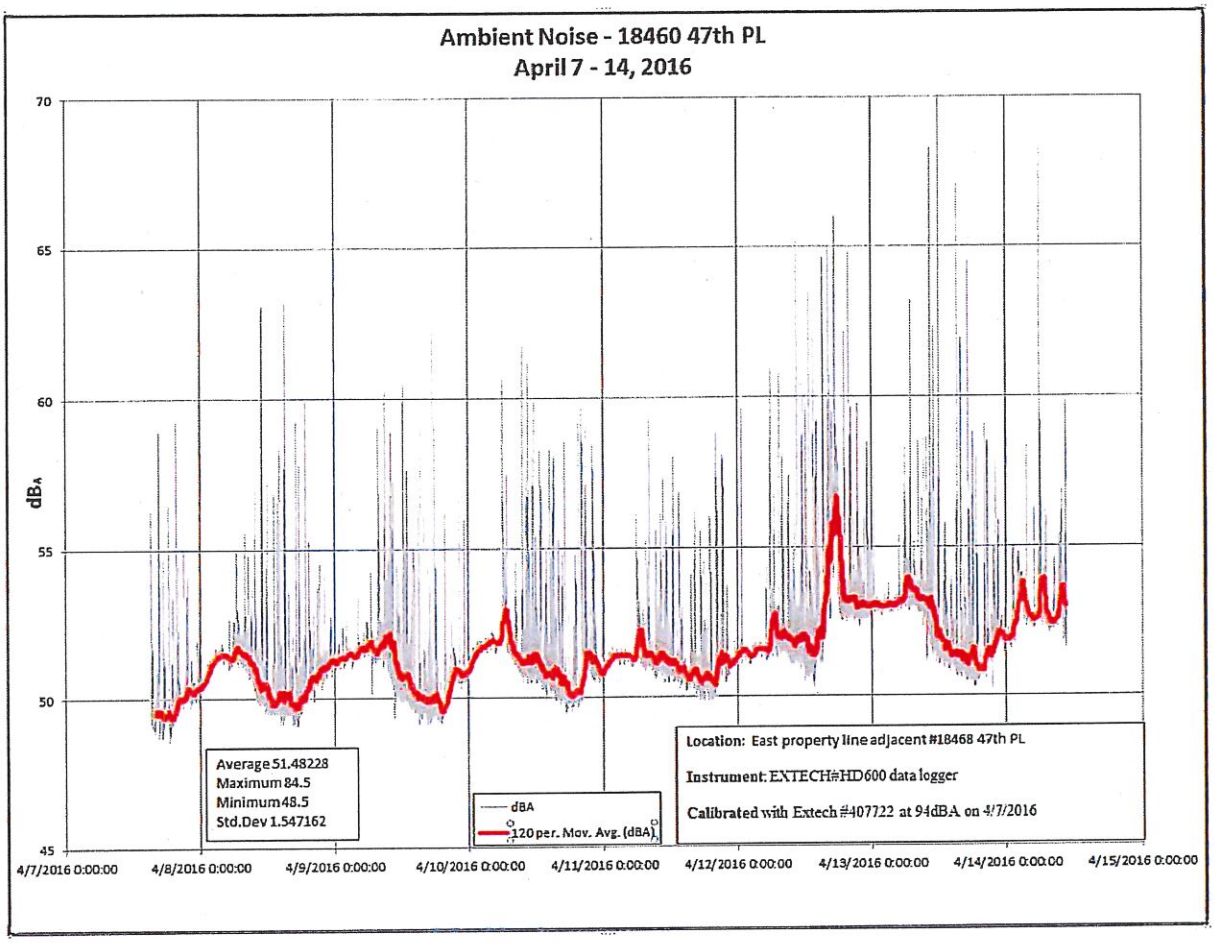

Figure 2-0-2 Ambient Noise at #18460 47th PL

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3. Proposed Facility Design

The proposed pumphouse facility described in **Figure 3-1** and **Figure 3-2** will have a concrete basement and masonry upper level construction with insulation in the ceiling and a metal roof with 8ft x 8ft removable skylight. There will be a balcony with 8ft x 8ft removable grating below the skylight to allow natural lighting and provide access for removal of water apparatus as needed. Overall dimensions of the building are 32ft x 24ft. The lower level will house pumps, valves and provision for iron/manganese removal treatment vessels and the upper level will have an area for electrical controls, switching as well as a partitioned office/operator control space, lavatory, lunch and storage area. Noise attenuating panels will be fastened to walls and ceiling near the pumps and portable self-standing noise attenuating partition panels will also be positioned to minimize reverberating noise in the pump gallery. Spray on noise attenuating coatings will be used in the pump gallery to further reduce reverberating noise and HDPE piping will be used where possible to reduce noise propagation. The assumption here is that overall Noise Reduction Coefficient (NRC) in the pump gallery will be increased to atleast 0.30 where 0 = complete reflection, and 1 = complete attenuation.

Design objectives for noise are full compliance with Lake Forest Park Municipal Code (LFPMC) Chapter 8.24 "Noise Control„. LFPMC 8.24.050 calls for mitigation of noise as follows:

> *Noise-producing equipment shall be baffled, shielded, enclosed or placed on the property so as to insure that the dBA level does not exceed 55 by day or 45 by night at the property line. In the event of persistent noise problems it shall be the owner's responsibility to retain a noise consultant and to take necessary action to mitigate the impacts immediately. (Ord. 349 § 5, 1986)*

While the centrifugal pumps are a dominant source of noise it is anticipated that in normal operation the facility will generate noise in several ways including:

Item	Noise Generator	Normal Noise, dB_A at 5ft from source	Duration/ time of day	Notes
1	Electric driven centrifugal water transfer pumps (25hp/3600rpm)	94	1 hours/day	*Source*: field measurement inside at 5ft, reflects maximum normal condition
		82	18hours/day	
2	Vehicular activity maint. staff, engines idling	51.4	8am – 5pm 1 hour/day	F450 pickup truck, idling *Source*: Auto Decibel Database
3	Staff on site speaking outside	60.0	8am – 5pm 2 hours/day	*Source*: Engineeringtoolbox.com Ref. "loud speaking„
4	Exhaust fan for building ventilation	48.0	18 hours/day	900cfm minimum capacity based on 3+ air changes per hour, 12in axial shutter fan *Source*: Central Fan mdl. TX12WL

Table 3-1 Sources of Noise at Proposed McKinnon Pumphouse

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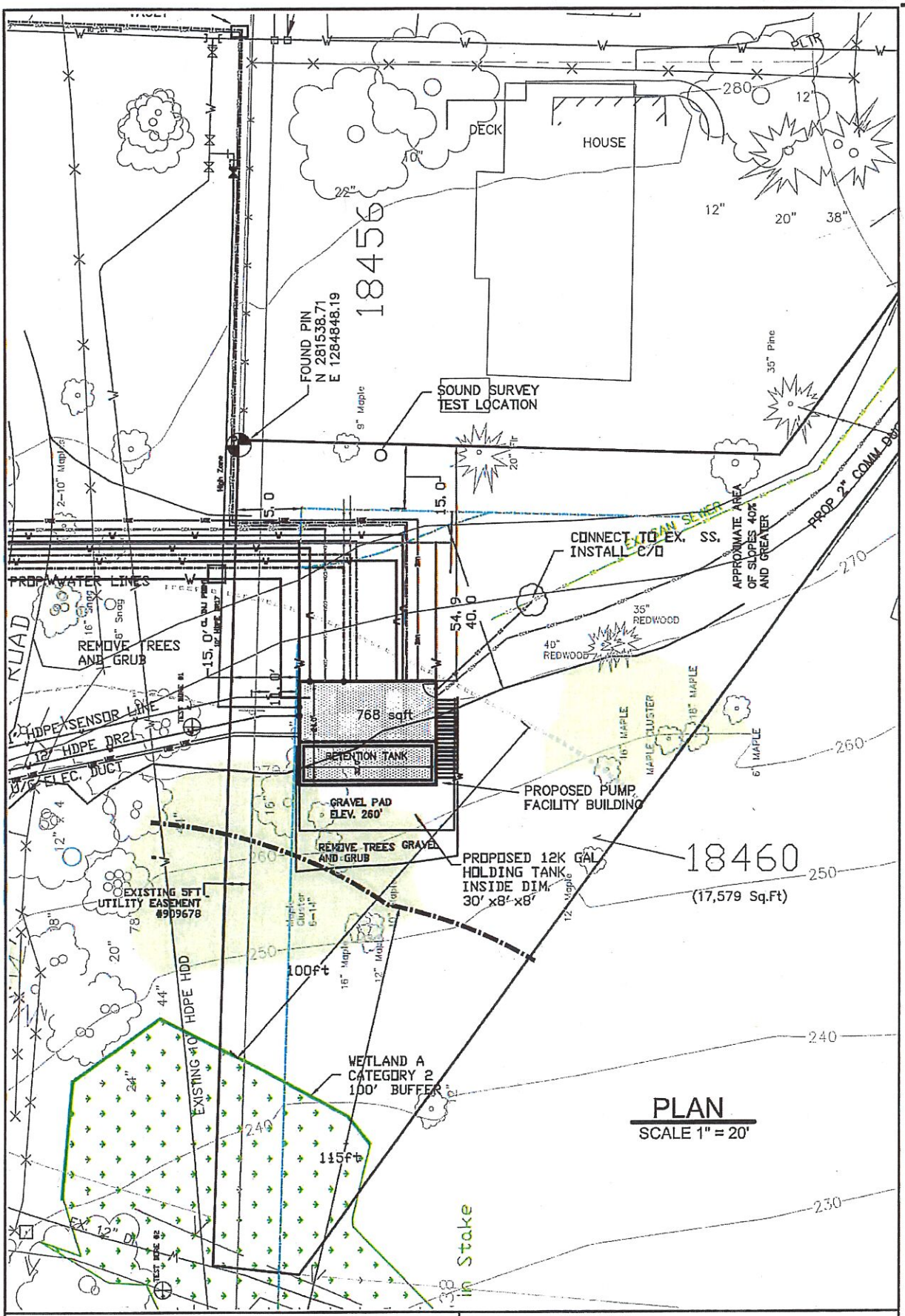

FIGURE 3-1 - Site Plan

Proposed McKinnon Creek Pump Facility Building

18460 47th PL NE

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Figure 3-2 Proposed McKinnon Cr. Pumphouse - Building

EXHIBIT # 8.10

Estimated noise at different locations in and around the McKinnon Creek Pumphouse is predicted in **Table 3-2** below based on observed noise data from the existing pumps and formulae provided by industry reference Pumping Station Design, Jones, Sanks, Tchobanoglous Rev. 3rd ed, 2008 and on-line calculators at: www.sengpielaudio.com

Location	Predicted dB_A	Maximum Duration /day normal op.	Regulation Allowed Max. duration or sound level	Notes:
Inside: Pump gallery (downstairs)	98.0 (2 pumps – max. for normal operation) 86.4 (1 pump typical)	1.0hr 18.0hr	2.6hours OSHA 13.0hours OSHA	Calculated at 3ft distance Based on observed at 5ft Ref. OSHA 29CFR for workers
Inside:,Balcony (upstairs) with partial catwalk opening	96.0 (2 pumps) 84.4 (1 pump)	1.0hr 18.0hr	3.5hours OSHA 17.0 hours OSHA	Calculated noise reduction to upstairs balcony with reverberation NRC=0.30 (composite assuming concrete construction with some sound absorbing surfaces). Area=2656sq-ft
Inside: Operator station (upstairs – enclosed office with 20% wall safety glass windows to balcony)	96.0-36=60.0 (2 pumps) 84.4-36=48.4 (1 pump)	1.0hr 18.0hr	No limit OSHA No limit OSHA	Based on noise at balcony - STC36 for 6„ stud wall + insulation to office. Note there will be a safety glass/steel door 20% of wall area.
Outside: at Pumphouse wall	96.0-36=36=60.0 (2 pumps) 60.0 (staff speaking) **Combined noise 63.0** 84.4-36=48.4 (1 pump) 60.0 (staff speaking) **Combined noise 60.3**	1.0hr 18.0hr 2.0hr	Daytime $55dB_A$ Night $45dB_A$ per LFPMC 8.24.050 at property line	12ft dist – STC36 for plain masonry wall, 20% of area is doors, windows **Note:** other noise sources such as ventilation fan and vehicular noise are much less than pumps and staff speaking so are ignored here.
Outside: 20ft from pumphouse	60.0-6.4=53.6 (2 pumps) 60.0 (staff speaking @20ft) **Combined noise 60.9** 48.4-6.4=42.0 (1 pump) 60.0 (staff speaking @20ft) **Combined noise 60.0**	1.0hr 2.0hr 18.0hr 2.0hr	Daytime $55dB_A$ Night $45dB_A$ per LFPMC 8.24.050 at property line	Exceeds max dB_A at night per LFPMC 8.24.050 if pumphouse is 20ft from property line **Note:** other noise sources such as ventilation fan and vehicular noise are much less than pumps and staff speaking so are ignored here.
Outside: 50ft from pumphouse	60.0-15.6=44.4 (2 pumps) 60.0-15.6=44.4 (staff@20ft from pumphouse) **Combined noise 47.4** 44.0-15.6=28.4 (1 pump) 60.0-15.6=44.4 (staff@20ft from pumphouse) **Combined noise 44.4**	1.0hr 18.0hr	Daytime $55dB_A$ Night $45dB_A$ Per LFPMC 8.24.050 at property line	Complies with LFPMC 8.24.050 if pumphouse is 50 ft from property line except if two pumps are running at night time and staff outside speaking would raise noise levels slightly above LFPMC allowance. Normal staff hours are 8:30-4:30pm so this does not present a problem. **Note:** other noise sources such as ventilation fan and vehicular noise are much less than pumps and staff speaking so are ignored here.

Table 3-2 Predicted Noise levels – McKinnon Cr. Pumphouse

4. Summary and Conclusions

Lake Forest Park Water District has conducted field sampling and design calculations in an effort to determine possible noise impacts that will result from siting a community water pumphouse on a residential lot - #18460 47th Place. Calculations presented here are conservative but show that with mitigative measures outlined here the pumphouse facility will comply with applicable noise codes and will be less audible than the existing above ground wooden pumphouse. In addition to other mitigative measures special attention in the site design is made to locate the pumphouse at least 50 feet from the property line – as indicated on the site plan and designed as described in this report to ensure adequate attenuation of noise. Sound level testing should be conducted upon startup to confirm design assumptions. Some additional noise control measures may be considered after startup should this prove necessary. These include – in order of desirability:

- Operational adjustments to further reduce likelihood of duplex pump operation at night
- Augment 8' x 8' floor grating with sound attenuating clear panels to restrict open passage from the lower level
- Wall/ceiling coatings in the upper level
- 6ft masonry wall along east property line built with sound attenuating cinder block design.