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October 2, 2020

J.H. Edmonds, P.E.
Director of Engineering Services
City of Corpus Christi
P.O. Box 9277
Corpus Christi, TX 78469-9277

Re: Restoration of S.E.A. District Water Features (E16458)
City of Corpus Christi
Feasibility MSA (Bond 2020)
City Contract No. 2853
LNV Project No. 180340.040
Task Order #4 – Letter Report: In Place Water Gardens Fountain Repairs

Dear Mr. Edmonds:

LNV presents this letter report in response to the City's request to LNV to detail and explain the issues associated with repairing the Water Gardens Fountain using the existing underground vault and the required improvements.

ORIGINAL DESIGN & EXISTING CONDITIONS

The *Water Gardens Fountain* ("fountain") was constructed in 1987. The fountain was designed with an underground vault installed on the east side of the fountain beneath the grass lawn to serve as the pump house for the fountain. The underground vault houses all the mechanical equipment and electrical controls that operate the fountain. The vault was designed underground in order to preserve the view corridor from the fountain to Corpus Christi Bay. Being underground, however, has subjected the vault to flooding for most of its existence.

The fountain and the underground vault are located within a 100-year floodplain with a flood depth of three (3) feet. Since its construction, the underground vault has flooded on numerous occasions causing the fountain to become inoperable. The vault is equipped with a sump and pumps, but the electrical controls that operate the sump pumps are located in the vault. When the electrical controls for the sump pumps fail, the pumps quit running and the vault is completely submerged causing a complete failure of all the fountain equipment. In addition to flooding from stormwater runoff, the vault also experiences water infiltration from an unidentified source that causes the vault to flood. Around the time of Hurricane Harvey in 2017, the vault was flooded, and the sump pumps stopped working for the last time. Since 2017, the vault has flooded on a daily basis from either stormwater runoff or the unidentified groundwater infiltration. In order to remove the water from the vault, City Parks Department staff has used portable dewatering pumps and hoses to pump the water from the vault into a nearby wastewater manhole.

The fountain was constructed prior to the current OSHA Standards of Safety. Per today's OSHA Standards, the vault is considered a "confined space". Since the vault floods frequently creating

a hazard to public safety, it is further classified as a “permitted confined space”. In accordance with OSHA standards, the vault should only be entered by personnel licensed for confined space entry and only with the appropriate safety equipment.

Access to the underground vault is extremely limited. Personnel access to the vault is accomplished through a small metal hatch at ground level and a near vertical ladder to the floor of the vault. The hatch and ladder create a hazardous condition for accessing the vault and limit the amount and size of equipment that can enter the vault. The only other access to the vault is through a large, concrete hatch in the ceiling. This hatch was used to bring the large equipment into the vault when it was originally constructed. It is unlikely that the hatch has been removed since initial construction. In order to access the concrete hatch, the roof of the vault must be excavated from above and large equipment must be used to remove the concrete hatch. This makes maintenance or replacement of equipment in the vault impractical.

The fountain has an upper and a lower basin. The fountain was designed to use split-case pumps as the main operational pumps. These pumps are fed directly by gravity drain lines coming from the lower basin of the fountain. This creates a “closed system” that prevents the lower basin from being drained. When the lower basin must be drained for maintenance, Parks Department staff must use portable dewatering pumps and hoses to pump the water from the lower basin into the upper basin, which can be drained using the sand filter discharge lines.

The fountain was designed with an overflow pipe from the lower basin to handle flooding from an extreme rain event. The overflow discharges into a nearby stormwater manhole. Current Texas Commission on Environmental Quality (TCEQ) rules require that discharge from the fountain be directed into the City’s wastewater system.

The fountain was designed to use two (2) 125 hp pumps running simultaneously to operate the main display, one (1) 50 hp pump to operate the waterfall, and one (1) 20 hp pump to operate the sand filter. No redundancy was designed into the fountain; so, if a pump goes down, the related portion of the fountain goes down.

REQUIRED IMPROVEMENTS TO THE EXISTING UNDERGROUND VAULT

In order to repair the fountain to operational condition using the existing underground vault, the following improvements are required:

1. All existing equipment and electrical controls must be removed from the vault;
2. The vault must be waterproofed, and the source of the infiltration should be identified and eliminated;
3. The vault sump must be demolished and reconstructed and must incorporate duplex sump pumps;
4. All mechanical equipment must be replaced with new equipment including, but not limited to, the pumps controlling fountain operation, the sand filter pumps, the sand filter system, other water quality management systems, valves, etc.;
5. New above-ground buildings must be erected to house new electrical controls and chemical treatment equipment, separately;

6. New HVAC or ventilation systems and gas detection systems must be designed and installed in the underground vault and in the new chemical building;
7. Access to the underground vault must be improved and protected from stormwater infiltration from rain events up to a 100-year storm; and,
8. The fountain overflow must be re-routed from the City storm sewer system to the City wastewater system.

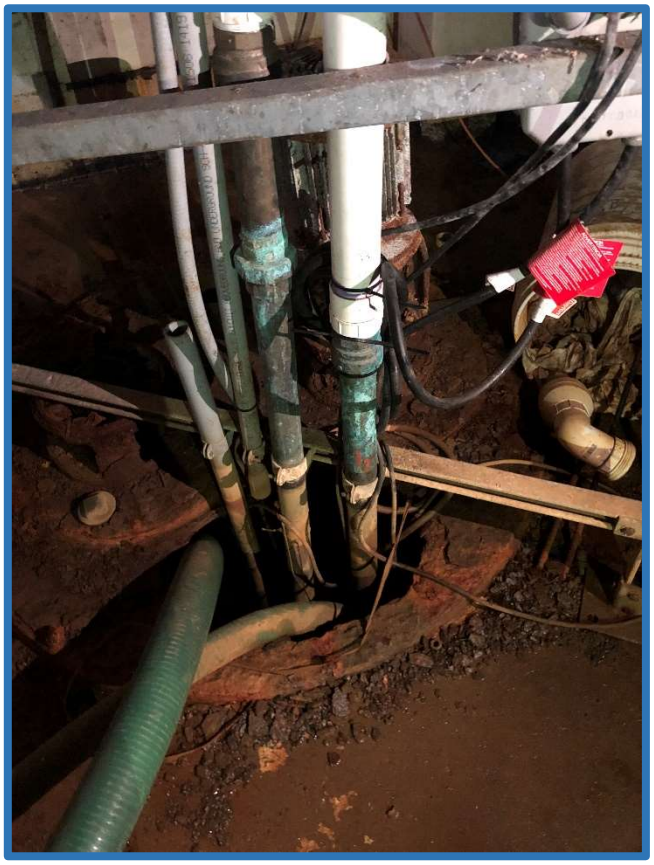
The following actions are required to accomplish the above-stated improvements:

1. The underground vault has essentially been under water continuously for the past two (2) years. All equipment and electrical controls are corroded and beyond repair and must be removed and replaced. The pictures below illustrate the water damage and corrosion of equipment on February 8, 2018.

Electrical Control Panel – Corrosion Indicates Water Level

Corroded Sand Filter Pump

Corroded Main Display Pump



Corroded Vault Sump (*)

(* The sump has been demolished since this picture in an attempt to identify and stop the inflow of water into the sump.)

2. Once all the equipment has been removed from the vault, the vault must be thoroughly cleaned and investigated for sources of infiltration. (Note: An asbestos survey of the vault has been performed, and no sources of asbestos were observed in the vault.) Excavation around the outer perimeter of the vault may be required in order to determine the source, or sources, of water infiltration. Identified sources of infiltration must be remedied. All excavations must be properly backfilled and restored to existing grades. The walls, floor and ceiling of the vault must be coated with an appropriate waterproofing membrane. The large, equipment access hatch in the vault roof must be waterproofed. The metal, personnel hatch must be replaced with a waterproof accessway.

3. Failure of the sump pumps to keep up with incoming flood waters is a significant factor, if not the major source, of past vault flooding. Either the pump electrical controls were shorted due to incoming water, preventing the pumps from running, or the pumps did not have the capacity to keep up with incoming flood water, which ultimately lead to water reaching the electrical controls and causing a short. Once the sump pumps stopped working, the vault would flood, inundating all the equipment. To try and prevent future flooding, the existing sump should be demolished and replaced with a new, larger sump. Duplex submersible pumps should be incorporated into the new sump, and the new pumps should be sized to individually handle a worst-case flooding event. Construction of the new sump should occur after sources of infiltration have been identified and eliminated and before waterproofing measures are employed in the vault. Electrical controls that operate the sump pumps must be located outside of the vault in a new, above-ground electrical control building. It should be noted that, because the vault is underground, the threat of potential flooding cannot be completely removed.

4. As stated in Item 1 above, all existing equipment in the underground vault is damaged beyond repair and must be removed and replaced with new equipment. In order to re-use the existing underground vault, the type of pumps and pump configuration must remain the same. This means the replacement pumps must be split case pumps and pump redundancy cannot be incorporated into the vault repairs. Split case pumps are known to be more expensive, less reliable, and have a higher O&M cost than other pump options such as submersible pumps. Lack of redundancy means that after repairs are made and the fountain is running again, the fountain will go down if any of the pumps fail and will remain down until the pump can be repaired or replaced. In addition to the new pumps, new equipment to be installed in the vault will include a sand filter, mechanical and electrically controlled valves, solenoids, and a UV sterilizer. It is anticipated that the new equipment will not take up as much space as the existing equipment, which will allow space for creation of personnel safety features such as eye wash and emergency shower stations.

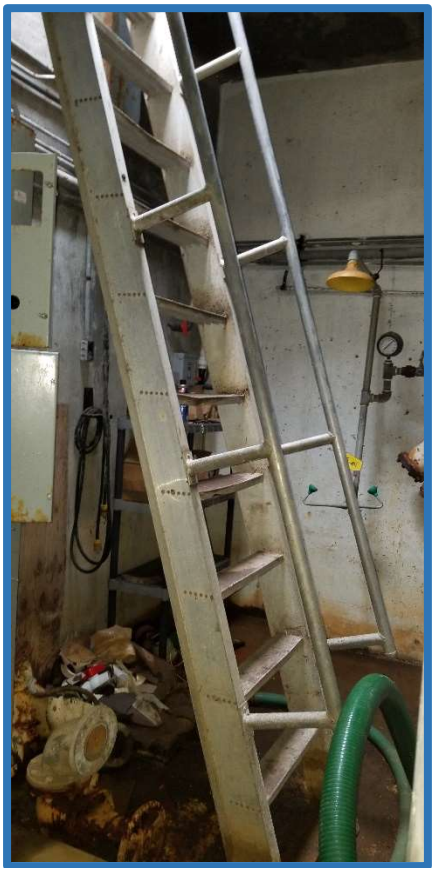
5. All the electrical controls for the fountain are currently located in the underground vault. Given the highly humid environment of the vault and the potential for flooding, all the new electrical equipment and controls must be located outside of the vault and in an elevated, electrical control building. The depth of water during a 100-year flood event in the fountain area is estimated to be three (3) feet above natural ground per FEMA. As such, the finish floor elevation of the new electrical control building must be a minimum of four (4) feet above natural ground. In addition to the electrical controls, all chemicals and chemical treatment equipment must be located outside of the vault. Removal of hazardous chemicals from the vault will reduce the severity of the confined space characteristics of the underground vault and improve the safety to personnel entering vault. The chemicals

and chemical treatment equipment, including the chlorinator and CO_2 pH controller, must be housed in their own separate enclosure and away from the new electrical equipment. The most economical approach to the elevated buildings will likely be prefabricated fiberglass or concrete buildings set on an elevated foundation. The most likely location for these buildings will be the northwest corner of the Selena Auditorium in the area currently occupied by the fountain power station.

6. The original design of the underground vault utilized two (2) 24" concrete pipes to ventilate air from the vault to the surface. The ventilation equipment consisted of large fans mounted on the vault wall over the ends of the 24" pipes. These fans have long ago deteriorated and stopped working, so there is currently no circulation of air in the underground vault. In order to re-use the underground vault, a new ventilation system must be designed and employed. At a minimum, the new ventilation system must include large fans capable of circulating the entire volume of air in the underground vault in a short period of time. The new electrical control building will require an HVAC system. As an upgrade to improve working conditions in the underground vault, an HVAC system could be designed to provide conditioned air to the electrical control building and the vault. The chemical building will also require a ventilation system. In addition to ventilation, the chemical room and the underground vault will require gas detection systems with alarms to alert personnel to the presence of any hazardous chemicals. The HVAC and ventilation equipment must be located outside the vault and above the reach of 100-year flood waters. The most likely location for this equipment would be on the roof or adjacent to the new electrical control building.

7. As previously mentioned, access to the underground vault is extremely limited. Personnel must enter the vault using a metal hatch at ground level and a steep ladder down to the floor of the vault. Access to equipment can only occur through the large, concrete hatch in the vault roof, which must be first excavated and then removed using large equipment. (See pictures on the following page.) One of the defining characteristics of a "confined space" is limited access. Although it is not possible to remove the classification of the vault as a "confined space", because it is underground with only one access point, access to the vault for both personnel and equipment should be improved. The personnel access should be improved to include stairs down to the vault. The stairs should be wide enough for two (2) people to access simultaneously. The extra width to the stairs will also allow personnel to carry large tools, or equipment, into the vault. A double-door, ground level hatch could be used to access the stairs if the hatch were waterproof. Another option would be to have the stairs exit onto an elevated, concrete foundation with a finish floor elevation at least four (4) feet above natural ground. A previous suggestion for an improvement to the Water Gardens area was to add a bandstand for outdoor concerts. An elevated bandstand could serve as an exit for the stairs that is above the elevation of the 100-year flood waters. To improve access to equipment for maintenance and removal/installation, a concrete collar should be constructed around the hole in the vault roof and extended to the surface. A double-door, ground level hatch could be installed at ground level. This improvement will eliminate the need to employ excavation equipment to access equipment in the vault. Large equipment will still be required to remove/install equipment in the vault. The ground level hatch must be waterproof to prevent stormwater runoff from entering the vault.

Ground Level Personnel Hatch



Ladder to Vault Floor

Concrete Equipment Hatch in Vault Roof

8. The existing fountain overflow discharges into the City's stormwater infrastructure via a storm manhole adjacent to the fountain. TCEQ regulations require that chlorinated waters from a public fountain be discharged into a sanitary sewer system. The overflow line from the fountain must be intercepted and connected to the City wastewater line running on the south side of the fountain.

COMPARISON OF WATER GARDENS FOUNTAIN REPAIR OPTIONS -

REUSE OF EXISTING, UNDERGROUND VAULT vs NEW, ABOVE-GROUND PUMP HOUSE

The new, above-ground pump house design addresses all the issues associated with reusing the underground vault mentioned in this report as shown in the table below.

ISSUE	EXISTING U/G VAULT	NEW ABOVE-GROUND PUMP HOUSE
Confined Space Classification	Yes	No
Protection from Flooding	Underground facility subject to potential flooding and reliant upon sump pumps.	Dock height facility above the 100-year flood elevation.
Ease of Access	Only one personnel access to vault via ladder or stairs. Only one equipment access requiring crane or other heavy equipment to remove or install equipment.	Above ground building with personnel doors and garage doors for accessing facility. Electrically controlled trolley on rail for removal/installation of equipment in sump. Pallet jack for moving equipment from dock height floor to flatbed truck.
New Equipment	Requires use of split case pumps. Requires separate, above-ground building for electrical, chemical, and HVAC equipment.	Allows use of submersible pumps, which are known to be more reliable and have a lower O&M cost than split case pumps. New pump house provides rooms for electrical controls, HVAC, and chemical treatment all in one building.
Equipment Redundancy	Provides no redundancy for fountain pumps. If a pump goes down, the fountain will be down until pump is repaired.	Provides an extra pump for the fountain display, waterfall, and sand filter. This allows the fountain to continue operation while a pump is being repaired. It also allows the pumps to be cycled to reduce wear and tear on the pumps.

ISSUE	EXISTING U/G VAULT	NEW ABOVE-GROUND PUMP HOUSE
Flood Control, Overflow, Maintenance Draining, and Chemical Treatment	Relies on an overflow pipe for flood control that must be re-routed from storm system to wastewater system. Requires manual pumping of lower basin into upper basin for maintenance draining.	The sump beneath the new pump building provides flood control of the fountain and the ability to drain both upper and lower basins for maintenance. Sump provides a convenient location for water quality sampling and dosing.

FOUNTAIN RESTORATION

The scope of improvements required for restoration of the actual fountain is the same for the underground vault option or the new, above-ground pump house option. The fountain itself requires concrete repairs, repairs to the staircases, installation of new electrical conduit and new LED lighting, and surface cleaning and resealing. The cost of those repairs should be on the order of $1 million.

GENERAL COST COMPARISON: NEW PUMP HOUSE vs U/G VAULT

The cost of the new, above-ground pump house option will be more than the cost of reusing the existing, underground vault, because the scope of improvements is larger. The increased scope of improvements associated with the above-ground pump house, however, includes significant improvements to fountain reliability, ease of access and maintainability, and longevity of the Water Gardens Fountain. The total construction cost of the new, above-ground pump house option, including fountain restoration measures listed above, is estimated to be on the order of $5 to $7 million.

The cost of restoring the underground vault will not be inexpensive. The scope of equipment improvements for the underground vault option is similar to that of the above-ground pump house, excluding the redundant pumps. The sand filter, UV sterilizer, chlorinator, and pH controller are the same. The split case pumps in the underground vault will cost more than the submersible pumps used in the above-ground pump house option. The HVAC, ventilation and gas detection systems for the underground vault will cost the same as, if not more than, those for the above-ground pump house, because they are in separate locations from the underground vault. The construction cost of required mechanical improvements for the underground vault should be on the order of $1 to $2 million. The cost of electrical improvements required to restore the underground vault will also be very similar to the above-ground pump house option with an estimated construction cost on the order of $0.5 to $1 million. The structural improvements and waterproofing measures required of the underground vault are estimated to have a construction cost on the order of $1 to $2 million. The total cost of restoring the underground vault, including fountain restoration measures, is estimated to be on the order of $3.5 to $6 million – subject to change dependent upon final design.

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CONCLUSIONS

The cost of repairing the Water Gardens Fountain with a new, above-ground pump house may be more than repairing the fountain using the existing underground vault, but the end result is a restored City landmark that is:

- More Reliable;
- Not Subject to Flooding;
- Cost Less to Operate;
- Costs Less to Maintain;
- Easier on City Staff to Maintain; and,
- Provides a Longer Extended Life for the Fountain.

If the Water Gardens Fountain is repaired by reusing the existing underground vault, the City will still spend millions of dollars on repairs, and the end result will be a restored fountain that is:

- Less Reliable;
- Costs More to Operate;
- Costs More to Maintain;
- Significantly Harder on City Staff to Maintain; and,

has a pump house that is:

- Still Classified as a Confined Space;
- Still Difficult to Access; and,
- Still Has the Potential for Flooding and Fountain Down Time.

If you have any questions or if you would like to discuss in more detail, please contact D. Scott Jones, P.E., or myself, at 361-883-1984.

Sincerely,
LNV, LLC.
TBPE Firm No. F-366

D. Scott Jones, P.E.
Public Works Group Leader

DSJ/dsj