Attachment D

Memo

Date:	Thursday, October 30, 2014
Project:	Betasso WTF CIP
To:	Gary Fuller, Jennifer Stillman
From:	Vince Fallon
Subject:	Architectural SWAT Condition Assessment

This memorandum includes a tabulation of architectural observations made on Monday, October 20, 2014 at the Betasso WTF during the SWAT Condition Assessment.

The following Work Area Categories are used to identify the area of the facility for each item:

1. Administration Area
2. Operators and Maintenance Area (includes: lime room, microstrainer room, maintenance shop)
3. Filter Room
4. E-Tech Room
5. Pipe Gallery
6. Floc/Sed Basins
7. Pump Building (houses washwater pumps and filtrate pumps and small generator)
8. DAF Building / SBE Basin (Spent Backwash Equalization - buried)
9. Chemical Building (includes: sodium hypochlorite, alum, fluoride, scrubber room, PAC room)
10. Residuals Lagoons and Drying Beds
11. Raw Water Vaults (includes MOCVAL vault and others)
12. Outdoor Equipment (includes: CO2, propane tanks, generators, electrical gear, oil water separator, etc.)
13. Outdoor Tanks (includes Backwash, Clearwells, and Filtrate)
14. Building Exterior and Roof

A chronology of major plant improvements is as follows:

1962 – Original plant construction

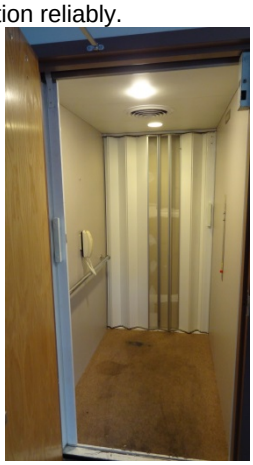
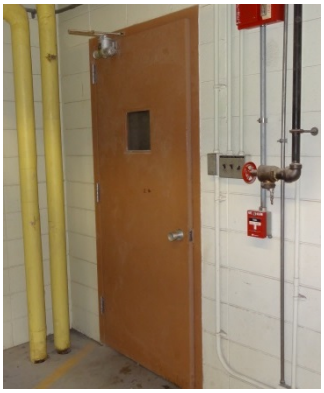
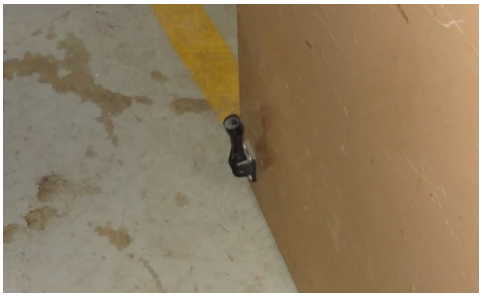
1976 – Plant expansion

1992 – Chemical Feed Building, Lime Storage and Clearwell additions

1994 – Administrative and Maintenance additions

1999 – Pretreatment improvements and DAF Building addition

ITEM	WORK AREA CATEGORY	CONDITION
Administration Area lobby and stair	1	Interior finishes are dated and worn. Railings do not meet current code requirements for a space accessible to the general public. Open riser stairs are no longer allowed by Code for means of egress stairs on an accessible route.

Administration Area wheelchair lift	1	Wheelchair lift providing accessible route from lobby up to Filter Room level and Administration Offices is in disrepair and does not function reliably. 
Operators and Maintenance Area Chemical and Lime Storage	2	Fire-rated doors do not self-close and latch as required by Code. 
Operators and Maintenance Area Chemical and Lime Storage	2	Fire-rated doors have hold-open devices installed in violation of Building and Fire Codes. 

Operators and Maintenance Area Pilot Plant area	2	Openings cut in wall of former microstrainer tanks are not flush with adjacent floor, creating a trip hazard in the means of egress.
Operators and Maintenance Area	2	Ships ladder from Pilot Plant room down to Maintenance Shop does not have an adequate landing at top. Safety chains across opening do not provide OSHA compliant fall protection.

Operators and Maintenance Area	2	Freight elevator was reported by plant staff to not operate reliably. Elevator equipment is located in Pipe Gallery, rather than a dedicated machine room. Cold temperatures adversely affect operation of elevator hydraulics. If the elevator is replaced, it will be required to have a separate dedicated elevator equipment room with heating and cooling.

Operators and Maintenance Area	2	Windows in small staff kitchen do not appear to be adequate for cold temperatures and high winds experienced. Damaged glazing was observed and plant staff report dust infiltration and excessive vibration during wind events.
Operators and Maintenance Area	2	Partitions and openings separating the lime slaking room from the adjacent areas do not appear to be of appropriate rated construction as would be required for a hazardous occupancy. Bringing the Lime Room up to current code for hazardous occupancy classification would have a significant impact and cost.

Filter Room	3	Filter cells are not provided with adequate fall protection. "Safety chains" do not meet OSHA requirements for fall protection.
Filter Room	3	Several doors swing into the corridor, encroaching on the required clear width for a means of egress path.

Filter Room	3	Egress doors from Filter Room do not open onto a code compliant landing and do not provide an appropriate path to a public way.
Pipe Gallery Stairs	5	Piping and equipment has been installed in such a manner as to encroach on the means of egress path.
Pipe Gallery	5	Drainage from the Flocculation/Sedimentation drive areas spills onto the stairs creating a slip hazard.

Pipe Gallery	5	Egress stairs exceed the allowable rise for a single flight (12' maximum). Stair rise and run and stair railings are not in compliance with current codes.

Pipe Gallery	5	Varying degrees of corrosion was observed on piping and appurtenant surfaces. Condensation was evident on most piping.

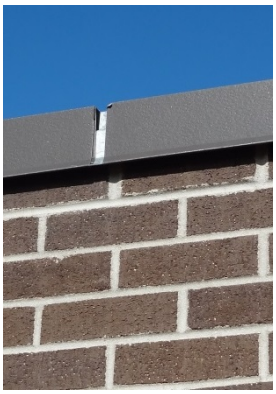
Pipe Gallery	5	Entrances at top of ships ladders should be protected with a self-closing gate in order to meet OSHA fall protection requirements.
Pipe Gallery	5	Plant staff does not have adequate access to piping and valves at upper level of Pipe Gallery. A need was expressed for ladders, platforms and/or catwalks as necessary to provide safe access to piping and valves for maintenance.

Flocculation and Sedimentation drives	6	Drive areas are very congested and do not have an easily discernable egress path. Motors and equipment components obstruct the egress path.

Pump Building	7	Pump Building exterior is generally in good condition, needing minor masonry repairs and tuckpointing. Doors showed some degree of corrosion, but appeared to function adequately.

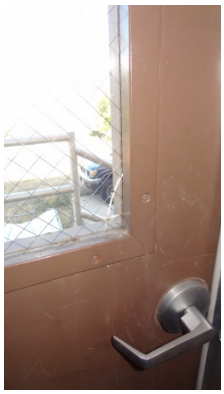
Pump Building	7	Grout at head of east door has deteriorated.
Pump Building	7	Interior surface of walls showed evidence of moisture accumulation and efflorescence. This could be an indication that the room needs better ventilation/dehumidification or it could also indicate inadequate heating and/or cooling. The efflorescence appears to be purely cosmetic at this point, but it should be removed and repainted to negate any long-term impacts.

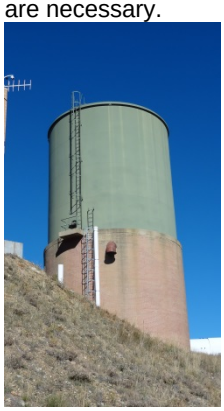
Pump Building	7	Access to and egress from washwater recovery pit is blocked by pumps and piping. Ladders are not in compliance with OSHA standards. Safety chain does not meet OSHA requirements for fall protection - ladder openings should be protected with a self-closing gate.
Pump Building	7	Overhead door at generator room is showing significant deterioration from weathering. (It is unknown, whether the door is functional.) At a minimum, the door should be repainted. The preferred option is to replace the door with an insulated aluminum overhead door.

DAF Building	8	Openings to ladders should be protected with a self-closing gate. Safety chain does not meet OSHA requirements
DAF Building	8	Ships ladder at DAF tank leads to grating platform without fall protection, presenting both a fall hazard and a confined space concern.
DAF Building	8	Coping at roof perimeter does not have splice plates correctly installed and shows evidence of probable wind damage. Exterior masonry appears to be in good condition 

DAF Building	8	Roof was not accessible for observation. Refer to Betasso Roof Assessment report for additional information.
Chemical Building	9	Exterior masonry appeared to be in generally good condition with minor cracking and mortar degradation noted. Concrete appeared to be in good condition with minor shrinkage cracking at construction joints.
Chemical Building	9	Entrances to infrequently used stairs should be protected with a self-closing gate in accordance with OSHA standards.

Chemical Building	9	Ladders at roof hatches should be equipped with telescoping extension safety posts to facilitate access to and from ladder. Roof hatch openings should be protected with an OSHA compliant railing system to protect unattended openings.
Chemical Building	9	Coping was observed to have several missing or improperly installed splice plates at joints, leaving the system susceptible to wind damage and/or water intrusion.
Chemical Building	9	Roofing pavers are generally in good condition. Refer to Betasso Roof Assessment report for additional information.

Chemical Building	9	Wired glass in egress doors does not meet current Building Code requirements and poses a serious safety hazard. Glass meeting impact requirements of CSPC 16 CFR 1201 should be provided wherever safety glass is required by current Codes. 
Chemical Building	9	Configuration of piping and equipment does not provide safe access to tank access ladders.
Raw Water Vaults	11	Due to the potential for oxygen displacement, the vaults should be considered permit required confined spaces. Investigate OSHA compliant signage and additional measures as appropriate to meet the OSHA requirements.

Clearwells	13	Clearwell tanks showed evidence of coating degradation and physical damage. Observation of interior of tanks was not performed. Repainting of tanks is recommended. Refer to structural observations for additional information on physical damage.
Backwash supply tank	13	Steel backwash tank coating showed evidence of coating degradation. Masonry base showed significant masonry deterioration. Cleaning, masonry repairs and tuckpointing are necessary. 

Main Plant Exterior and Roof	14	The brick masonry on the 1962 and 1976 areas of the main plant were generally in good shape with isolated areas of mortar degradation. Need for repair and restoration of mortar and sealants at cast stone sills was evident.

		Several areas of moderate to significant masonry degradation were observed on the 1994 additions, especially at the administration area. Repairs and tuckpointing will be required.
Main Plant Exterior and Roof	14	Areas of damage to the EIFS façade were observed. Repairs will be necessary to restore the weather tightness of the façade.

Main Plant Exterior and Roof	14	Plant staff indicated that the metal stair structure from the Pilot Plant area becomes very icy and slippery during the winter months. Measures to protect the stairs from weather, such as screening or a canopy should be considered.
Main Plant Exterior and Roof	14	A cursory review of the various roof areas was performed. Refer to Betasso Roof Assessment report for additional information.
Main Plant Exterior and Roof	14	Some areas of flashing failure were noted at the EPDM membrane over the 1976 building addition.

Main Plant Exterior and Roof	14	The roof walkway pads are beginning to lose adhesion, posing a potential tripping hazard. Loose pads should be replaced.
Main Plant Exterior and Roof	14	Punctures and physical damage were observed on the KEE roofing at the 1962 low roof.
Main Plant Exterior and Roof	14	The ladder to the maintenance addition was not properly fabricated for the field conditions and was not installed appropriately. The ladder has been fastened to the adjacent wall and cast stone sill, damaging the masonry. Ideally, the ladder should be replaced with a cross-over stair since there is not enough room for adequate attachment of a ships ladder.

Main Plant Exterior and Roof	14	Areas of damaged and/or deteriorating pavers were observed on the Administration roof. Damaged pavers should be replaced.
Main Plant Exterior and Roof	14	The ladder access to the Administration roof was not properly coordinated at the time of installation and results in an unsafe condition for accessing and entering the ladder. It should be possible to modify and reinstall the ladder.

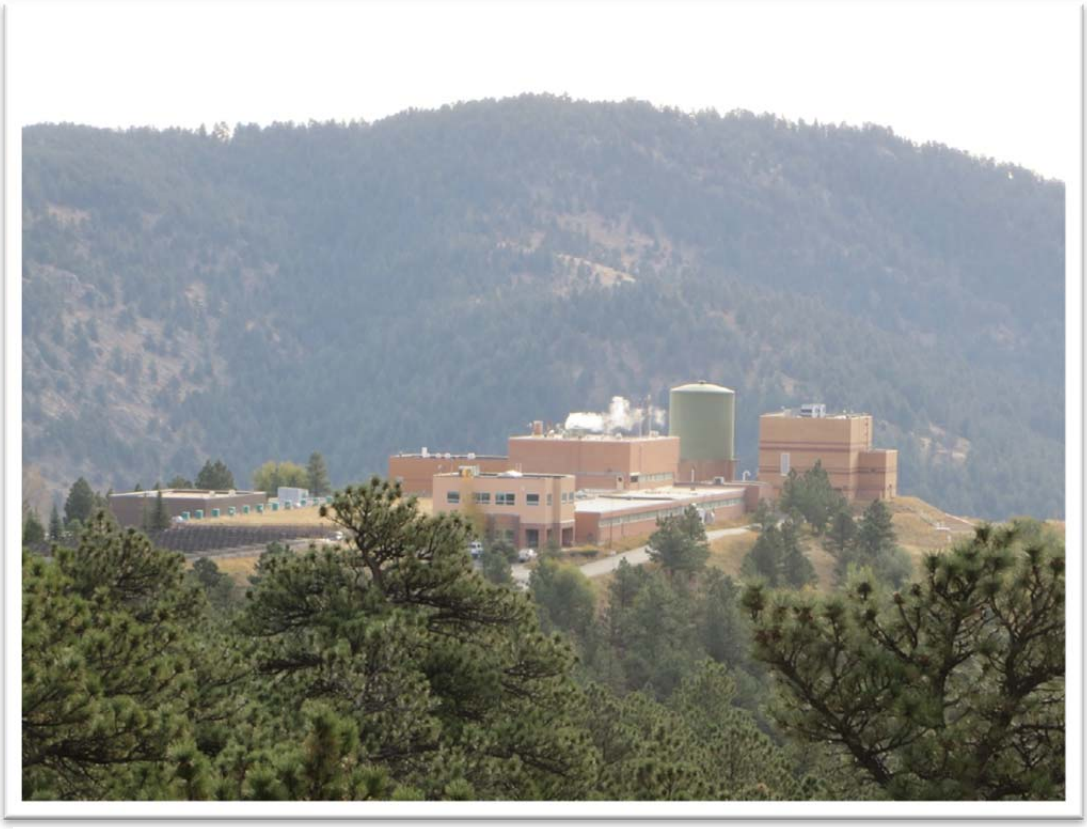
Memo

Date:	Friday, October 24, 2014
Project:	Betasso WTF CIP
To:	Gary Fuller, Jennifer Stillman
From:	Richard Thornton
Subject:	Site Civil and Stormwater Management SWAT Condition Assessment

Observations of site civil and stormwater management conditions within the site are based on a site visit on October 31, 2014 attended by Steve Buckbee, Gary Fuller and Steve Folle, and are tabulated in this memorandum. A photo log and accompanying photo log site map are included in the appendix of this SWAT Memo.

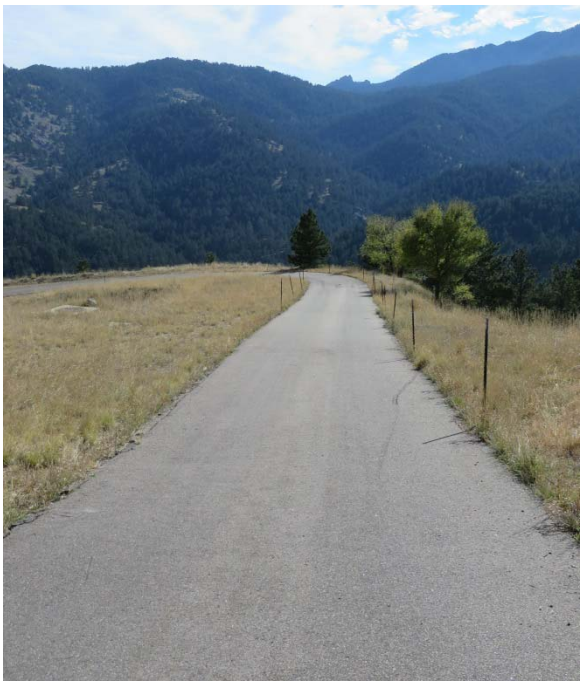
The following Work Area Categories are used to identify the area of the plant for each item:

C-1. Oil/Water Separator and Lift Station – Access Road Erosion
C-2. Oil/Water Separator and Lift Station – Stormwater/Grey-water Separation
C-3. Finished Water Storage Reservoir – Access Road Drainage and Surface Ponding
C-4. Finished Water Storage Reservoir – Access Road Safety
C-5. Sludge Lagoon – Surface Drainage Entering South Lagoon
C-6. Residual Storage/Drying Beds – County NPDES Coordination



Betasso WTF site is situated on a hill top making control of off-site stormwater discharges a key site civil component.

ITEM	WORK AREA CATEGORY	CONDITION
Oil/Water Separator and Lift Station – Access Road Erosion	C-1	Issue: The access road surface is steep (8% +/-) and is treated with mag-chloride to help improve wet-weather stability. Erosion observed is along the north road edge, at the road-vegetation interface. Geoweb installation was visible at the bottom of the road slope due to erosion. Vehicular access is not a regular occurrence to the oil/water separator or lift station and, as such, an asphalt surface is not warranted. Recommendation: Fill eroded area with 4" D50 riprap and granular bedding keeping the top of stone below the road edge as to not prohibit runoff from sheeting off the road surface and into the riprap shoulder.
Oil/Water Separator and Lift Station – Stormwater/Grey-water Separation	C-2	Issue: Stormwater and grey-water (faucets, floor drains, etc) from within the WTF are conveyed to the oil/water separator and then pumped via the lift station to the WTF lagoons and drying beds. These flows reduce the capacity of the lagoons and residual handling process and therefore, it is desirable to remove the stormwater volume from this discharge. Several stormwater sources were observed in the vicinity of the Hydro Building and lab/operator shop where roof drains discharge to the surface and are intercepted, along with surface drainage, by area inlets, which ultimately discharge to the oil/water separator. These roof drains and inlets are documented on the Photo Log and accompanying Photo Log Site Map. Recommendation: Develop site specific SWMP to address stormwater pollution prevention via catch basin covers at loading dock during deliveries and other housekeeping BMPs. Intercept the storm drain line to the oil/water separator (at the intersection of the oil/water separator access road and the finished water storage tank road) and construct a new storm drain running east down along the north side of the storage tank road. Construct a new oil/water separator south of the storage tanks with a new stormwater only outfall. Note this Recommendation should be integrated with Work Category C-3 Finished Water Storage Reservoir – Access Road Drainage and Surface Ponding.

Finished Water Storage Reservoir – Access Road Drainage and Surface Ponding	C-3	Issue: A berm was constructed along the east of the storage tanks along the east edge of the access road to mitigate uncontrolled off-site discharge of stormwater. This has resulted in runoff ponding along the access road following storm events and during spring snow melt. Runoff will pond in two distinct locations (see photo log, IMG_0970 and IMG_0971) along the access road and eventually seep into the existing communication vault(s) through the vault access hatches. Runoff from within the vaults is discharged by gravity via a small (6-inch +/-, see photo log, IMG_0969) drain pipe that projects out of the hillside, east of the access road and berm. Recommendation: Construct a small local drainage system that collects surface runoff and conveys it to a new oil/water separator and stormwater outfall (see Work Category C-2). It is envisioned that the local drainage system will address nuisance flows only to remove frequent ponding and discharge into the communication vault(s). Consider installing water-tight hatches on the communication vaults in addition to the local drainage system Recommendation.
Finished Water Storage Reservoir – Access Road Safety	C-4	Issue: The steep storage tank access road, relatively sharp left-hand turn at the bottom of the slope, and steep drop-off at the access road edge creates safety concerns during the winter for vehicle and plow access to the storage tank area.  Recommendation: Install approximately 150-feet of CDOT Type 3 W-beam Guard Rail along the outside edge of the access road to improve safety.

Sludge Lagoon – Surface Drainage Entering South Lagoon	C-5	Issue: Stormwater runoff enters the south lagoon from sheet flow off the steep hillside to the south as well as from roof drain discharge from the filter building/settling basin roof top (see photo log, IMG_0978). This surface water volume reduces the capacity of the lagoons and therefore, it is desirable to remove the stormwater volume from this discharge. Recommendation: Construct a 12" high (+/-) concrete curb, doweled into the existing concrete liner, at the top of the lagoon and adjacent to the vegetated hillside. Behind the curb/stem wall, install a slotted HDPE/PVC drain pipe encased in drain rock to collect hillside runoff and convey it around the lagoon with discharge to the north. The roof drain discharges on the hillside south of the lagoons and east of the lagoon control/slide gates (see photo log, IMG_0977). Extend the roof drain discharge pipe north and east under the lagoon access road to discharge north of the access road and lagoons. A flow spreader and riprap pad should be constructed at the new discharge location to mitigate potential for erosion.

Residual Storage/Drying Beds – County NPDES Coordination	C-6	Issue: The dry bed facility consists of a concrete pad, concrete wall, and berm to contain and dry residuals. The County has voiced concerns that the drying bed containment could be breached through wall/berm failure or overtopping during storm events, which would result in sediment discharge off the facility site. Controlling sediment discharges and water quality associated with construction, post-construction, and facility operations is an aspect of the County's NPDES MS4 permit. It was observed, during the site visit, that a significant grass buffer exists between the residual storage and property line, along the west and south sides of the area. This grass buffer can act as a best management practice (BMP) to reduce sediment discharge, if properly maintained. Maintenance would include maintaining existing vegetation and removal of sediment/residuals if spillage did occur. Between the residual storage area and the facility access control gate/fence, the grassed berm decreases in elevation creating a low point where there is the potential for residuals and sediment to be discharged off-site during storm events. Similarly, the WTF entrance road has a culvert (see photo log) with the inlet immediately adjacent to the residual storage area and dirt access road. The culvert and WTF entrance roadside ditch adjacent to the dirt access road has the potential to receive sediment and convey it off-site through the culvert during storm events. Recommendation: Extend the grass buffer and berm to the facility access control gate/fence as an extension of the existing BMP to reduce risk of sediment being conveyed off-site. Improve the berm adjacent to the dirt access road and WTF entrance roadside ditch to reduce the risk of sediment being conveyed off-site through the culvert. Develop a site specific stormwater management plan (SWMP) / stormwater pollution prevention plan (SWPPP) for the facility and coordinate preparation of the plan with the County. The SWMP should address management of residuals and containment of sediment, identification and mapping of stormwater systems and outfalls, identification of erosion control measures at stormwater outfalls, good housing-keeping BMPs already in place as well as those proposed with Work Category C-2 and C-3 recommendations.

Betasso WTP Facility Assessment

Photo Log

Civil and Stormwater Site Assessment

10/31/2014

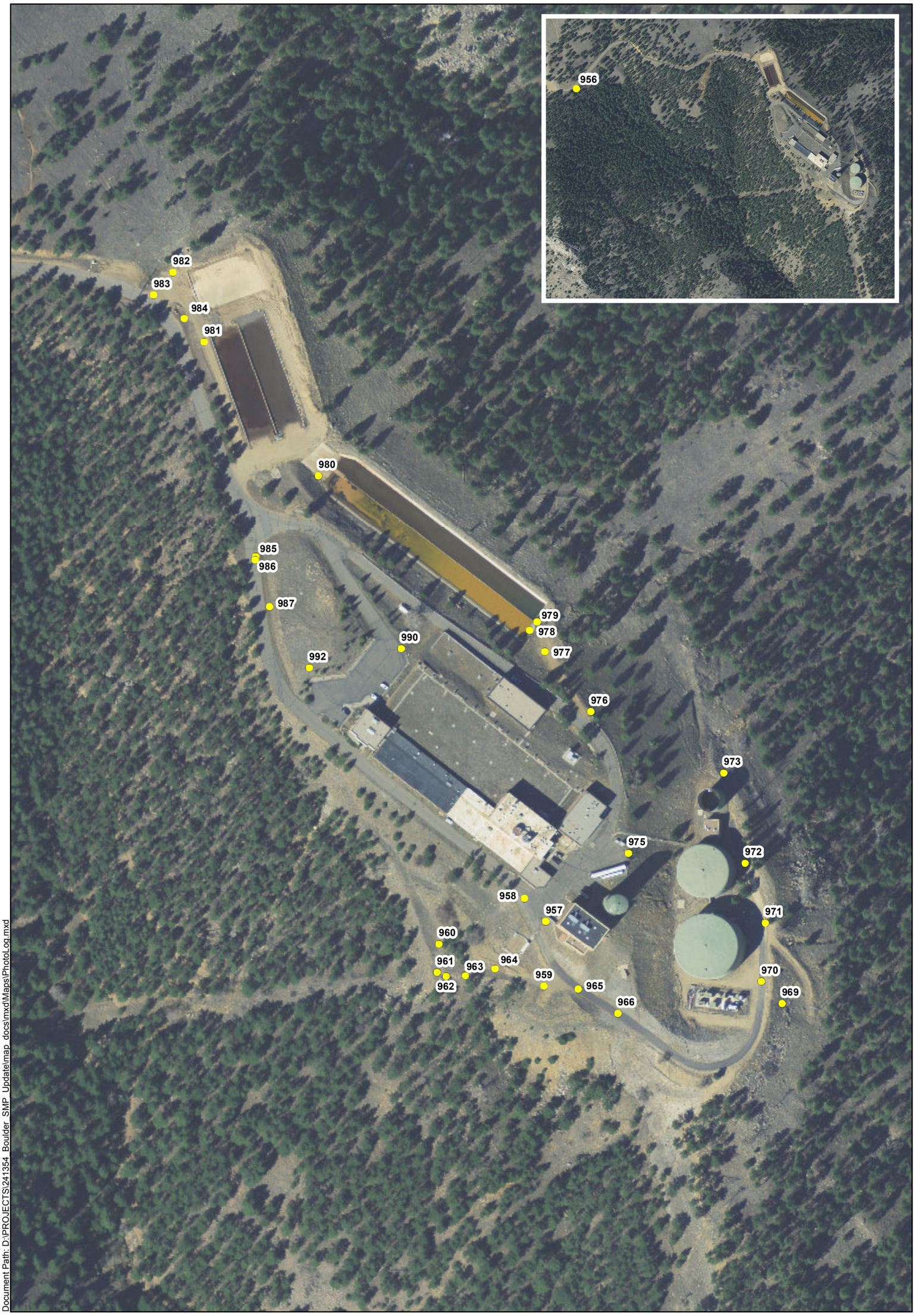


Photo Location (Oct. 31, 2014)

0 75 150 Feet

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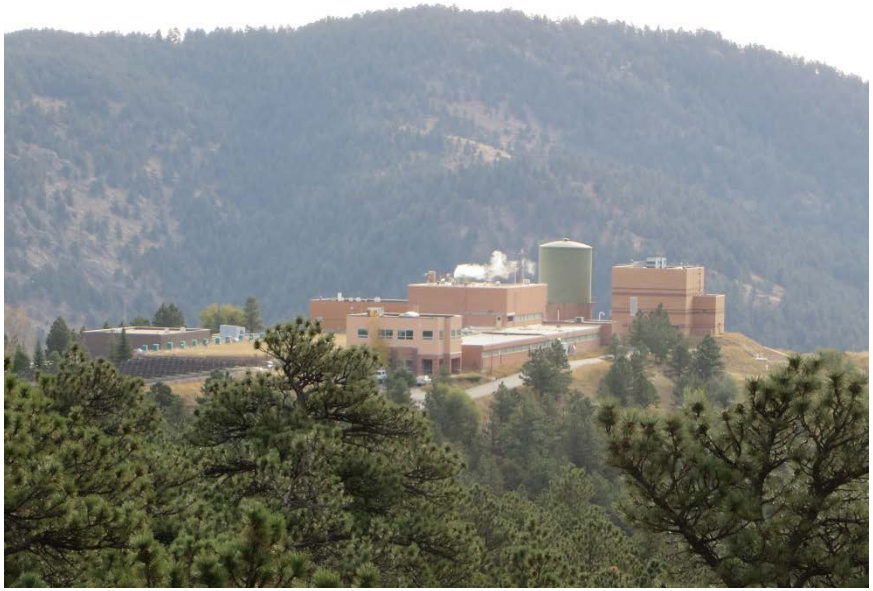
Betasso WTP CIP

Civil and Stormwater Site Assessment Photo Log



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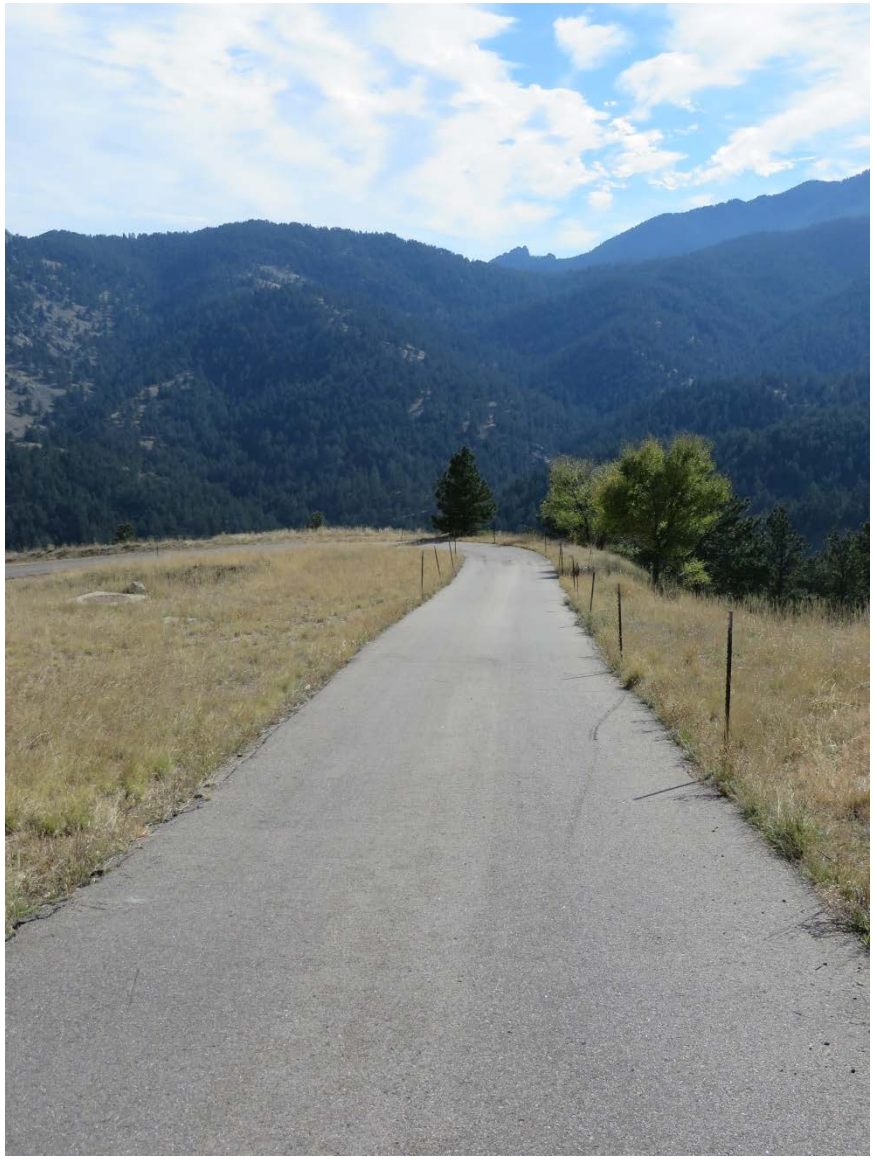

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Memo

Date:	Friday, October 24, 2014
Project:	Betasso WTP CIP
To:	Gary Fuller, Jennifer Stillman
From:	Travis Moore
Subject:	Electrical and I&C SWAT Condition Assessment

This memorandum includes a tabulation of electrical and I&C observations made on Monday, October 20, 2014 at the Betasso WTF during the SWAT Condition Assessment. A Power Distribution Functional Diagram showing the facility power distribution system in schematic form is attached to this memo for reference (Note - diagram is under development).

The following Work Area Categories are used to identify the area of the facility for each item:

1. Administration Area
2. Operators and Maintenance Area (includes: lime room, microstrainer room, maintenance shop)
3. Filter Room
4. E-Tech Room
5. Pipe Gallery
6. Floc/Sed Basins
7. Pump Building (houses washwater pumps and filtrate pumps and small generator)
8. DAF Building / SBE Basin (Spent Backwash Equalization - buried)
9. Chemical Building (includes: sodium hypochlorite, alum, fluoride, scrubber room, PAC room)
10. Residuals Lagoons and Drying Beds
11. Raw Water Vaults (includes MockVeld Vault and others)
12. Outdoor Equipment (includes: CO2, propane tanks, generators, electrical gear, oil water separator, etc.)
13. Outdoor Tanks (includes Backwash, Clearwells, and Filtrate)

General Observations:

1. In general, the electrical distribution equipment in the facility is either in good condition and can be expected to provide good service into the future, or is beyond the end of its expected service life and should be scheduled for replacement.

2. The facility power distribution system is illustrated on the Power Distribution Functional Diagram. The facility receives 480V power through two transformers, each of which is powered from a switch in the cogeneration switchyard. The older transformer and associated switchboard in the East Yard were running at about one-third of their capacity at the time of observation. The newer transformer and associated switchgear at the DAF area are about twice the size of the East Yard equipment, and were also running at a fraction of their capacity at the time of observation. (The transformers and associated distribution gear are described in more detail in the assessment table below.) This arrangement makes central standby power generation difficult, and places the larger facility electrical load on the older/smaller equipment while the smaller facility electrical load is placed on the newer/larger equipment. The DAF-area equipment appears to have been designed to become the main facility power distribution equipment. The DAF-area equipment could accommodate the full facility electrical load, which would enable removal of the aging East

Yard equipment and implementation of central standby power generation if needed. The DAF-area equipment is also arranged to be expandable in case a dual-feed power distribution arrangement is desired.

3. The Siemens MCCs installed in approximately 1992 appear to be in good condition. However, this Siemens product line is no longer manufactured. Therefore, replacement components may become more difficult to obtain in the future and may need to be obtained from aftermarket sources.

4. The electrical system in the facility has evolved over 50+ years and now has elements installed at times ranging from the original facility construction through the most recent upgrade projects. Older elements of the core electrical systems should be replaced to enable confident facility operation into the future. Key elements to consider replacing or upgrading include:

    - "Trunk" power circuits and raceways
    - Distribution panelboards and motor control centers
    - Standby power generation systems

    In some cases, replacement elements may need to be constructed prior to the items being replaced to maintain continuous facility operation. Electrical upgrade items can be coordinated with other facility upgrade projects to reduce overall disruptions to facility operations.

5. Power meters on the electrical equipment installed in approximately 2000 are generally not working. Older electrical equipment does not have power meters. Installing additional meters will improve the ability to track which equipment and processes are consuming energy. First priority should be major power buses, followed by smaller equipment. If very specific information is desired, "smart" power distribution and motor control equipment can be specified when electrical equipment is replaced, which can enable monitoring on a machine-by-machine basis. Power metering should be arranged to support the facility's monitoring and energy conservation programs.

A chronology of major electrical installation events is as follows:

1962 – MCC in original Filter Building installed

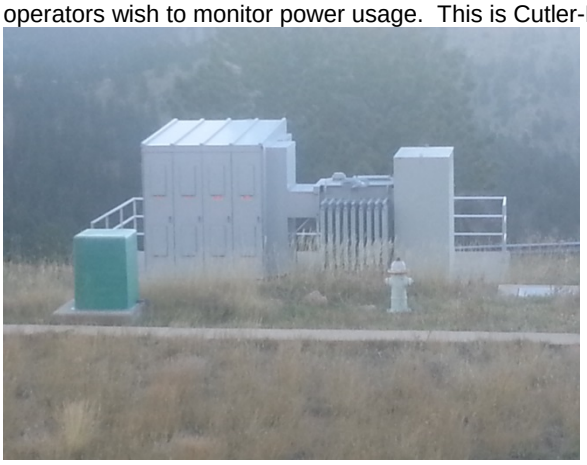
1976 – Original MCC modified into MCC-A and MCC-EA. Switchgear in yard and pad-mounted transformer installed. MCC-B and MCC-C installed. 100kW generator and 225A transfer switch installed.

1992 – Original MCC-A and MCC-EA removed and replaced with new MCC-A and MCC-EA. MCC-C modified into MCC-C and MCC-EC. MCC-D installed. New 600A breaker probably scabbed onto the outdoor switchgear to power new MCC-A. ATS and generator relocated from Filter Building to Pump Building. New 400A ATS and 250kW generator installed at Filter Building.

1999 – Outdoor unit substation installed next to DAF building. MCC-E installed in DAF Building. MCC-F installed in Chemical Building.

2012 – Generator in the Pump Building replaced.

ITEM	WORK AREA CATEGORY	CONDITION
Main Switchgear (East Yard)	12	This 800A outdoor switchboard is powered from an adjacent 500kVA pad-mounted transformer, which is in turn powered from a fused switch in the medium-voltage switchyard below the hydropower plant. Inspection showed that the switchboard was operating at approximately 200A at the time of the site visit. (Note: the transformer/switchboard combination has a useable capacity of approximately 600A; therefore, the electrical loads served from this switchboard were about one-third of capacity.) The switchboard has had an after-market circuit breaker installed in a separate enclosure attached to the outside of the switchboard. The switchboard and transformer were installed in approximately 1976 and are therefore nearly 40 years old. The enclosure shows significant rust and corrosion. This equipment should be replaced. This switchboard is GE "AV-Line".

Main Switchgear (DAF area)	12	The switchgear lineup outdoors near the DAF is a secondary unit substation powered from a fused switch in the medium-voltage switchyard below the hydropower plant. The unit substation includes a primary terminal box, 1000kVA dual-temperature rated step-down transformer with auxiliary cooling fans, and walk-in 1600A switchgear assembly, and was installed in approximately 2000. All of this equipment is in good condition. The power meter on the switchgear is not functional, and could be replaced if plant operators wish to monitor power usage. This is Cutler-Hammer equipment. 
MCC-A / MCC-EA	3 (Electrical Room)	MCC-A and MCC-EA are located along a wall in the Electrical Room across the hallway from the Filter Room. These MCCs are connected by an automatic transfer switch, so that MCC-EA has standby power available. These MCCs were installed in approximately 1992 and are in good condition. These MCCs are Siemens “Model 95”.

MCC-B	3 (Electrical Room)	MCC-B is a back-to-back MCC lineup located in the center of the Electrical Room across the hallway from the Filter Room. This MCC was installed in approximately 1976, and is therefore nearly 40 years old. This MCC has been modified several times through several plant projects. Replacement parts are still available from GE and from aftermarket suppliers, but the overall MCC is showing its age. This MCC should be replaced. This MCC is GE “7700 Line”.
MCC-C / MCC-EC	7	MCC-C and MCC-EC are located in the Pump Building. These MCCs are connected by an automatic transfer switch, so that MCC-EC has standby power available. These MCCs were installed in approximately 1976 and are therefore nearly 40 years old. These MCCs have been modified several times through several plant projects. Replacement parts are still available from GE and from aftermarket suppliers, but the overall MCC is showing its age. This MCC should be replaced. These MCCs are GE “7700 Line”.
MCC-D	9	MCC-D is located in the Electrical Room of the Chemical Building, and was installed in approximately 1992. This MCC is in good condition.

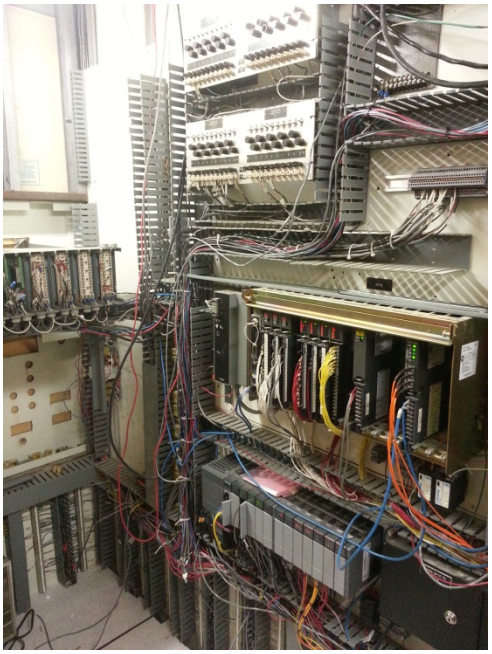
MCC-E	8	MCC-E is located in the DAF Building and was installed in approximately 2000. This MCC is in good condition. The power meter is not working, and could be replaced if operators wish to monitor power usage at this location. This MCC is Cutler-Hammer “Freedom 2100”.
MCC-F	2	MCC-F is a small MCC located near the lime silos on the upper level of the Filter Building. This MCC was installed in approximately 2000 and is in good condition. The power meter is not working, and could be replaced if operators wish to monitor power usage at this location. Given the relatively small loads carried by MCC-F, the replacement power monitor could be a simpler model with fewer features than the existing IQ Analyzer model. This MCC is Cutler-Hammer “Freedom 2100”.

Generator (south of Filter Building)	1	The diesel-powered engine generator on the south side of the Filter Building provides standby power to MCC-EA through the associated automatic transfer switch. The generator was installed in approximately 1992. Visual inspection could not accurately determine the condition of the mechanical components, but the run time on the meter was 790 hours as of the date of observation. This is a common magnitude of runtime for standby generators of this age, resulting from testing and exercise as well as power outage events. The sub-base fuel tank shows fuel/grease residue on the exterior, which should be cleaned off to facilitate inspection for leaks or corrosion. Interior inspection of the tank was not possible. It is recommended that a generator technician from either the generator manufacturer (Kohler) or a third-party firm provide an opinion on the mechanical condition of the generator and sub-base fuel tank. The generator housing is in moderately poor condition, showing rust and poorly-fitting doors. The original door latches apparently do not work, and extra latches have been retrofit to the enclosure to keep the doors closed. This generator is a Kohler unit, with a Detroit Diesel engine.
Transfer Switch (Filter Building)	3 (Electrical Room)	The transfer switch in the Filter Building Electrical Room switches the power to MCC-EA between normal power and standby power. This transfer switch was installed in approximately 1992 and is in good condition.

Generator (Wash Water Pump Bldg.)	7	The generator in the Pump Building is nearly new. It had 119 hours of runtime as of the date of observation. Plant personnel noted that most of the runtime was accumulated during flood events in the fall of 2013. The generator is fueled from a small floor-mounted tank located adjacent to the generator. This is a Kohler generator and is in good condition.
Panelboards	General	There are a number of panelboards in the facilities that are beyond the end of their service life. The installation date is not easily determined, but they are likely from either original plant construction in approximately 1962 or the plant expansion in 1976. These panels are a brand that is presently uncommon and obtaining replacement parts may be difficult. The circuit breakers are aging, and may not have adequate short circuit interrupting current ratings for application on present-day electrical systems (i.e. the circuit breakers may not be able to safely open if there is a short circuit). The panels and circuit breakers, and the transformers that feed them, should be analyzed to determine their short circuit compatibility. These panels may be replaced opportunistically in conjunction with other electrical projects.
Raceways and Wiring	General	Conduits, cable tray, and pullboxes in numerous locations are showing rust and corrosion, typical of raceways that have been in service for many years. Raceways that were likely installed in 1962 or 1976 show the most rust and corrosion, while newer conduits are generally in better condition. Pullboxes in the Pipe Gallery and in the Pump Building are both heavily rusted. Pullboxes are difficult to replace in situ, and it is recommended that opportunities are sought to replace or remove the pullboxes during a large wiring project.

		  The cable tray in the Pipe Gallery contains numerous wires of various signal types. It is usually recommended that power, control and instrument cabling be located in separate raceways both for signal integrity and for personnel safety during maintenance. It is suggested that the cable tray be removed and replaced with separate cable trays or other raceways during a future wiring project. Wiring was not inspected, but wiring installed during the original plant construction in 1962 or the plant expansion in 1976 has reached the end of its expected service life. It is recommended that wiring be replaced in conjunction with MCC or control system replacements. Installation of new wiring in new raceways will allow removal of old wiring and raceways, and possibly junction and pullboxes.
Lighting Systems	General	Interior lighting throughout the plant is generally functional and in acceptable condition. The Filter Room and the Pump Building are two indoor areas of the plant that would benefit from improved lighting. Exterior lighting is not extensive, and there are a number of locations where light pole bases remain in place, but the lights and poles have been removed. Removal of exterior lights may have been done, at least in part, to promote good relations with neighbors and to comply with the Boulder County outdoor lighting requirements. Several pole-mounted lights are still in place around the Pump Building and water tanks, but are reported to not be working, possibly due to the underground circuit to the lights having been cut. It is recommended that outdoor lighting for the whole facility be examined, and a lighting plan developed that supports outdoor facility operational needs while also complying with Boulder County requirements and minimizing impact on neighboring residents.

Medium Voltage Equipment	12	The exterior of the medium voltage equipment in the switchyard was briefly examined. Most cabinets are in acceptable or good condition. One of the Xcel Energy metering cabinets shows rust on the exterior doors.
Standby Power	General	Only portions of the plant have standby power available. Therefore, during power outages, there are portions of the plant that do not have any standby power.

PLC equipment and control systems	General	The plant control system includes a mix of Allen-Bradley “PLC-5” equipment and Allen-Bradley “SLC 5/xx” equipment. Plant personnel have a stock of spare PLC-5 cards that were removed from filter control consoles and feel that they have a reasonable number of spares for future use. PLC equipment appears to be in good condition. Plant personnel have been adding plant control functionality to the touchscreens on the filter control panels to provide operational flexibility and allow more control locations than just the dedicated SCADA terminals in the Control Room. There is not a PLC in the Pump Building, so control and instrument signals are carried on long cables from the Pump Building to the main part of the facility.. These cables present a risk of incurring equipment damage during lightning storms. One major area of concern is the “closet” that is behind the former annunciator panel. All devices have been removed from the annunciator panel, and various control system equipment has been installed. The closet contains several PLC systems, panelboards, fiber optic panels, and other control equipment. A loft area holds a network rack, and a UPS. Specific concerns include the wet sprinkler system in the room, and the relatively high temperatures in the loft area, which will affect the lifespan and performance of the network rack and UPS. More generally, the various generations of wiring and equipment in this space will make maintenance and troubleshooting difficult. Much of the plant control wiring enters this room, so relocating the control system hardware will require either installation of new wiring, or extension of the existing wiring. Replacement or removal of wiring installed before approximately 1992 can be accomplished along with other wiring projects. 

Memo

Date:	Friday, October 24, 2014
Project:	Betasso WTP CIP
To:	Gary Fuller, Jennifer Stillman
From:	Travis Moore
Subject:	Electrical and I&C SWAT Condition Assessment

This memorandum includes a tabulation of electrical and I&C observations made on Monday, October 20, 2014 at the Betasso WTF during the SWAT Condition Assessment. A Power Distribution Functional Diagram showing the facility power distribution system in schematic form is attached to this memo for reference (Note - diagram is under development).

The following Work Area Categories are used to identify the area of the facility for each item:

1. Administration Area
2. Operators and Maintenance Area (includes: lime room, microstrainer room, maintenance shop)
3. Filter Room
4. E-Tech Room
5. Pipe Gallery
6. Floc/Sed Basins
7. Pump Building (houses washwater pumps and filtrate pumps and small generator)
8. DAF Building / SBE Basin (Spent Backwash Equalization - buried)
9. Chemical Building (includes: sodium hypochlorite, alum, fluoride, scrubber room, PAC room)
10. Residuals Lagoons and Drying Beds
11. Raw Water Vaults (includes MockVeld Vault and others)
12. Outdoor Equipment (includes: CO2, propane tanks, generators, electrical gear, oil water separator, etc.)
13. Outdoor Tanks (includes Backwash, Clearwells, and Filtrate)

General Observations:

1. In general, the electrical distribution equipment in the facility is either in good condition and can be expected to provide good service into the future, or is beyond the end of its expected service life and should be scheduled for replacement.

2. The facility power distribution system is illustrated on the Power Distribution Functional Diagram. The facility receives 480V power through two transformers, each of which is powered from a switch in the cogeneration switchyard. The older transformer and associated switchboard in the East Yard were running at about one-third of their capacity at the time of observation. The newer transformer and associated switchgear at the DAF area are about twice the size of the East Yard equipment, and were also running at a fraction of their capacity at the time of observation. (The transformers and associated distribution gear are described in more detail in the assessment table below.) This arrangement makes central standby power generation difficult, and places the larger facility electrical load on the older/smaller equipment while the smaller facility electrical load is placed on the newer/larger equipment. The DAF-area equipment appears to have been designed to become the main facility power distribution equipment. The DAF-area equipment could accommodate the full facility electrical load, which would enable removal of the aging East

Yard equipment and implementation of central standby power generation if needed. The DAF-area equipment is also arranged to be expandable in case a dual-feed power distribution arrangement is desired.

3. The Siemens MCCs installed in approximately 1992 appear to be in good condition. However, this Siemens product line is no longer manufactured. Therefore, replacement components may become more difficult to obtain in the future and may need to be obtained from aftermarket sources.

4. The electrical system in the facility has evolved over 50+ years and now has elements installed at times ranging from the original facility construction through the most recent upgrade projects. Older elements of the core electrical systems should be replaced to enable confident facility operation into the future. Key elements to consider replacing or upgrading include:

    - "Trunk" power circuits and raceways
    - Distribution panelboards and motor control centers
    - Standby power generation systems

    In some cases, replacement elements may need to be constructed prior to the items being replaced to maintain continuous facility operation. Electrical upgrade items can be coordinated with other facility upgrade projects to reduce overall disruptions to facility operations.

5. Power meters on the electrical equipment installed in approximately 2000 are generally not working. Older electrical equipment does not have power meters. Installing additional meters will improve the ability to track which equipment and processes are consuming energy. First priority should be major power buses, followed by smaller equipment. If very specific information is desired, "smart" power distribution and motor control equipment can be specified when electrical equipment is replaced, which can enable monitoring on a machine-by-machine basis. Power metering should be arranged to support the facility's monitoring and energy conservation programs.

A chronology of major electrical installation events is as follows:

1962 – MCC in original Filter Building installed

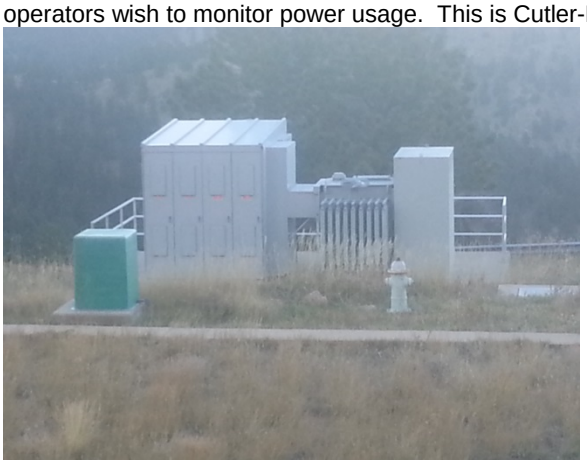
1976 – Original MCC modified into MCC-A and MCC-EA. Switchgear in yard and pad-mounted transformer installed. MCC-B and MCC-C installed. 100kW generator and 225A transfer switch installed.

1992 – Original MCC-A and MCC-EA removed and replaced with new MCC-A and MCC-EA. MCC-C modified into MCC-C and MCC-EC. MCC-D installed. New 600A breaker probably scabbed onto the outdoor switchgear to power new MCC-A. ATS and generator relocated from Filter Building to Pump Building. New 400A ATS and 250kW generator installed at Filter Building.

1999 – Outdoor unit substation installed next to DAF building. MCC-E installed in DAF Building. MCC-F installed in Chemical Building.

2012 – Generator in the Pump Building replaced.

ITEM	WORK AREA CATEGORY	CONDITION
Main Switchgear (East Yard)	12	This 800A outdoor switchboard is powered from an adjacent 500kVA pad-mounted transformer, which is in turn powered from a fused switch in the medium-voltage switchyard below the hydropower plant. Inspection showed that the switchboard was operating at approximately 200A at the time of the site visit. (Note: the transformer/switchboard combination has a useable capacity of approximately 600A; therefore, the electrical loads served from this switchboard were about one-third of capacity.) The switchboard has had an after-market circuit breaker installed in a separate enclosure attached to the outside of the switchboard. The switchboard and transformer were installed in approximately 1976 and are therefore nearly 40 years old. The enclosure shows significant rust and corrosion. This equipment should be replaced. This switchboard is GE "AV-Line".

Main Switchgear (DAF area)	12	The switchgear lineup outdoors near the DAF is a secondary unit substation powered from a fused switch in the medium-voltage switchyard below the hydropower plant. The unit substation includes a primary terminal box, 1000kVA dual-temperature rated step-down transformer with auxiliary cooling fans, and walk-in 1600A switchgear assembly, and was installed in approximately 2000. All of this equipment is in good condition. The power meter on the switchgear is not functional, and could be replaced if plant operators wish to monitor power usage. This is Cutler-Hammer equipment. 
MCC-A / MCC-EA	3 (Electrical Room)	MCC-A and MCC-EA are located along a wall in the Electrical Room across the hallway from the Filter Room. These MCCs are connected by an automatic transfer switch, so that MCC-EA has standby power available. These MCCs were installed in approximately 1992 and are in good condition. These MCCs are Siemens “Model 95”.

MCC-B	3 (Electrical Room)	MCC-B is a back-to-back MCC lineup located in the center of the Electrical Room across the hallway from the Filter Room. This MCC was installed in approximately 1976, and is therefore nearly 40 years old. This MCC has been modified several times through several plant projects. Replacement parts are still available from GE and from aftermarket suppliers, but the overall MCC is showing its age. This MCC should be replaced. This MCC is GE “7700 Line”.
MCC-C / MCC-EC	7	MCC-C and MCC-EC are located in the Pump Building. These MCCs are connected by an automatic transfer switch, so that MCC-EC has standby power available. These MCCs were installed in approximately 1976 and are therefore nearly 40 years old. These MCCs have been modified several times through several plant projects. Replacement parts are still available from GE and from aftermarket suppliers, but the overall MCC is showing its age. This MCC should be replaced. These MCCs are GE “7700 Line”.
MCC-D	9	MCC-D is located in the Electrical Room of the Chemical Building, and was installed in approximately 1992. This MCC is in good condition.

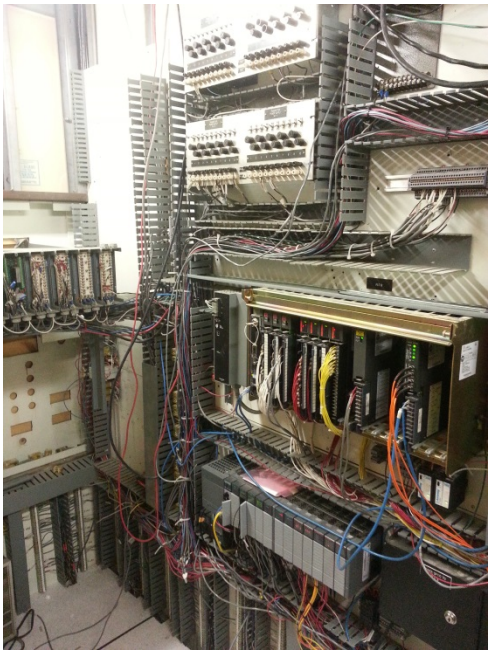
MCC-E	8	MCC-E is located in the DAF Building and was installed in approximately 2000. This MCC is in good condition. The power meter is not working, and could be replaced if operators wish to monitor power usage at this location. This MCC is Cutler-Hammer “Freedom 2100”.
MCC-F	2	MCC-F is a small MCC located near the lime silos on the upper level of the Filter Building. This MCC was installed in approximately 2000 and is in good condition. The power meter is not working, and could be replaced if operators wish to monitor power usage at this location. Given the relatively small loads carried by MCC-F, the replacement power monitor could be a simpler model with fewer features than the existing IQ Analyzer model. This MCC is Cutler-Hammer “Freedom 2100”.

Generator (south of Filter Building)	1	The diesel-powered engine generator on the south side of the Filter Building provides standby power to MCC-EA through the associated automatic transfer switch. The generator was installed in approximately 1992. Visual inspection could not accurately determine the condition of the mechanical components, but the run time on the meter was 790 hours as of the date of observation. This is a common magnitude of runtime for standby generators of this age, resulting from testing and exercise as well as power outage events. The sub-base fuel tank shows fuel/grease residue on the exterior, which should be cleaned off to facilitate inspection for leaks or corrosion. Interior inspection of the tank was not possible. It is recommended that a generator technician from either the generator manufacturer (Kohler) or a third-party firm provide an opinion on the mechanical condition of the generator and sub-base fuel tank. The generator housing is in moderately poor condition, showing rust and poorly-fitting doors. The original door latches apparently do not work, and extra latches have been retrofit to the enclosure to keep the doors closed. This generator is a Kohler unit, with a Detroit Diesel engine.
Transfer Switch (Filter Building)	3 (Electrical Room)	The transfer switch in the Filter Building Electrical Room switches the power to MCC-EA between normal power and standby power. This transfer switch was installed in approximately 1992 and is in good condition.

Generator (Wash Water Pump Bldg.)	7	The generator in the Pump Building is nearly new. It had 119 hours of runtime as of the date of observation. Plant personnel noted that most of the runtime was accumulated during flood events in the fall of 2013. The generator is fueled from a small floor-mounted tank located adjacent to the generator. This is a Kohler generator and is in good condition.
Panelboards	General	There are a number of panelboards in the facilities that are beyond the end of their service life. The installation date is not easily determined, but they are likely from either original plant construction in approximately 1962 or the plant expansion in 1976. These panels are a brand that is presently uncommon and obtaining replacement parts may be difficult. The circuit breakers are aging, and may not have adequate short circuit interrupting current ratings for application on present-day electrical systems (i.e. the circuit breakers may not be able to safely open if there is a short circuit). The panels and circuit breakers, and the transformers that feed them, should be analyzed to determine their short circuit compatibility. These panels may be replaced opportunistically in conjunction with other electrical projects.
Raceways and Wiring	General	Conduits, cable tray, and pullboxes in numerous locations are showing rust and corrosion, typical of raceways that have been in service for many years. Raceways that were likely installed in 1962 or 1976 show the most rust and corrosion, while newer conduits are generally in better condition. Pullboxes in the Pipe Gallery and in the Pump Building are both heavily rusted. Pullboxes are difficult to replace in situ, and it is recommended that opportunities are sought to replace or remove the pullboxes during a large wiring project.

		  The cable tray in the Pipe Gallery contains numerous wires of various signal types. It is usually recommended that power, control and instrument cabling be located in separate raceways both for signal integrity and for personnel safety during maintenance. It is suggested that the cable tray be removed and replaced with separate cable trays or other raceways during a future wiring project. Wiring was not inspected, but wiring installed during the original plant construction in 1962 or the plant expansion in 1976 has reached the end of its expected service life. It is recommended that wiring be replaced in conjunction with MCC or control system replacements. Installation of new wiring in new raceways will allow removal of old wiring and raceways, and possibly junction and pullboxes.
Lighting Systems	General	Interior lighting throughout the plant is generally functional and in acceptable condition. The Filter Room and the Pump Building are two indoor areas of the plant that would benefit from improved lighting. Exterior lighting is not extensive, and there are a number of locations where light pole bases remain in place, but the lights and poles have been removed. Removal of exterior lights may have been done, at least in part, to promote good relations with neighbors and to comply with the Boulder County outdoor lighting requirements. Several pole-mounted lights are still in place around the Pump Building and water tanks, but are reported to not be working, possibly due to the underground circuit to the lights having been cut. It is recommended that outdoor lighting for the whole facility be examined, and a lighting plan developed that supports outdoor facility operational needs while also complying with Boulder County requirements and minimizing impact on neighboring residents.

Medium Voltage Equipment	12	The exterior of the medium voltage equipment in the switchyard was briefly examined. Most cabinets are in acceptable or good condition. One of the Xcel Energy metering cabinets shows rust on the exterior doors.
Standby Power	General	Only portions of the plant have standby power available. Therefore, during power outages, there are portions of the plant that do not have any standby power.

PLC equipment and control systems	General	The plant control system includes a mix of Allen-Bradley “PLC-5” equipment and Allen-Bradley “SLC 5/xx” equipment. Plant personnel have a stock of spare PLC-5 cards that were removed from filter control consoles and feel that they have a reasonable number of spares for future use. PLC equipment appears to be in good condition. Plant personnel have been adding plant control functionality to the touchscreens on the filter control panels to provide operational flexibility and allow more control locations than just the dedicated SCADA terminals in the Control Room. There is not a PLC in the Pump Building, so control and instrument signals are carried on long cables from the Pump Building to the main part of the facility.. These cables present a risk of incurring equipment damage during lightning storms. One major area of concern is the “closet” that is behind the former annunciator panel. All devices have been removed from the annunciator panel, and various control system equipment has been installed. The closet contains several PLC systems, panelboards, fiber optic panels, and other control equipment. A loft area holds a network rack, and a UPS. Specific concerns include the wet sprinkler system in the room, and the relatively high temperatures in the loft area, which will affect the lifespan and performance of the network rack and UPS. More generally, the various generations of wiring and equipment in this space will make maintenance and troubleshooting difficult. Much of the plant control wiring enters this room, so relocating the control system hardware will require either installation of new wiring, or extension of the existing wiring. Replacement or removal of wiring installed before approximately 1992 can be accomplished along with other wiring projects. 

Memo

Date:	Monday, October 27, 2014
Project:	Betasso WTP Plant Evaluation
To:	Gary Fuller, Jennifer Stillman, Brian Daw, Travis Moore
From:	Matt McFadden (Process Engineer)
Subject:	Electrical and I&C SWAT Condition Assessment

I accompanied Travis Moore and the Boulder electrical and I&C folks (Noel Johnson, Dave Scuchter, and Jason Gil) during the SWAT condition assessment on Monday, October 20, 2014. The summary included herein does not emphasize the reproduction of nameplate data or equipment condition. (This is addressed in the memorandum prepared by HDR's electrical engineer, Travis Moore.) Instead, the emphasis of this memorandum is to document key information that is EI&C-related that was discussed by our group during the condition assessment as well as a few process-related observations.

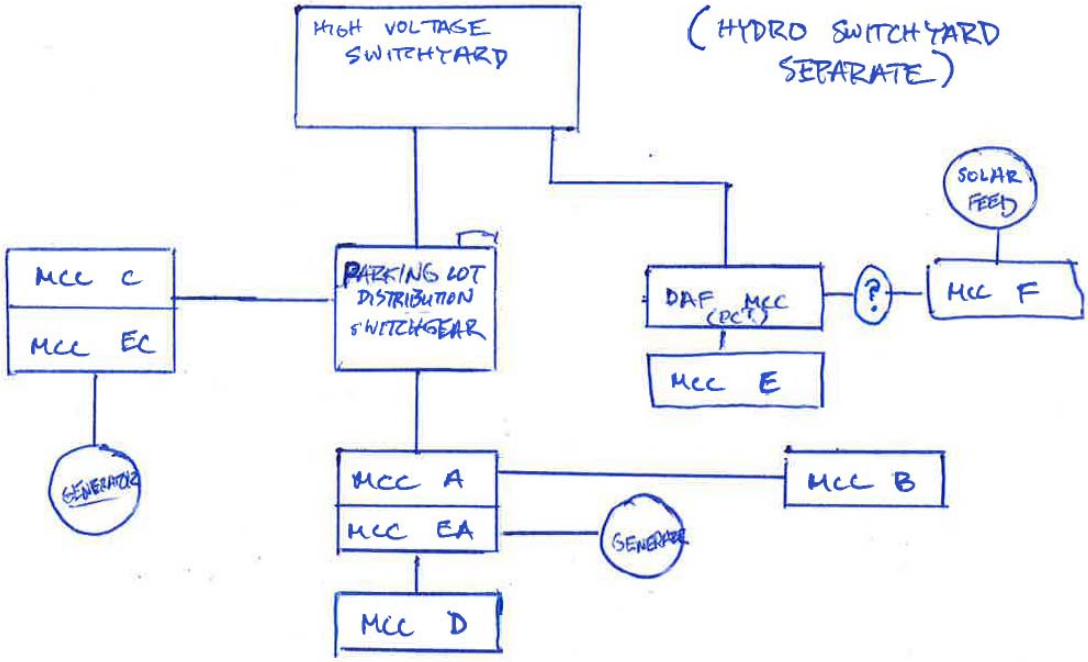
The following Work Area Categories are used to identify the areas of the facility:

1. Administration Area
2. Operators and Maintenance Area (includes: lime room, microstrainer room, maintenance shop)
3. Filter Room
4. E-Tech Room
5. Pipe Gallery
6. Floc/Sed Basins
7. Pump Building (houses washwater pumps and filtrate pumps and small generator)
8. DAF Building / SBE Basin (Spent Backwash Equalization - buried)
9. Chemical Building (includes: sodium hypochlorite, alum, fluoride, scrubber room, PAC room)
10. Residuals Lagoons and Drying Beds
11. Raw Water Vaults (includes MOCVAL vault and others)
12. Outdoor Equipment (includes: CO2, propane tanks, generators, electrical gear, oil water separator, etc.)
13. Outdoor Tanks (includes Backwash, Clearwells, and Filtrate)

GENERAL

1. There are no recent electrical 1-line or P&ID drawings. The group sees a clear and immediate need for these types of clarifying documents. The current facility electrical and I&C are a collection of previous improvements and some type of roadmap is needed.
2. The City expressed concern that the hydro switchyard is not synced to the treatment facility. Clarity of operation between the hydro and the treatment facility is a perceived need. Some staff feel that the plant should receive, or at least have the capability to receive, power directly from the hydro plant. Ultimately, they suggested a 'Lakewood Needle' and a "Barker Needle".
3. The propane heat source for the treatment facility is relatively expensive, costing around $1,000 per week.
4. There is no redundant SCADA server. This is considered a single point of failure. IT backs up iFix daily, usually using touchscreens that have been retrofit into the filter control panels.
5. The City is concerned about the Maintenance Shop Closet containing two PLCs and process Ethernet switch. There are fire sprinkler heads in this room. There is a lot of obsolete wiring in this location.

6. The City is concerned about back-up power. A generator with a 200 Amp breaker (outside the Filter Room) supplies power to the MCC's located in the Electrical Room off of the hall that runs along the Filter Room. MCC's A, EA, D and B are fed by this generator (see sketch of plant power distribution below). A second smaller generator feeds MCCs C and EC located in the Pump Building. MCC's E, F and the main DAF PLC do not receive back-up power from the generators; systems that don't receive back-up power (including DAF) are not considered critical.
    a. The City is also concerned that they don't have fuel storage for extended emergency power events (24 hrs is available).



7. The City considers Plant PLCs a single point of failure (SPF).
    a. Some argue that they are not an SPF because they run filters with an "intermediary" level of control (i.e. operating in 'hand' rather than 'auto'). Some critical instrumentation would require grab samples to inform operation if the PLCs failed, but it can be done.
    b. Backwash is not very feasible by manual control.
8. The facility has experienced some partial power outages without obvious causes. Betasso Hill is hit pretty hard by lightning, but consensus among the City is that lightning was not the cause of the partial power outages.
9. Power supply at the front of the plant needs to be cleaned-up. The City suggested a medium voltage generator to power up the entire plant.
10. The City noted that previous designs for various system improvements have included a lot of alarms that shut-down the entire treatment system. They have spent a fair amount of time adding jumpers to avoid whole process shut-downs. They would like to avoid this problem in the future when possible.

FILTER ROOM

The Electrical Room across the hall from the Filter Room has been included in this plant work area. It contains MCC A, MCC EA, and MCC B, as well as the transfer switch from the outdoor generator that feeds MCC EA.

1. MCC B is the oldest MCC, installed in 1976. It is a GE 7700 and feeds the floc drives and water heater.

2. MCC-A and MCC-EA were installed in the early 90's and appear to be in better condition than MCC B. They are Siemens "Model 95".
    a. MCC A powers lights, power roof, HVAC (dust collection for lime), RTU #2, and RW boosters.
    b. MCC EA powers the surface wash pumps, lime and chem feed equipment, master backwash valve, and air compressors. It also feeds MCC D located outside in the Chemical Building.

3. Kohler switch gear for the main diesel generator is located in the Electrical Room. It was installed in the early 90's and appears to be in good condition. I believe this is a 225A transfer switch. The City didn't express concern about it.

Inside the Filter Room, each filter has a control panel that has been retrofit with a touchscreen so that the plant can be controlled from other locations than the main Control Room (upstairs near lab in Operators Area). Expansion of the touch screen capabilities is ongoing. The panels have been fit with Allen Bradley SLC 500. Each filter is equipped with a Rosemount level indicator. These appear to be in good condition and their signals are registered consistently at the main control computer in the control room.

OUTDOOR EQUIPMENT

The main plant emergency power 100kW diesel generator (Kohler with a Detroit Diesel engine) is located just outside the Filter Building. It has about 800 hrs of logged run-time. While the cabinet shows signs of age, including a door that doesn't open or close without a lot of trouble, the unit appears to be in

operational condition. About half of its run-time hours were logged during the outages associated with the September 2013 flood event. The City didn't express any specific concern over this equipment.

The CO2 tank is in the parking area between the hydro facility and the plant. The tank itself, part of a Tomco "Lycarbo" packaged system, appears to be in fairly good condition, except for paint chipping and mild corrosion in a few places. There is a local panel that appears to be in poor condition, though the stainless steel piping leading to the vaporizer skids in the Pipe Gallery appears sound. There was brief discussion about the fact that when the CO2 system was installed, it wasn't on emergency backup power, but this has since been resolved by way of an in-house effort.

The main plant switchgear is located in the parking lot next to the CO2 tank. The transformer next to it is powered from the switchyard in the lower yard (near the clearwells). The switchgear (GE AV-Line) is mid-70's vintage and is showing signs of its age. The cabinet has a lot of corrosion. A separate enclosure houses a circuit breaker that was not installed with the original equipment. City staff expressed general concern regarding the age and condition of the switchgear.

CHEMICAL BUILDING

The only part of the Chemical Building that we spent any time in was the small room housing MCC-D just outside of the Chlorine Room. The MCC is from the early 90's and appears to be in good condition. My understanding is that this MCC feeds the CO2 system, NaOCl transfer pumps, and other chemical system equipment.

There are two small transformers mounted on the wall in this room just over the entryway. This isn't a code violation, and there may not be another convenient place to hang them, but they do crowd the headspace above the entry.

The control panel in this room is also pretty clean. It contains Allen Bradley PLC 5 components for which spare parts are unavailable. The City stripped PLC 5 parts from the filter control panels and kept them as spares. Travis and the City all have good things to say about the PLC 5 equipment, and generally expressed confidence. Wiring in the panel could be better organized – this was acknowledged by the City. I believe this control center is named "PLC 7" – the City mentioned it controlling alum feed, fluoride feed, and chlorine feed.

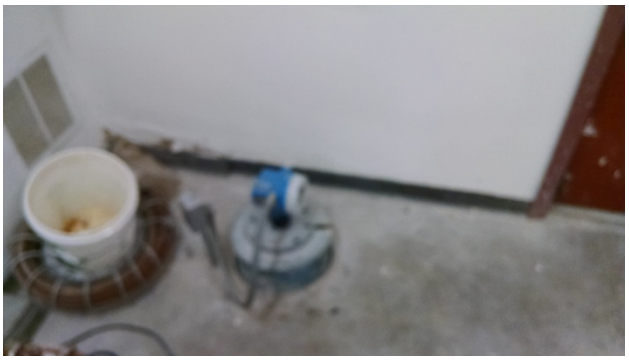
OPERATORS AND MAINTENANCE AREA

The following observations were made regarding the “closet” where the old control room was located in the current Maintenance Office:

- There are two fire system sprinklers overhead creating a potential SPF.
- There is a UPS in a relatively small upstairs attic space, rigged with an external fan for cooling – this is a potential SPF.
- My understanding is that there are two PLCs in this room: PLC 6 and PLC 8. PLC 6 is an old Allen Bradley and probably should be replaced. (I think it is an early predecessor of PLC 5). PLC 8 has been replaced with Allen Bradley SLC 500.
- There are a lot of old panels and old wiring in this closet, some of which is obsolete.

In the Lime Room, I noted the ultrasonic over the Parshall flume which is located in a vault beneath the Lime Room floor. This instrument is the only way of measuring total flow into the plant without summing filter effluent meters (as I understand it). It may be difficult to add a new flow meter for this purpose, as there is very little room between the flume and the tee that combines Lakewood and Barker influents.

Presumably the flume could be replaced with a meter to improve their flow pacing. None of the chemical feed is actually flow-paced or automated, with the exception of CO_2. Metering is adjusted by hand.



Generally, the lime handling equipment looked fairly clean. The City reported difficulties with screw feeders and some dissatisfaction with the vibrators on the silos. CO_2 is presumably automatically

adjusted based on the density of the lime slurry. Mixers are made by Vektor. There is also a Rosemount pressure transmitter providing the master filter level in this room.

The upstairs Lime Room (including PACl storage) contains MCC-F, which powers some of the dust control equipment. It also receives a feed from the solar power system, which can feed any of the equipment powered by MCC-F.

The Control Room included three computer consoles, which have been set up to mimic the control room at 63rd St. Elements of the distribution system can be controlled from here in addition to the Betasso WTF. The distribution system is on Motorola controls that have limited compatibility with the plant Allen Bradley equipment. The City is working on expanding compatibility and remote DS control.

Generally, the City seemed relatively satisfied with the SCADA system and control center consoles in the Control Room. Data reported and trending capability in SCADA includes the following:

1. Influent PSI, CFS, MGD, NTU
2. Flow and turbidity in basins (4)
3. BW and FTW tank levels, and flow
4. Filtered water pH, particle counts, turbidity
5. Flume turbidity
6. Tank 1 pH
7. Finished water Cl2
8. SCMs
9. Status of metering pumps
10. Alum, PACl, Cl2 and fluoride feed rates
11. DAF influent turbidity
12. Filter run times

There is a dedicated screen at the control center for the remote cameras. It provides live camera feed from several key locations around the distribution system and plant. Generally, the City seemed quite satisfied with the remote camera system.

<u>ADMINISTRATION AREA</u> – NOT USED

<u>PIPE GALLERY</u>

Generally, the Pipe Gallery is full of cable trays and pull boxes that are rusty. There is a lot moisture in there, so this isn't too surprising. There was talk about the benefits of rewiring in order to eliminate old conduits and wires that are not used anymore. The City would also like an alarm in the Pipe Gallery to alert operators to flooding conditions in the gallery.

There is not a low air pressure alarm on the compressed air system and the compressor has no redundancy. This is a major concern for the City.

<u>FLOC/SED BASINS</u>

I'm putting the DAF switchgear here because it's located near the basins. The switchgear portion is a Cutler Hammer walk-in building installed about 2000. The entire unit is pad-mounted, including an integral step-down transformer. It looks very clean. Travis and the City discussed that the unit was significantly oversized.

PUMP BUILDING

There is a relatively new generator in the Pump Building. It has just over 100 hrs of runtime associated with the flood of last year. This is a Kohler unit, similar to the main generator in the filter area. It looks very clean. The generator feeds MCC-EC.

The other side of the Pump Building houses MCC-C and MCC-EC. These MCCs power the washwater pumps and the other pumps in the building (decant from the SBE). The MCCs are GE 7700 series like those in the electrical room across from the filter room; mid-70's vintage.

The City noted a need for additional interior lighting in the Pump Building.

The City would like a PLC in the Pump Building. Currently, they have control wires running up the hill to the main Filter Building.

DAF BUILDING / SBE BASIN

MCC-E is located in the DAF building, installed around 2000. It is Cutler Hammer, presumably installed as a package with the switchgear near the basins. It appears to be in good condition. The power meter on the MCC is broken.

The DAF control panel looks clean. The City used PLC 5, even though it was being phased out at the time of installation. This was done for compatibility with the rest of the plant, and considered the fact that they would have spare parts from the retrofit of the filter panels. The City pointed out that they have added a little device to make the PLC5 equipment compatible with the SLC 500 that is the basis of the DAF system controls. The City didn't report any problems with the functionality of the DAF system.

OUTDOOR TANKS

The City reported that the lights in the lower yard are problematic. Apparently there isn't a home run (i.e. the circuit is incomplete because there is no return wiring). It is not clear whether these lights should work currently, or whether the lights were disabled intentionally.

We also looked at the equipment in the switchyard. Generally, the equipment here looks to be in good condition, and the City didn't report any problems with functionality. A few of the cabinets, of varying age, have rust.

RESIDUALS LAGOONS AND DRYING BEDS – NOT USED

RAW WATER VAULTS – NOT USED

Memo

Date:	Friday, November 07, 2014
Project:	Betasso WTF CIP
To:	Gary Fuller, Jenn Stillman
From:	Paul O'Brien
Subject:	Mechanical SWAT Condition Assessment

This memorandum includes a tabulation of mechanical observations made on Monday, October 20, 2014 at the Betasso WTF during the SWAT Condition Assessment. Please reference the attached Photo Log for the photos referenced in this memorandum.

The following Work Area Categories are used to identify the area of the facility for each item:

1. Administration Area
2. Operators and Maintenance Area (includes: lime room, microstrainer room, maintenance shop)
3. Filter Room
4. E-Tech Room
5. Pipe Gallery
6. Floc/Sed Basins
7. Pump Building (houses washwater pumps and filtrate pumps and small generator)
8. DAF Building / SBE Basin (Spent Backwash Equalization - buried)
9. Chemical Building (includes: sodium hypochlorite, alum, fluoride, scrubber room, PAC room)
10. Residuals Lagoons and Drying Beds
11. Raw Water Vaults (includes MockVeld Vault and others)
12. Outdoor Equipment (includes: CO2, propane tanks, generators, electrical gear, oil water separator, etc.)
13. Outdoor Tanks (includes Backwash, Clearwells, and Filtrate)

General Observations:

1. The HVAC controls through the plant need to be investigated. Systems that are designed to be interlocked do not appear to be functioning as designed and each piece of equipment has to be operated manually.
2. The boiler system does not have a way of introducing chemicals to treat the water. This is a closed system and the water should be tested annually. There are chemical treatment companies that will test the water or provide a kit to allow plant staff to do the test. Based on the results, chemicals should be added to the system to minimize corrosion in the boilers, piping system and individual coils in equipment.
3. Roof mounted equipment shows damage due to wind. Damage seems to be cosmetic (Photo 1).

The following sections include observations that are categorized by the Work Areas listed above.

1. **Administration Area**
    a. HVAC:
        i. Heating and cooling provided with roof top package unit (Photo 2):
            1. Unit was installed in 1994.
            2. Air handling unit is not reliable.
            3. Unit shows weathering.
            4. Refrigerant is R-22, which is being phased out. R-22 is difficult and costly to purchase.
        ii. Space temperature control is not satisfactory:
            1. Without looking at the program architecture, it is hard to address changes that could be made. However, the Solidyne M2 universal programmable controller is now on revision #4 and changing the controller and making a few programming changes may improve the system performance.
            2. Also, Carrier Corporation makes a complete system called the "VVT" system. An advantage of the Carrier system is it is from one manufacturer, as opposed to a system that is assembled by a control company with third party pieces.

2. **Operators and Maintenance Area (includes: lime room, microstrainer room, maintenance shop)**
    a. **Lime Room**
        i. HVAC:
            1. Room ventilation cross connects with other areas.(Photo 3 and Photo 4)
            2. Room ventilation is a manual operation. (Photo 5)
        ii. Plumbing:
            1. Room floor drain is plugged and non-functional.
            2. There is a concern as to where the drain discharges to (should not go to the septic system).
    b. **Operators Control Room and Lab**
        i. HVAC:
            1. Heating and cooling provided with roof top package unit: (Photo 2)
                a. Unit was installed in 1994.
                b. Unit shows weathering, but appears to be in good shape.
                c. Refrigerant is R-22, which is being phased out. R-22 is difficult and costly to purchase.
            2. Supply fan and duct heater for lab fume hood auxiliary supply are not energized when the fume hood exhaust fan is energized. (Photo 6)
    c. **Boiler Room**
        i. HVAC:
            1. Room is very hot.
                a. Boiler room should have ventilation to remove heat.
            2. Old boiler should be removed. (Photo 7)
            3. South pump in system (Blue Zone) is not reliable.(Photo 8)
            4. New modulator boilers installed in 2012. Piping connections exist for third boiler. (Photo 9)
3. **Filter Room**
    a. HVAC:
        i. Air handling unit is disabled.
        ii. Condensation does not seem to be a problem.

4. **E-Tech Room**
    a. HVAC:
        i. Heating and cooling provided with roof top package unit: (Photo 2)
            1. Unit was installed in 1994.
            2. Unit shows weathering, but appears to be in good shape.
            3. Refrigerant is R-22, which is being phased out. R-22 is difficult and costly to purchase.

5. **Pipe Gallery**
    a. HVAC:
        i. The controls for AHU-1 do not appear to be working as designed.
            1. The three way valve controlling the hot water to the booster pump is not installed as shown in the 1976 drawings. The drawings show the valve providing variable temperature water to the coil. It appears that the way the valve was installed, the coil receives 180-Deg F water whenever the pump is on. Controls for the system need further investigation.(Photo 10)
        ii. Condensation is an issue in the Pipe Gallery:
            1. There are a number of ways to deal with the high humidity in the Pipe Gallery, which is causing the condensation issues.
                a. One method is to install a dehumidifier(s) to dehumidify the air in the Pipe Gallery.
                b. Another method is to ventilate the gallery with outside air, which usually has a dew point lower than the temperature of the water in the piping system. This would be a once thru system that would pick up evaporated water from open water sources and carry it off to be exhausted outdoors.
            2. Controlling the humidity will reduce the amount of water separated out of the compressed air system by both the moisture separators at the compressors and the refrigerant air dryer. The will reduce the amount of water going to the septic system.
        iii. Pipe Gallery is high bay and the air stratifies. No mater the method used to control gallery humidity, a system of fans should be considered to circulate the stratified air from the ceiling down to the lower regions of the gallery. Ducting would take the upper region air thru fans to be distributed low in the gallery. The fans should be located low for maintenance access.
        iv. Ductwork has been used as a working platform.
            1. New platforms could be mounted on the wall at each valve actuator location to eliminate the need to stand on the ductwork while servicing the automatic valves.(Photo 11)
    b. Plumbing:
        i. The potable water piping material is PVC and is sagging between hangers. (Photo 12)
            1. PVC is an easy system to perform maintenance.
            2. Should be schedule 80.
            3. Should be supported continuously or at least at 5 ft intervals.
        ii. Sanitary drainage piping system in gallery has a length of soil pipe showing leakage. The pipe section is just before the piping system exits the gallery. (Photo 13)
        iii. There is a lot of sample water going to the septic system. This increases the frequency for pump out. This is also contributing to the high humidity level in the Pipe Gallery.
    c. Compressed Air System:
        i. Numerous leaks in the system are causing the compressors to run in excess of what is required. This is an energy waste for compressor run and refrigerant air system operation.

1. Leaks seem to be from abandoned lines that are crimped by bending the tubing over on it self. These lines should be removed and capped at the header attachment point. (Photo 14)

ii. The air piping system consists of steel, copper and aluminum pipe material. The most resent repair was done with aluminum. All future repairs should be done with the aluminum piping material. (Photo 15)

iii. Compressors are 50 years old. (Photo 16)

1. Compressors are still serviceable, but soon parts will no longer be available.

iv. The air dryer is 7 years old and uses the newer refrigerant R-134A. Air dryer is functioning well. (Photo 17

d. Elevator equipment:

i. Elevator equipment should be in a separate room dedicated to the elevator equipment.

6. Floc/Sed Basins – not observed during the mechanical SWAT condition assessment.

7. Pump Building (houses washwater pumps and filtrate pumps and small generator)

a. Generator Room HVAC:

i. Ventilation air is supplied by a wall louver. The louver is on the same wall as the exhaust air louver for the generator. The air from the louver short circuits to the radiator fan and does not provide adequate ventilation for the generator. The air supply should be ducted to the generator end of the gen. set for proper cooling of the generator.(Photo 18)

b. Pump Room HVAC:

i. Ventilation is adequate.

ii. Heat is provided with electric unit heaters. Both unit heaters have been replaced and are functioning well.

iii. Efflorescence is occurring on the inside of the pump room. This could be caused by maintaining the room temperature in the pump room at too low of a setting, causing moisture from outside to wick in thru the block. Further investigation is required.

8. DAF Building / SBE Basin (Spent Backwash Equalization - buried)

a. HVAC:

i. DAF Room:

1. Propane fired unit heaters are original and functioning well.

ii. Electrical room:

1. Ventilation system is with wall louver and exhaust fan. Both are operating without issue.

9. Chemical Building (includes: sodium hypochlorite, alum, fluoride, scrubber room, PAC room)

a. HVAC:

i. There does not seem to be enough pressure in the hot water heating system to supply the unit heaters and outside air heating coil for the alum and fluoride room.

1. There are a number of reasons for this:

a. The piping is too small serving this area either due to physical size or fouling.

b. The coils are fouled and will not allow enough hot water to pass.

2. Possible remedies:

a. Replace the coils.

b. Install a chemical system to treat the hot water circulating system. There should be a way of introducing treatment

chemicals to all hot water systems and the systems should be monitored annually.

3. The hot water unit heater in the south east corner of the room is showing leakage.

10. **Residuals Lagoons and Drying Beds – not observed during the mechanical SWAT condition assessment.**

11. **Raw Water Vaults (includes MockVeld Vault and others)**
    a. HVAC:
        i. The MockVeld Vault could be considered confined space. At a minimum, an indoor air quality monitor should be installed. The monitor should turn on a red light at the entrance to the vault on a fault, to signal trouble and increase the ventilation rate to 1 cfm per square foot to restore the vault to a safe environment.

12. **Outdoor Equipment (includes: CO2, propane tanks, generators, electrical gear, oil water separator, etc.) – not observed during the mechanical SWAT condition assessment.**

13. **Outdoor Tanks (includes Backwash, Clearwells, and Filtrate) – not observed during the mechanical SWAT condition assessment.**

Photo 1: Typical wind damage to roof mounted exhaust fans and intake hoods.

Photo 2: Roof mounted packaged air handling unit serving the Administration Area. Typical of units serving E-Tech room and Operator and Laboratory Areas.

Photo 3: Lime Room ventilation cross connection with the hallway.

Photo 4: Lime Room ventilation cross connection with Pilot Room.

Memo

Date:	Friday, November 7, 2014
Project:	Betasso WTF CIP
To:	Gary Fuller, Jennifer Stillman
From:	Ron Manske
Subject:	Structural SWAT Condition Assessment

This memorandum includes a tabulation of structural observations made on Monday, October 20, 2014 at the Betasso WTF during the SWAT Condition Assessment.

The following Work Area Categories are used to identify the area of the facility for each item:

1. Administration Area
2. Operators and Maintenance Area (includes: lime room, microstrainer room, maintenance shop)
3. Filter Room
4. E-Tech Room
5. Pipe Gallery
6. Floc/Sed Basins
7. Pump Building (houses washwater pumps and filtrate pumps and small generator)
8. DAF Building / SBE Basin (Spent Backwash Equalization - buried)
9. Chemical Building (includes: sodium hypochlorite, alum, fluoride, scrubber room, PAC room)
10. Residuals Lagoons and Drying Beds
11. Raw Water Vaults (includes MOCVAL vault and others)
12. Outdoor Equipment (includes: CO2, propane tanks, generators, electrical gear, oil water separator, etc.)
13. Outdoor Tanks (includes Backwash, Clearwells, and Filtrate)
14. Building Exterior and Roof

A chronology of major plant improvements is as follows:

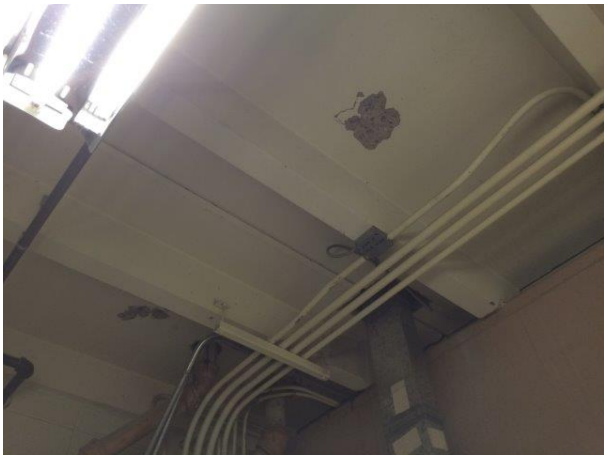
1962 – Original plant construction

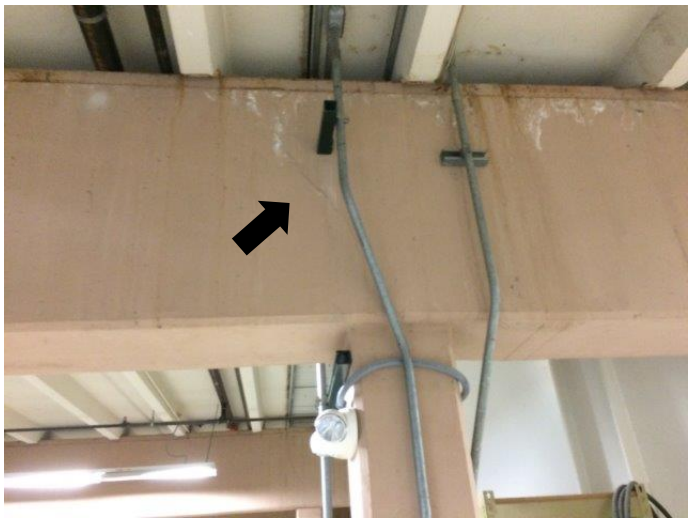
1976 – Plant expansion

1992 – Chemical Feed Building, Lime Storage and Clearwell additions

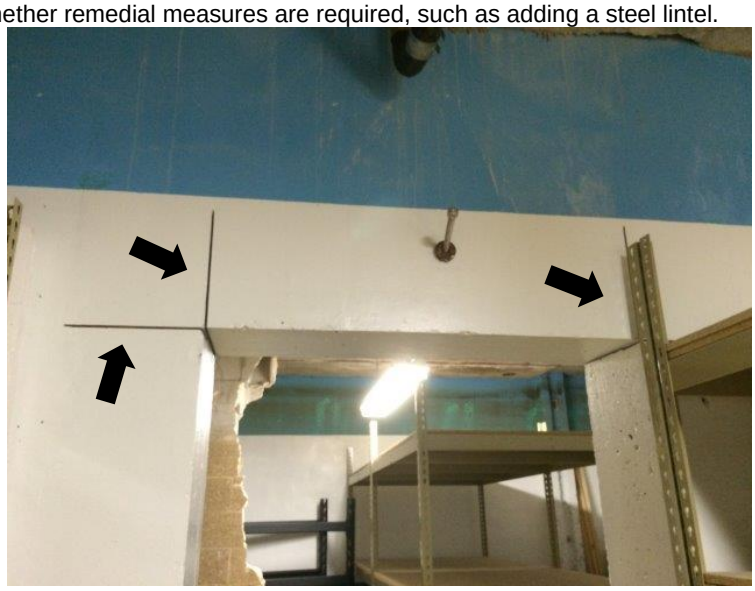
1994 – Administrative and Maintenance additions

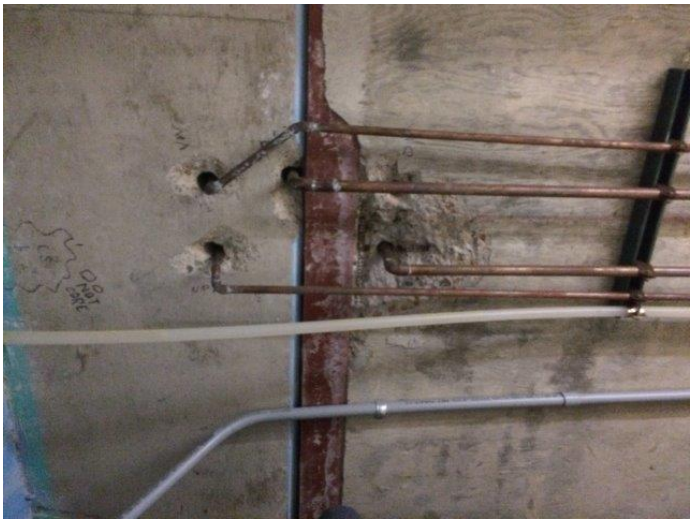
1999 – Pretreatment improvements and DAF Building addition

ITEM	WORK AREA CATEGORY	CONDITION
Operators and Maintenance Area Chemical and Lime Storage	2	Moltz Construction reported that when double-tees were removed to install lime storage silos in their place, they “crumbled” when lifted. We can only speculate on the cause. Concrete degradation was not apparent in the double-tees remaining. It is possible that when lifting the double-tees, they weren’t fully released from their supports and the tees experienced a load-reversal (meaning that portions of the tees expected to be in tension or little compression experienced large compression forces, and portions of the tees designed to be in compression experienced tension forces). Some minor spalling was noted at some of the tees as seen in the photograph, but they appeared to be in otherwise satisfactory condition. Our observations do not lead us to believe that there is cause for structural concern or need for repair at this time. 

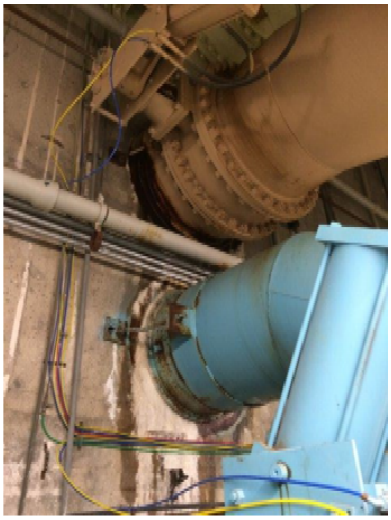
Operators and Maintenance Area Chemical and Lime Storage	2	The floor slab was worn and had numerous hairline cracks that appeared to be attributed to age and use. Further action does not appear to be required at this time, since this is a dry area and functionality does not appear to be compromised.
Operators and Chemical and Lime Storage	2	Concrete beams supporting the roof have small diagonal cracks at or near supports. The small nature of the cracks did not warrant immediate cause for concern, but should be reviewed to verify that the beams are appropriately designed for the loads supported. 

Operators and Maintenance Area Microstrainer Room	2	A 24” to 32” long by 8” wide, full height portion of a partially demolished CMU wall exists in a storage area, in the room furthest east of the previous microstrainer tanks. The remaining CMU is ungrouted. This was likely a former non-structural partition wall, but the facility drawings should be reviewed to confirm that it is nonstructural.
Operators and Maintenance Area Microstrainer Room	2	The threshold leading into the same east room as discussed above is a trip hazard. It should be ground smooth with the adjacent floors.

Operators and Maintenance Area Microstrainer Room	2	At the same entryway as discussed above, the head and jambs of the opening are severely overcut. The primary concern is the vertical load-carrying capacity of the head section, since reinforcing at the bottom of it was likely cut. The load demand above should be reviewed to determine whether remedial measures are required, such as adding a steel lintel. 

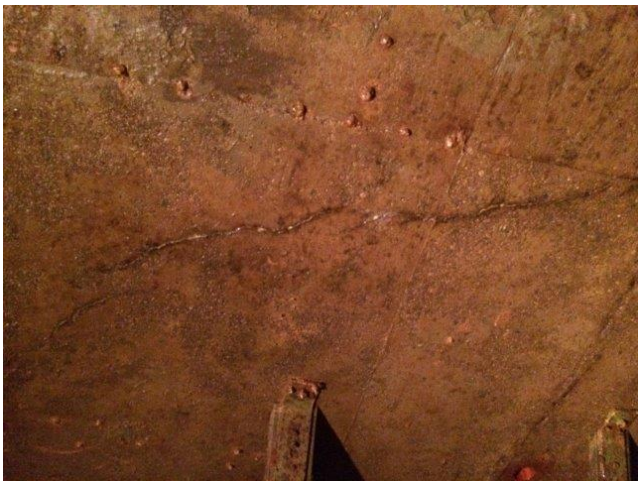
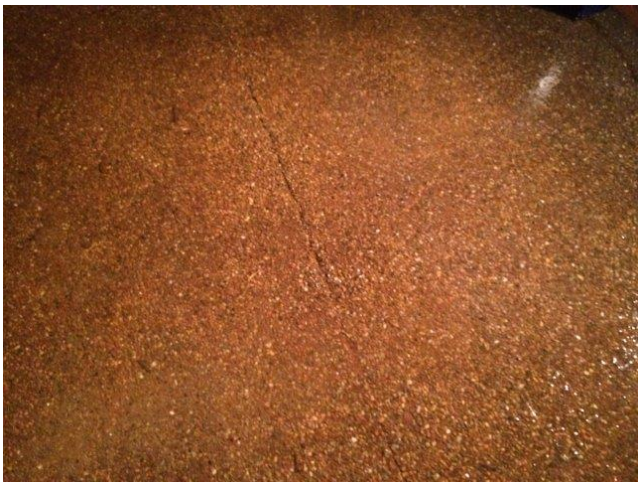
Operators and Maintenance Area Microstrainer Room	2	The floor above these same areas was infilled during a prior plant improvement. Concrete formwork appeared somewhat uneven, but did not appear distressed to indicate concerns such as overload. Isolated waterline penetrations occur near supports. While concrete around the penetrations appears spalled, it doesn't appear to have compromised the section. The concrete can be patched with a repair mortar. 

Filter Room	3	Erosion of the surface mortar at submerged concrete was noted in Filter #6, which was taken down for cleaning and inspection. The erosion found was similar in nature to that in the Floc/ Sed basins, which will be further discussed later in this memo. HDR believes that surface repairs of the filters will be required in the same or similar manner as the Floc/Sed basins.

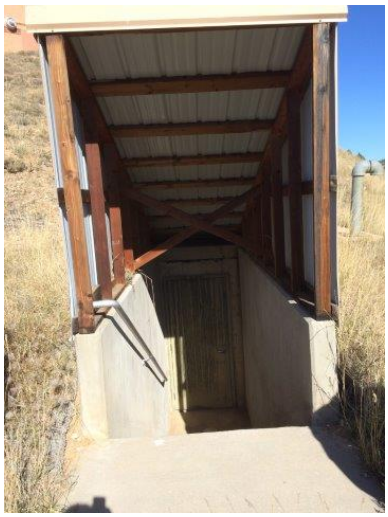
Pipe Gallery	5	Numerous link seals at pipes appear to be leaking and require replacement. These can be reviewed on an individual basis, but a more appropriate long-term course of action might be to replace all of the link seals, so that additional leakage issues do not arise from those not replaced in a future program. 

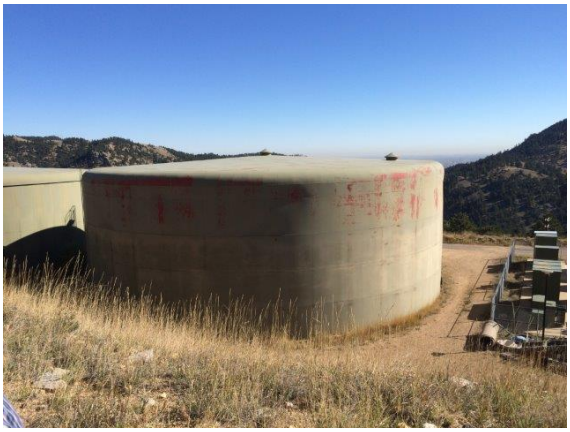
Pipe Gallery	5	Efflorescence was observed in several locations in the concrete walls in the Pipe Gallery. This is indicative of slow leaks in the walls. These areas should be cleaned and investigated for signs of corrosion or other degradation, and then injected with epoxy to plug the leaks and prevent corrosion of reinforcing steel inside the concrete.

Pipe Gallery	5	City staff discussed that access to valves and equipment located in the upper level of the Pipe Gallery is difficult. They inquired about whether it would be feasible to install a catwalk in the Pipe Gallery for this purpose. There is evidence that the HVAC ductwork has been used to access some of these items. While no harm appears to have occurred yet by this activity, HDR recommends that it stop immediately. As seen in the photo below, the ductwork has undergone some deformation. The ductwork and its supports to the ceiling above were not intended to be used in this manner, and at best, were intended to support light construction loads during installation. A catwalk is possible but would be interrupted frequently by pipes crossing the gallery. After some discussion, HDR recommends that individual ladders with access platforms be installed at the valves and equipment requiring access.
Pipe Gallery	5	We noted water condensing on pipes and dripping to the floor. There is a particular concern where the condensation is dripping onto electrical equipment. The overall humidity levels in the Pipe Gallery should be addressed.
Flocculation and Sedimentation Basins	6	HDR reviewed the interior of Floc/Sed Basin #4 during a visit on 9/10/14 while the basin was drained for maintenance. The purpose of our visit was to get an overview of the basin and mixer conditions. Overall, the basin appeared to be in fair condition for its age. Assuming all 4 basins are in similar condition, it appeared that with some repair work, these basins can continue to be used for a long time. Hatch Mott McDonald conducted detailed inspections of the basins and HDR was provided with a copy of their report. Notable items from the report included the following: • Access ladders are rusted and require replacement. • Some precast members were fabricated with insufficient cover and may require repair and patching. • Embedded steel plates are rusting and should be cleaned and painted. • Widespread erosion of cement paste, particularly in walls and columns, was observed at a depth of 3/8” to 1/2”. The report recommends that the areas eroded at depths of 3/8” to 1/2” be repaired by cleaning and applying repair mortar. The report states that other areas (generally floors and ceilings, with 1/8” to 1/4” of erosion) did not require immediate repair, but might be used for 10-15 years before repair is required. Our observations agree with Hatch Mott McDonald’s observations of significant erosion at walls and columns. We believe that the basins will require surface coatings in the next 1 to 5 years to extend their life. There are a number of systems and approaches that can be explored, from repair mortars coupled with epoxies and urethanes to crystalline waterproofing repair products. All of these should be explored and judged against future needs and budget. Depending on future use, and if budgets allow, we believe repairing all surfaces at once (floors, ceilings, walls, and columns) should be explored so that moving forward, all elements of these basins are restored to a “like new” condition with regards to the surface condition.

Flocculation and Sedimentation Basins	6	The following photos depict HDR's general observations of concrete conditions in Floc/Sed Basin #4. These pictures depict the underside of the middle-slab (separating the upper and lower basins), the floor of one of the levels, and a typical wall, respectively:  

Chemical Building	9	At the east wall, two locations were observed where joints in the concrete had opened up, but did not appear to be severe. These can be sealed with a flexible sealant to prevent moisture from infiltrating.
Chemical Building	9	A fan hood on the roof appeared to have been damaged by debris.

Raw Water Vaults	11	Entrances to vaults have wood framed roofs with metal panels on roof and walls. These appear to be in adequate condition, but the condition of the wood should be reviewed periodically for deterioration. 
Clearwells and Exterior Tanks	13	HDR was provided with copies of videos taken at Clearwells 1 and 2, and the Backwash tank. Video was taken primarily of the roofs from access hatches with limited views. We observed the following items in the videos: • Both Clearwells 1 and 2 showed signs of paint deterioration and rust at their roofs, most notably at panel joints. • At Clearwell 1, rust and discoloration was evident at steel members at or below the waterline. The video of Clearwell 2 did not provide similar views to discern. • Clearwell 2 showed more rust and scaling of paint at the roof than Clearwell 1. • The extent of rust and corrosion to the roofs does not appear to be immediately detrimental, but may only require a new coating. An inspection would be required to confirm. • The Backwash Tank surfaces appeared to be in good condition with no major signs of rust and corrosion observed. As steel tanks age, the coatings wear and need to be replaced. Corrosion of roof support members, particularly at connections, is often a concern. If these are allowed to deteriorate severely, they will compromise the structural capacity of the tank roofs. If the clearwell tanks have not been inspected in the past few years, HDR recommends that they be inspected to determine whether coating replacement or structural repairs are required to enable the clearwells to function into the future.

Clearwells	13	Exterior coatings, particularly on the south clearwell, need to be replaced. 
Clearwells	13	The north clearwell roof shows signs of damage. City staff thought that the damage might be attributed to a snow event. If this is true, then it's possible these roofs were not designed for the appropriate snow load and they should be reviewed. However, the 'kinked' nature of the damage suggests that it may have been caused by debris or a crane hitting the tank. These locations should be reviewed more closely both from above and below to determine whether there is structural damage to the roof support members.
Main Plant Exterior and Roof	14	See Architectural SWAT Condition Assessment Memo. There were several locations, particularly on the south and east faces, where veneer is worn or requires tuckpointing and other repair work.

Main Plant Exterior and Roof	14	At the south face of the tall portion of the main building, brick veneer has cracks running through the bricks (as opposed to the mortar joints). These cracks may be due to weathering and freeze thaw. Cracks of this nature are sometimes due to settling as well. The structural drawings should be reviewed to verify whether there is a possibility of a member below deflecting to allow the settlement and the veneer should be repaired. (One crack is noted in the photo below, but other smaller cracks exist, which are not apparent in the photo.)

Main Plant Exterior and Roof	14	Near the exercise room, the veneer is worn and requires tuckpointing.
Main Plant Exterior and Roof	14	Bracing at the monorail beam on the east side of the facility could use a new coat of paint, but appeared satisfactory otherwise.

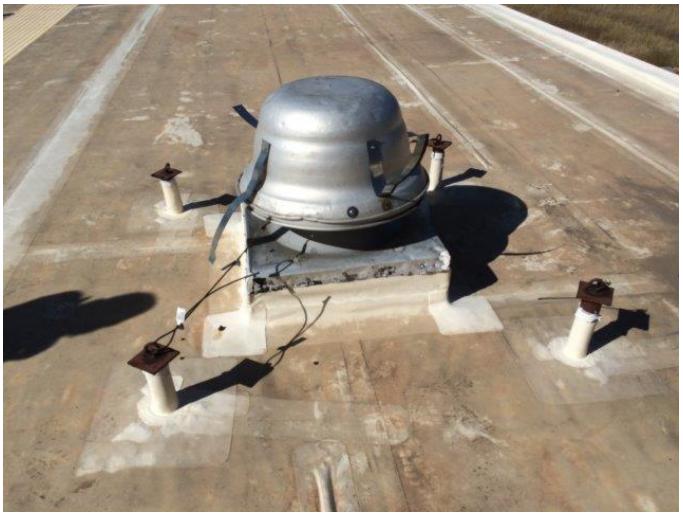
Main Plant Exterior and Roof	14	At several rooftop equipment locations, cable tie-downs were loose or were missing. Where equipment is intended to be tied down, HDR recommends that cables be tightened or replaced. 

Photo 5: Manually operated Lime Room exhaust fan.

Photo 6: Outside louver, supply fan and duct heater for laboratory fume hood.

Photo 7: Old boiler should be removed.

Photo 8: Heating water pumps - red pumps serve Zone 1 and blue pumps serve Zone 2.

Photo 9: Three way control valve for coil in MAU-1

Photo 10: Laars modulator boilers installed in 2012.

Photo 11: Ductwork damage do to use as working platform for valve actuator access.

Photo12: PVC house water line sagging between hangers.

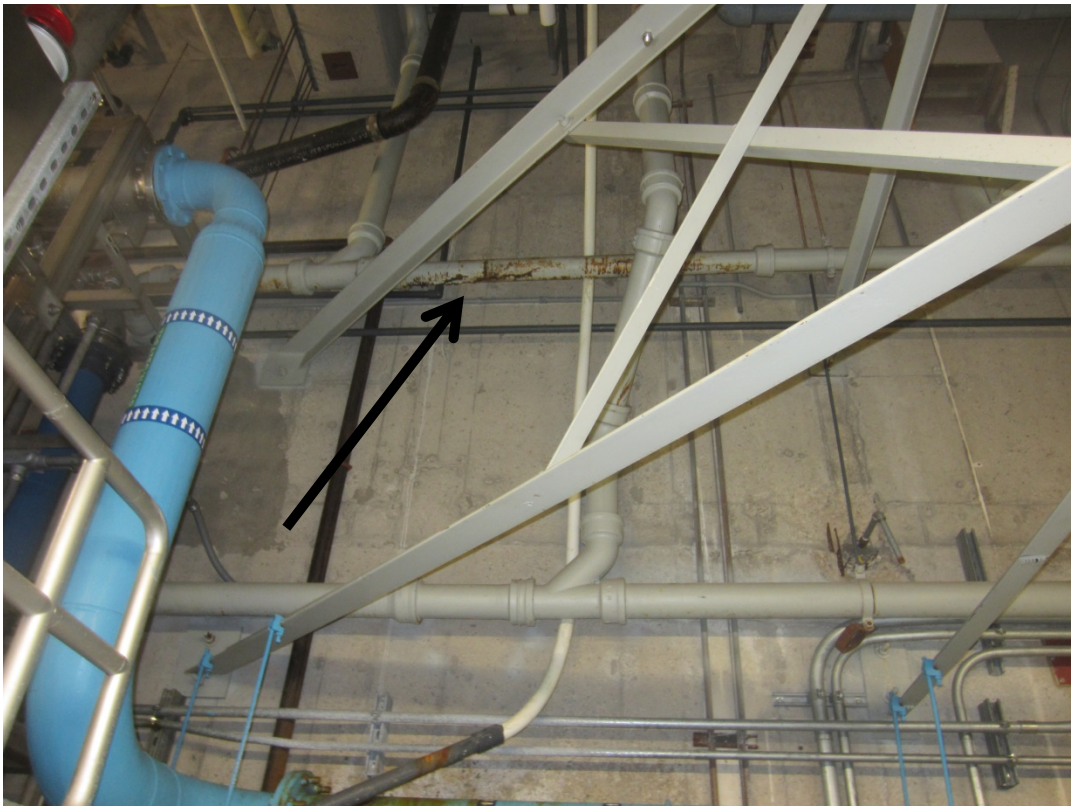


Photo 13 Compromised sanitary piping should be replaced (black arrow).

Photo 14 Abandoned air line folded and crimped.

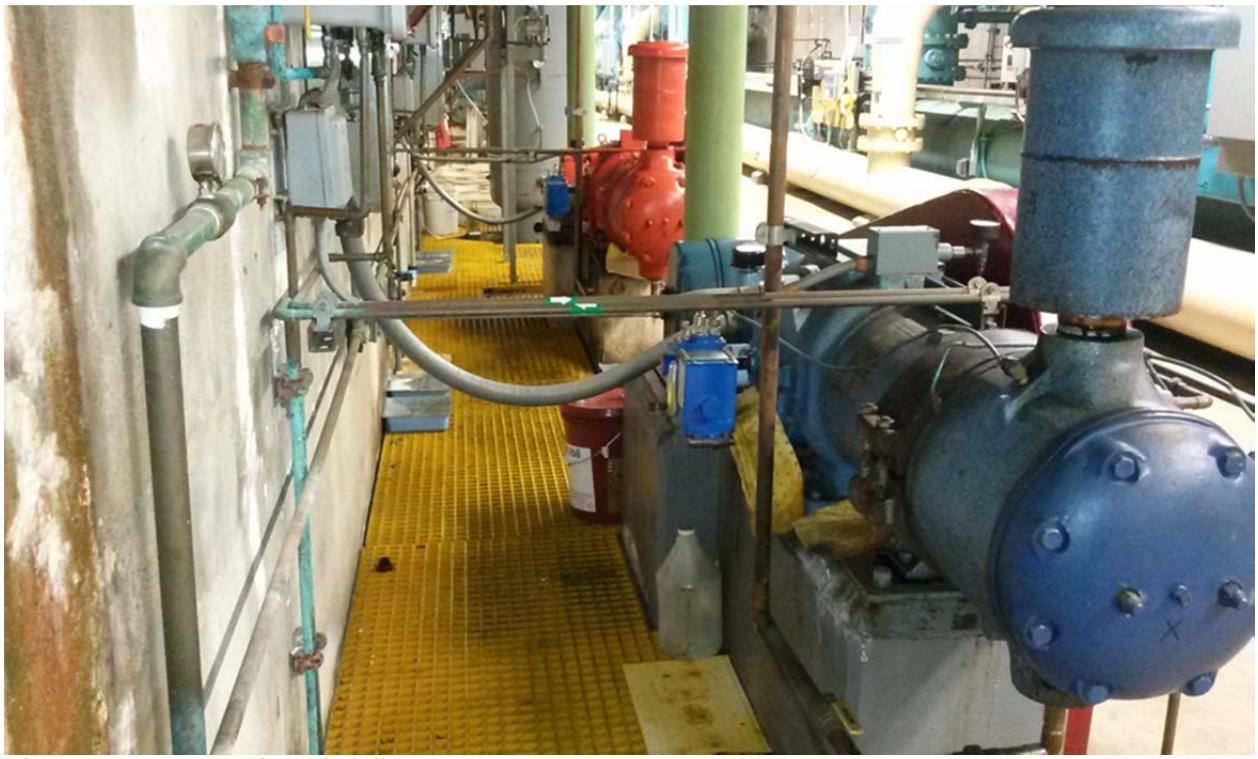


Photo 15: Copper and steel air lines.

Photo 16: Main compressors are 50 years old.

Photo 17: Compressed air dryer.

Photo 18: Small generator; louver on same wall as radiator. Air short-circuits and does not cool the generator.