



LETTER OF TRANSMITTAL

To: NCDENR DWQ Aquifer Protection Section
 512 N. Salisbury St.
 Raleigh, NC 27604

ATTENTION: Mr. Nathaniel D. Thornburg

DATE January 31, 2013

PROJECT NO: 1488-0032 TASK NO:

RE: WQ0023896 Add. Info. Request #2 Response
 UNC-CH Bingham Facility
 Wastewater Irrigation System
 Orange County

TRANSMITTAL NO: PAGE 1 OF 1

WE ARE SENDING: Originals Prints Shop Drawings Samples
 Specifications Calculations Other -

Quantity	Drawing No.	Rev.	Description	Status
4			Revised Application Form and Supporting Documentation	G
4			Design Calculation Manual Amendment No. 1	G
4			Technical Specifications	G
4			Project Drawings (full size)	G
2			CD-R w/ 11x17 PDF Project Drawings	G

Issue Status Code: A. Preliminary B. Fabrication Only C. For Information D. Bid
 E. Construction F. For Review & Comments G. For Approval H. See Remarks

Action Status Code: 1. No Exceptions Taken 2. Make Corrections Noted 3. Other
 4. Amend & Resubmit 5. Rejected - See Remarks

REMARKS:

RECEIVED/DENR/DWQ

JAN 31 2013

Aquifer Protection Section

1730 Varsity Drive Suite 500, Raleigh, NC 27606 919/233-8091 Fax 919/233-8031

cc: File

McKIM & CREED, PA

Signed Stephanie Kellogg
 Stephanie Kellogg, EA

THE UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL

**UNC-BINGHAM FACILITY
WASTEWATER SURFACE IRRIGATION PROJECT**

**DWQ PERMIT NUMBER WQ0023896
RESPONSES TO ADDITIONAL INFORMATION REQUEST #2
REVISED APPLICATION FORM AND SUPPORTING DOCUMENTATION**

JANUARY 2013



Prepared By:

McKim & Creed, Inc.
1730 Varsity Drive, Suite 500
Raleigh, NC 27606

JAN 31 2013



The University of North Carolina at Chapel Hill
Department of Environment, Health & Safety
1120 Estes Drive Ext., CB# 1650
Chapel Hill, North Carolina 27599-1650

January 31, 2013

Mr. Nathaniel D. Thornburg
North Carolina Department of Environment and Natural Resources
Division of Water Quality
Aquifer Protection Section
Land Application Unit
1636 Mail Service Center
Raleigh, NC 27699-1636

RE: Application No. WQ0023896 UNC-CH Bingham Facility
Additional Information Submittal #2
UNC-CH Bingham Facility
Wastewater Irrigation System
Orange County

Dear Mr. Thornburg:

We received your December 6, 2012 letter "Additional Information Request #2" in connection with UNC-CH Application WQ0023896. We have reviewed your comments and have addressed each of your specific comments in the order that you presented them. Your comments are provided in italics and our responses follow.

General Comments:

Item 1:

Per the Attorney General's Office determination that a public school bus stop is a "place of public assembly," UNC-CH shall determine the exact location of this bus stop and provide setbacks accordingly. If UNC-CH intends to continue to use spray irrigation as a disposal method, then a minimum setback of 400 feet shall be provided to this bus stop. If UNC-CH elects to use drip irrigation as a disposal method in this affected area, then the setback shall be at least 100 feet. Please note that while the Division will not require a flow reduction, it is suggested that UNC-CH reevaluate the amount of wastewater generated at this facility, and potentially submit a flow reduction request in order to reduce the facility's permitted flow and subsequently the amount of irrigation area needed. Amend the application, plans, site map, etc., accordingly.

In consultation with the Orange County School System, the locations of the existing school bus stops on Orange Chapel Clover Garden Road are shown on the revised Site Map in Tab #2 of this application resubmittal package. Since the bus stops were deemed "places of public assembly" and the spray irrigation system is not in compliance with the 400 foot setback required by 15A NCAC 02T .0506.a from the school bus stops, UNC-CH made the decision to redesign the spray irrigation system to a drip irrigation system. The required setback for the drip irrigation system is 100 feet from the school bus stops. The 100 foot setback from the school bus stops is shown on the Site Map in Tab #2. Since UNC-CH chose to redesign to drip irrigation in lieu of submitting a flow reduction request, the design capacity and application criteria of the drip irrigation system will be the same as the spray irrigation system. The licensed soil scientists and hydrogeologists on the project, Edwin Andrews & Associates, P.C., evaluated the switch to a drip irrigation system and the proposed application rates, and a letter stating their concurrence with the design is present in Tab #8. The plans and specifications for the drip irrigation system have been revised accordingly, and these documents are submitted under separate

cover for review and permitting. In addition, the permit application, in Tab #1, has been amended to reflect the proposed drip irrigation system.

Item 2:

Amend the proposed monitoring well network to include additional wells on the review boundary to the southwest and south of the irrigation field to help ensure that any groundwater contamination flow in the direction of adjacent residences is detected prior to reaching the Bingham facility's compliance boundary located within the property boundary. Amend the application, plans, and site map accordingly.

The Site Map in Tab #2 has been revised to include two (2) additional sentinel monitoring wells to the southwest and south of the irrigation fields to help ensure that any impacted groundwater flow in the direction of the adjacent residences is detected prior to the compliance boundary. In consultation with DWQ on 01/09/13, proposed monitoring well #1 was relocated to the south of the wet weather storage basin to monitor groundwater quality in the vicinity of the wet weather storage basin. The permit application and plans and specifications have been revised accordingly.

Item 3:

Amend the monitoring plan to include upstream and downstream surface water monitoring stations for all surface waters located on the property. Each monitoring location shall be at the upstream and downstream sites closest to UNC-CH's property line with adjoining neighbors. These stations shall monitor for BOD₅, pH, Dissolved Oxygen, Total Nitrogen and Total Phosphorus, and are meant to quantify UNC-CH's impacts (if any) on surface waters while on their property. Amend the plans and site map to denote the location of these surface water monitoring stations.

The Site Map in Tab #2 has been revised to include two (2) upstream and two (2) downstream surface water monitoring stations along the unnamed tributaries of Collins Creek. Each monitoring station has been located at the upstream and downstream sites closest to UNC-CH's property line and that of adjoining neighbors. The data from these four sampling stations will provide information regarding surface water quality in the tributaries of Collins Creek as the streams enter, cross, and exit the UNC-CH Bingham Facility. Surface water samples will be collected twice per calendar year, with one sampling event occurring in the winter and the second event occurring in the summer. To ensure that the samples are representative of water within the stream corridor, they will not be collected during a precipitation event. Samples will be collected when flow is present in the streams. Surface water samples will be analyzed for 5-day biochemical oxygen demand (BOD₅), pH, dissolved oxygen, total nitrogen, and total phosphorus. The permit application and the plans have been revised to show these sampling locations.

It is noted that pre-construction background samples will be collected, and it is our understanding that DENR will entertain a request to discontinue the surface water monitoring program if no downstream water quality impacts are documented after one full year of operation.

Item 4:

Provide a Priority Pollutant Analysis on a representative sample of the Bingham Facility's currently generated wastewater.

A representative sample of the wastewater was collected at the current pump and haul location, and an EPA priority pollutant analysis was conducted by a certified laboratory. Results of the analysis are included in Tab #3 and are further addressed in the Item 7 section below.

Item 5:

Provide a disclosure and identification of any radio-isotopes or known carcinogens that may be present in the wastewater, as well as a discussion about the treatment effectiveness of these contaminants (if present) by the proposed wastewater treatment system.

The Bingham Facility, formerly known as Research Resource Facility and Animal Care Facility before that, was never licensed for dispersible radioactive materials use or research in its known history either through UNC's broad-scope academic Radioactive Materials License (#068-0214-1) issued by the Department of Health and Human Services, Radiation Protection Section or by the Radiation Safety Section of the Department of Environment Health and Safety (who administers the license). Any future use of radioactive materials (which has not been indicated) would be subject to Radiation Safety Committee approval, amendment of the UNC broad-scope license, and subsequent issuance of an internal source license issued by the Radiation Safety Section.

Based on the results of the priority pollutant analysis and our review of the material safety data sheets (MSDS) for all substances used at the UNC-CH Bingham Facility, we are not aware of any known carcinogens that may be present in the wastewater at this facility.

The Bingham Facility will be used as a dry bedding animal holding facility. All large and small research animals (e.g. caged rodents) will be housed on dry bedding. Currently, carcinogenesis studies are not conducted at the Bingham Facility. If future carcinogenesis studies are proposed (e.g. animals are to be dosed with known carcinogens) then the appropriate approval by UNC Environment Health and Safety is required prior to beginning the study to determine proper handling of animal waste. Animals will be treated with veterinary drugs on occasion to maintain animal health (e.g. vitamins, minerals, antimicrobials, antiparasitics, antifungals, steroids, antihistamines, psychotropic drugs, etc.). Animal liquid and solid waste will be captured via disposable dry bedding such that the animal waste will not be discharged to the on-site sewer system.

Item 6:

Submit a description of the type(s) and amount(s) of surfactants used in the dishwasher, laundry washer, cage washer and wet lab facilities.

A list of the types and amounts of surfactants used at UNC-CH Bingham Facility is included in Tab #4.

Item 7:

Based on Items #4, 5 and 6 above, submit verification that the proposed wastewater treatment system is capable of treating to secondary standards, as well as its effectiveness at removing any identified pollutants of concern.

An evaluation was conducted on the capability of the proposed wastewater treatment system to meet secondary treatment standards as well as the impact / removal of the applicable pollutants identified in Items 4, 5, and 6 above. This written performance evaluation is included in Tab #5.

Item 8:

Provide at least one year's worth of groundwater usage flows from the onsite water supply well. If these values are not available, UNC-CH shall at a minimum provide one year's worth of wastewater effluent flow records.

A table showing the daily groundwater usage in gallons from the onsite water supply well at the UNC Bingham Facility from December 2011 to November 2012 is included in Tab #6.

Item 9:

Provide an amended Operation and Maintenance (O&M) plan to address the following concerns:

- *Description of the operation of the system in sufficient detail to show what operations are necessary for the system to function and by whom the functions are to be conducted.*
- *Description of anticipated maintenance of the system.*
- *Include provisions for safety measures including restriction of access to the site and equipment.*
- *Include spill control provisions such as response to upsets and bypasses including control, containment and remediation, as well as contact information for plant personnel, emergency responders and regulatory agencies.*

In addition, amend the O&M Plan to reflect the proposed system design that specifically addresses at a minimum: safety and notification protocols; emergency plans associated with the chlorine disinfection system; emergency contacts; and operation and maintenance of the facility during severe weather related events.

The Operation and Maintenance (O&M) Plan was revised to address the following concerns:

1. Description of the operation of the system in sufficient detail to show what operations are necessary for the system to function and by whom the functions are to be conducted.
2. Description of anticipated maintenance of the system.
3. Include provisions for safety measures including restrictions of access to the site and safety equipment.
4. Include spill control provisions such as upsets and bypasses including control, containment and remediation, as well as contact information for plant personnel, emergency responders and regulatory agencies.

The O&M plan was amended to reflect the proposed system design and specifically addresses the following: safety and notification protocols, emergency plans associated with the chlorine disinfection system, emergency contacts, and operation and maintenance of the facility during severe weather related events.

The revised O&M Plan is included in Tab#7.

Additional Information Submittal Tabs:

- Tab #1 – Amended Permit Application Form WWIS 12-06
- Tab #2 – Revised Site Map
- Tab #3 – Priority Pollutant Analysis
- Tab #4 - List of Surfactants and Quantities used at UNC-CH Bingham Facility

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Tab #5 – Performance Evaluation of Proposed Wastewater Treatment System
Tab #6 – Daily Potable Well Water Usage (December 2011 – November 2012)
Tab #7 – Amended Operation and Maintenance Plan
Tab #8 – Hydrogeologist and Soil Scientist Letter of Concurrence

If you have any questions about this submittal or require additional information, please contact me at 919-843-5913 or mbkoza@ehs.unc.edu.

Sincerely,

A handwritten signature in cursive script that reads "Mary Beth Koza".

Mary Beth Koza
Director of the Department of Environment, Health, and Safety
The University of North Carolina at Chapel Hill

cc: Chuck Riley, Jr. PE, McKim & Creed, Inc.



State of North Carolina
Department of Environment and Natural Resources
Division of Water Quality

WASTEWATER IRRIGATION SYSTEMS APPLICATION
INSTRUCTIONS FOR FORM: WWIS 12-06

The Division of Water Quality (Division) will not accept this application package unless all the instructions are followed. Plans, specifications and supporting documents shall be prepared in accordance with 15A NCAC 02T .0100, 15A NCAC 02T .0500 and good engineering practices. Failure to submit all of the required items will lead to additional processing and review time for the permit application.

For more information, links to forms requested in this application, or for an electronic version of this form, visit the Land Application Unit (LAU) web site at: <http://portal.ncdenr.org/web/wq/aps/lau>

A. Application Form (All Application Packages):

- ✓ Submit one (1) original and three (3) copies of the completed and appropriately executed application form. The instructions (Pages 1 through 4) need not be submitted. Any content changes made to this form will result in the application package being returned. The Division will only accept application packages that have been fully completed with all applicable items addressed.
- ✓ If the Applicant is a corporation or company, it must be registered for business with the NC Secretary of State (<http://www.secretary.state.nc.us/Corporations/CSearch.aspx>).
- ✓ If the Applicant is a partnership, sole proprietorship, trade name, or d/b/a, enclose a copy of the certificate filed with the Register of Deeds in the county of business.
- ✓ The application must be signed appropriately in accordance with 15A NCAC 02T .0106(b). An alternate person may be designated as the signing official, provided that a delegation letter is provided from a person who meets the referenced criteria.
- ✓ The facility name on all forms should be consistent with the facility name on the plans, specifications, agreements, etc.
- ✓ If this project involves a modification of an existing irrigation system, submit four (4) copies of the most recently issued existing permit.
- ✓ If this project is for a renewal without modification, please use the most recent FORM: NDWWSR, which can be downloaded at: <http://portal.ncdenr.org/web/wq/aps/lau/applications#Irrigation>.

B. Attachment (All New or Major Modification Application Packages):

- ✓ Submit a completed and properly executed Watershed Classification Attachment (FORM: WSCA), along with the 8.5" by 11" topographic map locating the facility, for each watershed within the facility location (including irrigation areas). The most recent version of FORM: WSCA may be found at: <http://portal.ncdenr.org/web/wq/aps/lau/applications#Agreements>.

C. Application Fee (All New or Major Modification Application Packages):

- ✓ The appropriate application fee can be determined from the Division's fee schedule found at: <http://portal.ncdenr.org/web/wq/aps/lau/fees>.
- ✓ Submit a check or money order in the appropriate amount made payable to: North Carolina Department of Environment and Natural Resources (NCDENR).

D. Cover Letter (All Application Packages):

- ✓ Submit one (1) original and three (3) copies of a cover letter, which lists all items and attachments included in the application package as well as a brief description of the requested permitting action.
- ✓ If necessary for clarity, include attachments to the application. Such attachments will be considered part of the application package and should be numbered to correspond to the section to which they refer.

E. Property Ownership Documentation (All New or Modification Application Packages involving new and/or relocated treatment or irrigation components):

- ✓ Provide either:
 - ✓ Legal documentation of the ownership (such as a contract, deed, article of incorporation, etc.) of the property, or
 - ✓ Written notarized agreement signed by both parties indicating future purchase of the property by the permit applicant and a plat or survey map showing the property, or
 - ✓ Written notarized long term lease agreement signed by both parties and specifically indicating intended use of the property and a plat or survey map showing the property addressed in the lease.

F. Environmental Assessments (May be required if public lands and/or monies are used – See 15A NCAC 1C .0100 to .0400):

- ✓ Submit one (1) copy of the Findings of No Significant Impact (FONSI) or Environmental Impact Statement (EIS).
- ✓ Include information on any mitigating factor(s) from the Environmental Assessment (EA) that impact the design and/or construction of the wastewater treatment and disposal system.

- G. **Certificates of Public Convenience and Necessity** (All New Application Packages if the applicant is a Privately-Owned Public Utility per determination by the NC Utilities Commission: <http://www.ncuc.commerce.state.nc.us/>):
- ✓ Submit four (4) copies of the Certificate of Public Convenience and Necessity, which demonstrates that the public utility is authorized to hold the utility franchise for the area to be served by the wastewater system.
 - ✓ If a Certificate of Public Convenience and Necessity has not been issued, provide four (4) copies of a letter from the NC Utilities Commission's Public Staff that states that an application for a franchise has been received, that the service area is contiguous to an existing franchised area, and/or that franchise approval is expected.
- H. **Operational Agreements** (All New Application Packages if the applicant is a Homeowners' Association, or a Developer and lots are to be sold):
- ✓ Submit one (1) original and three (3) copies of a properly executed operational agreement if the irrigation system will be serving, or currently serves, residential or commercial lots that are to be sold. Appropriate forms can be downloaded at: <http://portal.ncdenr.org/web/wq/aps/lau/applications#Agreements>.
 - ✓ If applicant is a HOMEOWNERS' ASSOCIATION, use the most recent version of FORM: HOA, and submit the following information: articles of incorporation, bylaws, and current or proposed annual budget.
 - ✓ If applicant is a DEVELOPER that intends to turn ownership and responsibility of the wastewater system over to a homeowners' association, submit the most recent version of FORM: DEV.
- I. **Analysis of Wastewater** (All New Application Packages or Modifications that are not 100% Domestic Waste):
- ✓ Submit four (4) copies of a complete chemical analysis of the effluent wastewater including but not limited to the following parameters: Total Organic Carbon, 5-day Biochemical Oxygen Demand (BOD₅), Chemical Oxygen Demand (COD), Nitrate Nitrogen (NO₃-N), Ammonia Nitrogen (NH₃-N), Total Kjeldahl Nitrogen (TKN), pH, Chloride, Total Phosphorus, Phenol, Total Volatile Organic Compounds, Fecal Coliform, Calcium, Sodium, Magnesium, Sodium Adsorption Ratio (SAR), Total Trihalomethanes, Toxicity Test Parameters and Total Dissolved Solids in compliance with 15A NCAC 02T.0504(h).
 - ✓ A laboratory certified by the Division shall perform all testing.
- J. **Soil Evaluation** (All New Application Packages or Modifications that include new irrigation sites):
- ✓ Submit four (4) copies of a detailed soil evaluation in accordance with 15A NCAC 02T .0504(b) and current Division Policy available at: <http://portal.ncdenr.org/web/wq/aps/lau/policies>.
- K. **Water Balance** (All New Application Packages or Modifications that include new irrigation sites):
- ✓ Submit four (4) copies of a completed and accurate water balance in accordance with 15A NCAC 02T .0504(k) and current Division Policy available at: <http://portal.ncdenr.org/web/wq/aps/lau/policies>.
- L. **Agronomist Evaluation** (All New Application Packages or Modifications that include new irrigation sites or new cropping patterns for existing irrigation sites):
- ✓ Submit four (4) copies of a detailed agronomist evaluation in accordance with 15A NCAC 02T .0504(i).
- M. **Hydrogeologic Report** (All facilities treating industrial waste, and New Application Packages with Design Flows over 25,000 GPD or Modifications involving increasing the total design flow to over 25,000 GPD):
- ✓ Submit four (4) copies of a detailed hydrogeologic evaluation in accordance with 15A NCAC 02T .0504(e) and current Division Policy available at: <http://portal.ncdenr.org/web/wq/aps/lau/policies>.
- N. **Detailed Plans** (All New or Modification Application Packages):
- ✓ Submit four (4) sets of standard size plans and two (2) sets of 11" by 17" plans (electronic format is acceptable - Adobe PDF only) that have been signed, sealed, and dated by a NC licensed Professional Engineer in accordance with 15A NCAC 02T .0504(c) and (d). For Modifications, submit plans specific to the modification(s) only.
 - ✓ Plans must include the following minimum items:
 - ✓ A general location map, a vicinity map and a topographic map.
 - ✓ Plan and profile views of all treatment/storage/disposal units, piping, valves, and equipment (i.e., pumps, blowers, mixers, diffusers, flow meters, etc.) including dimensions and elevations of all treatment/storage/disposal units.
 - ✓ Hydraulic profile from the treatment plant headworks to the highest disposal point.
 - ✓ Highest drip/spray irrigation nozzle/emitter, locations within the irrigation system of air releases and system drains, locations within the irrigation system of all control valves, and other essential equipment.
 - ✓ For automated spray/drip irrigation systems, the design must include equipment to prevent spray/drip irrigation during precipitation events or when the soil is in a condition that the spray/drip irrigation wastewater could not be assimilated.
 - ✓ A map showing the entire irrigation area with an overlay of the suitable irrigation area depicted by the soil scientist's evaluation. The irrigation plans shall show each nozzle/emitter and wetted area (when applicable). Clearly label spray/drip irrigation zones as they will be operated.
 - ✓ Plans must depict a completed design and not be labeled with preliminary phrases (e.g., FOR REVIEW ONLY, NOT FOR CONSTRUCTION, etc.) that indicate that they are anything other than final plans. However, the plans may be labeled with the phrase: FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION.

O. **Site Map** (All New or Modification Application Packages):

- ✓ Submit four (4) copies of a standard size site map and two (2) copies of an 11" by 17" site map (electronic format is acceptable - Adobe PDF only) that have been signed, sealed, and dated by a NC licensed Professional Engineer and/or Professional Land Surveyor in accordance with 15A NCAC 02T .0504(d). For Modifications, submit an updated site map specific to the modification(s) only.
- ✓ The site map shall include the following minimum items:
 - ✓ A scaled map of the site, with topographic contour intervals not exceeding 10 feet or 25 percent of total site relief and showing all facility-related structures and fences within the treatment, storage and disposal areas.
 - ✓ Soil mapping units shown on all disposal sites.
 - ✓ The location of all wells (including usage and construction details if available), streams (ephemeral, intermittent, and perennial), springs, lakes, ponds, and other surface drainage features within 500 feet of all waste treatment, storage, and disposal site(s).
 - ✓ Delineation of the review and compliance boundaries.
 - ✓ Setbacks as required by 15A NCAC 02T .0506.
 - ✓ Site property boundaries within 500 feet of all waste treatment, storage, and disposal site(s).
 - ✓ All habitable residences or places of public assembly within 500 feet of all waste treatment, storage, and disposal site(s).

P. **Specifications** (All New or Modification Application Packages):

- ✓ Submit four (4) sets of specifications that have been signed, sealed, and dated by a NC licensed Professional Engineer in accordance with 15A NCAC 02T .0504(c). For Modifications, submit specifications specific to the modification(s) only.
- ✓ Specifications must include the following minimum items:
 - ✓ Detailed specifications for each treatment/storage/disposal unit, piping, valves, equipment (i.e., pumps, blowers, mixers, diffusers, flow meters, etc.), nozzles/emitters (if applicable), precipitation/soil moisture sensor (if applicable), audible/visual high water alarms, etc.
 - ✓ Site Work (i.e., earthwork, clearing and grubbing, excavation and backfill, fencing, seeding, etc.)
 - ✓ Materials (i.e., concrete, masonry, steel, method of construction, etc.)
 - ✓ Mechanical and Electrical (i.e., control panels, transfer switches, generator, etc.)
 - ✓ Means for ensuring quality and integrity of the finished product including leakage and pressure testing.
 - ✓ Specifications must represent a completed design and not be labeled with preliminary phrases (e.g., FOR REVIEW ONLY, NOT FOR CONSTRUCTION, etc.) that indicate that they are anything other than final specifications. However, the specifications may be labeled with the phrase: FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION.

Q. **Engineering Calculations** (All New or Modification Application Packages):

- ✓ Submit four (4) copies of all design calculations that have been signed, sealed, and dated by a NC licensed Professional Engineer in accordance with 15A NCAC 02T .0504(c). For Modifications, submit calculations specific to the modification(s) only.
- ✓ Calculations must include the following minimum items:
 - ✓ Hydraulic and pollutant loading calculations for each treatment unit (Note: "black box" calculations are unacceptable).
 - ✓ Sizing criteria for each treatment unit and associated equipment.
 - ✓ Friction/total dynamic head calculations and system curve analysis for each pump used.
 - ✓ Pump selection information including pump curves.
 - ✓ Manufacturer's information for all packaged treatment units, pumps, blowers, mixers, diffusers, flow meters, etc.
 - ✓ Flotation calculations for all tanks constructed partially or entirely below grade.
 - ✓ Submit the selected drip/spray irrigation system information including manufacturer's information and recommended installation guidelines.
 - ✓ Irrigation pump capacity should consider reasonable operational control, address multiple zones of the irrigation system, address variability of nozzle sizing as necessary, and include the ability to irrigate all areas in an appropriate amount of time.

R. **Reliability** (All New or Major Modification Application Packages):

- ✓ Submit documentation of system reliability in accordance with 15A NCAC 02T .0505(l).
- ✓ Ensure that the plans and specifications detail the generator, the automatic transfer switch, and how these items interact with the system instrumentation/controls.
- ✓ All generators must be capable of powering all essential treatment units.

- S. **Operation and Maintenance Plan** (All New or Major Modification Application Packages):
- ✓ Submit four (4) copies of an operation and maintenance plan in accordance with 15A NCAC 02T .0507 that shall be maintained for all systems and include at a minimum:
 - ✓ Description of the operation of the system in sufficient detail to show what operations are necessary for the system to function and by whom the functions are to be conducted.
 - ✓ Description of anticipated maintenance.
 - ✓ Include safety measures including restriction of access to the site and equipment.
 - ✓ Spill prevention provisions such as response to upsets and bypasses including how to control, contain and remediate.
 - ✓ Contact information for plant personnel, emergency responders and regulatory agencies.
- T. **Residuals Management Plan** (All New or Modification Application Packages that include new treatment systems or an expansion of the treatment system):
- ✓ Submit a detailed explanation describing how the residuals (including trash, sediment and grit) that are generated by the wastewater treatment system will be stored, treated, and disposed, in accordance with 15A NCAC 02T .0504(j) and 15A NCAC 02T .0508.
 - ✓ An evaluation of the residuals storage requirements for the treatment facility based upon the maximum anticipated residuals production rate and ability to remove residuals.
 - ✓ A permit for residuals utilization or a written commitment to the Permittee of a Department approved residuals disposal/utilization program accepting the residuals which demonstrates that the approved program has adequate capacity to accept the residuals, or that an application for approval has been submitted
 - ✓ If oil or grease removal and collection is a designed unit process, please submit an oil/grease disposal plan.
 - ✓ If an on-site restaurant or other business with food preparation is contributing waste to this system an oil/grease disposal plan will be necessary. Please note that operation and maintenance of all grease traps will be the responsibility of the permittee.
- U. **General** (All New or Modification Application Packages):
- ✓ Please ensure that any systems within the Coastal Area as defined in 15A NCAC 2H .0400 meet all requirements required by that Section.
 - ✓ Note that all designs and documentation must conform to all state and federal rules and regulations.
 - ✓ Note that if other approvals are necessary for the construction of these facilities (i.e. Wetlands, Stormwater, Dam Safety, etc) the Division may hold approval of this application package to coordinate with other approvals.
 - ✓ Provide documentation of floodway compliance in accordance with 15A NCAC 02T .0105(c)(8)
 - ✓ Sewers tributary to the subject facilities must be applied for separately from this application in accordance with the Surface Water Protection Section's requirements (<http://portal.ncdenr.org/web/wq/swp/ps/cs>).

**THE COMPLETED APPLICATION PACKAGE, INCLUDING ALL SUPPORTING INFORMATION AND MATERIALS,
SHOULD BE SENT TO THE FOLLOWING ADDRESS:**

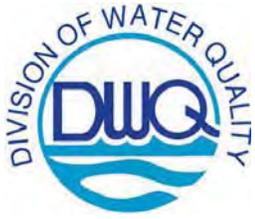
**NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
DIVISION OF WATER QUALITY
AQUIFER PROTECTION SECTION
LAND APPLICATION UNIT**

**By U.S. Postal Service:
1636 MAIL SERVICE CENTER
RALEIGH, NORTH CAROLINA 27699-1636**

**By Courier/Special Delivery:
2728 CAPITAL BOULEVARD
RALEIGH, NORTH CAROLINA 27604**

TELEPHONE NUMBER: (919) 733-3221

FAX NUMBER: (919) 715-6048



State of North Carolina
Department of Environment and Natural Resources
Division of Water Quality

WASTEWATER IRRIGATION SYSTEMS APPLICATION
FORM: WWIS 12-06

(THIS FORM MAY BE PHOTOCOPIED FOR USE AS AN ORIGINAL)

Application Number: _____ (to be completed by DWQ)

I. GENERAL INFORMATION:

1. Applicant's name (**See Instruction A**): The University of North Carolina at Chapel Hill
 Applicant type: Individual Corporation General Partnership Privately Owned Public Utility
 Federal State Municipal County
 Signature authority's name: Karol Kain Gray (per 15A NCAC 02T .0106) Title: Vice Chancellor Finance & Administration
 Applicant's mailing address: The University of North Carolina at Chapel Hill, CB#1000, 302A South Building
 City: Chapel Hill State: NC Zip: 27599-1000
 Telephone number: (919) 962-3795 Fax number: (919) 962-0647 Email Address: kkgray@unc.edu

2. Facility name (name of the subdivision, shopping center, etc.): UNC-CH Bingham Facility
 Facility's physical address: 1907 Orange Chapel Clover Garden Road
 City: Chapel Hill State: NC Zip: 27516-_____ County: Orange
 Wastewater Treatment Facility: Latitude: 35 54' 09 Longitude: -79 14' 18" USGS Map Name: White Cross

3. Consulting Engineer's name: Charles D. Riley, Jr. License Number: 013260 Firm: McKim & Creed
 Engineer's mailing address: McKim & Creed, Venture IV Building, Suite 500, 1730 Varsity Drive
 City: Raleigh State: NC Zip: 27606-_____
 Telephone number: (919) 233-8091 Fax number: (919) 233-8031 Email Address: criley@mckimcreed.com

4. Consulting Soil Scientist's name: Scott J. Frederick License Number: 1236 Firm: Soil, Water, & Environment Group, PLLC
 Soil Scientist's mailing address: 3216 Byers Drive, Suite B
 City: Raleigh State: NC Zip: 27607-_____
 Telephone number: (919) 831-1234 Fax number: (919) 899-9100 Email Address: sjfrederick@swegrp.com

5. Consulting Geologist's name: Edwin Andrews License Number: G-224 Firm: Edwin Andrews & Associates
 Geologist's mailing address: PO Box 30653
 City: Raleigh State: NC Zip: 27622-_____
 Telephone number: (919) 851-7844 Fax number: (919) 851-6058 Email Address: andwater@aol.com

6. Consulting Agronomist's name: Scott J. Frederick Firm: Soil, Water, & Environment Group, PLLC
 Agronomist's mailing address: 3216 Byers Drive, Suite B
 City: Raleigh State: NC Zip: 27606-3601
 Telephone number: (919) 831-1234 Fax number: (919) 899-9100 Email Address: sjfrederick@swegrp.com

II. PERMIT INFORMATION:

1. Project is: New Major Modification Minor Modification

2. Fee submitted: \$245.00 (See Instruction C) Existing Permit No.: WQ0023896, issue date: February 12, 2007

3. Facility status: Existing Proposed

Was this system approved for reclaimed disposal under 15A NCAC 2H .0219(k)? Yes or No

4. Does this project utilize: public funds and/or private funds; public lands and/or private lands

5. What is the status of the following appropriate permits/certifications?

Permit/Certification	Submitted	Approved	Permit/Certification No.	Agency Reviewer
Erosion & Sedimentation Control Plan	6-2-11	6-17-11	ORANG-2011-010	DLQ
Nationwide 39		5-18-10	SAW-2010-00812	USACE
Wetlands 401	5-27-10	6-25-10	DWQ Project No. 10-0451	DWQ
Stormwater Management Plan	3/25/11	9/19/11	SW5110901	DWQ
Dam Safety	N/A	N/A	N/A	N/A
Sewer System	N/A	N/A	N/A	N/A
Other: Air Permit	5-28-10	6-8-10	03036R14	NCDENR Division of Air Quality

6. Does the project comply with all setbacks found in the river basin rules (15A NCAC 2B .0200)? Yes or No
If no, list non-compliant setbacks: _____

7. Is the project in a Coastal Area as defined per 15A NCAC 2H .0403? Yes or No

If yes, verify that the facility will comply with the following requirements in 15A NCAC 2H .404(g) as applicable:

- ✓ Is aerated flow equalization of at least 25% average daily flow provided? Yes or No
- ✓ How will noise and odor be controlled? _____
- ✓ Are all essential treatment units provided in duplicate? Yes or No
- ✓ Is there an impounded public surface water supply within 500 feet of the wetted area? Yes or No
- ✓ Is there a public shallow ground water supply (less than 50 feet deep) within 500 feet of the facility? Yes or No
- ✓ Is the disposal loading rate greater than 10 gallons per day per square foot (GPD/ft²)? Yes or No
- ✓ How much green area is provided? _____ square feet (ft²)
- ✓ Is the green area shown on the plans? Yes or No

III. INFORMATION ON WASTEWATER GENERATION:

1. What is the origin of the wastewater (i.e., school, subdivision, hospital, municipality, shopping center, industry, apartments, condominiums, etc.)? The UNC-CH Bingham Facility is an animal research facility that has historically housed canines for medical research as well as other animals that were occasionally held at the Bingham Facility for a limited time. As a result, the wastewater treated onsite was a combination of domestic wastewater from employees and animal wastewater. Currently, the Bingham Facility is being re-purposed as a dry-bedding animal holding facility and will initially house caged rodents. However, larger animals may also be housed at the facility under the condition that all liquid and solid waste will be captured via disposable dry bedding such that none of the animal waste will be discharged to the on-site sewer system. With the re-purposing of the facility as a dry bedding animal holding facility, the primary sources of wastewater generated at the facility will be from personnel working at the facility; therefore, the wastewater will be typical domestic strength wastewater. Wastewater sources include toilets, dishwasher, laundry washers, and showers. Other sources include wash water from an animal cage washer, holding room washdown water, wet lab sinks, spent brine from small softener systems, and small amounts of boiler blow-down water.
2. Volume of wastewater flow for this project: 3,556 gallons per day (GPD)
3. Explanation of how wastewater flow was determined (15A NCAC 02T .0114(c)): This is the permitted flow for the existing domestic wastewater treatment and disposal system.
4. Table 1 - Composite & Design Wastewater Characterization

Wastewater Source	Qty	Unit Flow (GPD)	Total Flow (GPD)	BOD (mg/l)	TSS (mg/l)	TKN (mg/l)	TP (mg/l)
People	15	35	525	250	180	40	7
Dishwasher	1	375	375	200	50	40	7
Laundry Washer	2	500	1000	200	50	40	7
Cage Washer	1	140	140	20	20	10	7
Wet Lab	2	200	400	200	50	40	7
Softener Brine	2	80	160	25	30	50	7
Boiler Blow down	2	25	50	50	40	50	7
Calculated Composite			2,650	187	73	39	7
Design			3,556	250	200	40	7

BOD – Biochemical Oxygen Demand, TSS – Total Suspended Solids, TKN – Total Kjeldahl Nitrogen, TP – Total Phosphorus

5. Nature of wastewater: 100% Domestic Waste (residential, commercial, etc)
 100% Industrial
 Combination of Industrial and Domestic Waste: _____% Domestic _____% Industrial
 Municipal waste (town, city, etc.)
 ↳ Is there a Pretreatment Program in effect? Yes or No

6. Wastewater characteristics (See 15A NCAC 02T .0505(b)):

Parameter	Estimated Influent Concentration	Designed Effluent Concentration (monthly average)
Biochemical Oxygen Demand (BOD ₅)	250 mg/l	10 mg/l
Total Suspended Solids (TSS)	200 mg/l	10 mg/l
Ammonia Nitrogen (NH ₃ -N)	25 mg/l	15 mg/l
Nitrate Nitrogen (NO ₃ -N)	0 mg/l	10 mg/l
Nitrite Nitrogen (NO ₂ -N)	0 mg/l	0 mg/l
Total Nitrogen	40 mg/l	25 mg/l
Total Phosphorus	7 mg/l	5 mg/l
Total Kjeldhal Nitrogen (Org N + NH ₃)	40	15 mg/l
Fecal Coliforms		200 per 100 ml

IV. GENERAL PROJECT INFORMATION:

1. Brief project description: The UNC Bingham Facility is an animal research facility that has historically housed canines for use in medical research as well as other large & small animals that were occasionally held at the Facility for a limited time. Currently, the Bingham Facility is being re-purposed as a dry-bedding animal holding facility and will initially house caged rodents. However, larger animals may also be housed at the facility under the condition that all liquid and solid waste will be captured via disposable dry bedding such that none of the animal waste will be discharged to the on-site sewer system. With the re-purposing of the facility as a dry bedding animal holding facility, the primary sources of wastewater generated at the re-purposed facility will be from personnel working at the facility. Other sources include wash water from a new animal cage washer, holding room washdown water, wet lab sinks, spent brine from small softener systems, and small amounts of boiler blow-down water.
2. This modification includes the following wastewater system improvements:
 - a. Gravity sewer collection system improvements to deliver raw wastewater generated from all three existing buildings to the existing 8,000 gallon domestic wastewater septic tank. The effluent from the septic tank will be pumped via the existing pump station to the existing 3,556 GPD AdvanTex domestic wastewater treatment facility.
 - b. Refurbish the existing AdvanTex domestic wastewater treatment facility to provide secondary treatment in accordance with 15A NCAC 02T .0500 rules and regulations for wastewater irrigation systems. The existing ultraviolet disinfection system will be removed and replaced with a chlorine contact tank and chlorine chemical feed system to meet disinfection requirements.
 - c. A new secondary effluent pump station will be constructed to pump effluent from the treatment facility to the wet weather storage basin via the existing 3 inch PVC forcemain.
 - d. The existing “animal” wastewater treatment system effluent upset storage basin, located adjacent to the AdvanTex facility, will be refurbished as an emergency 125,000 gallon effluent storage basin which can be used as supplemental wet weather storage. The effluent storage lagoon will be interconnected with the proposed secondary effluent pump station to pump effluent from the basin to the wet weather storage basin.
 - e. The existing 1.6 MG wet weather storage basin will be reconstructed to repair the structurally unstable earthen embankments and reconfigured for a wet weather storage capacity of 1.1 MG gallons. The basin will be constructed with a cement stabilized compacted clay liner to replace the existing damaged synthetic liner.
 - f. The existing irrigation pump station will be refurbished with new irrigation pumps, piping, valves, and electrical equipment to pump to the new drip irrigation system.
 - g. Construct a new low-rate secondary effluent drip irrigation system consisting of four (4) separate drip irrigation zones with a total of approximately 5.72 acres of irrigation area. The drip irrigation system will be designed for dispersal of 3,556 GPD of secondary effluent.

3. In accordance with 15A NCAC 02T .0506, provide the minimum distance in feet from the facility's irrigation system and treatment/storage units to each parameter (distances greater than 500 feet may be marked N/A):

Setback Parameter	Irrigation System	Treatment/Storage Units
Any habitable residence or place of assembly under separate ownership or not to be maintained as part of the project site	250'	320'
Any habitable residence or place of assembly owned by the permittee to be maintained as part of the project site	201'	
Any private or public water supply source	250'	325'
Surface waters (streams – intermittent and perennial, perennial waterbodies, and wetlands)	100'	50'
Groundwater lowering ditches (where the bottom of the ditch intersects the SHWT)	N/A	
Subsurface groundwater lowering drainage systems	N/A	
Surface water diversions (ephemeral streams, waterways, ditches)	100'	
Any well with exception of monitoring wells	250'	325'
Any property line	150'	50'
Top of slope of embankments or cuts of two feet or more in vertical height	N/A	
Any water line from a disposal system	160'	
Any swimming pool	N/A	
Public right of way	150'	
Nitrification field	N/A	
Any building foundation or basement	120'	
Impounded public water supplies	N/A	
Public shallow groundwater supply (less than 50 feet deep)	N/A	

- ✓ Does the Applicant intend on complying with 15A NCAC 02T .0506(c)? Yes or No

If yes, complete the following table:

Parameter	Estimated Influent Concentration	Designed Effluent Concentration (monthly average)	Designed Effluent Concentration (daily maximum)
Biochemical Oxygen Demand (BOD ₅)	mg/l	mg/l	mg/l
Total Suspended Solids (TSS)	mg/l	mg/l	mg/l
Ammonia Nitrogen (NH ₃ -N)	mg/l	mg/l	mg/l
Nitrate Nitrogen (NO ₃ -N)	mg/l	mg/l	
Fecal Coliforms		per 100 ml	per 100 ml
Turbidity			NTUs

- ✓ If any setback is not met, how will the project provide equal or better protection of the Waters of the State with no increased potential for health concerns or nuisance conditions? _____

4. The treatment and disposal facilities must be secured to prevent unauthorized entry. Details and notations of restricted access measures shall be shown on submitted plans and specifications. Briefly describe the measures being taken in accordance with 15A NCAC 02T .0505(q): The system is secured by perimeter fencing with locked access gate.
5. What is the 100-year flood elevation? N/A. Source
- ✓ Are any treatment units or wetted areas located within the 100-year flood plain? Yes or No
- If yes, briefly describe which treatment units and/or irrigation areas are affected: _____, and the measures being taken to protect them against flooding: _____
- If yes, does the Applicant have documentation of compliance with §143 Article 21 Part 6? Yes or No
6. Method to provide system reliability per 15A NCAC 02T .0505(l) (**See Instruction R**): The existing treatment system's standby power generator and automatic transfer switch is adequate to provide emergency power to the wastewater treatment and disposal system.
7. What is the specified method of disinfection? Chlorination using liquid sodium hypochlorite
- ✓ If chlorine, specify detention time provided: 50 minutes (30 minutes minimum required). Please indicate in what part of the wastewater system chlorine contact time occurs (i.e. chlorine contact chamber): Chlorine Contact Chamber
- ✓ If ultraviolet (UV), specify the number of banks: _____, total lamps: _____ and maximum capacity: _____ gpm.
8. How many days of residuals storage are provided (15A NCAC 02T .0505(o))? No residuals storage is required for the proposed AdvanTex system. The septic tank will require pumping every 3 to 5 years to remove solids.

V. DESIGN INFORMATION FOR NEW OR MODIFIED PORTIONS OF THE WASTEWATER TREATMENT FACILITY

1. Type of treatment system (fixed film, suspended growth, etc): Refurbish existing AdvanTex filter system.
2. Provide the number and dimensions of each treatment unit, and provide their location in the specifications and plans. If an item is not applicable, do not fill in the requested information:
 - a. PRELIMINARY TREATMENT (i.e., physical operations such as large solids screening and equalization to remove problem characteristics such as abrasive grit and clogging rags, as well as to dampen high flows):

Treatment Unit	Number of Units	Manufacturer or Material	Dimensions (ft) / Spacings (in)	Volume (gallons)	Plan Sheet Number	Specification Page Number
Select						
Select						
Select						
Select						

- b. PRIMARY TREATMENT (i.e., physical operations such as fine screening and sedimentation to remove floating and settleable solids):

Treatment Unit	Number of Units	Manufacturer or Material	Dimensions (ft) / Spacings (mm)	Volume (gallons)	Plan Sheet Number	Specification Page Number
Existing Primary Settling Chamber (Septic Tank)	one	Existing-Unknown	10' x 20'	8,000	C04,C09	11100
Septic Tank Effluent Lift Station	one	Existing Unknown	6' ID x 10'deep	2,100	CO4, CO9	11100

- c. SECONDARY / TERTIARY TREATMENT (i.e., biological and chemical processes to remove organics and nutrients)

Treatment Unit	Number of Units	Manufacturer or Material	Dimensions (ft)	Volume (gallons)	Plan Sheet Number	Specification Page Number
Textile Fabric Packed Bed Filter	two	Orengo AdvanTex	7' x 15' x 4' deep	3,150 ea	CO4,CO9	11100
Packed Bed Recirculation Blend Pump Station	one	Orengo AdvanTex	7' x 12' x 6' deep	4,000	CO4,CO9	11100
Select						
Select						
Select						
Select						
Select						
Select						

d. DISINFECTION

Treatment Unit	Number of Units	Manufacturer or Material	Dimensions (ft)	Volume (gallons)	Plan Sheet Number	Specification Page Number
Chlorine Contact Tank	1	Pre-Cast Concrete Tank w/ Baffle Walls	6' x 4' x 4'	525 gallons	M01	03420
Double Wall Containment Chemical Storage Tank	1	High Density Crosslinked Polyethylene	3' x 2.5' Overall Height	55 gallons	M01	11232
Select						

e. RESIDUAL TREATMENT

Treatment Unit	Number of Units	Manufacturer or Material	Dimensions (ft)	Volume (gallons)	Plan Sheet Number	Specification Page Number
Select						
Select						
Select						

f. PUMPS

Location	Number of Pumps	Purpose	Manufacturer / Type	Capacity		Plan Sheet Number	Spec. Page Number
				GPM	TDH		
Chemical Feed Area	2	Sodium Hypochlorite Chemical Metering Pumps	Positive Displacement Peristaltic	7.1 GPH	100 psi	M01	11232
Effluent Pump Station	2	Effluent Transfer from Treatment Area to Wet Weather Storage Basin	Non-Clog Submersible Wastewater Pumps	80 GPM	52 ft. TDH	M02	11310
Irrigation Pump Station	2	Irrigation System Pumps	Submersible Well Pumps	Zone 1: 153 GPM Zone 2: 155 GPM Zone 3: 155 GPM Zone 4: 109 GPM	140.45 ft. 118.48 ft. 131.15 ft. 130.56 ft.	M03	11315

g. BLOWERS

Location	No. of Blowers	Units Served	Manufacturer / Type	Capacity (CFM)	Plan Sheet Number	Specification Page Number

h. MIXERS

Location	No. of Mixers	Units Served	Manufacturer / Type	Power (hp)	Plan Sheet Number	Specification Page Number

i. RECORDING DEVICES & RELIABILITY

Device	Number of Units	Maximum Capacity	Manufacturer	Location	Plan Sheet Number	Specification Page Number
Existing Effluent Flow Meter (Parshall Flume)	1	6,000 gpd	Existing Unknown	Follows chlorine contact tank	C09	11100
Select						
Select						
Select						
Select						

VI. DESIGN INFORMATION FOR STORAGE IMPOUNDMENTS

1. Provide the number of earthen impoundments in the system: 2
2. Are any impoundments designed to receive adjacent surface runoff? Yes or No
 If Yes, please specify which impoundment: _____ and the drainage area: _____ ft².
3. Are impoundment(s) designed to include a discharge point (pipe, emergency spillway, etc)? Yes or No
4. Provide the design measures proposed for impoundment liner protection from wind driven wave action: Basins are proposed to be refurbished by removing existing plastic liners, reconstructing embankments, re-grading side slopes, and installing compacted cement stabilized clay liners. The cement stabilized soil layer consists of a ratio of 4% cement to soil and is placed over the compacted clay liner.
5. Provide the location of each design element in the specifications and engineering plans for each storage unit:

Storage Impoundment: Effluent Storage Lagoon				Plan Sheet Number	Specification Page Number
Liner material (15A NCAC 02T .0505(e) and (f))?	<input type="checkbox"/> Synthetic	<input checked="" type="checkbox"/> Clay		C11	02210
	<input type="checkbox"/> Concrete	<input type="checkbox"/> Steel			
Liner installation and testing requirements				C10, C11	02210
Inside berm surface dimensions (L x W x H)	75 ft	X	29 ft	C10	-
Bottom dimensions (L x W)	48 ft		14 ft	C10	-
Embankment side slope	3 : 1			C11	-
Mean seasonal high water table depth *	> 6 ft. BLS			-	-
Finished grade elevation	485 ft			C10	-
Depth from bottom to top of embankment	9 ft			C10 & C11	-
Total volume	- ft ³	207,267 gallons		C10	ADV-1
Design freeboard	2 ft			C10 & C11	-
Depth of minimum liquid level (above permanent liquid level)	0 ft			C11	-
Effective volume provided **	- ft ³	125,724 gallons		C10	-
Effective storage time provided	35 days			C10	

* NOTE: The liner shall be protected from impacts of the seasonal high water table as necessary.

** NOTE: The storage volume should be calculated between the top of any permanent liquid level (as indicated by outlet pipe) and maximum allowable liquid level in the impoundment.

Storage Impoundment: Wet Weather Storage Basin				Plan Sheet Number	Specification Page Number
Liner material (15A NCAC 02T .0505(e) and (f))?	<input type="checkbox"/> Synthetic	<input checked="" type="checkbox"/> Clay		C12	02210
	<input type="checkbox"/> Concrete	<input type="checkbox"/> Steel			
Liner installation and testing requirements				C12	02210
Inside berm surface dimensions (L x W x H)	110 ft	X	41 ft	C12	-
Bottom dimensions (L x W)	90 ft		90 ft	C12	-
Embankment side slope	3 : 1			C12	-
Mean seasonal high water table depth *	> 6 ft. BLS			-	-
Finished grade elevation	495 ft			C12	-
Depth from bottom to top of embankment	12.5 ft			C12	-
Total volume	- ft ³	1,471,050 gallons		C12	ADV-1
Design freeboard	2 ft			C12	-
Depth of minimum liquid level (above permanent liquid level)	0 ft			C12	-
Effective volume provided **	- ft ³	1,122,440 gallons		C12	-
Effective storage time provided	315 days			C12	

* NOTE: The liner shall be protected from impacts of the seasonal high water table as necessary.

** NOTE: The storage volume should be calculated between the top of any permanent liquid level (as indicated by outlet pipe) and maximum allowable liquid level in the impoundment.

VII. DESIGN INFORMATION FOR IRRIGATION SYSTEM

1. The irrigation system is: Spray Drip
2. Disposal system is: existing proposed.
3. If applicable, provide the location of each design element in the specifications and engineering plans:

Irrigation Pump Tank				Plan Sheet Number	Specification Page Number
Internal dimensions (L x W x H or φ x H)	-	4 ft	16.5 ft	M03	-
Total volume	200 ft ³		1,495 gallons	C12 & M03	-
Dosing volume	ft ³		gallons		
Audible & visual alarms	Pump Failure Alarm			E04 & E07	11950
Equipment to prevent irrigation during rain events	Rain Sensor Cutout			E04 & E07	11950

4. List any equipment (note sheet number of the plans or page number in the specifications) not specifically mentioned above (pump hoist, odor control equipment, etc.):
 - Intake Screen w/ Air Backpulse – Drawing C12, Specification Section 11335
 - Irrigation Controller – Drawing E04 & E07, Specification Section 11950
 - Zone Control Valves – Drawing C13, Specification Section 11950
 - Drip Tubing – Drawing C13, Specification Section 11950
5. Minimum depth to mean seasonal high water table within irrigation field(s) per Soil Scientist's Evaluation: > 6 feet below ground surface. Must be at least one-foot vertical separation between SHWT and ground surface per 15A NCAC 02T .0505(p).
6. Are there any artificial drainage or water movement structures within 200 feet of any irrigation area? Yes or No
If Yes, please explain if the soil scientist report addresses artificial structures and please indicate if structures are to be maintained or modified: _____
7. Loading rates recommended by the Soil Scientist Evaluation:

Soil Series	Fields within Soil Area	Recommended Loading Rate (in/hr)	Recommended Loading Rate (in/yr)	Loading Recommended	If Seasonal, list appropriate months
SA1 - Georgeville	1, 2, 3, 4	0.1 in per dose; 0.21 inch / week avg.;	10.92	<input checked="" type="checkbox"/> Annual <input type="checkbox"/> Seasonal	
SA2 - Herndon	1, 2, 3, 4	0.1 in. / dose; 0.21 in. / week avg.	10.92	<input checked="" type="checkbox"/> Annual <input type="checkbox"/> Seasonal	
				<input type="checkbox"/> Annual <input type="checkbox"/> Seasonal	
				<input type="checkbox"/> Annual <input type="checkbox"/> Seasonal	
				<input type="checkbox"/> Annual <input type="checkbox"/> Seasonal	

8. Design loading rates are equal or less than the loading rates recommended by Soil Scientist? Yes or No
If No, explain why 15A NCAC 02T .0505(n) is not met: _____

10. Irrigation Design (fill in the appropriate information for either a spray or drip irrigation system):

a. **Spray Irrigation:**

Field / Zone	Design Area (ft ²)	Number of Nozzles	Maximum Irrigation Precipitation Rate (in/hr)	Design Annual Loading Rate (in/yr)
<i>Total</i>				

Spray Irrigation Design Element		Plan Sheet Number	Specification Page Number
Wetted diameter of nozzles	ft		
Wetted area of nozzles	ft ²		
Nozzle capacity	gpm		
Nozzle manufacturer / model	/		
Elevation of highest nozzle	ft		

b. **Drip Irrigation:**

Field / Zone	Design Area (ft ²)	Number of Emitters	Maximum Irrigation Precipitation Rate (in/hr)	Design Annual Loading Rate (in/yr)
1	66,647	5,100	0.22 in/hr at 0.1 inch dose	10.92
2	67,518	5,167	0.22 in/hr at 0.1 inch dose	10.92
3	67,518	5,167	0.22 in/hr at 0.1 inch dose	10.92
4	47,480	3,634	0.22 in/hr at 0.1 inch dose	10.92
<i>Total</i>	249,163	19,068		

Drip Irrigation Design Element		Plan Sheet Number	Specification Page Number
Wetted area of emitters	5,027 ft ²	C13	-
Distance between laterals	80 ft	C13	-
Distance between emitters	1.5 ft	C13	11950
Emitter capacity	0.033 gpm	-	11950
Emitter manufacturer / model	Dura-Flo Dripperline / SFPC-BR-7818-05	-	11950
Elevation of highest emitter	518.75 ft	C13	-

11. Cover crop information:

Use the Nutrient Management in North Carolina's Realistic Yield Expectations webpage

(<http://www.soil.ncsu.edu/nmp/ncnmwg/yields/index.php#county>) to determine the PAN (lbs/acre) and Phosphorus removal (lbs/acre) rates for each cover crop.

See Agronomist Report for more detailed discussion.

Cover Crop	Soil Series	% Slope	Nitrogen Removal Rate (lbs/acre)	Phosphorus Removal Rate (lbs/acre)
Fescue	SA1 - Georgeville	2-6%	136	51
Coastal Bermuda	SA1 - Georgeville	2-6%	159	46
Forest	SA1 - Georgeville	2-6%	150+	40+
Fescue	SA2 - Herndon	2-6%	174	63
Coastal Bermuda	SA2 - Herndon	2-6%	213	58
Forest	SA2 - Herndon	2-6%	150+	40+

✓ Proposed mineralization rate: 40% and volatilization rate: 50%

✓ Irrigation area based upon the nitrogen balance:

- SA1 Fescue – 70,595 ft²
- SA1 Coastal Bermuda – 60,383 ft²
- SA1 Forest – 64,006 ft²
- SA2 Fescue – 29,581 ft²
- SA2 Coastal Bermuda – 27,220 ft²
- SA2 Forest – 38,653 ft²

✓ Irrigation area based upon the phosphorus balance:

- SA1 Fescue – 37,650 ft²
- SA1 Coastal Bermuda – 41,743 ft²
- SA1 Forest – 48,004 ft²
- SA2 Fescue – 24,158 ft²
- SA2 Coastal Bermuda – 19,993 ft²
- SA2 Forest – 28,990 ft²

✓ Irrigation area based upon the water balance: 249,163 ft²

✓ Site is: hydraulically limited nutrient limited

Professional Engineer's Certification:

I, Charles D. Riley, Jr., attest that this application for UNC-CH Bingham Facility Wastewater Improvements Wastewater Surface Irrigation Major Modification has been reviewed by me and is accurate, complete and consistent with the information supplied in the engineering plans, calculations, and all other supporting documentation to the best of my knowledge. I further attest that to the best of my knowledge the proposed design has been prepared in accordance with this application package and its instructions as well as all applicable regulations and statutes. Although other professionals may have developed certain portions of this submittal package, inclusion of these materials under my signature and seal signifies that I have reviewed this material and have judged it to be consistent with the proposed design. **Note:** In accordance with NC General Statutes 143-215.6A and 143-215.6B, any person who knowingly makes any false statement, representation, or certification in any application package shall be guilty of a Class 2 misdemeanor, which may include a fine not to exceed \$10,000 as well as civil penalties up to \$25,000 per violation.

North Carolina Professional Engineer's seal, signature, and date:



Applicant's Certification (signing authority must be in compliance with 15A NCAC 02T .0106(b)):

I, Karol Kain Gray Vice Chancellor Finance & Administration
(signing authority name) (title)

attest that this application for UNC-CH Bingham Facility
(facility name)

has been reviewed by me and is accurate and complete to the best of my knowledge. I understand that any discharge of wastewater from this non-discharge system to surface waters or the land will result in an immediate enforcement action that may include civil penalties, injunctive relief, and/or criminal prosecution. I will make no claim against the Division of Water Quality should a condition of this permit be violated. I also understand that if all required parts of this application package are not completed and that if all required supporting information and attachments are not included, this application package will be returned to me as incomplete. I further certify that the applicant or any affiliate has not been convicted of an environmental crime, has not abandoned a wastewater facility without proper closure, does not have an outstanding civil penalty where all appeals have been exhausted or abandoned, are compliant with any active compliance schedule, and do not have any overdue annual fees under Rule 2T .0105. **Note:** In accordance with NC General Statutes 143-215.6A and 143-215.6B, any person who knowingly makes any false statement, representation, or certification in any application package shall be guilty of a Class 2 misdemeanor, which may include a fine not to exceed \$10,000 as well as civil penalties up to \$25,000 per violation.

Signature: Karol Kain Gray Date: 1/30/13

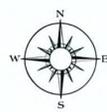
Provide the following information for the location of each new groundwater monitoring well / surface water monitoring point:

Well / Point	Latitude			Longitude		
Monitoring Well #1	35	54	15.422 N	79	14	20.262 W
Monitoring Well #2	35	54	10.006 N	79	14	30.744 W
Monitoring Well #3	35	54	9.156 N	79	14	27.879 W
Monitoring Well #4	35	54	13.906 N	79	14	21.604 W
Surface Water Monitoring Point #1	35	54	16.451 N	79	14	23.716 W
Surface Water Monitoring Point #2	35	54	10.095 N	79	14	15.646 W
Surface Water Monitoring Point #3	35	54	20.336 N	79	14	12.103 W
Surface Water Monitoring Point #4	35	54	5.899 N	79	14	13.48 " W

- ✓ Level of accuracy? Seconds
- ✓ Method of measurement? MAP
- ✓ Datum? NAD 83

Bingham Facility Wastewater System Improvements

Orange County, NC



01/2013
1 inch = 150 feet

- Bus Stops
- New Monitoring Wells
- Existing Monitoring Wells
- Potable Wells
- Surface Water Monitoring
- Sanitary Sewer
- Potable Water Piping
- Effluent Forcemain
- - - Fenceline
- Drip Irrigation Layout
- Stream (survey)
- Stream (County GIS)
- Streets
- 2-ft Contour
- 10-ft Contour
- - - Compliance Boundary
- - - Review Boundary
- ▨ Wetlands (survey)
- ▨ Existing Building Footprints
- ▨ Existing Paved Area
- ▨ Bingham Property Boundary
- ▨ Orange County Parcels
- ▨ Well Setback
- ▨ 50' Setback
- ▨ 100' Setback
- ▨ 150' Setback
- ▨ 200' Setback
- ▨ 500' Area of Interest
- ▨ 100' Buffer from Bus Stops
- ▨ UNC Owned Property
- ▨ Wastewater Treatment Plant
- ▨ Effluent Storage Basin
- ▨ Irrigation Pump Station
- ▨ Wet Weather Storage Basin
- ▨ Habitable Residences Not Within 500 feet
- ▨ Habitable Residences Within 500 feet
- ▨ Georgeville Soils
- ▨ Herndon Soils

Revision 1 10/2011
Revision 2 01/2013

SETBACKS (Per 15A NCAC 02T.00.506 (a) and (b) - Rev September 1, 2006)

Description	Treatment Units/Storage	Irrigation System	Minimum Distance From Treatment Units/Storage**	Minimum Distance From Irrigation System**
Any habitable residence or place of public assembly under separate ownership or not to be maintained as part of the project site	100 feet	100 feet	320 feet	250 feet
Any habitable residence or place of public assembly under separate ownership to be maintained as part of the project site	--	15 feet	--	201 feet
Any private or public water supply source	100 feet	100 feet	325 feet	250 feet
Surface Waters (streams- intermittent and perennial, perennial water bodies, and wetlands)	50 feet	100 feet	50 feet	100+ feet
Groundwater lowering ditches (where the bottom of the ditch intersects the SHWT)	--	100 feet	--	N/A
Subsurface groundwater lowering drainage systems	--	100 feet	--	N/A
Surface water diversions (ephemeral streams, waterways, ditches)	--	25 feet	--	100+ feet
Any well with the exception of monitoring wells	100 feet	100 feet	325 feet	250 feet
Any property line	50 feet	50 feet	50+ feet	150+ feet
Top of slope of embankments or cuts of 2-ft or more in vertical height	--	15 feet	--	N/A
Any water line from a disposal system	--	10 feet	--	160 feet
Any swimming pool	--	100 feet	--	N/A
Public right of way	--	50 feet	--	150+ feet
Nitrification field	--	20 feet	--	N/A
Any building foundation or basement	--	15 feet	--	120 feet





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(252) 473-5702

NCDENR: DWQ CERTIFICATE #94. DLS CERTIFICATE #37729

McKim & Creed - Raleigh

1730 Varsity Drive #500
Raleigh NC 27606
Attention: Chuck Riley PE

Date of Report: Dec 31, 2012

Customer PO #:

Report #: 2012-14246

Report to: Chuck Riley PE

Project ID: UNC Bingham WWTP

Lab ID	Sample ID: Wastewater @ EQ Tank	Collect Date/Time	Matrix	Sampled by
12-35025	Site:	12/11/2012 12:50 PM	Water	Jay Baker

Test	Method	Results	Date Analyzed
Asbestos	EPA 100.1	<16 MFL	12/14/2012
Cyanide	EPA 335.4	<0.005 mg/L	12/19/2012
Dioxin			
2,3,7,8-TCDD	1613 B	<0.1 ng/L	12/17/2012
EPA 624 Extended			
1,1,1-Trichloroethane	EPA 624	< 5.00 µg/L	12/21/2012
1,1,2,2-Tetrachloroethane	EPA 624	< 5.00 µg/L	12/21/2012
1,1,2-Trichloroethane	EPA 624	< 5.00 µg/L	12/21/2012
1,1-Dichloroethane	EPA 624	< 5.00 µg/L	12/21/2012
1,1-Dichloroethene	EPA 624	< 5.00 µg/L	12/21/2012
1,2-Dichlorobenzene	EPA 624	< 5.00 µg/L	12/21/2012
1,2-Dichloroethane	EPA 624	< 5.00 µg/L	12/21/2012
1,2-Dichloropropane	EPA 624	< 5.00 µg/L	12/21/2012
1,3-Dichlorobenzene	EPA 624	< 5.00 µg/L	12/21/2012
1,4-Dichlorobenzene	EPA 624	< 5.00 µg/L	12/21/2012
2-Chloroethylvinyl ether	EPA 624	< 5.00 µg/L	12/21/2012
Acrolein	EPA 624	< 50.0 µg/L	12/21/2012
Acrylonitrile	EPA 624	< 50.0 µg/L	12/21/2012
Benzene	EPA 624	< 5.00 µg/L	12/21/2012
Bromodichloromethane	EPA 624	< 5.00 µg/L	12/21/2012
Bromoform	EPA 624	< 5.00 µg/L	12/21/2012
Bromomethane	EPA 624	< 5.00 µg/L	12/21/2012
Carbon tetrachloride	EPA 624	< 5.00 µg/L	12/21/2012
Chlorobenzene	EPA 624	< 5.00 µg/L	12/21/2012
Chloroethane	EPA 624	< 5.00 µg/L	12/21/2012
Chloroform	EPA 624	< 5.00 µg/L	12/21/2012



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Chloromethane	EPA 624	< 5.00 µg/L	12/21/2012
cis-1,3-Dichloropropene	EPA 624	< 5.00 µg/L	12/21/2012
Dibromochloromethane	EPA 624	< 5.00 µg/L	12/21/2012
Ethylbenzene	EPA 624	11.6 µg/L	12/21/2012
IPE	EPA 624	< 5.00 µg/L	12/21/2012
M+P Xylene	EPA 624	19.9 µg/L	12/21/2012
Methylene chloride	EPA 624	< 5.00 µg/L	12/21/2012
MTBE	EPA 624	< 5.00 µg/L	12/21/2012
Naphthalene	EPA 624	13.8 µg/L	12/21/2012
ortho-Xylene	EPA 624	7.89 µg/L	12/21/2012
Tetrachloroethene	EPA 624	< 5.00 µg/L	12/21/2012
Toluene	EPA 624	34.0 µg/L	12/21/2012
Trans-1,2-Dichloroethene	EPA 624	< 5.00 µg/L	12/21/2012
trans-1,3-Dichloropropene	EPA 624	< 5.00 µg/L	12/21/2012
Trichloroethene	EPA 624	< 5.00 µg/L	12/21/2012
Trichlorofluoromethane	EPA 624	< 5.00 µg/L	12/21/2012
Vinyl chloride	EPA 624	< 5.00 µg/L	12/21/2012
EPA 625 Acids			
2,4,6-Trichlorophenol	EPA 625	<40 µg/L	12/12/2012
2,4-Dichlorophenol	EPA 625	<40 µg/L	12/12/2012
2,4-Dimethylphenol	EPA 625	<40 µg/L	12/12/2012
2,4-Dinitrophenol	EPA 625	<200 µg/L	12/12/2012
2-Chlorophenol	EPA 625	<40 µg/L	12/12/2012
2-Methyl-4,6-dinitrophenol	EPA 625	<200 µg/L	12/12/2012
2-Nitrophenol	EPA 625	<200 µg/L	12/12/2012
4-Chloro-3-methylphenol	EPA 625	<40 µg/L	12/12/2012
4-Nitrophenol	EPA 625	<200 µg/L	12/12/2012
Pentachlorophenol	EPA 625	<200 µg/L	12/12/2012
Phenol	EPA 625	186 µg/L	12/12/2012

EPA 625 BN



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1,2-Diphenylhydrazine	EPA 625	<40 µg/L	12/12/2012
1,2,4-Trichlorobenzene	EPA 625	<40 µg/L	12/12/2012
1,2-Dichlorobenzene	EPA 625	<40 µg/L	12/12/2012
1,3-Dichlorobenzene	EPA 625	<40 µg/L	12/12/2012
1,4-Dichlorobenzene	EPA 625	<40 µg/L	12/12/2012
1-Methylnaphthalene	EPA 625	<40 µg/L	12/12/2012
2,4-Dinitrotoluene	EPA 625	<40 µg/L	12/12/2012
2,6-Dinitrotoluene	EPA 625	<40 µg/L	12/12/2012
2-Chloronaphthalene	EPA 625	<40 µg/L	12/12/2012
2-Methylnaphthalene	EPA 625	<40 µg/L	12/12/2012
3,3'-Dichlorobenzidine	EPA 625	<80 µg/L	12/12/2012
4-Bromophenyl phenyl ether	EPA 625	<40 µg/L	12/12/2012
4-Chlorophenyl phenyl ether	EPA 625	<40 µg/L	12/12/2012
Acenaphthene	EPA 625	<40 µg/L	12/12/2012
Acenaphthylene	EPA 625	<40 µg/L	12/12/2012
Anthracene	EPA 625	<40 µg/L	12/12/2012
Benzidine	EPA 625	<80 µg/L	12/12/2012
Benzo [a]pyrene	EPA 625	<40 µg/L	12/12/2012
Benzo(a)anthracene	EPA 625	<40 µg/L	12/12/2012
Benzo(b)fluoroanthene	EPA 625	<40 µg/L	12/12/2012
Benzo(g,h,i)perylene	EPA 625	<40 µg/L	12/12/2012
Benzo(k)fluoranthene	EPA 625	<40 µg/L	12/12/2012
Bis (chloromethyl) ether	EPA 625	<40 µg/L	12/12/2012
Bis(2-Chloroethoxy)methane	EPA 625	<40 µg/L	12/12/2012
Bis(2-Chloroethyl)ether	EPA 625	<40 µg/L	12/12/2012
Bis(2-Chloroisopropyl)ether	EPA 625	<40 µg/L	12/12/2012
Bis(2-ethylhexyl)phthalate	EPA 625	204 µg/L	12/12/2012
Butylbenzylphthalate	EPA 625	191 µg/L	12/12/2012
Chrysene	EPA 625	<40 µg/L	12/12/2012
Dibenzo(a,h)anthracene	EPA 625	<40 µg/L	12/12/2012



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Diethylphthalate	EPA 625	<40 µg/L	12/12/2012
Dimethylphthalate	EPA 625	48.9 µg/L	12/12/2012
Di-n-Butylphthalate	EPA 625	<40 µg/L	12/12/2012
Di-n-Octylphthalate	EPA 625	<40 µg/L	12/12/2012
Fluoranthene	EPA 625	<40 µg/L	12/12/2012
Fluorene	EPA 625	<40 µg/L	12/12/2012
Hexachlorobenzene	EPA 625	<40 µg/L	12/12/2012
Hexachlorobutadiene	EPA 625	<40 µg/L	12/12/2012
Hexachlorocyclopentadiene	EPA 625	<200 µg/L	12/12/2012
Hexachloroethane	EPA 625	<40 µg/L	12/12/2012
Indeno(1,2,3-cd)pyrene	EPA 625	<40 µg/L	12/12/2012
Isophorone	EPA 625	<40 µg/L	12/12/2012
Naphthalene	EPA 625	<40 µg/L	12/12/2012
Nitrobenzene	EPA 625	<40 µg/L	12/12/2012
N-nitroso-dimethylamine(NDMA)	EPA 625	<40 µg/L	12/12/2012
N-Nitroso-di-n-propylamine	EPA 625	<40 µg/L	12/12/2012
N-Nitroso-diphenylamine	EPA 625	<40 µg/L	12/12/2012
Phenanthrene	EPA 625	<40 µg/L	12/12/2012
Pyrene	EPA 625	<40 µg/L	12/12/2012
Metals			
Arsenic	EPA 200.7	<0.010 mg/L	12/17/2012
Beryllium	EPA 200.7	<0.010 mg/L	12/17/2012
Cadmium	EPA 200.7	<0.010 mg/L	12/17/2012
Chromium	EPA 200.7	<0.010 mg/L	12/17/2012
Copper	EPA 200.7	0.291 mg/L	12/17/2012
Lead	EPA 200.7	<0.010 mg/L	12/17/2012
Nickel	EPA 200.7	<0.010 mg/L	12/17/2012
Selenium	EPA 200.7	<0.010 mg/L	12/17/2012
Silver	EPA 200.7	<0.010 mg/L	12/17/2012
Zinc	EPA 200.7	1.06 mg/L	12/17/2012



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Antimony	EPA 200.8	< 0.010 mg/L	12/20/2012
Thallium	EPA 200.8	<0.010 mg/L	12/26/2012
Mercury	EPA 245.1	<0.0002 mg/L	12/28/2012



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Raleigh NC 27606
Attention: Chuck Riley PE

Date of Report: Dec 31, 2012
Customer PO #:
Report #: 2012-14246
Report to: Chuck Riley PE
Project ID: UNC Bingham WWTP

Lab ID	Sample ID: Wastewater @ EQ TankA	Collect Date/Time	Matrix	Sampled by
12-35025A	Site:	12/11/2012 12:50 PM	Water	Jay Baker

Test	Method	Results	Date Analyzed
EPA 608			
Alachlor	EPA 608	<0.016 mg/L	12/14/2012
Aldrin	EPA 608	<0.0004 mg/L	12/14/2012
Alpha - BHC	EPA 608	<0.0004 mg/L	12/14/2012
Aroclor - 1016	EPA 608	<0.04 mg/L	12/14/2012
Aroclor - 1221	EPA 608	<0.04 mg/L	12/14/2012
Aroclor - 1232	EPA 608	<0.04 mg/L	12/14/2012
Aroclor - 1242	EPA 608	<0.04 mg/L	12/14/2012
Aroclor - 1248	EPA 608	<0.04 mg/L	12/14/2012
Aroclor - 1254	EPA 608	<0.04 mg/L	12/14/2012
Aroclor - 1260	EPA 608	<0.04 mg/L	12/14/2012
Atrazine	EPA 608	<0.008 mg/L	12/14/2012
Beta-BHC	EPA 608	<0.0004 mg/L	12/14/2012
Butachlor	EPA 608	<0.008 mg/L	12/14/2012
Chlordane	EPA 608	<0.04 mg/L	12/14/2012
DDD	EPA 608	<0.0004 mg/L	12/14/2012
DDE	EPA 608	<0.0004 mg/L	12/14/2012
DDT	EPA 608	<0.0004 mg/L	12/14/2012
Delta-BHC	EPA 608	<0.0004 mg/L	12/14/2012
Dieldrin	EPA 608	<0.0004 mg/L	12/14/2012
Endosulfan I	EPA 608	<0.0004 mg/L	12/14/2012
Endosulfan II	EPA 608	<0.0004 mg/L	12/14/2012
Endosulfan sulfate	EPA 608	<0.0004 mg/L	12/14/2012
Endrin	EPA 608	<0.0004 mg/L	12/14/2012
Endrin aldehyde	EPA 608	<0.0004 mg/L	12/14/2012
Gamma-BHC	EPA 608	<0.0004 mg/L	12/14/2012
Heptachlor	EPA 608	<0.0004 mg/L	12/14/2012



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Heptachlor epoxide	EPA 608	<0.0004 mg/L	12/14/2012
Hexachlorobenzene	EPA 608	<0.0004 mg/L	12/14/2012
Hexachlorocyclopentadiene	EPA 608	<0.0004 mg/L	12/14/2012
Methoxychlor	EPA 608	<0.0004 mg/L	12/14/2012
Metolachlor	EPA 608	<0.008 mg/L	12/14/2012
Metribuzin	EPA 608	<0.0008 mg/L	12/14/2012
Propachlor	EPA 608	<0.008 mg/L	12/14/2012
Simazine	EPA 608	<0.0056 mg/L	12/14/2012
Toxaphene	EPA 608	<0.04 mg/L	12/14/2012

Comment: Reporting level for 624, 625 and 608 elevated due to matrix interference.

Reviewed by: Ray [Signature]



Analytical & Consulting Chemists

ENVIRONMENTAL CHEMISTS, INC

NCDENR: DWQ CERTIFICATION # 94 NCDHHS: DLS CERTIFICATION # 37729

6602 Windmill Way Wilmington, NC 28405
OFFICE: 910-392-0223 FAX 910-392-4424
Info@environmentalchemists.com

COLLECTION AND CHAIN OF CUSTODY

Client: **McKim & Creed-Raleigh** PROJECT NAME: **UNC Bingham WWTP** REPORT NO: **12-14246**

ADDRESS: CONTACT NAME: **Chuck Riley, PE** PO NO:

REPORT TO: PHONE/FAX:

COPY TO: email:

Sampled By: T. Baker / S. ... SAMPLE TYPE: I = Influent, E = Effluent, W = Well, ST = Stream, SO = Soil, SL = Sludge, Other:

Sample Identification	Collection			Sample Type	Composite or Grab	Container (P or G)	Chlorine mg/L	LAB ID NUMBER	PRESERVATION						ANALYSIS REQUESTED	
	Date	Time	Temp						NONE	HCL	H2SO4	HNO3	NAOH	THIO		OTHER
Wastewater	12/14/12	12:50	14 °C	C	P			35025	X	X	X	X	X	X		Priority Pollutants (see attached list)
				G	G											
				C	P											
				G	G											
				C	P											
				G	G											
				C	P											
				G	G											
				C	P											
				G	G											
				C	P											
				G	G											
				C	P											
				G	G											
				C	P											
				G	G											
				C	P											
				G	G											

Transfer Relinquished By: Date/Time Received By: Date/Time

1. Temperature when Received: 22 Accepted: Rejected: Resample Requested:

Delivered By: T. Baker Received By: S. ... Date: 12/14/12 Time: 6:20

Comments: TURNAROUND:

Substance	Tested Concentrations	15A NCAC 2B Freshwater Aquatic Life Standards	15A NCAC 2L .0202 Groundwater Standard	Known Carcinogen based on EPA's <i>Integrated Risk Information System</i> ?
Ethylbenzene	11.6 µg/L	97 µg/L	600 µg/L	No*
meta + para-Xylene	19.9 µg/L	meta-800 µg/L, para-(LD)	500 µg/L	No**
Naphthalene	13.8 µg/L	330 µg/L	6 µg/L	No*
ortho-Xylene	7.89 µg/L	800 µg/L	500 µg/L	No**
Toluene	34.0 µg/L	11 µg/L	600 µg/L	No**
Phenol	186 µg/L	Narrative Standard	30 µg/L	No**
Bis(2-ethylhexyl)phthalate	204 µg/L		3 µg/L	No*
Butylbenzylphthalate	191 µg/L	19 µg/L	1 mg/L	No**
Dimethylphthalate	48.9 µg/L	3.4 µg/L		No
Copper	0.291 mg/L	7 µg/L (AL)	1 mg/L	No
Zinc	1.06 mg/L	50 µg/L (AL)	1 mg/L	No

NOTES

Shaded cells indicate tested raw wastewater concentration values that are above either freshwater standards or groundwater standards listed.

AL - Action level standard

LD - Level is based on limited data

* - Is a group 2B - *possible* human carcinogen according to the International Agency for Research on Cancer (IARC)

** - is/are in group 3 of the IARC listing meaning *"Not classifiable as to its carcinogenicity to humans"*

Surfactants

Chemical / Product Name	Type	Typical Quantities on Hand
Chlorhexidine gluconate 2% medical scrub	topical disinfectant with surfactants	(1) gallon
Chlorhexidine gluconate 4% medical scrub (Dermachlor)	topical disinfectant with surfactants	(1) gallon
Povidone Iodine (Betadine, Poviderm) medical scrub	topical disinfectant with surfactants	(1) gallon
Aloe & oatmeal shampoo	medicated shampoo	(1) gallon
Cherry grooming shampoo (Priority Care)	grooming shampoo	(1) gallon
Dermachlor (chlorhexidene 2%) shampoo	medicated shampoo	1 gallon
Dermachlor (chlorhexidene 4%) shampoo	medicated shampoo	1 gallon
Dermallay oatmeal shampoo	medicated shampoo	2 x 16 oz containers
Health Guard shampoo w/ antibacterial activity	medicated shampoo	16 fl oz
Malaseb shampoo (Chlorhexidene gluconate 2%, miconazole nitrate 2%)	medicated shampoo	(1) Gallon
Mane N' Tail shampoo	grooming shampoo	(1) 32 oz bottle
Phytovet CK dog shampoo (Chlorhexidene 2%, ketoconazole 1%, phytosphingosine 0.05%)	antiseptic shampoo	1 x 16 oz bottle
Oatmeal Shampoo	medicated shampoo	16 fl oz (1)
Pyoben (benzoyl peroxide) dog shampoo	medicated shampoo	2 x 16 oz containers
Supra pet shampoo odor control (soap and detergent free)	grooming shampoo	17 fl oz (1)
Tropiclean Berry Clean shampoo	grooming shampoo	(1) gallon
Ultra 84:1 pet shampoo	grooming shampoo	1 gallon
Hydro Surge Derm Silk Conditioner	coat conditioner	1 gallon
Clipper blade cleaner (Oster)	clipper/equipment maintenance	(2) 14 oz cans
Liquid live odor digestor	odor neutralizer/sanitation	(1) gallon
Safelle's AP neutral disinfectant concentrate(alkyl dimethyl benzyl ammonium chloride)	sanitation	(1) gallon
Lysol disinfectant spray	disinfectant	1 can 19oz
Neutral Disinfection Cleaner (Quaternary Ammonium)	disinfectant	(3) gallons (concentrate)
Betco Quat-Stat (Quaternary ammonia solution)	disinfectant/detergent	4 gallons
Gain liquid dish washing soap	detergent	(3) 28 fl oz bottles
Dawn liquid dishwashing detergent	detergent	(1) 50 oz
Dial Liquid Hand Soap	hand soap	40 fl oz
Antibacterial Hand Soap (Butler)	hand soap	1 gallon
Citrus antibiotic soap	hand soap	(2) gallons
Lotion soap (Safelle)	hand soap	(1) Gallon
Meyers Clean Day liquid soap	hand soap	12.5 fl oz bottle (1)
Provon (hand soap)	hand soap	(1) 18oz bottle
Betco Fight Bac RTU	antibacterial surface cleaner	12 quarts
Sparkle stainless steel cleaner and polish	cleaner	15 oz aerosol can
Bleach	Cleaner	(1) gallon
Expo white board cleaner	Cleaner	(1) 4 oz bottle
Bio Strip 200	Cage washer	150oz/month
PH neutralizer	Cage washer	150oz/month

Tab #5. Assessment of the Fate of Trace Organic Compounds

Wastewater Treatment Facilities at UNC-CH Bingham Facility

January 15, 2013

Composite samples of the raw wastewater at the UNC-CH Bingham Facility were collected at the existing holding tank for the ongoing pump and haul operation. These samples were analyzed for EPA priority pollutants as required in connection with the NCDENR DWQ review of the non-discharge permit modification submittal by UNC-CH. Results of the testing indicated the presence of trace organic compounds in the raw wastewater.

Phthalates are softener compounds used as additives in virtually all plastic materials to render the plastics soft and workable. They are also used as enteric coatings in pharmaceuticals and can enter the environment from food packaging (milk, butter, etc.) They are generally non-reactive and therefore not chemically bound which enables them to migrate to the surface of the material where they can be transported to surrounding environments including water, air, soil, etc. Long chain phthalates such as di-(2 ethylhexyl)-phthalate (DEHP), the most commonly encountered phthalate ester in the environment, is predominately degraded by aerobic decomposition. Phthalates are hydrophobic compounds and sparingly soluble. They readily adsorb on particulate matter and sludge resulting in sedimentation and subsequent biodegradation.

Conventional treatment with septic tanks and soil infiltration in drain fields typically decreases concentrations of trace organic contaminants such as surfactant metabolites, phthalate compounds, and many other compounds by greater than 90 percent. Removal of these trace organics by anaerobic primary treatment in septic tanks is typically less than 50 percent and is primarily attributed to sorption on solids and biotransformation. The majority of treatment occurs during soil infiltration and percolation through mechanisms of volatilization, adsorption to soil particles and organic matter, and aerobic transformation ultimately to carbon dioxide and water.

The AdvanTex system consists of anaerobic primary treatment in a conventional septic tank followed by aerobic treatment of the effluent from the septic tank on the synthetic filter fabric in the polishing filter pods. The AdvanTex system provides the equivalent of secondary treatment which typically provides removal of trace organic contaminants such as surfactants and phthalates in the influent by greater than 95 percent. Post treatment of the effluent by drip irrigation will provide even greater overall removal of these compounds by outgassing, adsorption on soil and organic matter, and biodegradation by the natural bacterial ecosystems present in the soils in the drip irrigation fields. It is anticipated that overall removal of these trace organic compounds in the wastewater treatment and dispersal system will result in less than detection limit concentrations of these compounds.

Removal of trace organics in engineered systems such as the AdvanTex system can be optimized by increased hydraulic and sludge retention time within the septic tank, minimizing solids discharge from the tank, appropriate selection of soils for the irrigation sites, and proper control of the application rates at the receiver sites. All of these factors have been carefully considered in the evaluation of the design of the wastewater treatment and dispersal system at the UNC-CH Bingham Facility. The septic tank is the primary treatment process, and the hydraulic detention time at a design flow of 3500 gpd is over 50 hours. Most conventional secondary treatment systems for domestic wastewater treatment provide hydraulic detention times of 12 to 24 hours. Septic tanks provide a large reservoir for solids accumulation and anaerobic degradation of the organic pollutants. The AdvanTex system blend tank provides greater than 24 hours of hydraulic retention time with continuous recirculation of the influent through the synthetic media biofilters for outgassing of volatile compounds and aerobic degradation for removal of influent organics. The design application rate for the drip irrigation system was determined by exhaustive consideration of the existing soil types, hydraulic soil conductivity, and nutrient uptake as discussed in the hydrogeologic, soils, and agronomic evaluations conducted on-site.

References:

1. Patrick Fauser, Peter B. Sorensen, Lars Carlsen, and Jorgen Vikelsoe. *Phthalates, Nonylphenols and LAS in Roskilde Wastewater Treatment Plant, Fate Modelling Based on Measures Concentrations in Wastewater and Sludge*. NERI Technical report No. 354, 2001.
2. Stephen Heise, Norbert Litz. *Phthalates*. German Federal Environmental Agency. Berlin, Germany.
3. *Phthalates TEACH Chemical Summary*. US Environmental Protection Agency. October 2007.

**Tab #5 - Assessment of the Fate of Aromatic Hydrocarbons at the
UNC-CH Bingham Wastewater Treatment Facility**

January 15, 2013

Composite samples of the raw wastewater at the UNC-CH Bingham Facility were collected at the existing holding tank for the ongoing pump and haul operation. These samples were analyzed for EPA priority pollutants as required in connection with the NCDENR DWQ review of the non-discharge permit modification submittal by UNC-CH. Results of the testing indicated the presence of trace concentrations of toluene (34 micrograms per liter) in the raw wastewater. A search of the literature indicates that total aromatic hydrocarbons (BTXs) are commonly found in domestic wastewater in concentrations ranging from about 1 to over 900 micrograms per liter. Aromatic hydrocarbons including toluene, benzene, and xylenes are listed by EPA as priority pollutants. Toluene is commonly found in municipal wastewater in concentrations ranging from 1 to 240 micrograms per liter.

Aromatic hydrocarbons are produced in large quantities and extensively used in many industrial applications and domestic products including fuels, solvents, paints, varnishes, and many different commonly used aerosols, adhesives, and glues.

Conventional biological treatment systems are generally not adversely affected by toluene. In fact, the EPA wastewater treatment manual lists an inhibition threshold of about 200 mg/L for toluene in activated sludge treatment systems.

Conventional biological treatment including anaerobic and aerobic treatment processes are known to effectively remove these volatile compounds by biodegradation and adsorption in high concentrations on solids such as MLSS, sludge, soils, etc. Anaerobic biological treatment processes including septic tanks (primary treatment for the AdvanTex system) can provide as much as 50 percent removal by biodegradation and adsorption on biosolids and other surfaces in the process tank. Aerobic processes, such as the AdvanTex tertiary filtration process, can remove these pollutants by biodegradation, and a high percentage of volatile pollutants such as toluene are stripped to the atmosphere during aeration. At a toluene influent concentration of 34 micrograms per liter, it is anticipated that the AdvanTex biological treatment process at UNC-CH Bingham Facility will remove approximately 90 percent resulting in effluent concentrations less than 5 micrograms per liter.

In addition, residual toluene concentrations will be further reduced by dilution, soil adsorption, and biodegradation in the drip irrigation fields. Based on this assessment, it is highly improbable that the trace amounts of toluene found in the raw wastewater at UNC-CH

Bingham Facility will result in the contravention of NCDENR freshwater or groundwater standards.

References:

1. Bozena Mrowiec and Jan Suschka, *Presence and Effects of Aromatic Hydrocarbons on Sewage Treatment Efficiency*, Proceedings of the Annual International Conference on Soils, Sediment, Water and Energy, January 2009
2. Tom Parkenton, *Analysis of Benzene Fate in Industrial Wastewater Treatment Plants: Implications for the EU Existing Substances Risk*, CEFIC Aromatics Producers Association and CONCAWE, August 2001

UNC Bingham Facility

Response to DENR Dec 6, 2012 Letter -- General: Item 8. One year of groundwater usage (in gallons) based on water supply well system.

Day	Month and Year											
	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12
1	2600	1400	3600	2000	1900	2600	1600	1000	1700	900	2300	2400
2	1800	1700	3500	2200	2100	2100	1300	2200	1800	1000	2900	2700
3	1400	3000	1300	1400	1600	2000	900	1700	1300	800	2700	1700
4	1800	17400	1000	900	2100	1900	3300	1000	1000	1900	2200	2000
5	3100	3600	3500	1800	1900	1100	2100	1900	900	2200	1400	2200
6	3600	1600	4100	2200	1200	1100	2200	1700	1500	1500	1000	2900
7	2300	1400	5000	2400	1100	2100	2000	800	2000	1200	3000	3100
8	5800	1100	3900	2800	1200	1700	2200	800	1600	800	2500	2500
9	2900	2300	4900	2200	1700	2500	1200	2500	1300	1000	2200	2400
10	3100	4800	3800	1000	1700	2200	1000	1200	1500	1600	2600	1400
11	3400	4500	2100	1000	2200	2300	2400	1800	800	3000	2200	1400
12	3100	2900	2800	2000	2100	1000	2000	1700	900	1600	1600	2600
13	3500	2700	3600	1900	1500	1200	2100	900	1600	3400	1300	2300
14	1700	1500	3600	2500	1200	2000	2100	900	1400	1500	1200	3300
15	3100	1700	3900	2000	1200	3200	1600	800	1900	1100	2500	2900
16	2200	2700	3500	1800	2700	2100	1100	1600	1600	700	2200	1800
17	1100	2700	2700	900	1800	2200	1300	1400	1300	1600	2600	1800
18	2200	3200	1300	1000	2500	1900	2000	2000	1000	2800	2100	1500
19	2600	3500	1900	2000	2000	800	3000	1600	1100	1500	2600	2900
20	2500	3000	2900	2900	1600	1400	2600	1600	1300	2000	900	2200
21	2500	1300	2400	2300	1100	2000	2100	700	2200	1500	1800	3100
22	1300	2300	3300	2100	1200	1800	2200	900	1600	900	2600	1500
23	900	2900	2200	1800	2300	2000	1200	1600	1800	1000	2500	3000
24	1500	3900	1600	1000	1800	2100	1100	2200	1000	2000	2600	1100
25	1200	3500	900	1100	1900	1400	2400	1600	1000	2000	2000	1600
26	3500	3300	1400	2400	2100	1100	1800	1400	900	2400	1600	2500
27	3200	2700	3100	2500	1400	900	2300	1200	1300	2200	1100	3000
28	2100	1300	1700	2500	1100	1200	1900	800	1700	1700	1000	3300
29	2300	2900	1800	1900	1200	2600	2200	800	1900	1400	2600	2300
30	1400	2100		1600	2300	2000	1100	1500	1500	1400	3300	2600
31	1500	2800		1000		1500		1300	1300		2200	

**The University of North Carolina at Chapel Hill
Bingham Facility, Orange County, NC**

General Operation and Maintenance Plan for Wastewater Irrigation System

January 15, 2013

Description

The University of North Carolina at Chapel Hill (University) owns and operates the wastewater collection, treatment, and disposal system for the UNC-CH Bingham Facility in Orange County, NC. The wastewater treatment system is designed to treat and dispose of an average of 3,556 gallons per day (GPD) of domestic strength wastewater in accordance with NCDENR wastewater irrigation rules and regulations (15A NCAC 02T .0500).

The collection system consists of an 8-inch PVC gravity sewer system for the domestic wastewater generated on site. Wastewater is conveyed from the existing three (3) buildings on site to an existing 8,000-gallon baffled septic tank where natural biological and physical processes provide primary treatment. The wastewater separates into three layers – a floating scum layer, a bottom layer of accumulated solids where anaerobic digestion of organic matter takes place, and relatively clean layer of liquid in the middle which is discharged to the septic tank effluent pump station.

The effluent from the septic tank is pumped via the existing duplex submersible effluent pump station to the 4,000-gallon blend tank at the existing AdvanTex wastewater treatment system. From the blend tank, the wastewater is pumped via two recirculation pumps through the spray nozzles onto the synthetic filter media for aerobic treatment of the remaining organics in the wastewater. The effluent from the filters is recirculated back to the blend tank. A control valve on the recirculation line bypasses a portion of the effluent to the chlorine contact tank.

The AdvanTex system treatment of the septic tank effluent provides the equivalent of secondary effluent quality with BOD and TSS concentrations in the range of 10 to 15 mg/l, and ammonia concentrations less than 10 mg/l. The effluent from the AdvanTex system flows through a new baffled chlorine contact tank for disinfection of the wastewater with sodium hypochlorite at a concentration of 5 mg/l. A new sodium hypochlorite chemical feed system consisting of duplex chemical metering pumps and a 50-gallon double wall polyethylene containment storage tank is provided for wastewater disinfection.

From the chlorine contact tank the wastewater flows through an existing 60 degree trapezoidal flume with an ultrasonic level sensor, transmitter, and flow totalizer system. The flow monitoring system provides a 4 - 20 milliamp output signal in proportion to flow to modulate the chlorine metering pumps. From the flow metering flume, the wastewater flows to a new secondary effluent pump station.

The secondary effluent pump station pumps effluent to the wet weather storage basin. The wet weather storage basin provides storage for the effluent during periods of wet weather or other conditions that prevent surface irrigation of the wastewater. The refurbished basin is provided with an inlet structure, screened outlet structure to the drip irrigation pump station, and an 18-inch compacted clay liner with a 12-inch cement stabilized soil liner.

The refurbished drip irrigation pump station at the wet weather storage basin consists of two (2) new well type submersible pumps installed in the existing wetwell, with variable frequency motor drives, piping, valves, and electrical controls for drip irrigation of the effluent. An automatically backwashed screen filter is provided to remove particulates that could plug the drip emitters.

A new 5.7-acre drip irrigation system on-site consists of buried PVC transmission mains and laterals with parallel drip irrigation tubing with pre-installed drip emitters in the tubing for even distribution of the effluent over the drip irrigation area. In the drip irrigation sites, the treated effluent is dispersed for percolation into the soil layer, evaporation, and evapotranspiration. Residual wastewater constituents are treated in the soil by adsorption on the soil and biodegradation by bacteria in the soil matrix.

Operation and Maintenance Manual

A comprehensive Operation and Maintenance Manual will be prepared during construction of the wastewater treatment system improvements and will be submitted to NC DENR prior to operation of the system. The O&M Manual will include the following sections:

1. Introduction and General Process Description
2. Unit Treatment Process Descriptions
3. Operational Control and Alarm Systems
4. Systematic Process Startup, Shutdown, and Normal Operation
5. Maintenance Requirements
6. Sampling, Monitoring, and Testing
7. Record Keeping
8. Emergency Operating Procedures and Contacts

This General Operation and Maintenance Plan briefly outlines certain key aspects of the O&M Manual including: operation, maintenance, provisions for safety measures, and emergency procedures and contacts in the following paragraphs. Details will be provided in the O&M Manual.

Operation

The University maintains certified wastewater treatment system operators on staff to operate, monitor, and maintain the wastewater treatment facilities. General operational responsibilities of the University include the following:

1. Comply with NCDENR rules and regulations.
2. Monitor, operate, and maintain treatment system performance.
3. Maintain records of water usage and irrigation.
4. Perform required compliance testing in accordance with permit requirements.
5. Submit monitoring and other reports as required by NCDENR.
6. Comply with all safety rules and regulations.
7. Report any line breaks or spills to the proper authorities.

Some specific operational activities of the wastewater treatment system operators include the following:

1. Inspect the sanitary sewer collection system on a regular basis to ensure that wastewater is properly flowing to the septic tank system, and clean/remove any obstructions in the sewer lines or manholes.
2. Check the operation of the septic tank system for sludge accumulation level, excessive scum, and plugged influent and effluent piping and screens.
3. Check for proper operation of the septic tank effluent pump station.
4. Inspect the operation of the AdvanTex blend tank, recirculation pumps, spray nozzles in the synthetic filter system, filter vents, and the splitter valve.
5. Check the operation of the chemical feed system including chemical level in the storage tank, pump operation, and calibration.
6. Check the operation of the chlorine contact tank for accumulated solids in the tank and arrange for removal of excessive solids. Collect effluent samples and test chlorine residuals.
7. Check the operation of the flow metering system and for proper control of the chemical metering pumps.
8. Check the operation of the pumps and controls in the effluent pump station.
9. Check operating levels in the wet weather storage basin and adjust drip irrigation schedule as required to prevent excessive water volume in the basin.
10. Check the operation of the drip irrigation pump station, screen filter system, and pump and irrigation controls and make adjustments as required.
11. Check the operation of the drip irrigation system including operation of control valves, piping system, and emitter operation. Insure that no ponding and runoff is occurring in the drip irrigation system. Make any repairs or adjustments as required to ensure proper operation.

Maintenance

Maintenance of the wastewater treatment and disposal system generally includes the following:

1. Provide preventive maintenance of equipment as required per manufacturer's instructions and as specified in the O&M manual.
2. Adhere to the preventive maintenance schedule in the O&M manual.
3. Maintain necessary tools and supplies on-site for proper maintenance work.
4. In accordance with the Residuals Management Plan, arrange for removal of excessive solids from the septic tank as required based on solids accumulation to a licensed operator and receiving facility.
5. Repair any broken equipment or piping leaks as required.
6. Keep spare parts, piping repair equipment, etc. in inventory for emergency repairs.
7. Perform field sampling, testing, and observations of the operation of the AdvanTex system. Check the splitter valve on a regular basis and test effluent for clarity, odor, and dissolved oxygen levels. Record testing results and observations in an operational log.
8. Check operation of the blend tank recirculation pumps.
9. Check the operation of the pump floats and timers, and make sure audible and visual alarms are activating properly.
10. Clean the biotube filters on the recirculation pumps in the blend tank.
11. Check the operation of the filter spray nozzles and adjust, repair, or replace as required.
12. Inspect and clean the filter media as required to ensure proper operation.
13. Maintain sufficient chlorine solution level in the bulk storage tank.
14. Adjust the operation of the chemical metering pumps as required for proper operation and disinfection of the effluent.
15. Check the solids level in the chlorine contact tank and clean as required to ensure proper operation of the disinfection system.
16. Check the operation and calibration of the flow monitoring system, and maintain daily flow records.
17. Check the operation of the effluent pump station pumps and controls and make any repairs or adjustments required.
18. Check the irrigation controller for proper pump operation settings and make any adjustments required for proper operation of the drip irrigation system.
19. Check the operation of the drip irrigation pumps, screen filter system, and controls for proper operation and make any adjustments or repairs as required.
20. Maintain records of flow to each drip irrigation site for NCDENR compliance reporting.
21. Clear and maintain corridors for inspection, repair, and monitoring the performance of the drip irrigation laterals and drip tubing lines.
22. Control the growth of excessive vegetation and grass growth in the drip irrigation system.
23. Perform necessary housekeeping activities as required.
24. Keep all operation and maintenance records in a safe and central location for routine inspection and reporting.

Provisions for Safety Measures

Access to the wastewater treatment system, emergency effluent storage basin, wet weather storage basin, and spray irrigation system is restricted to authorized personnel by perimeter fencing.

The 125,000-gallon emergency effluent storage basin is interconnected with the secondary effluent pump station and can be used for emergency containment of off-specification wastewater or additional wet weather storage capacity. A floating pump and fill station is provided at the basin for recirculation of off-specification wastewater to the wastewater treatment system or pump and haul, as required.

The bulk sodium hypochlorite storage tank is a 50-gallon dual wall polyethylene tank to prevent chlorine spills. The bulk sodium hypochlorite is provided in 5 to 15 gallon containers in 5.25 percent solution, similar to normal household bleach solution, for safety of handling and dealing with any spills on site. The location of the chemical feed system is upstream of the emergency wastewater storage basin for additional containment capacity in the event of an emergency.

Additional safety equipment including fire extinguishers and other items including safety apparel, safety glasses, gloves, and emergency first aid kits and emergency medical supplies is maintained on site for use.

The operation of the drip irrigation system is interconnected with rain sensors to prevent operation of the system during wet weather. Operational protocols will be implemented to maintain minimum wet weather storage basin level to accommodate unusual or extreme rain events.

Notification protocols:

1. Spills and accidental discharges of off-specification wastewater will be reported within 24 hours to the UNC Dept. of Environment, Health, and Safety and to the NCDENR Raleigh Regional Office.

Additional safety measures and concerns will be addressed in the Operation and Maintenance Manual.

Emergency Procedures and Contacts

Emergencies will be managed in accordance with the UNC Emergency Operations Plan, the UNC EHS Emergency Response Manual, and the Facilities Services Emergency Response Plan

Emergency contacts are as follows:

University of North Carolina at Chapel Hill

Operators in Responsible Charge
Clay Teague 919-883-7074
James Smith 919-833-6003

UNC Dept. of Environment, Health, and Safety
Report any emergencies or accidents 919-962-5507

UNC Energy Services
Water, Wastewater, and Stormwater
919-843-0364

Other Emergency Contacts

NCDENR Environmental Emergency
1-800-858-0368

DWQ Raleigh Regional Office
919-791-4200

White Cross Fire Department 911 or 919-942-1194

Orange County EMS: 911 or 919-732-5923

Emergency Medical Facilities: UNC Hospitals, 919-966-4131

Other emergency contacts and information will be included in the Operation and Maintenance Manual.

EDWIN ANDREWS & ASSOCIATES, P.C.
CONSULTING HYDROGEOLOGY AND SOIL SCIENCE

P.O. BOX 30653
RALEIGH, N.C. 27622 - 0653
PHONE: (919) 851-7844
FAX: (919) 851-6058

December 21, 2012

Mr. Chuck Riley, Jr. PE Senior Project Engineer
McKim & Creed Engineers
1730 Varsity Dr.
Raleigh, NC 27606

Re: Irrigation Method - UNC Bingham Facility
Hydrogeology Evaluation - Permit Application Request Support
Orange County, North Carolina

Dear Mr. Riley,

It is understood that McKim & Creed proposes to apply effluent using drip irrigation in lieu of spray irrigation. From a hydrogeological and agronomic perspective, a drip irrigation system is actually preferred because the low dose requirements recommended in the "Hydrogeologic Evaluation, Wastewater Disposal, UNC Bingham Facility, Orange County, North Carolina," March 2011 report are more readily achieved by drip irrigation rather than spray irrigation. The hydrogeologic and soil report support the use of drip irrigation at the UNC Bingham Facility as well as spray irrigation, assuming the loading rates and area irrigated remain the same..

If you have any questions please contact me at my office 919-851-7844 or on my cell at 919-306-3069.

Very truly yours,
Edwin Andrews & Associates, P.C.



Edwin E. Andrews III, P.G., N.C.L.S.S.
Consulting Hydrogeologist and Soil Scientist



UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL

**BINGHAM FACILITY
WASTEWATER SYSTEM IMPROVEMENTS**

SCO FILE # 11-08872-01A

**CONTRACT DOCUMENTS AND
TECHNICAL SPECIFICATIONS**

M&C Project No. 01488-0032



**Final Design – Not for
Construction**

January 2013



**1730 Varsity Drive, Suite 500
Raleigh, North Carolina 27606
(919) 233-8091
License No. F-1222**

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SECTION 01010 – SUMMARY OF WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 WORK COVERED BY CONTRACT

- A. The Project consists of improvements to the wastewater collection system and existing domestic wastewater treatment system, re-construction of the existing secondary effluent storage basin and wet weather storage basin, improvements to the existing irrigation pump station, and construction of a new 5.72 acre drip irrigation system for dispersal of secondary treated effluent on-site. Improvements to the domestic wastewater treatment system include removal of an existing ultraviolet system, construction of a new chlorine contact tank with chlorine feed system, refurbishment of the existing AdvanTex domestic wastewater treatment system, and construction of a new effluent pump station. The project also includes phased demolition of existing wastewater collection and treatment equipment.

- 1. Project Location: 1907 Orange Chapel Clover Garden Rd.,
UNC Bingham Facility, Orange County, NC

- 2. Owner: The University of North Carolina at Chapel Hill

- B. Contract Documents, dated July 2011 were prepared for the Project by McKim & Creed, Inc., 1730 Varsity Drive, Suite 500, Raleigh, North Carolina 27606, (919) 233-8091.

- C. The Work consists of furnishing all labor, materials, tools, equipment and related items and services required for construction in strict accordance with the Contract Documents. All Bids shall include mobilization, administration, labor, materials, tools, equipment, transportation, taxes, insurance, and all other items necessary for a complete and functional wastewater collection, treatment, and disposal system.

- D. The Work will be constructed under a single prime contract with award based on the lowest responsive bid.

1.3 WORK UNDER OTHER CONTRACTS (Not applicable)

1.4 FUTURE WORK (Not Applicable)

1.5 WORK SEQUENCE

- A. The Work shall be conducted in an orderly manner by the Contractor and in accordance with the written sequence of construction. The existing pump and haul operation shall be maintained in operation until refurbishments to the existing sewer collection, treatment , and disposal system are complete and ready for start-up and operation. The Contractor shall employ sufficient number of construction crews to meet the critical project schedule of the University. .
- B. The University has strict security measures at Bingham, and the contractor shall strictly adhere to these requirements. See the Supplemental General Conditions.
- C. Requests for time extensions and resultant extra costs shall be submitted to the Designer within twenty (20) working days of the date of the delay. Each request shall fully describe the delay, when it occurred, what the effects were, who was responsible, possible mitigation measures, reference to the contract sections and drawing numbers, and a detailed cost estimate including direct and indirect reimbursement requested. In addition, the Contractor shall describe what effect, if any, the delay may have on the contract completion date. All claims for extra cost and time extensions shall be submitted in accordance with the contract documents.
- D. Claims for weather delays shall be submitted on a monthly basis and over the entire course of the project. Claims for weather delays shall account for both weather that are above and below the normal intensity, such that a complete evaluation of the requested time extension request can be completed.

1.6 CONTRACTOR USE OF PREMISES

- A. The Contractor is responsible for remaining within Bingham Facility property and restricting work to the established limits of construction as defined in the contract drawings. The Contractor's use of the premises is limited only by the Owner's right to perform work or to retain other contractors on portions of the Project.
- B. Contractor staging and storage area: No dedicated staging and storage areas have been designated for this project. The Contractor shall utilize the area within the designated limits of disturbance unless approved by the University. The facility is a secured area with a card controlled security gate and security fencing around the facility. All other staging and storage shall be arranged by the Contractor off-site and deliveries scheduled on an "as needed" basis.

1.7 OCCUPANCY REQUIREMENTS (Not Applicable)

1.8 PRODUCTS ORDERED IN ADVANCE (Not Applicable)

1.9 OWNER-FURNISHED PRODUCTS (Not Applicable)

1.10 MISCELLANEOUS PROVISIONS (Not Applicable)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)
END OF SECTION 01010

SECTION 01050 - ALLOWANCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements governing allowances.
 - 1. Certain items are specified in the Contract Documents by allowances. Allowances have been established in lieu of additional requirements and to defer selection of actual materials and equipment to a later date when direction will be provided to the Contractor. If necessary, additional requirements will be issued by Change Order.
- B. Types of allowances include the following:
 - 1. Lump-sum allowances.
 - 2. Unit-cost allowances.
 - 3. Quantity allowances.
 - 4. Contingency allowances.
 - 5. Testing and inspecting allowances.
- C. Related Sections:
 - 1. Division 1 Section "Measurement and Payment" for procedures for using unit-cost and lump-sum prices.
 - 2. Division 1 Section "Quality Control" for procedures governing the use of allowances for testing and inspecting.
 - 3. Divisions 2 through 16 Sections for items of Work covered by allowances.

1.3 SELECTION AND PURCHASE

- A. At the earliest practical date after award of the Contract, advise Engineer of the date when final selection and purchase of each product or system described by an allowance must be completed to avoid delaying the Work.
- B. At Engineer's request, obtain proposals for each allowance for use in making final selections. Include recommendations that are relevant to performing the Work.

- C. Purchase products and systems selected by Engineer or Owner from the designated supplier.

1.4 SUBMITTALS

- A. Submit proposals for purchase of products or systems included in allowances, in the form specified for Change Orders.
- B. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.
- C. Submit time sheets and other documentation to show labor time and cost for installation of allowance items that include installation as part of the allowance.
- D. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.

1.5 COORDINATION

- A. Coordinate allowance items with other portions of the Work. Furnish templates as required to coordinate installation.

1.6 ALLOWANCES

- A. Allowance shall include cost to Contractor of specific products and materials ordered by Owner or selected by Engineer under allowance and shall include taxes, freight, and delivery to Project site.
- B. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials under allowance shall be included as part of the Contract Sum and not part of the allowance.
- C. Unused Materials: Return unused materials purchased under an allowance to manufacturer or supplier for credit to Owner, after installation has been completed and accepted.
 - 1. If requested by Engineer, retain and prepare unused material for storage by Owner. Deliver unused material to Owner's storage space as directed.

1.7 CONTINGENCY ALLOWANCES

- A. Use the contingency allowance only as directed by Engineer for Owner's purposes and only by Change Orders that indicate amounts to be charged to the allowance.
- B. Contractor's related costs for products and equipment ordered by Owner under the contingency allowance are included in the allowance and are not part of the

Contract Sum. These costs include delivery, installation, taxes, insurance, equipment rental, and similar costs.

- C. Change Orders authorizing use of funds from the contingency allowance will include Contractor's related costs and reasonable overhead and profit margins.
- D. At Project closeout, credit unused amounts remaining in the contingency allowance to Owner by Change Order.

1.8 TESTING AND INSPECTING ALLOWANCES

- A. Testing and inspecting allowances include the cost of engaging testing agencies, actual tests and inspections, and reporting results.
- B. The allowance does not include incidental labor required to assist the testing agency or costs for retesting if previous tests and inspections result in failure. The cost for incidental labor to assist the testing agency shall be included in the Contract Sum.
- C. Costs of services not required by the Contract Documents are not included in the allowance.
- D. At Project closeout, credit unused amounts remaining in the allowances to Owner by Change Order.

1.9 ADJUSTMENT OF ALLOWANCES

- A. Allowance Adjustment: To adjust allowance amounts, prepare a Change Order proposal based on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place where applicable. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.
 - 1. Include installation costs in purchase amount only where indicated as part of the allowance.
 - 2. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other margins claimed.
 - 3. Submit substantiation of a change in scope of work, if any, claimed in Change Orders related to unit-cost allowances.
 - 4. Owner reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.
- B. Submit claims for increased costs because of a change in scope or nature of the allowance described in the Contract Documents, whether for the purchase order amount or Contractor's handling, labor, installation, overhead, and profit.
 - 1. Do not include Contractor's or subcontractor's indirect expense in the Change Order cost amount unless it is clearly shown that the nature or

extent of work has changed from what could have been foreseen from information in the Contract Documents.

2. No change to Contractor's indirect expense is permitted for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

3.2 PREPARATION

- A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

3.3 SCHEDULE OF ALLOWANCES

- A. Allowance No. 1: Testing and Inspection Allowance: Include the lump sum of \$40,000 for soils compaction testing, clay liner permeability testing as required by the specifications, and cement stabilized soil liner testing.

END OF SECTION 01210

SECTION 01060 - REGULATORY REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Requirements and procedures for obtaining permits and complying with permits.

1.2 PERMITS

- A. Obtain County, State and Federal permits not obtained by Owner, which may include but may not be limited to the following:
 - 1. Building Permit
 - 2. Electrical Permit
 - 3. Plumbing Permit
 - 4. Fire Prevention
 - 5. Inspection
 - 6. Reinspection
- B. Owner will obtain the following permits as required:
 - 1. DENR Non-Discharge Permits;
 - 2. Sediment & Erosion Control Permit;
 - 3. Stormwater;
 - 4. Nationwide Permits;
 - 5. 404 Permits;
- C. Documents:
 - 1. Owner will furnish signed and sealed sets of Contract Documents for permit applications.
 - 2. Owner will furnish copies of permits obtained by Owner and required to be posted on the job site. Copies of permits will be forwarded to Contractor prior to start of construction.
 - 3. Contractor shall furnish copies of permits obtained by the Contractor. Forward copies of permits to the Engineer prior to commencement of work requiring permits.
 - 4. CONTRACTOR shall give all notices and comply with all environmental permits applicable to furnishing and performance of the Work notwithstanding the fact that the CONTRACTOR may not be a permittee or co-permittee with respect to some or all of such environmental permits.
 - 5. CONTRACTOR shall be liable for failure to comply with the provisions or conditions of the permit and shall be liable for any fines or cost of mitigation requirements imposed by the regulatory agency.

1.3 CODES

- A. Codes applicable to this project include, but are not necessarily limited to, the following:
 - 1. Standard Building Codes.

2. Title 29, Part 1926, Construction Safety and Health Regulations, Code of Federal Regulations (OSHA), including all changes and amendments thereto.
3. Title 29, Part 1910, Occupational Safety and Health Standards, Code of Federal Regulations (OSHA), including all changes and amendments thereto.
4. Accessibility Requirements Manual, North Carolina Board of Building Codes and Standards.
5. The Americans with Disabilities Act (ADA) 1990 36 CFR Part 1191 Architectural and Transportation Barriers Compliance Requirements.
6. NFPA 101 Life Safety Code, 1994 Edition.
7. Standard Fire Prevention Code, 1985 Edition.
8. State Fire Marshal's Uniform Fire Safety Rules.

B. If there is a conflict in regulations, codes, or regulations and codes, the more stringent requirements shall govern.

1.4 FEES

A. Contractor will pay the costs for permit fees and inspections. No separate compensation will be allowed.

1.5 SPECIAL REQUIREMENTS

The Contractor shall be responsible for knowing and complying with regulatory requirements - Federal, State and Local - pertaining to legal disposal of all construction and demolition waste materials, including but not limited to the following:

A. N.C. General Statute 130A

1. **Whole Tires** as of March 1, 1990 banned in landfills
2. **Used Oil** as of October 1, 1990, banned in landfills
3. **Yard Waste** as of January 1, 1993, banned in landfills
4. **Aluminum Cans** as of July 1, 1994, banned in landfills or incinerators.
5. **White Goods** as of January 1, 1991, banned in landfills. Incineration banned as of July 1, 1994.
6. Orange County Regulated Recyclable Materials Ordinance requires **cardboard, clean wood, scrap metal and pallets** to be either source separated or taken in mixed loads to a permitted facility (contact OWRR or Orange County Solid Waste at 919/968-2788 for a list of facilities). It also requires that **anyone hauling** these wastes in a vehicle that is 9,000 lb. or greater within Orange County must have a license. Contact Orange County Solid Waste to obtain a license. All containers (dumpsters, rolloffs, compactors) for regulated materials must display a unique identifying number at least 3" high, along with the name of the owner or hauler.

- B. University policy regarding hazardous materials, UNC-Chapel Hill Design Guidelines, Chapter IV (Supplemental Guidelines): Hazardous and Universal Waste Issues. Contact: UNC-Chapel Hill Office of Environment, Health and Safety.

PART 2 - PRODUCTS (not used)

PART 3 - EXECUTION

3.1 VERIFICATION AND CONFORMANCE

- A. Verify that all permits, which Owner is required to obtain, have been obtained. Copies of these permits will be made available to the Contractor at office of Engineer.
- B. Obtain all permits Contractor is responsible for obtaining and submit three copies of each to Engineer.
- C. Conform to all requirements of each permit.

END OF SECTION 01060

SECTION 01095 - REFERENCE STANDARDS AND DEFINITIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 DEFINITIONS:

- A. **General:** Basic contract definitions are included in the Conditions of the Contract.
- B. **"Indicated":** The term "indicated" refers to graphic representations, notes, or schedules on the Drawings; or to other paragraphs or schedules in the Specifications and similar requirements in the Contract Documents. Terms such as "shown," "noted," "scheduled," and "specified" are used to help the user locate the reference. Location is not limited.
- C. **"Directed":** Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean directed by the Engineer, requested by the Engineer, and similar phrases.
- D. **"Approved":** The term "approved," when used in conjunction with the Engineer's action on the Contractor's submittals, applications, and requests, is limited to the Engineer's duties and responsibilities as stated in the Conditions of the Contract.
- E. **"Regulations":** The term "regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. **"Furnish":** The term "furnish" means to supply and deliver to the Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. **"Install":** The term "install" describes operations at the Project site including the actual unloading, temporary storage, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- H. **"Provide":** The term "provide" means to furnish and install, complete and ready for the intended use.
- I. **"Installer":** An installer is the Contractor or another entity engaged by the Contractor, either as an employee, subcontractor, or contractor of lower tier, who performs a particular construction activity including installation, erection, application, or similar operations. Installers are required to be experienced in the operations they are engaged to perform.

1. The term "experienced," when used with the term "installer," means having successfully completed a minimum of 5 previous projects similar in size and scope to this Project; being familiar with the special requirements indicated; and having complied with requirements of authorities having jurisdiction.
 2. Trades: Using terms such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to tradespeople of the corresponding generic name.
 3. Assigning Specialists: Certain Sections of the Specifications require that specific construction activities shall be performed by specialists who are recognized experts in those operations. The specialists must be engaged for those activities, and their assignments are requirements over which the Contractor has no option. However, the ultimate responsibility for fulfilling contract requirements remains with the Contractor.
 - a. This requirement shall not be interpreted to conflict with enforcing building codes and similar regulations governing the Work. It is also not intended to interfere with local trade-union jurisdictional settlements and similar conventions.
- J. "Project site" is the space available to the Contractor for performing construction activities, either exclusively or in conjunction with others performing work as part of the Project. The extent of the Project site is shown on the Drawings and may or may not be identical with the description of the land on which the Project is to be built.
- K. "Testing Agencies": A testing agency is an independent entity engaged to perform specific inspections or tests, either at the Project site or elsewhere, and to report on and, if required, to interpret results of those inspections or tests.

1.3 SPECIFICATION FORMAT AND CONTENT EXPLANATION:

- A. Specification Format: These Specifications are organized into Divisions and Sections based on the Construction Specifications Institute's 16-division format and "MasterFormat" numbering system.
- B. Specification Content: These Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 1. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be interpolated as the sense requires. Singular words shall be interpolated as plural and plural words interpreted as singular where applicable as the context of the Contract Documents indicates.

2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by the Contractor. At certain locations in the Text, subjective language is used for clarity to describe responsibilities that must be fulfilled indirectly by the Contractor or by others when so noted.
 - a. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

1.4 INDUSTRY STANDARDS:

- A. **Applicability of Standards:** Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
- B. **Publication Dates:** Comply with the standards in effect as of the date of the Contract Documents.
- C. **Conflicting Requirements:** Where compliance with 2 or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer to the Engineer before proceeding for a decision on requirements that are different but apparently equal, and where it is uncertain which requirement is the most stringent.
 1. **Minimum Quantity or Quality Levels:** The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of the requirements. Refer uncertainties to the Engineer for a decision before proceeding.
- D. **Copies of Standards:** Each entity engaged in construction on the Project must be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
 1. Where copies of standards are needed to perform a required construction activity, the Contractor shall obtain copies directly from the publication source and make them available on request.
- E. **Abbreviations and Names:** Trade association names and titles of general standards are frequently abbreviated. The following abbreviations and acronyms, as referenced in the Contract Documents, mean the associated names. Names and addresses are subject to change and are believed, but are

not assured, to be accurate and up-to-date as of the date of the Contract Documents.

AA	Aluminum Association, Inc. 900 19th Street, NW, Suite 300 Washington, DC 20006	(202) 862-5100
AASHTO	American Association of State Highway and Transportation Officials 444 North Capitol Street, Suite 249 Washington, DC 20001	(202) 624-5800
ACI	American Concrete Institute P.O. Box 19150 Detroit, MI 48219	(313) 532-2600
ACIL	American Council of Independent Laboratories 1629 K Street, NW Washington, DC 20006	(202) 887-5872
ACPA	American Concrete Pipe Association 8300 Boone Boulevard, Suite 400 Vienna, VA 22182	(703) 821-1990
AI	Asphalt Institute Research Park Drive P.O. Box 14052 Lexington, KY 40512-4052	(606) 288-4960
AIA	American Insurance Assoc. 1130 Connecticut Avenue, NW, Suite 1000 Washington, DC 20036	(202) 828-7100
ASC	Adhesive and Sealant Council 1627 K Street, NW, Suite 1000 Washington, DC 20006-1707	(202) 452-1500
ASCE	American Society of Civil Engineers 345 East 47th Street New York, NY 10017-2398	(800) 548-2723
ASME	American Society of Mechanical Engineers 345 East 47th Street New York, NY 10017	(212) 705-7722
ASSE	American Society of Sanitary Engineering 901 Canterbury Road, Suite A Westlake, OH 44145	(440) 835-3040
ASTM	American Society for Testing and Materials	

	100 Barr Harbor Drive West Conshohocken, PA 19428	(610) 832-9585
AWWA	American Water Works Assoc. 6666 W. Quincy Avenue Denver, CO 80235	(303) 794-7711
CISPI	Cast Iron Soil Pipe Institute 5959 Shallowford Road, Suite 419 Chattanooga, TN 37421	(615) 892-0137
CLFMI	Chain Link Fence Manufacturers Institute 1776 Massachusetts Avenue, NW, Suite 500 Washington, DC 20036	(202) 659-3537
DIPRA	Ductile Iron Pipe Research Assoc. 245 Riverchase Parkway East Birmingham, AL 35124	(205) 988-9870
HI	Hydraulic Institute 9 Sylvan Way Parsippany, NJ 07054-3802	(201) 267-9700
HI	Hydronics Institute P.O. Box 218 35 Russo Place Berkeley Heights, NJ 07922	(908) 464-8200
ILI	Indiana Limestone Institute of America Stone City Bank Building, Suite 400 Bedford, IN 47421	(812) 275-4426
IMSA	International Municipal Signal Assoc. 165 E. Union Street Newark, NY 14513	(315) 331-2182
IRI	Industrial Risk Insurers P.O. Box 5010 85 Woodland Street Hartford, CT 06102-5010	(203) 520-7300
MIA	Marble Institute of America 30 Eden Alley, Suite 201 Columbus, OH 43215	(614) 228-6194
MIA	Masonry Institute of America 2550 Beverly Blvd. Los Angeles, CA 90057	(213) 388-0472
ML/SFA	Metal Lath/Steel Framing Assoc.	

	(A Division of the NAAMM) 11 South LaSalle Street, Suite 1400 Chicago, IL 60603	(312) 201-0101
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry 127 Park Street, NE Vienna, VA 22180-4602	(703) 281-6613
NAA	National Arborist Assoc. The Meeting Place Mall Route 101, P.O. Box 1094 Amherst, NH 03031-1094	(603) 673-3311
NEC	National Electrical Code (Available from NFPA)	
NECA	National Electrical Contractors Assoc. 3 Bethesda Metro Center, Suite 1100 Bethesda, MD 20814-5372	(301) 657-3110
NPCA	National Paint and Coatings Assoc. 1500 Rhode Island Avenue, NW Washington, DC 20005	(202) 462-6272
NSF	NSF International (Formerly National Sanitation Foundation) 3475 Plymouth Road P.O. Box 130140 Ann Arbor, MI 48113-0140	(313) 769-8010
PATMI	Power Actuated Tool Manufacturers' Institute, Inc. 1603 Boonslick Road St. Charles, MO 63301	(314) 947-6610
PCA	Portland Cement Assoc. 5420 Old Orchard Road Skokie, IL 60077-1083	(708) 966-6200
PCI	Precast/Prestressed Concrete Institute 175 W. Jackson Blvd. Chicago, IL 60604	(312) 786-0300
PDI	Plumbing and Drainage Institute c/o Sol Baker 1106 W. 77th Street, South Drive Indianapolis, IN 46260	(317) 251-6970

PEI	Porcelain Enamel Institute 102 Woodmont Center, Suite 360 Nashville, TN 37205	(615) 385-0758
PIMA	Polyisocyanurate Insulation Manufacturers Association 1001 Pennsylvania Avenue, NW 5th Floor North Washington, DC 20004	(202) 624-2709
RFCI	Resilient Floor Covering Institute 401 East Jefferson Street, Suite 102 Rockville, MD 20850	(301) 340-8580
RIS	Redwood Inspection Service 405 Enfrente Drive, Suite 200 Novato, CA 94949	(415) 382-0662
RMA	Rubber Manufacturers Assoc. 1400 K Street, NW Washington, DC 20005	(202) 682-4800
SAE	SAE International 400 Commonwealth Drive Warrendale, PA 15096-0001	(412) 776-4841
SDI	Steel Deck Institute P.O. Box 25 Fox River Grove, IL 60021	(847) 889-0010
SDI	Steel Door Institute 30200 Detroit Road Cleveland, OH 44145-1967	(216) 889-0010
SEFA	Scientific Equipment and Furniture Assoc. 1028 Duchess Drive McLean, VA 22102	(703) 790-8661
SGCC	Safety Glazing Certification Council c/o ETL Testing Laboratories U.S. Route 11, Industrial Park P.O. Box 2040 Cortland, NY 13045	(607) 753-6711
SHLMA	Southern Hardwood Lumber Manufacturers Assoc. (Now HMA)	
SIGMA	Sealed Insulating Glass Manufacturers Assoc. 401 N. Michigan Avenue Chicago, IL 60611	(312) 644-6610

SJI	Steel Joist Institute 1205 48th Avenue North, Suite A Myrtle Beach, SC 29577-5424	(803) 449-0487
SMA	Screen Manufacturers Assoc. 2850 South Ocean Boulevard, #114 Palm Beach, FL 33480-6205	(561) 533-0991
SMACNA	Sheet Metal and Air Conditioning Contractors' National Assoc. 4201 Lafayette Center Drive P.O. Box 221230 Chantilly, VA 22022-1230	(703) 803-2980
SPIB	Southern Pine Inspection Bureau 4709 Scenic Highway Pensacola, FL 32504-9094	(904) 434-2611
SPRI	SPRI (Formerly Single Ply Roofing Institute) 175 Highland Avenue Needham, MA 02194	(617) 444-0242
SSIUS	Specialty Steel Industry of the United States 3050 K Street, NW Washington, DC 20007	(202) 342-8630
SSPC	Steel Structures Painting Council 4516 Henry Street, Suite 407 Pittsburgh, PA 15213	(412) 687-1113
SSPMA	Sump and Sewage Pump Manufacturers Assoc. P.O. Box 647 Northbrook, IL 60065-0647	(708) 559-9233
STI	Steel Tank Institute 570 Oakwood Road Lake Zurich, IL 60047	(708) 438-8265
SWI	Steel Window Institute c/o Thomas Associates, Inc. 1300 Sumner Avenue Cleveland, OH 44115-2851	(216) 241-7333
SWPA	Submersible Wastewater Pump Assoc. 1806 Johns Drive Glenview, IL 60025-1657	(847) 729-7972

TCA	Tile Council of America, Inc. 100 Clemson Research Boulevard Anderson, SC 29625	(864) 646-8453
TIMA	Thermal Insulation Manufacturers Assoc. (Now NAIMA)	
TPI	Truss Plate Institute 583 D'Onofrio Drive, Suite 200 Madison, WI 53719	(608) 833-5900
TPI	Turfgrass Producers International (Formerly American Sod Producers Assoc.) 1855-A Hicks Road Rolling Meadows, IL 60008	(800) 405-8873
UL	Underwriters Laboratories 333 Pfingsten Road Northbrook, IL 60062-2096	(708) 272-8800
UNI	Uni-Bel PVC Pipe Assoc. 2655 Villa Creek Drive, Suite 155 Dallas, TX 75234	(214) 243-3902
USP	U.S. Pharmacopeia (Formerly U.S. Pharmacopoeial Convention) 12601 Twinbrook Pkwy Rockville, MD 20852	(301) 881-0666
WA	Wallcoverings Assoc. 401 N. Michigan Avenue Chicago, IL 60611-4267	(312) 644-6610
WCLIB	West Coast Lumber Inspection Bureau P.O. Box 23145 Portland, OR 97281	(503) 639-0651
WCMA	Window Covering Manufacturers Assoc. 355 Lexington Avenue, 17th Floor New York, NY 10017	(212) 661-4261
WIC	Woodwork Institute of California 3164 Industrial Boulevard 95891 P.O. Box 980247 West Sacramento, CA 95798-0247	(916) 372-9943
WMMPA	Wood Moulding & Millwork Producers Assoc. P.O. Box 25278 Portland, OR 97225	(503) 292-9288

WRI	Wire Reinforcement Institute 1101 Connecticut Avenue NW, Suite 700 Washington, DC 20036-4303	(202) 429-5125
WSC	Water Systems Council Building C, Suite 20 800 Roosevelt Road Glen Ellyn, IL 60137	(708) 545-1762
WSFI	Wood and Synthetic Flooring Institute (Now MFMA)	
WWCA	Western Wall and Ceiling Assoc. (Formerly Western Lath, Plaster, Drywall Industries Assoc.) 7571 Mission Gorge Road San Diego, CA 92120	(619) 229-8307
WWPA	Western Wood Products Assoc. Yeon Building 522 SW 5th Avenue Portland, OR 97204-2122	(503) 224-3930
WWPA	Woven Wire Products Assoc. 4940 Elmgate Drive Orchard Lake, MI 48324	(810) 681-1055

G. Federal Government Agencies: Names and titles of Federal Government standards- or specification-producing agencies are often abbreviated. The following abbreviations and acronyms referenced in the Contract Documents indicate names of standards- or specification-producing agencies of the Federal Government. Names and addresses are subject to change and are believed, but are not assured, to be accurate and up-to-date as of the date of the Contract Documents.

CE	Corps of Engineers (U.S. Department of the Army) Chief of Engineers General Information Referral 20 Massachusetts Avenue, NW Washington, DC 20314	(202) 761-0660
CFR	Code of Federal Regulations (Available from the Government Printing Office) 732 N. Capitol Street, NW Washington, DC 20401 (Material is usually published first in the "Federal Register.")	(202) 512-0000

CPSC	Consumer Product Safety Commission East West Towers 4330 East-West Hwy Bethesda, MD 20814	(800) 638-2772
CS	Commercial Standard (U.S. Department of Commerce) Government Printing Office Washington, DC 20402	(202) 512-0000
DOC	Department of Commerce 14th Street and Constitution Avenue, NW Washington, DC 20230	(202) 482-2000
DOT	Department of Transportation 400 Seventh Street, SW Washington, DC 20590	(202) 366-4000
EDA	Economic Development Administration - Regional Office 300 Fayetteville Street Mall Raleigh, NC 27601	(919) 856-4570
EPA	Environmental Protection Agency 401 M Street, SW Washington, DC 20460	(202) 260-2090
FAA	Federal Aviation Administration (U.S. Department of Transportation) 800 Independence Avenue, SW Washington, DC 20591	(202) 366-4000
FCC	Federal Communications Commission 445 12 th Street SW Washington, DC 20554	(888) 225-5322
FDA	Food and Drug Administration 5600 Fishers Lane Rockville, MD 20857	(301) 443-1544
FHA	Federal Housing Administration (U.S. Department of Housing and Urban Development) 451 Seventh Street, SW Washington, DC 20410	(202) 708-1112
FS	Federal Specification Unit (Available from GSA) 470 East L'Enfant Plaza, SW, Suite 8100 Washington, DC 20407	(202) 755-0325

GSA	General Services Administration 18 th and F Streets, NW Washington, DC 20405	(202) 708-5082
MIL	Military Standardization Documents (U.S. Department of Defense) Defense Printing Service 700 Robbins Avenue, Building 4D Philadelphia, PA 19111	(215) 697-2179
NIST	National Institute of Standards and Technology (U.S. Department of Commerce) Building 101, #A1134 Rte. I-270 and Quince Orchard Road Gaithersburg, MD 20899	(301) 975-2000
OSHA	Occupational Safety and Health Administration (U.S. Department of Labor) 200 Constitution Avenue, NW Washington, DC 20210	(202) 219-5000
PS	Product Standard of NBS (U.S. Department of Commerce) Government Printing Office Washington, DC 20402	(202) 512-0000
RUS	Rural Utilities Service (Formerly Rural Electrification Administration) (U.S. Department of Agriculture) 14th Street and Independence Avenue, SW Washington, DC 20250	(202) 720-9560
USDA	U.S. Department of Agriculture 14th Street and Independence Avenue, SW Washington, DC 20250	(202) 720-8732
USDA	USDA Rural Development 4405 Bland Road, Suite 260 Raleigh, NC 27609	(919) 873-2054
USPS	U.S. Postal Service 475 L'Enfant Plaza, SW Washington, DC 20260-0010	(202) 268-2000
H.	State Government Agencies: The following state government agency produces standards referenced in the Contract Documents:	
NCDOT	NC Department of Transportation 4009 District Drive Raleigh, NC 27607	(919) 733-3213

	NC Department of Transportation District Engineer, District Office P.O. Box 2275 New Bern, NC 28560	(252) 514-4761
	NC Department of Transportation District Engineer, District Office P.O. Box 1107 Statesville, NC 28687	(704) 876-3947
	NC Department of Transportation District Engineer, District Office 2671 US 70 West Goldsboro, NC 27530	(919) 731-7938
	NC Department of Transportation District Engineer, District Office 1060 Eastern Boulevard Henderson, NC 27536	(252) 492-0111
	NC Department of Transportation District Engineer, District Office P.O. Box 502 Wilmington, NC 28402	(910) 251-5785
	NC Department of Transportation District Engineer, District Office 1701 W. 5 th Street Washington, NC 27889	(252) 946-3689
Construction Grants	Division of Water Quality NCDENR 1633 Mail Service Center Raleigh, NC 27699-1633	(919) 733-6900
Water Quality Section	Division of Water Quality NCDENR 1617 Mail Service Center Raleigh, NC 27699-1617	(919) 733-5083
	Division of Water Quality NCDENR Washington Regional Office 943 Washington Square Mall Washington, NC 27889	(252) 946-6481

	Division of Water Quality NCDENR Raleigh Regional Office 1628 Mail Service Center Raleigh, NC 27699-1628	(919) 571-4700
	Division of Water Quality NCDENR Wilmington Regional Office 127 Cardinal Drive Extension Wilmington, NC 28405	(910) 395-3900
Land Quality	Division of Land Resources NCDENR Raleigh Regional Office 1628 Mail Service Center Raleigh, NC 27699-1628	(919) 571-4700
	Division of Land Resources NCDENR Washington Regional Office 943 Washington Square Mall Washington, NC 27889	(252) 946-6481
	Division of Land Quality NCDENR Wilmington Regional Office 127 Cardinal Drive Extension Wilmington, NC 28405	(910) 395-3900
Public Water Supply	Division of Environmental Health NCDENR 1634 Mail Service Center Raleigh, NC 27699-1634	(919) 733-2321

1.5 GOVERNING REGULATIONS AND AUTHORITIES: (Not Applicable)

1.6 SUBMITTALS:

- A. Permits, Licenses, and Certificates: For the Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 01095

SECTION 01240 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. General project coordination procedures.
 - 2. Administrative and supervisory personnel.
 - 3. Coordination drawings.
 - 4. Requests for Information (RFIs).
 - 5. Project meetings.
- B. Each contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific contractor.
- C. Related Sections:
 - 1. Division 1 Section "Project Meetings".
 - 2. Division 1 Section "Project Schedule".
 - 3. Division 1 Section "Contract Closeout".

1.3 DEFINITIONS

- A. RFI: Request from Owner, Engineer, or Contractor seeking information from each other during construction.

1.4 COORDINATION

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.

2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
 3. Make adequate provisions to accommodate items scheduled for later installation.
- B. Coordination: Each contractor shall coordinate its construction operations with those of other contractors and entities to ensure efficient and orderly installation of each part of the Work. Each contractor shall coordinate its operations with operations, included in different Sections, that depend on each other for proper installation, connection, and operation.
1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 2. Coordinate installation of different components with other contractors to ensure maximum performance and accessibility for required maintenance, service, and repair.
 3. Make adequate provisions to accommodate items scheduled for later installation.
- C. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.
- D. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
1. Preparation of Contractor's construction schedule.
 2. Preparation of the schedule of values.
 3. Installation and removal of temporary facilities and controls.
 4. Delivery and processing of submittals.
 5. Progress meetings.
 6. Preinstallation conferences.
 7. Project closeout activities.
 8. Startup and adjustment of systems.
 9. Project closeout activities.
- E. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. Refer to other Sections for disposition of salvaged materials that are designated as Owner's property.

1.5 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings in accordance with requirements in individual Sections, where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
 - a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
 - b. Coordinate the addition of trade-specific information to the coordination drawings by multiple contractors in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
 - c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
 - e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
 - f. Indicate required installation sequences.
 - g. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Engineer indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
- B. Coordination Drawing Organization: Organize coordination drawings as follows:
1. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire protection, fire alarm, and electrical equipment.
 2. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
 3. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
 4. Mechanical and Plumbing Work: Show the following:
 - a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.

- b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
 - c. Fire-rated enclosures around ductwork.
 - 5. Electrical Work: Show the following:
 - a. Runs of vertical and horizontal conduit 1-1/4 inch diameter and larger.
 - b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire alarm locations.
 - c. Panel board, switch board, switchgear, transformer, busway, generator, and motor control center locations.
 - d. Location of pull boxes and junction boxes, dimensioned from column center lines.
 - 6. Review: Engineer will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are the Contractor's responsibility. If the Engineer determines that the coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, the Engineer will so inform the Contractor, who shall make changes as directed and resubmit.
 - 7. Coordination Drawing Prints: Prepare coordination drawing prints in accordance with requirements of Division 1 Section "Submittal Procedures."
- C. Coordination Digital Data Files: Prepare coordination digital data files in accordance with the following requirements:
 - 1. File Preparation Format: Same digital data software program, version, and operating system as the original Drawings.
 - 2. File Preparation Format: DWG, Version 2008, operating in Microsoft Windows operating system.
 - 3. File Submittal Format: Submit or post coordination drawing files using format same as file preparation format.
 - 4. Engineer will furnish Contractor one set of digital data files of the Drawings for use in preparing coordination digital data files.
 - a. Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to the Drawings.
 - b. Contractor shall execute a data licensing agreement in the form acceptable to the Owner and Engineer.

1.6 KEY PERSONNEL

- A. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home, office, and cellular telephone numbers and email addresses. Provide names,

addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.

1. Post copies of list in project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.

1.7 REQUESTS FOR INFORMATION (RFIs)

A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.

1. Engineer will return RFIs submitted to Engineer by other entities controlled by Contractor with no response.
2. Coordinate and submit RFIs in a prompt manner so as to prevent delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:

1. Project name.
2. Project number.
3. Date.
4. Name of Contractor.
5. Name of Engineer.
6. RFI number, numbered sequentially.
7. RFI subject.
8. Specification Section number and title and related paragraphs, as appropriate.
9. Drawing number and detail references, as appropriate.
10. Field dimensions and conditions, as appropriate.
11. Contractor's suggested resolution. If Contractor's solution(s) impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
12. Contractor's signature.
13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

C. RFI Forms: CJCDC Forms acceptable to the Engineer.

D. Engineer's Action: Engineer will review each RFI, determine action required, and respond. Allow seven working days for Engineer's response for each RFI. RFIs received by Engineer after 1:00 p.m. will be considered as received the following working day.

1. The following RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for coordination information already indicated in the Contract Documents.
 - d. Requests for adjustments in the Contract Time or the Contract Sum.
 - e. Requests for interpretation of Engineer's actions on submittals.
 - f. Incomplete RFIs or inaccurately prepared RFIs.
 2. Engineer's action may include a request for additional information, in which case Engineer's time for response will date from time of receipt of additional information.
 3. Engineer's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Division 1 Section "Contract Modification Procedures."
 - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Engineer in writing within 10 days of receipt of the RFI response.
- E. On receipt of Engineer's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Engineer within 7 days if Contractor disagrees with response.
- F. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly with the following information:
1. Project name.
 2. Name and address of Contractor.
 3. Name and address of Engineer.
 4. RFI number including RFIs that were dropped and not submitted.
 5. RFI description.
 6. Date the RFI was submitted.
 7. Date Engineer's response was received.
 8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
 9. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

1.8 PROJECT MEETINGS

- A. General: Engineer will schedule and conduct meetings and conferences at Project site, unless otherwise indicated.
1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Engineer of scheduled meeting dates and times.

2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
 3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner, Engineer, within 5 days of the meeting.
- B. Preconstruction Conference: Engineer will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Engineer, but no later than 15 days after execution of the Agreement.
1. Conduct the conference to review responsibilities and personnel assignments.
 2. Attendees: Authorized representatives of Owner, Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Tentative construction schedule.
 - b. Phasing.
 - c. Critical work sequencing and long-lead items.
 - d. Designation of key personnel and their duties.
 - e. Lines of communications.
 - f. Procedures for processing field decisions and Change Orders.
 - g. Procedures for RFIs.
 - h. Procedures for testing and inspecting.
 - i. Procedures for processing Applications for Payment.
 - j. Distribution of the Contract Documents.
 - k. Submittal procedures.
 - l. Sustainable design requirements.
 - m. Preparation of record documents.
 - n. Use of the premises.
 - o. Work restrictions.
 - p. Working hours.
 - q. Owner's occupancy requirements.
 - r. Responsibility for temporary facilities and controls.
 - s. Procedures for moisture and mold control.
 - t. Procedures for disruptions and shutdowns.
 - u. Construction waste management and recycling.
 - v. Parking availability.
 - w. Office, work, and storage areas.
 - x. Equipment deliveries and priorities.
 - y. First aid.
 - z. Security.
 - aa. Progress cleaning.
 4. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.

- C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.
1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Engineer and Owner's representative of scheduled meeting dates.
 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. Contract Documents.
 - b. Options.
 - c. Related RFIs.
 - d. Related Change Orders.
 - e. Purchases.
 - f. Deliveries.
 - g. Submittals.
 - h. Review of mockups.
 - i. Possible conflicts.
 - j. Compatibility problems.
 - k. Time schedules.
 - l. Weather limitations.
 - m. Manufacturer's written recommendations.
 - n. Warranty requirements.
 - o. Compatibility of materials.
 - p. Acceptability of substrates.
 - q. Temporary facilities and controls.
 - r. Space and access limitations.
 - s. Regulations of authorities having jurisdiction.
 - t. Testing and inspecting requirements.
 - u. Installation procedures.
 - v. Coordination with other work.
 - w. Required performance results.
 - x. Protection of adjacent work.
 - y. Protection of construction and personnel.
 3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Project Closeout Conference: Engineer will schedule and conduct a Project closeout conference, at a time convenient to Owner and Engineer, but no later than 90 days prior to the scheduled date of Substantial Completion.

1. Conduct the conference to review requirements and responsibilities related to Project closeout.
 2. Attendees: Authorized representatives of Owner, Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
 - a. Preparation of record documents.
 - b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
 - c. Submittal of written warranties.
 - d. Requirements for preparing sustainable design documentation.
 - e. Requirements for preparing operations and maintenance data.
 - f. Requirements for demonstration and training.
 - g. Preparation of Contractor's punch list.
 - h. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
 - i. Submittal procedures.
 - j. Coordination of separate contracts.
 - k. Owner's partial occupancy requirements.
 - l. Installation of Owner's furniture, fixtures, and equipment.
 - m. Responsibility for removing temporary facilities and controls.
 4. Minutes: Entity conducting meeting will record and distribute meeting minutes.
- E. Progress Meetings: Engineer will conduct progress meetings at monthly intervals.
1. Coordinate dates of meetings with preparation of payment requests.
 2. Attendees: In addition to representatives of Owner, Engineer, and each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

- 1) Review schedule for next period.
- b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Status of submittals.
 - 4) Deliveries.
 - 5) Off-site fabrication.
 - 6) Access.
 - 7) Site utilization.
 - 8) Temporary facilities and controls.
 - 9) Progress cleaning.
 - 10) Quality and work standards.
 - 11) Status of correction of deficient items.
 - 12) Field observations.
 - 13) Status of RFIs.
 - 14) Status of proposal requests.
 - 15) Pending changes.
 - 16) Status of Change Orders.
 - 17) Pending claims and disputes.
 - 18) Documentation of information for payment requests.
4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
 - a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.
- F. Coordination Meetings: Engineer will conduct project coordination meetings as required. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.
 1. Attendees: In addition to representatives of Owner, Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meetings shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in

relation to combined Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

- b. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
 - c. Review present and future needs of each contractor present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Status of submittals.
 - 4) Deliveries.
 - 5) Off-site fabrication.
 - 6) Access.
 - 7) Site utilization.
 - 8) Temporary facilities and controls.
 - 9) Work hours.
 - 10) Hazards and risks.
 - 11) Progress cleaning.
 - 12) Quality and work standards.
 - 13) Change Orders.
3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01310

SECTION 01300 - SUBMITTALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for submittals required for performance of the Work, including the following:
 - 1. Contractor's construction schedule.
 - 2. Submittal schedule.
 - 3. Shop Drawings.
 - 4. Product Data.
 - 5. Samples.
 - 6. Quality assurance submittals.
 - 7. As-built Drawings.
- B. Administrative Submittals: Refer to other Division 1 Sections and other Contract Documents for requirements for administrative submittals. Such submittals include, but are not limited to, the following:
 - 1. Permits.
 - 2. Applications for Payment.
 - 3. Performance and payment bonds.
 - 4. Insurance certificates.
 - 5. List of subcontractors.
- C. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 1 Section 01240 "Project Management and Coordination" specifies requirements for submittal and distribution of meeting and conference minutes.
 - 2. Division 1 Section 01400 "Quality Control" specifies requirements for submittal of inspection and test reports.
 - 3. Division 1 Section 01700 "Project Closeout" specifies requirements for submittal of Project Record Documents and warranties at project closeout.

1.3 DEFINITIONS

- A. Coordination Drawings show the relationship and integration of different construction elements that require careful coordination during fabrication or installation to fit in the space provided or to function as intended.

1. Preparation of Coordination Drawings is specified in Division 1 Section "Coordination" and may include components previously shown in detail on Shop Drawings or Product Data.
- B. Field samples are full-size physical examples erected on-site to illustrate finishes, coatings, or finish materials. Field samples are used to establish the standard by which the Work will be judged.
- C. Mockups are full-size assemblies for review of construction, coordination, testing, or operation; they are not Samples.

1.4 SUBMITTAL PROCEDURES

- A. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination.
 - a) The Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until all related submittals are received.
 3. Processing: To avoid the need to delay installation as a result of the time required to process submittals, allow sufficient time for submittal review, including time for resubmittals.
 - a) Allow 2 weeks for initial review. Allow additional time if the Engineer must delay processing to permit coordination with subsequent submittals.
 - b) If an intermediate submittal is necessary, process the same as the initial submittal.
 - c) Allow 2 weeks for reprocessing each submittal.
 - d) No extension of Contract Time will be authorized because of failure to transmit submittals to the Engineer sufficiently in advance of the Work to permit processing.
- B. Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block.
 1. Include the following information on the label for processing and recording action taken.
 - a) Project name.

- b) Date.
 - c) Name and address of the Engineer.
 - d) Name and address of the Contractor.
 - e) Name and address of the subcontractor.
 - f) Name and address of the supplier.
 - g) Name of the manufacturer.
 - h) Number and title of appropriate Specification Section.
 - i) Drawing number and detail references, as appropriate.
- C. Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal from the Contractor to the Engineer using a transmittal form. The Engineer will not accept submittals received from sources other than the Contractor.
- 1. On the transmittal, record relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including variations and limitations. Include Contractor's certification that information complies with Contract Document requirements.

1.5 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Bar-Chart Schedule: Prepare a fully developed, horizontal bar-chart-type, contractor's construction schedule. Submit within 30 days after the date established for the "Agreement" or by the Preconstruction Conference.
- 1. Provide a separate time bar for each significant construction activity. Provide a continuous vertical line to identify the first working day of each week. Use the same breakdown of units of the Work as indicated in the "Schedule of Values."
 - 2. Within each time bar, indicate estimated completion percentage in 10 percent increments. As Work progresses, place a contrasting mark in each bar to indicate Actual Completion.
 - 3. Prepare the schedule on a sheet, or series of sheets, of stable transparency, or other reproducible media, of sufficient width to show data for the entire construction period.
 - 4. Secure time commitments for performing critical elements of the Work from parties involved. Coordinate each element on the schedule with other construction activities; include minor elements involved in the sequence of the Work. Show each activity in proper sequence. Indicate graphically the sequences necessary for completion of related portions of the Work.
 - 5. Coordinate the Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittal Schedule, progress reports, payment requests, and other schedules.
 - 6. Indicate completion in advance of the date established for Substantial Completion. Indicate Substantial Completion on the schedule to allow time for the Engineer's procedures necessary for certification of Substantial Completion.

- B. Phasing: On the schedule, show how requirements for phased completion, if required, to permit Work by separate Contractors and partial occupancy by the Owner affect the sequence of Work.
- C. Distribution: Following response to the initial submittal, print and distribute copies to the Engineer, Owner, subcontractors, and other parties required to comply with scheduled dates. Post copies in the Project meeting room and temporary field office.
 - 1. When revisions are made, distribute to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in construction activities.
- D. Schedule Updating: Revise the schedule after each meeting, event, or activity where revisions have been recognized or made. Issue the updated schedule concurrently with the report of each meeting.

1.6 SUBMITTAL SCHEDULE

- A. After development and acceptance of the Contractor's Construction Schedule, prepare a complete schedule of submittals. Submit the schedule within 10 days of the date required for submittal of the Contractor's Construction Schedule.
 - 1. Coordinate Submittal Schedule with the list of subcontracts, Schedule of Values, and the list of products as well as the Contractor's Construction Schedule.
 - 2. Prepare the schedule in chronological order. Provide the following information:
 - a) Scheduled date for the first submittal.
 - b) Related Section number.
 - c) Submittal category (Shop Drawings, Product Data, or Samples).
 - d) Name of the subcontractor.
 - e) Description of the part of the Work covered.
 - f) Scheduled date for resubmittal.
 - g) Scheduled date for the Engineer's final release or approval.
- B. Distribution: Following response to the initial submittal, print and distribute copies to the Engineer, Owner, subcontractors, and other parties required to comply with submittal dates indicated. Post copies in the Project meeting room and field office.
 - 1. When revisions are made, distribute to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in construction activities.

- C. Schedule Updating: Revise the schedule after each meeting or activity where revisions have been recognized or made and issue revised schedule to all parties.

1.7 DAILY CONSTRUCTION REPORTS (Not Applicable)

1.8 SHOP DRAWINGS

- A. Submit newly prepared information drawn accurately to scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not a Shop Drawing.
- B. Shop Drawings include fabrication and installation Drawings, setting diagrams, schedules, patterns, templates and similar Drawings. Include the following information:
 - 1. Dimensions.
 - 2. Identification of products and materials included by sheet and detail number.
 - 3. Compliance with specified standards.
 - 4. Notation of coordination requirements.
 - 5. Notation of dimensions established by field measurement.
 - 6. Initial Submittal: If an initial submittal is required by the Contractor or Engineer, submit 4 blue- or black-line prints for the Engineer's review. The Engineer will return two prints.
 - 7. Final Submittal: Submit 6 blue- or black-line prints as required by the Engineer for distribution. The Engineer will return 2 prints to the Contractor.
 - 8. Do not use Shop Drawings without an appropriate final stamp indicating action taken.

1.9 PRODUCT DATA

- A. Collect Product Data into a single submittal for each element of construction or system. Product Data includes printed information, such as manufacturer's installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring diagrams, and performance curves.
 - 1. Mark each copy to show applicable choices and options. Where printed Product Data includes information on several products that are not required, mark copies to indicate the applicable information. Include the following information:
 - a) Manufacturer's printed recommendations.
 - b) Compliance with trade association standards.
 - c) Compliance with recognized testing agency standards.
 - d) Application of testing agency labels and seals.
 - e) Notation of dimensions verified by field measurement.

- f) Notation of coordination requirements.
- 2. Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed.
- 3. Initial Submittal: If an initial submittal is required by the Contractor, Engineer, or Supplier, submit 4 copies of Product Data to the Engineer for review. The Engineer will return 2 copies to the Contractor.
- 4. Final Submittals: Submit 6 copies as required by the Engineer for distribution. The Engineer will return 2 copies to the Contractor.
- 5. Do not proceed with installation until a copy of Product Data is in the Installer's possession.
- 6. Do not permit use of unmarked copies of Product Data in connection with construction.

1.10 SAMPLES

- A. Submit full-size, fully fabricated Samples cured and finished as specified and physically identical with the material or product proposed. Samples include partial sections of manufactured or fabricated components, cuts or containers of materials, color range sets, and swatches showing color, texture, and pattern.
 - 1. Mount or display Samples in the manner to facilitate review of qualities indicated. Prepare Samples to match the Engineer's sample. Include the following:
 - a) Specification Section number and reference.
 - b) Generic description of the Sample.
 - c) Sample source.
 - d) Product name or name of the manufacturer.
 - e) Compliance with recognized standards.
 - f) Availability and delivery time.
 - 2. Submit Samples for review of size, kind, color, pattern, and texture. Submit Samples for a final check of these characteristics with other elements and a comparison of these characteristics between the final submittal and the actual component as delivered and installed.
 - a) Where variation in color, pattern, texture, or other characteristic is inherent in the material or product represented, submit at least 3 multiple units that show approximate limits of the variations.
 - b) Refer to other Specification Sections for requirements for Samples that illustrate workmanship, fabrication techniques, details of assembly, connections, operation, and similar construction characteristics.
 - c) Refer to other Sections for Samples to be returned to the Contractor for incorporation in the Work. Such Samples must be undamaged at time of use. On the transmittal, indicate special requests regarding disposition of Sample submittals.

- d) Samples not incorporated into the Work, or otherwise designated as the Owner's property, are the property of the Contractor and shall be removed from the site prior to Substantial Completion.
- 3. Submittals: Except for Samples illustrating assembly details, workmanship, fabrication techniques, connections, operation, and similar characteristics, submit 3 sets. The Engineer will return one set marked with the action taken.
- 4. Maintain sets of Samples, as returned, at the Project Site, for quality comparisons throughout the course of construction.
 - a) Unless noncompliance with Contract Document provisions is observed, the submittal may serve as the final submittal.
 - b) Sample sets may be used to obtain final acceptance of the construction associated with each set.
- B. Distribution of Samples: Prepare and distribute additional sets to subcontractors, manufacturers, fabricators, suppliers, installers, and others as required for performance of the Work. Show distribution on transmittal forms.
 - 1. Field samples are full-size examples erected on-site to illustrate finishes, coatings, or finish materials and to establish the Project standard.
 - a) Comply with submittal requirements to the fullest extent possible. Process transmittal forms to provide a record of activity.

1.11 QUALITY ASSURANCE SUBMITTALS

- A. Submit quality-control submittals, including design data, certifications, manufacturer's instructions, manufacturer's field reports, and other quality-control submittals as required under other Sections of the Specifications.
- B. Certifications: Where other Sections of the Specifications require certification that a product, material, or installation complies with specified requirements, submit a notarized certification from the manufacturer certifying compliance with specified requirements.
 - 1. Signature: Certification shall be signed by an officer of the manufacturer or other individual authorized to sign documents on behalf of the company.
- C. Inspection and Test Reports: Requirements for submittal of inspection and test reports from independent testing agencies are specified in Division 1 Section "Quality Control."

1.12 ENGINEER'S ACTION

- A. Except for submittals for the record or information, where action and return is required, the Engineer will review each submittal, mark to indicate action taken, and return promptly.
 - 1. Compliance with specified characteristics is the Contractor's responsibility.
- B. Action Stamp: The Engineer will stamp each submittal with a uniform, action stamp. The Engineer will mark the stamp appropriately to indicate the action taken, as follows:
 - 1. Final Unrestricted Release: When the Engineer marks a submittal "No Exceptions Taken," the Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents. Final payment depends on that compliance.
 - 2. Final-But-Restricted Release: When the Engineer marks a submittal "Make Corrections Noted," the Work covered by the submittal may proceed provided it complies with notations or corrections on the submittal and requirements of the Contract Documents. Final payment depends on that compliance.
 - 3. Returned for Resubmittal: When the Engineer marks a submittal "Amend and Resubmit" or "Rejected," do not proceed with Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal according to the notations; resubmit without delay. Repeat if necessary to obtain different action mark.
 - a) Do not use, or allow others to use, submittals marked "Amend and Resubmit" or "Rejected" at the Project Site or elsewhere where Work is in progress.
 - 4. Other Action: Where a submittal is for information or record purposes or special processing or other activity, the Engineer will return the submittal marked "Action Not Required."
- C. Unsolicited Submittals: The Engineer will return unsolicited submittals to the sender without action.

1.13 CONTRACTOR'S AS-BUILTS DRAWINGS

- A. Contractor shall record and submit accurate as-built information on a monthly basis and at the conclusion of the project. Monthly pay requests will not be processed until the Contractor submits evidence that all work to date has been properly surveyed and recorded.
- B. The final as-built drawings shall be signed and sealed by a licensed PLS in the State of North Carolina.

- C. The Contractor shall provide surveyed horizontal and vertical coordinates on the location of all fittings, valves, air release valves, blow-offs, meters, structures (center of manholes and corners of rectangular vaults) and structure penetrations. The Contractor shall also provide surveyed horizontal and vertical coordinates on the location of all existing utilities exposed during the course of the work and the locations of tie-ins to existing pipes where existing utilities had to be re-laid. The Contractor shall also provide information on the size and material of all existing utilities encountered.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

- A. It shall be the Contractor's responsibility to check shop drawings for accuracy and conformity with the Specifications before submission to the Engineer. Each drawing shall be clearly marked "Approved" or "Approved Subject to Noted Corrections," dated and signed by the Contractor before it is submitted to the Engineer. Any drawings not so marked will be returned to the Contractor without the Engineer's approval. The Engineer's approval of such drawings or schedules shall not relieve the Contractor from responsibility for deviations from plans or specifications, nor shall it relieve him from responsibility for errors of any sort on shop drawings or schedules.
- B. Submissions at variance with the requirements of the specifications or contract drawings shall be accompanied with a letter setting forth such variations and the credit to be allowed where such variations are less expensive than contract requirements. If, in the opinion of the Engineer, such variations are of a minor nature, and comply with the intent of the Contract Documents, approval will be given in writing. When variations are such as to involve a credit to the Owner, approval will be given only upon receipt of a reasonable and proper credit. In the absence of such approvals, the Contractor shall comply with all specification and drawing requirements.
- C. The Engineer's check of shop drawings cover general design only and will not include a quantity check or dimensional verifications. The Engineer will not undertake the determination of dimensions which, by their nature, must be established from field measurements. The determination of such dimensions shall be a part of the Contractor's checking and coordination of shop drawings. The approval of shop drawings shall not relieve the Contractor from the responsibility for conforming with drawings and specifications unless there is an accompanying letter from him which explicitly states that a deviation is to be made and written approval is obtained for such deviation, nor shall approval of shop drawing relieve him of the responsibility for errors in coordination of his work.
- D. Repairs, modifications, and corrections to other work due to lack of shop drawing data shall be the responsibility of the prime Contractor who failed to supply such data in sufficient time.
- E. Where equipment or materials proposed in shop drawings differ from those as shown on the contract drawings as to orientation, alignment, etc., the contractor shall be held liable for providing incidental changes for access, useability, or functionality of such equipment or materials.

- F. Shop drawings will be approved only to the extent of the information clearly shown and identified. Approval of an item of equipment or material shall not be construed to mean approval for components or materials of that kind for which the Contractor has provided no or insufficient information.

END OF SECTION 01300

SECTION 01310 – PROJECT SCHEDULES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide proposed project schedules for entire work.
 - 1. Have initial draft project schedule available to Engineer prior to preconstruction conference.
 - 2. Revise monthly.

1.2 PROJECT SCHEDULES, FORM AND CONTENT

- A. Prepare in form of horizontal bar graph to include:
 - 1. Provide separate horizontal bar column for each trade, operation, or construction activity.
 - 2. Order – Chronological order or beginning and ending of each item of work.
 - 3. Show Schedule of Payments.
- B. Identify work of separate phases or other logically grouped activities in accordance with Special Conditions and time restraints.
- C. Show projected percentage of completion for each item of work as of first of each month.

1.3 UPDATING

- A. Update at least monthly and submit with pay requisitions for review and approval by Engineer.
- B. Show all changes occurring since previous submission of updated schedule, including progress of each activity and revised completion dates.
 - 1. Include:
 - a) Major changes in scope.
 - b) Activities modified since previous updating.
 - c) Revised projections due to changes.
 - d) Other identifiable changes.

1.4 SUBMITTALS

A. Submit Project Schedules prior to:

1. Preconstruction Meeting.
2. With each monthly payment.

PART 2 - PRODUCTS (Not Applicable)

PART 3 – EXECUTION (Not Applicable)

END OF SECTION 01310

SECTION 01400 - QUALITY CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for quality-control services.
- B. Quality-control services include inspections, tests, and related actions, including reports performed by Contractor, by independent agencies, and by governing authorities. They do not include contract enforcement activities performed by Engineer.
- C. Inspection and testing services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with Contract Document requirements.
- D. Requirements of this Section relate to customized fabrication and installation procedures, not production of standard products.
 - 1. Specific quality-control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
 - 2. Specified inspections, tests, and related actions do not limit Contractor's quality-control procedures that facilitate compliance with Contract Document requirements.
 - 3. Requirements for Contractor to provide quality-control services required by Engineer, Owner, or authorities having jurisdiction are not limited by provisions of this Section.
- E. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 1 Section 01300 "Submittals" specifies requirements for development of a schedule of required tests and inspections.

1.3 RESPONSIBILITIES

- A. Contractor Responsibilities: Unless otherwise indicated as the responsibility of another identified entity, Contractor shall provide and pay for inspections, tests, and other quality-control services specified elsewhere in the Contract Documents

and required by authorities having jurisdiction. Costs for these services are included in the Contract Sum.

1. Where individual Sections specifically indicate that certain inspections, tests, and other quality-control services are the Contractor's responsibility, the Contractor shall employ and pay a qualified independent testing agency to perform quality-control services. Costs for these services are included in the Contract Sum.
 2. Where individual Sections specifically indicate that certain inspections, tests, and other quality-control services are the Owner's responsibility, the Owner will employ and pay a qualified independent testing agency to perform those services. The Contractor shall assist the Owner by providing men and equipment for excavation of test pits, excavation for test pads for density tests and moving testing equipment around the project site. The Owner shall retain the services of a testing laboratory to perform testing required at the project site for field density tests of fill and backfill material and concrete testing for slump, air entrainment, and strength.
 3. Where the Owner has engaged a testing agency for testing and inspecting part of the Work, and the Contractor is also required to engage an entity for the same or related element, the Contractor shall not employ the entity engaged by the Owner, unless agreed to in writing by the Owner.
- B. Retesting: The Contractor is responsible for retesting where results of inspections, tests, or other quality-control services prove unsatisfactory and indicate noncompliance with Contract Document requirements, regardless of whether the original test was Contractor's responsibility.
1. The cost of retesting construction, revised or replaced by the Contractor, is the Contractor's responsibility where required tests performed on original construction indicated noncompliance with Contract Document requirements. The cost to repair, rework, or replace material or work indicated noncompliance shall be born by the Contractor.
- C. Associated Services: Cooperate with agencies performing required inspections, tests, and similar services, and provide reasonable auxiliary services as requested. Notify the agency sufficiently in advance of operations to permit assignment of personnel. Auxiliary services required include, but are not limited to, the following:
1. Provide access to the Work.
 2. Furnish incidental labor and facilities necessary to facilitate inspections and tests.
 3. Take adequate quantities of representative samples of materials that require testing or assist the agency in taking samples.
 4. Provide facilities for storage and curing of test samples.
 5. Deliver samples to testing laboratories.
 6. Provide the agency with a preliminary design mix proposed for use for materials mixes that require control by the testing agency.

7. Provide security and protection of samples and test equipment at the Project Site.
- D. Duties of the Testing Agency: The independent agency engaged to perform inspections, sampling, and testing of materials and construction specified in individual Sections shall cooperate with the Engineer and the Contractor in performance of the agency's duties. The testing agency shall provide qualified personnel to perform required inspections and tests.
1. The agency shall notify the Engineer and the Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. The agency is not authorized to release, revoke, alter, or enlarge requirements of the Contract Documents or approve or accept any portion of the Work.
 3. The agency shall not perform any duties of the Contractor.
- E. Coordination: Coordinate the sequence of activities to accommodate required services with a minimum of delay. Coordinate activities to avoid the necessity of removing and replacing construction to accommodate inspections and tests.
1. The Contractor is responsible for scheduling times for inspections, tests, taking samples, and similar activities.

1.4 SUBMITTALS

- A. Unless the Contractor is responsible for this service, the independent testing agency shall submit a certified written report, in duplicate, of each inspection, test, or similar service to the Engineer. If the Contractor is responsible for the service, submit a certified written report, in duplicate, of each inspection, test, or similar service through the Contractor.
1. Submit additional copies of each written report directly to the governing authority, when the authority so directs.
 2. Report Data: Written reports of each inspection, test, or similar service include, but are not limited to, the following:
 - a) Date of issue.
 - b) Project title and number.
 - c) Name, address, and telephone number of testing agency.
 - d) Dates and locations of samples and tests or inspections.
 - e) Names of individuals making the inspection or test.
 - f) Designation of the Work and test method.
 - g) Identification of product and Specification Section.
 - h) Complete inspection or test data.
 - i) Test results and an interpretation of test results.
 - j) Ambient conditions at the time of sample taking and testing.
 - k) Comments or professional opinion on whether inspected or tested Work complies with Contract Document requirements.
 - l) Name and signature of laboratory inspector.

m) Recommendations on retesting.

1.5 QUALITY ASSURANCE

A. Qualifications for Service Agencies: Engage inspection and testing service agencies, including independent testing laboratories, that are prequalified as complying with the American Council of Independent Laboratories' "Recommended Requirements for Independent Laboratory Qualification" and that specialize in the types of inspections and tests to be performed.

1. Each independent inspection and testing agency engaged on the Project shall be authorized by authorities having jurisdiction to operate in the state where the Project is located.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 REPAIR AND PROTECTION

- A. General: Upon completion of inspection, testing, sample taking and similar services, repair damaged construction and restore substrates and finishes. Comply with Contract Document requirements for Division 1 Section "Cutting and Patching."
- B. Protect construction exposed by or for quality-control service activities, and protect repaired construction.
- C. Repair and protection is Contractor's responsibility, regardless of the assignment of responsibility for inspection, testing, or similar services.

END OF SECTION 01400

SECTION 01410 - TESTING LABORATORY SERVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Requirements and procedures for testing laboratory services.

1.2 RELATED SECTIONS

- A. Division 01 - General Requirements
 - 1. Section 01400, Quality Control
- B. Division 02 through Division 16
 - 1. Individual Specification Sections: Specific testing requirements.

1.3 REFERENCES

- A. General: as specified in Section 01095, Reference Standards and Definitions.
- B. ANSI/ASTM
 - 1. D3740 Standards Practice for Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
 - 2. E329 Practice for Inspection and Testing Agencies for Concrete, Steel, Bituminous Materials as Used in Construction

1.4 SELECTION AND PAYMENT

- A. Contractor shall secure the services of an independent testing laboratory approved by the Engineer and the Owner. Contractor shall pay for services of the independent testing laboratory with the testing allowance in the contract to perform specified inspection and testing.
- B. Employment of testing laboratory shall in no way relieve Contractor of obligation to perform work in accordance with requirements of Contract Documents.

1.5 QUALITY ASSURANCE

- A. Standards: Comply with requirements of ANSI/ASTM E329 and ANSI/ASTM D3740.
- B. Laboratory: Authorized to operate in State of North Carolina.
- C. Laboratory Staff: Maintain a full time registered Professional Engineer on staff to review services.

- D. Testing Equipment: Calibrated at reasonable intervals with devices of accuracy traceable to either National Bureau of Standards (NBS) Standards or accepted values of natural physical constants.

1.6 CONTRACTOR SUBMITTALS

- A. Prior to start of Work, submit testing laboratory name, address, and telephone number, and names of full time registered Engineer and responsible officer for approval by the Engineer and the Owner.
- B. Submit copy of report of laboratory facilities inspection made by Materials Reference Laboratory of National Bureau of Standards (NBS) during most recent tour of inspection, with memorandum of remedies of any deficiencies reported by the inspection.

1.7 LABORATORY RESPONSIBILITIES

- A. Test samples of mixes provided by Contractor.
- B. Provide qualified personnel at site. Cooperate with Engineer and Contractor in performance of services.
- C. Perform specified inspection, sampling, and testing of Products in accordance with specified standards.
- D. Ascertain compliance of materials and mixes with requirements of Contract Documents.
- E. Promptly notify Engineer and Contractor of observed irregularities or non-conformance of Work or Products.
- F. Perform additional inspections and tests required by Engineer.
- G. Attend preconstruction conferences and progress meetings.

1.8 LABORATORY REPORTS

- A. After each inspection and test, promptly submit two copies of laboratory report directly to Engineer. Include the following:
 - 1. Date issued,
 - 2. Project title and number,
 - 3. Name of inspector,
 - 4. Date and time of sampling or inspection,
 - 5. Identification of product and Specifications section,
 - 6. Location in the Project,
 - 7. Type of inspection or test,
 - 8. Date of test,
 - 9. Results of tests,
 - 10. Conformance with Contract Documents.

- B. When requested by Engineer, provide interpretation of test results.

1.9 LIMITS ON TESTING LABORATORY AUTHORITY

- A. Laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.
- B. Laboratory may not approve or accept any portion of the Work.
- C. Laboratory may not assume any duties of Contractor.
- D. Laboratory has no authority to stop the Work.

1.10 CONTRACTOR RESPONSIBILITIES

- A. Cooperate with laboratory personnel, and provide access to the Work.
- B. Provide incidental labor and facilities to provide access to Work to be tested, to obtain and handle samples at the site or at source of Products to be tested, to facilitate tests and inspections, storage and curing of test samples.
- C. Notify Engineer and laboratory 24 hours prior to expected time for operations requiring inspection and testing services.

1.11 SCHEDULE OF INSPECTIONS AND TESTS

- A. As specified in individual Sections

PART 2 - PRODUCTS (not used)

PART 3 - EXECUTION (not used)

END OF SECTION 01410

SECTION 01500 - CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes requirements for construction facilities and temporary controls, including temporary utilities, support facilities, and security and protection.
- B. Temporary utilities may include, but are not limited to, the following:
 - 1. Temporary electric power and light.
 - 2. Temporary heat.
 - 3. Telephone service.
 - 4. Sanitary facilities, including drinking water.
- C. Support facilities include, but are not limited to, the following:
 - 1. Field offices and storage sheds.
 - 2. Temporary roads.
 - 3. Dewatering facilities and drains.
 - 4. Temporary enclosures.
 - 5. Temporary project identification signs and bulletin boards.
 - 6. Waste disposal services.
 - 7. Construction aids and miscellaneous services and facilities.
- D. Security and protection facilities include, but are not limited to, the following:
 - 1. Temporary security fencing.
 - 2. Temporary fire protection.
 - 3. Barricades, warning signs, and lights.
 - 4. Sidewalk bridge or enclosure fence to protect pedestrians.
 - 5. Environmental protection.

1.3 SUBMITTALS (Not Applicable)

1.4 QUALITY ASSURANCE

- A. Regulations: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction including, but not limited to, the following:

1. Building code requirements.
 2. Health and safety regulations.
 3. Utility company regulations.
 4. Police, fire department, and rescue squad rules.
 5. Environmental protection regulations.
- B. Standards: Comply with NFPA 241 "Standard for Safeguarding Construction, Alterations, and Demolition Operations," ANSI A10 Series standards for "Safety Requirements for Construction and Demolition," and NECA Electrical Design Library "Temporary Electrical Facilities."
1. Electrical Service: Comply with NEMA, NECA, and UL standards and regulations for temporary electric service. Install service in compliance with NFPA 70 "National Electric Code."
- C. Inspections: Arrange for authorities having jurisdiction to inspect and test each temporary utility before use. Obtain required certifications and permits.

1.5 PROJECT CONDITIONS

- A. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Relocate temporary services and facilities as the Work progresses. Do not overload facilities or permit them to interfere with progress. Take necessary fire-prevention measures. Do not allow hazardous, dangerous, or unsanitary conditions, or public nuisances to develop or persist on-site.
- B. The Contractor shall furnish and cause to be worn by his employees, a distinctive identification badge. Such badge shall show the name of the employer and employee's name or identifying number. The Contractor shall require like identification of employees of all subcontractors.
- C. No photographs of the project, or any part of it will be allowed without the expressed written consent of the Owner.
- D. The Contractor shall not disclose in any advertisement, publicity or promotional material, without the prior written consent of the Owner in each instance, that the Contractor is performing or has performed the work.
- E. The Owner will supply only the security measures required for his operations.
- F. The Contractor shall provide the necessary security means to protect his work materials, tools, and construction equipment from vandalism, theft, and fire.
- G. The Contractor shall be responsible for replacement of his materials, machinery, equipment, tools, and supplies due to theft or mysterious disappearance.
- H. All tools and equipment shall be clearly marked with Contractor's identification. All tool boxes shall be clearly marked by the Contractor in the upper right-hand corner with two-inch high letters or numbers.

- I. Watchman services shall be supplied by the Contractor as he deems necessary. Any watchman service set up by Contractor shall be approved by the Owner and shall adhere to UNC Security procedures.
- J. Each Prime Contractor shall furnish the UNC Construction Administrator with a list of day and night phone numbers to be used in case of emergency during the course of the project.
- K. The Contractor shall be responsible for the security of the site, as well as all equipment, materials, etc. from the start of contract until final acceptance by the Owner.
- L. A minimum 40 foot perimeter transition area is desired between a campus facility and construction impact (roadway, infrastructure, building, etc.). The 40 foot perimeter during construction is defined by the limits of the construction fence. Appropriate building access and pedestrian walkways should be provided between the construction fence and the building. The 40 foot perimeter after construction should include landscaping and pedestrian walkways according to university standards.
- M. Dust Control measures to protect adjacent buildings and outdoor air intakes shall be providing during dust making construction activities. Include temporary filters and associated cleaning during construction process.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Provide new materials. If acceptable to the Engineer, the Contractor may use undamaged, previously used materials in serviceable condition. Provide materials suitable for use intended.
- B. Lumber and Plywood:
 - 1. For fences and vision barriers, provide minimum 3/8-inch thick exterior plywood.
 - 2. For safety barriers, sidewalk bridges, and similar uses, provide minimum 5/8-inch thick exterior plywood.
- C. Tarpaulins: Provide waterproof, fire-resistant, UL-labeled tarpaulins with flame-spread rating of 15 or less. For temporary enclosures, provide translucent, nylon-reinforced, laminated polyethylene or polyvinyl chloride, fire-retardant tarpaulins.
- D. Water: Provide potable water approved by local health authorities.
- E. Open-Mesh Safety Fencing: Provide 0.120-inch thick, galvanized 2-inch chainlink fabric fencing 6 feet high with galvanized barbed-wire top strand and

galvanized steel pipe posts, 1-1/2 inches I.D. for line posts and 2-1/2 inches I.D. for corner posts.

2.2 EQUIPMENT

- A. General: Provide new equipment. If acceptable to the Engineer, the Contractor may use undamaged, previously used equipment in serviceable condition. Provide equipment suitable for use intended.
- B. Electrical Power Cords: Provide grounded extension cords. Use hard-service cords where exposed to abrasion and traffic. Provide waterproof connectors to connect separate lengths of electric cords if single lengths will not reach areas where construction activities are in progress. Do not exceed safe length-voltage ratio.
- C. Lamps and Light Fixtures: Provide general service incandescent lamps of wattage required for adequate illumination. Provide guard cages or tempered-glass enclosures where exposed to breakage. Provide exterior fixtures where exposed to moisture.
- D. Temporary Toilet Units: Provide self-contained, single-occupant toilet units of the chemical, aerated recirculation, or combustion type. Provide units properly vented and fully enclosed with a glass-fiber-reinforced polyester shell or similar nonabsorbent material.
- E. Fire Extinguishers: Provide hand-carried, portable, UL-rated, Class A fire extinguishers for temporary offices and similar spaces. In other locations, provide hand-carried, portable, UL-rated, Class ABC, dry-chemical extinguishers or a combination of extinguishers of NFPA-recommended classes for the exposures.
 - 1. Comply with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Use qualified personnel for installation of temporary facilities. Locate facilities where they will serve the Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required.
- B. Provide each facility ready for use when needed to avoid delay. Maintain and modify as required. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

- A. General: Engage the appropriate local utility company to install temporary service or connect to existing service. Where company provides only part of the service, provide the remainder with matching, compatible materials and equipment. Comply with company recommendations.
 - 1. Arrange with company and existing users for a time when service can be interrupted, if necessary, to make connections for temporary services.
 - 2. Provide adequate capacity at each stage of construction. Prior to temporary utility availability, provide trucked-in services.
 - 3. Obtain easements to bring temporary utilities to the site where the Owner's easements cannot be used for that purpose.
 - 4. Use Charges: Cost or use charges for temporary facilities are not chargeable to the Owner or Engineer. Neither the Owner nor Engineer will accept cost or use charges as a basis of claims for Change Orders.

- B. Water Service: Install water service and distribution piping of sizes and pressures adequate for construction.
 - 1. Sterilization: Sterilize temporary water piping prior to use.

- C. Temporary Electric Power Service: Provide weatherproof, grounded electric power service and distribution system of sufficient size, capacity, and power characteristics during construction period. Include meters, transformers, overload-protected disconnects, automatic ground-fault interrupters, and main distribution switch gear.
 - 1. Install electric power service underground, except where overhead service must be used.
 - 2. Power Distribution System: Install wiring overhead and rise vertically where least exposed to damage. Where permitted, wiring circuits not exceeding 125 Volts, ac 20 Ampere rating, and lighting circuits may be nonmetallic sheathed cable where overhead and exposed for surveillance.

- D. Temporary Lighting: Provide temporary lighting with local switching where required to facilitate construction.
 - 1. Install and operate temporary lighting that will fulfill security and protection requirements without operating the entire system. Provide temporary lighting that will provide adequate illumination for construction operations and traffic conditions.

- E. Temporary Heat: Provide temporary heat required by construction activities for curing or drying of completed installations or for protection of installed construction from adverse effects of low temperatures or high humidity. Select safe equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce the ambient condition required and minimize consumption of energy.

- F. Heating Facilities: Except where the Owner authorizes use of the permanent system, provide vented, self-contained, LP-gas or fuel-oil heaters with individual space thermostatic control.
 - 1. Use of gasoline-burning space heaters, open flame, or salamander heating units is prohibited unless approved by the Owner and Engineer for specific site conditions.
- G. Temporary Telephones: Provide cell telephones for all supervisory personnel engaged in construction activities.
- H. Sanitary facilities include temporary toilets, wash facilities, and drinking-water fixtures. Comply with regulations and health codes for the type, number, location, operation, and maintenance of fixtures and facilities. Install where facilities will best serve the Project's needs.
 - 1. Provide toilet tissue, paper towels, paper cups, and similar disposable materials for each facility. Provide covered waste containers for used material.
- I. Toilets: Use of the Owner's existing toilet facilities will not be permitted.
- J. Toilets: Install sufficient number of self-contained toilet units.
- K. Drinking-Water Facilities: Provide containerized, tap-dispenser, bottled-water drinking-water units, including paper supply.

3.3 SUPPORT FACILITIES INSTALLATION

- A. Locate storage sheds, and other temporary construction and support facilities for easy access.
 - 1. Maintain support facilities until Substantial Completion and remove after Substantial Completion.
- B. Provide incombustible construction for sheds located within the construction area or within 30 feet of building lines. Comply with requirements of NFPA 241.
- C. Field Offices: Not Required.
- D. Temporary Roads and Parking: Construct and maintain temporary roads to support the indicated loading adequately and to withstand exposure to traffic during the construction period.
- E. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities.

1. Where heat is needed provide temporary enclosures where there is no other provision for containment of heat. Coordinate ventilating and material drying or curing requirements to avoid dangerous conditions and effects.
 2. Install tarpaulins securely, with incombustible wood framing and other materials. Close openings of 25 sq. ft. or less with plywood or similar materials.
 3. Close openings through floor or roof decks and horizontal surfaces with load-bearing, wood-framed construction.
- F. Project Identification and Temporary Signs: Prepare project identification and other signs as required. Install signs where indicated to inform the public and persons seeking entrance to the Project. Support on posts or framing of preservative-treated wood or steel. Do not permit installation of unauthorized signs.
1. Project Identification Signs: Engage an experienced sign painter to apply graphics.
 2. Temporary Signs: Prepare signs to provide directional information to construction personnel and visitors.
- G. Collection and Disposal of Waste: Collect waste from construction areas and elsewhere daily. Comply with requirements of NFPA 241 for removal of combustible waste material and debris. Enforce requirements strictly. Do not hold materials more than 7 days during normal weather or 3 days when the temperature is expected to rise above 80 deg F. Handle hazardous, dangerous, or unsanitary waste materials separately from other waste by containerizing properly. Dispose of material lawfully.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of the types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 10 "Standard for Portable Fire Extinguishers" and NFPA 241 "Standard for Safeguarding Construction, Alterations, and Demolition Operations."
1. Locate fire extinguishers where convenient and effective for their intended purpose.
 2. Store combustible materials in containers in fire-safe locations.
 3. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire-protection facilities, stairways, and other access routes for fighting fires. Smoking is prohibited on the project site.
 4. Provide supervision of welding operations, combustion-type temporary heating units, and similar sources of fire ignition.
- B. Barricades, Warning Signs, and Lights: Comply with standards and code requirements for erection of structurally adequate barricades. Paint with

appropriate colors, graphics, and warning signs to inform personnel and the public of the hazard being protected against. Where appropriate and needed, provide lighting, including flashing red or amber lights.

- C. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations, and minimize the possibility that air, waterways, and subsoil might be contaminated or polluted or that other undesirable effects might result. Avoid use of tools and equipment that produce harmful noise. Restrict use of noise-making tools and equipment to hours that will minimize complaints from persons or firms near the site.

3.5 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. Limit availability of temporary facilities to essential and intended uses to minimize waste and abuse.
- B. Maintenance: Maintain facilities in good operating condition until removal. Protect from damage by freezing temperatures and similar elements.
 - 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
 - 2. Protection: Prevent water-filled piping from freezing. Maintain markers for underground lines. Protect from damage during excavation operations.
- C. Termination and Removal: Unless the Engineer requests that it be maintained longer, remove each temporary facility when the need has ended, when replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with the temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
 - 1. Materials and facilities that constitute temporary facilities are the Contractor's property.
 - 2. Where the area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil in the area. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns.
 - 3. At Substantial Completion, clean and renovate permanent facilities used during the construction period including, but not limited to, the following:
 - a) Replace air filters and clean inside of ductwork and housings.
 - b) Replace significantly worn parts and parts subject to unusual operating conditions.
 - c) Replace lamps burned out or noticeably dimmed by hours of use.

END OF SECTION 01500

SECTION 01505 - CONSTRUCTION WASTE MANAGEMENT

PART 1 – GENERAL

1.1 RELATED SECTIONS:

- A. Waste Management Definitions.
- B. Waste Management Goals.
- C. Draft Waste Management Plan.
- D. Final Waste Management Plan.
- E. Implementation and Documentation of Waste Management Plan.

1.2 WASTE MANAGEMENT DEFINITIONS

- A. **Clean:** Untreated and unpainted; not contaminated with oils, solvents, caulk, or the like.
- B. **Commingling:** Mixing recyclable C/D material in one waste container. Materials Recovery Facilities (MRF) exist to sort and recycle commingled materials off-site.
- C. **Construction and Demolition Waste:** Includes all non-hazardous solid wastes resulting from construction, renovations, alterations, repair, and demolition.
- D. **Hazardous:** Exhibiting the characteristics of hazardous substances, i.e., ignitability, corrosiveness, toxicity or reactivity.
- E. **Material Recovery Facility (MRF):** A processing facility designed to sort and separate recyclables based on market needs and material components.
- F. **Non-hazardous:** Exhibiting none of the characteristics of hazardous substances, i.e., ignitability, corrosiveness, toxicity, or reactivity.
- G. **Nontoxic:** Neither immediately poisonous to humans nor poisonous after a long period of exposure.
- H. **Recyclable:** The ability of a product or material to be recovered at the end of its life cycle and remanufactured into a new product for reuse by others.
- I. **Recycling:** The process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for the purpose of using the altered form. Recycling does not include burning, incinerating, or thermally destroying waste. Can be conducted on-site (as in the grinding of concrete and reuse on-site).
- J. **Return:** To give back reusable items or unused products to vendors for credit.

- K. **Reuse:** To reuse a construction waste material without altering its form on the Project site or elsewhere.
- L. **Salvage:** To remove a waste material from the Project site to another site for resale or reuse by others.
- M. **Sediment:** Soil and other debris that has been eroded and transported by storm or well production runoff water.
- N. **Source Separation:** The act of keeping different types of waste materials separate beginning from the first time they become waste in order to reuse or recycle them.
- O. **Toxic:** Poisonous to humans either immediately or after a period of exposure.
- P. **Trash:** Any product or material unable to be reused, returned, recycled, or salvaged.
- Q. **Volatile Organic Compounds (VOCs):** Chemical compounds common in and emitted by many building products over time through offgassing: solvents in paints and other coatings; wood preservatives; strippers and household cleaners; adhesives in particleboard, fiberboard, and some plywood; and foam insulation. When released, VOCs can contribute to the formation of smog and can cause respiratory tract problems, headaches, eye irritations, nausea, damage to the liver, kidneys, and central nervous system, and possibly cancer.
- R. **Waste:** Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.
- S. **Waste Management Plan:** A Project-related plan for the collection, transportation, and disposal of the waste generated at the construction site. The purpose of the plan is to ultimately prolong the useable life of waste materials and reduce the amount of material being landfilled.

1.3 WASTE MANAGEMENT GOALS

- A. Within the limits of the construction schedule, contract sum, and available materials, equipment, products and services, the Owner has established that this Project shall generate the least amount of waste possible and employ processes that ensure the generation of as little waste as possible. This expectation is consistent with:
 - 1. The 1997 "Statement on Voluntary Measures to Reduce, Recover, and Reuse Building Construction Site Waste" released by the American Institute of Architects and the Associated General Contractors of America
 - 2. Federal Executive Order 13101
 - 3. EPA Comprehensive Procurement Guidelines (CPG)

4. North Carolina Executive Order 156-State Government Environmental Sustainability, Reduction of Solid Waste and Procurement of Environmentally Preferable Products.
- B. The Contractor shall develop, for the Engineer's and owner's review, a Waste Management Plan for this Project consistent with these goals.
1. Minimize the amount of C/D (construction and demolition) waste initially generated by such methods as efficient use of materials, appropriate planning, proper storage, prevention of breakage and damage to materials, avoidance of excess packaging and source separation of waste.
 2. Of the inevitable waste that is generated, as many of the waste materials as economically feasible shall be reused, salvaged, or recycled. Waste disposal in landfills shall be minimized. The project goal is to reuse, salvage, or recycle a minimum of 50% of the wastes generated by weight on demolition/renovation projects and 75% on new construction.
 3. Use recycled, salvaged, renewable and recyclable building materials.

1.4 DRAFT WASTE MANAGEMENT PLAN

- A. The Contractor shall provide, to the Owner and Engineer, a Draft Waste Management Plan within 5 business days after receipt of Notice to Proceed or prior to any waste removal, whichever occurs sooner. Consistent with Orange County ordinances and in order to achieve the waste diversion goals listed above, the Contractor may choose to separate waste and recyclables on-site or use a combination of source separation and a C/D sorting facility permitted by Orange County. The Contractor will submit the draft and final plans electronically on forms provided by OWRR. See www.fac.unc.edu/OWRRGuidelines (C/D Forms and Printed Materials).
- B. The Draft Waste Management Plan shall contain the following:
1. Waste assessment: An analysis of the proposed jobsite wastes to be generated, including types and estimated quantities. This includes salvageable materials as well as recyclables and trash.
 - a) Materials for reuse in project:
 - (1) Equipment
 - (2) Concrete products
 - (3) Cast Iron components
 - (4) Program equipment
 - b) Materials for reuse on campus: Contractor delivers to Owner.
 - c) Materials which must be recycled by law (also see Section 01060 Regulatory Requirements):
 - (1) Beverage containers

- (2) Cardboard
 - (3) Clean dimensional wood and pallets
 - (4) Scrap metal, including but not limited to metals from banding, stud trim, ductwork, piping, rebar, roofing, other trim, steel, iron, galvanized sheet steel, stainless steel, aluminum, copper, zinc, lead, brass, and bronze
 - (5) White goods
- d) Materials to be recycled:
- (1) Stone walls
 - (2) Bricks
 - (3) Concrete
 - (4) Plastic buckets, tanks, and containers
 - (5) Steel tanks (for salvage value)

2. Landfill options: The name of the landfill(s) where trash will be disposed of, the applicable landfill tipping fee(s), and the estimated cost of disposing of all Project waste in the landfill(s). This estimate will be used as a baseline for recycling/salvage cost comparison.

3. Waste Diversion Economic Analysis: A list of each material proposed to be salvaged, reused, or recycled during the course of the Project, the proposed local market for each material, and the estimated net cost savings or additional costs resulting from separating and recycling (versus landfilling) each material. "Net" means that the following have been subtracted from the cost of separating and recycling:

- a) revenue from the sale of recycled or salvaged materials
- b) landfill tipping fees saved due to diversion of materials from the landfill
- c) replacement value of materials reused in the project
- d) For a list of markets and resources, see www.fac.unc.edu/OWRRGuidelines (C/D Resources and Links).
- e) Also see Specification 02070 Selective Demolition for information regarding items to be salvaged.

1.5 FINAL WASTE MANAGEMENT PLAN

A. Once the Owner has determined which of the recycling options addressed in the Draft Waste Management Plan are acceptable, the Contractor shall provide a Final Waste Management Plan within 5 business days.

B. The Final Waste Management Plan shall contain the following:

- 1. Contact information: The name and contact information of who will be responsible for implementing the Solid Waste Management Plan.
- 2. Meetings/instruction: A description of the regular meetings to be held to address waste management.

3. Waste assessment: An analysis of the proposed jobsite wastes to be generated, including types and estimated quantities.
4. Alternatives to landfilling: A list of each material proposed to be salvaged, reused, or recycled during the course of the Project.
5. Landfilling information: The name of the landfill(s) where trash will be disposed of, the applicable landfill tipping fee(s), and the estimated quantity of waste to be landfilled.
6. Materials Handling Procedures: A description of the means by which any waste materials identified in items 4 and 5 above will be protected from contamination, and a description of the means to be employed in handling the above materials consistent with requirements for acceptance by designated facilities.
7. Transportation: A description of the means of transportation of recyclable materials and waste (whether materials will be site-separated and self-hauled to designated centers, or whether mixed materials will be collected by a waste hauler and removed from the site) and destination of materials.
8. Cost estimate summary: The estimated cost of implementing the final solid waste management plan, broken down by material.
9. Copy of Orange County RRMO hauling license: This license is required for any vehicle over 9000 lbs GVW hauling RRMO materials (see 01060). It must be renewed annually. Contact Orange County Solid Waste Management at 968-2800 ext. 163 for more info.

1.6 IMPLEMENTATION AND DOCUMENTATION OF WASTE MANAGEMENT PLAN

- A. Manager: The Contractor shall designate an on-site party (or parties) responsible for instructing workers and overseeing and documenting results of the Waste Management Plan for the Project. This contact will notify OWRR immediately should any deviance from the Final Waste Management plan be necessary.
- B. Distribution: The Contractor shall distribute copies of the Waste Management Plan to the Job Site Foremen. Subcontractors, the Owner, and the Engineer.
- C. Instruction: The Contractor shall provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the Project.
- D. Separation facilities: The Contractor shall designate and label a specific area to facilitate separation of materials for potential recycling, salvage, reuse, and return. Recycling and waste bin areas are to be kept neat and clean and clearly marked in order to avoid contamination of materials.

- E. Hazardous wastes: Hazardous wastes shall be separated., stored, and disposed of according to local regulations.
- F. Documentation: The Contractor shall submit with each Application for Progress Payment a Summary of Waste Generated by the Project. Failure to submit this information shall render the Application for Payment incomplete and shall delay Progress Payment. The Summary shall be submitted on a form acceptable to the Owner and shall contain the following information. For electronic forms see www.fac.unc.edu/OWRRGuidelines (C/D Forms and Printed Materials).
 - 1. Disposal information:
 - a) amount (in tons or cubic yards) of material landfilled from the Project
 - b) identity of the landfill
 - c) total amount of tipping fees paid at the landfill
 - d) total disposal cost (including transportation and container rental)
 - e) weight tickets, manifests, receipts, and invoices (attach copies)
 - 2. Recycling information:
 - a) amount (in tons or cubic yards)
 - b) date removed from the jobsite
 - c) receiving party
 - d) transportation cost
 - e) amount of any money paid or received for the recycled or salvaged material
 - f) net total cost or savings of salvage or recycling each material
 - g) manifests, weight tickets, receipts, and invoices (attach copies)
 - 3. Reuse and salvage information:
 - a) list of items salvaged for reuse on project or campus
 - b) amount (in tons or cubic yards)
 - c) receiving party or storage location
 - d) net savings (avoided tip fee and cost difference of item purchased new)
 - 4. Revenues: Revenues or other savings obtained from recycled, reused, or salvaged materials shall accrue to contractor unless otherwise noted in the contract documents

END OF SECTION 01505

SECTION 01600 - MATERIALS AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements governing the Contractor's selection of products for use in the Project.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 1 Section "Reference Standards and Definitions" specifies the applicability of industry standards to products specified.
 - 2. Division 1 Section "Submittals" specifies requirements for submittal of the Contractor's Construction Schedule and the Submittal Schedule.
 - 3. Division 1 Section "Substitutions" specifies administrative procedures for handling requests for substitutions made after award of the Contract.

1.3 DEFINITIONS

- A. Definitions used in this Article are not intended to change the meaning of other terms used in the Contract Documents, such as "specialties," "systems," "structure," "finishes," "accessories," and similar terms. Such terms are self-explanatory and have well-recognized meanings in the construction industry.
 - 1. "Products" are items purchased for incorporation in the Work, whether purchased for the Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 - a) "Named Products" are items identified by the manufacturer's product name, including make or model number or other designation, shown or listed in the manufacturer's published product literature, that is current as of the date of the Contract Documents.
 - 2. "Materials" are products substantially shaped, cut, worked, mixed, finished, refined or otherwise fabricated, processed, or installed to form a part of the Work.
 - 3. "Equipment" is a product with operational parts, whether motorized or manually operated, that requires service connections, such as wiring or piping.

1.4 SUBMITTALS

- A. Provide submittals for Materials and Equipment as outlined in Division I, Section 01300, Submittals.

1.5 QUALITY ASSURANCE

- A. All material and equipment shall be furnished by manufacturers who shall have at least 3 years experience in the design, production, assembly, and field service of the equipment of like type, size, and capacity. Where required by the Engineer, the Contractor shall supply a list of at least 3 successful installation in situations similar to those anticipated for this project. If experience requirements cannot be met, then manufacturers may post a bond or a cash deposit in such amount sufficient to allow replacement of the equipment with that shown on the Plans and specified herein, said bond or deposit to be applicable to any costs occasioned to the Owner in the event that the equipment supplied fails to meet performance standards specified herein. Said costs shall include purchase of replacement equipment, necessary demolition, structural and pipework modifications, controls replacement and rewiring, and other required appurtenances and incidentals necessary for the equipment replacement, including engineering costs for redesign and administration of construction and all required testing services, also including any increased operational or maintenance expenses that might have been incurred. The period for the bond shall be for 3 years less the manufacturer's actual experience.
- B. It is the intent of the Contract Documents to procure the best equipment and services available for the intended duty. Only those manufacturers' products will be accepted, who, in the judgement of the Engineer, can provide:
 - 1. the design services of an engineering staff in the manufacturer's employ (regularly and continuously on the manufacturer's payroll or with whom the manufacturer has and continues to have a contractual agreement to provide consulting engineering service), skilled in the application of the particular type of equipment required under the Contract;
 - 2. shop facilities adequate for and personnel skilled in the fabrication and assembly of the equipment of the type and size required on this Project;
 - 3. field service personnel in the manufacturer's employ, trained and skilled in the adjustment, servicing and repair of the equipment of like size, type, and capacity.
- C. The Engineer may require, and Contractor shall furnish, if directed, the data required to demonstrate compliance with requirements of this item, and that stipulated in the Information for Bidders. The judgement of the Engineer shall be final in all cases.
- D. Compatibility of Options: When the Contractor is given the option of selecting between 2 or more products for use on the Project, the product selected shall be compatible with products previously selected to the extent possible.

1. Each prime contractor is responsible for providing products and construction methods that are compatible with products and construction methods of other prime or separate contractors.
2. If a dispute arises between prime contractors over concurrently selectable, but incompatible products, the Engineer will determine which products shall be retained and which are incompatible and must be replaced.

E. Nameplates:

1. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated equipment. Locate on an easily accessible surface. The nameplate shall contain the following information and other essential operating data:
 - a) Name of product and manufacturer.
 - b) Model and serial number.
 - c) Capacity.
 - d) Speed.
 - e) Ratings.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products according to the manufacturer's recommendations, using means and methods that will prevent damage, deterioration, and loss, including theft.
1. Schedule delivery to minimize long-term storage at the site and to prevent overcrowding of construction spaces.
 2. Coordinate delivery with installation time to assure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 3. Deliver products to the site in an undamaged condition in the manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 4. Inspect products upon delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
 5. Store products at the site in a manner that will facilitate inspection and measurement of quantity or counting of units.
 6. Store heavy materials away from the Project structure in a manner that will not endanger the supporting construction.
 7. Store products subject to damage by the elements above ground, under cover in a weathertight enclosure, with ventilation adequate to prevent condensation. Maintain temperature and humidity within range required by manufacturer's instructions.

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION

- A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, new at the time of installation.
1. Provide products complete with accessories, trim, finish, safety guards, and other devices and details needed for a complete installation and the intended use and effect.
 2. Standard Products: Where available, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 3. **Electrical equipment, including control panels, that is furnished by any contractor or subcontractor shall be properly labeled by a testing laboratory recognized and approved by the State of North Carolina.**
- B. Product Selection Procedures: The Contract Documents and governing regulations govern product selection. Procedures governing product selection include the following:
1. Where Specifications specify products or manufacturers by name, accompanied by the term "or equal," comply with the Contract Document provisions concerning "substitutions" to obtain approval for use of an unnamed product.
 2. Nonproprietary Specifications: When Specifications list products or manufacturers that are available and may be incorporated in the Work, but do not restrict the Contractor to use of these products only, the Contractor may propose any available product that complies with Contract requirements. Comply with Contract Document provisions concerning "substitutions" to obtain approval for use of an unnamed product.
 3. Descriptive Specification Requirements: Where Specifications describe a product or assembly, listing exact characteristics required, with or without use of a brand or trade name, provide a product or assembly that provides the characteristics and otherwise complies with Contract requirements. Comply with the Contract Document provisions concerning "submittals" to obtain approval of products based on performance requirements.
 4. Performance Specification Requirements: Where Specifications require compliance with performance requirements, provide products that comply with these requirements and are recommended by the manufacturer for the application indicated.
 - a) Manufacturer's recommendations may be contained in published product literature or by the manufacturer's certification of performance.

- b) Comply with the Contract Document provisions concerning "submittals" to obtain approval of products based on performance requirements.
- 5. Compliance with Standards, Codes, and Regulations: Where Specifications only require compliance with an imposed code, standard, or regulation, select a product that complies with the standards, codes, or regulations specified.
 - 6. Visual Matching: Where Specifications require matching an established Sample, the Engineer's decision will be final on whether a proposed product matches satisfactorily.
 - a) Where no product available within the specified category matches satisfactorily and complies with other specified requirements, comply with provisions of the Contract Documents concerning "substitutions" for selection of a matching product in another product category.
 - 7. Visual Selection: Where specified product requirements include the phrase "... as selected from manufacturer's standard colors, patterns, textures ..." or a similar phrase, select a product and manufacturer that complies with other specified requirements. The Engineer will select the color, pattern, and texture from the product line selected.
 - 8. Allowances: Refer to individual Specification Sections and "Allowance" provisions in Division 1 for allowances that control product selection and for procedures required for processing such selections.

PART 3 - EXECUTION

3.1 INSTALLATION OF PRODUCTS

- A. Comply with manufacturer's instructions and recommendations for installation of products in the applications indicated. Anchor each product securely in place, accurately located and aligned with other Work.
 - 1. When equipment of any kind is to be installed in a building or structure and minor changes are necessary in the building or structure to accommodate the equipment, such changes shall be considered incidental to the proper completion of the work, and shall be made by the Contractor without additional compensation therefor.
 - 2. Manufacturers furnishing equipment shall include in their quotation the services of a qualified field representative to inspect the equipment installation, make necessary adjustments and field test prior to the equipment being placed in service. He shall then place the equipment in permanent operation. Such representative shall be furnished and shall be present on the job site without delay, upon request of the Contractor and/or Engineer. The Contractor shall cause the representative to submit by letter to the Owner the results of the equipment inspection and attest to proper installation and operation thereof or detail deficiencies and list remedies therefor.

3. Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

END OF SECTION 01600

SECTION 01631 - SUBSTITUTIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for handling requests for substitutions made after award of the Contract.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 1 Section "Reference Standards and Definitions" specifies the applicability of industry standards to products specified.
 - 2. Division 1 Section "Submittals" specifies requirements for submitting the Contractor's Construction Schedule and the Submittal Schedule.
 - 3. Division 1 Section "Materials and Equipment" specifies requirements governing the Contractor's selection of products and product options.

1.3 DEFINITIONS

- A. Definitions in this Article do not change or modify the meaning of other terms used in the Contract Documents.
- B. Substitutions: Changes in products, materials, equipment, and methods of construction required by the Contract Documents proposed by the Contractor after award of the Contract are considered to be requests for substitutions. The following are not considered to be requests for substitutions:
 - 1. Substitutions requested during the bidding period, and accepted by Addendum prior to award of the Contract, are included in the Contract Documents and are not subject to requirements specified in this Section for substitutions.
 - 2. Revisions to the Contract Documents requested by the Owner or Engineer.
 - 3. Specified options of products and construction methods included in the Contract Documents.
 - 4. The Contractor's determination of and compliance with governing regulations and orders issued by governing authorities.

1.4 SUBMITTALS

- A. Substitution Request Submittal: The Engineer will consider requests for substitution if received within 60 days after commencement of the Work. Requests received more than 60 days after commencement of the Work may be considered or rejected at the discretion of the Engineer.

1. Submit 3 copies of each request for substitution for consideration. Submit requests in the form and according to procedures required for change-order proposals.
2. Identify the product or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers.
3. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:
 - a) Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and separate contractors, that will be necessary to accommodate the proposed substitution.
 - b) A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements, such as performance, weight, size, durability, and visual effect.
 - c) Product Data, including Drawings and descriptions of products and fabrication and installation procedures.
 - d) Samples, where applicable or requested.
 - e) A statement indicating the substitution's effect on the Contractor's Construction Schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.
 - f) Cost information, including a proposal of the net change, if any in the Contract Sum.
 - g) The Contractor's certification that the proposed substitution conforms to requirements in the Contract Documents in every respect and is appropriate for the applications indicated.
 - h) The Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of the failure of the substitution to perform adequately.
4. Engineer's Action: If necessary, the Engineer will request additional information or documentation for evaluation within one week of receipt of a request for substitution. The Engineer will notify the Contractor of acceptance or rejection of the substitution within 2 weeks of receipt of the request, or one week of receipt of additional information or documentation, whichever is later. Acceptance will be in the form of a change order or letter of acceptance.
5. Use the product specified if the Engineer cannot make a decision on the use of a proposed substitute within the time allocated.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

- A. Conditions: The Engineer will receive and consider the Contractor's request for substitution when one or more of the following conditions are satisfied, as determined by the Engineer. If the following conditions are not satisfied, the Engineer will return the requests without action except to record noncompliance with these requirements.
1. Extensive revisions to the Contract Documents are not required.
 2. Proposed changes are in keeping with the general intent of the Contract Documents.
 3. The request is timely, fully documented, and properly submitted.
 4. The specified product or method of construction cannot be provided within the Contract Time. The Engineer will not consider the request if the product or method cannot be provided as a result of failure to pursue the Work promptly or coordinate activities properly.
 5. The requested substitution offers the Owner a substantial advantage, in cost, time, energy conservation, or other considerations, after deducting additional responsibilities the Owner must assume. The Owner's additional responsibilities may include compensation to the Engineer for redesign and evaluation services, increased cost of other construction by the Owner, and similar considerations.
 6. The specified product or method of construction cannot receive necessary approval by a governing authority, and the requested substitution can be approved.
 7. The specified product or method of construction cannot be provided in a manner that is compatible with other materials and where the Contractor certifies that the substitution will overcome the incompatibility.
 8. The specified product or method of construction cannot be coordinated with other materials and where the Contractor certifies that the proposed substitution can be coordinated.
 9. The specified product or method of construction cannot provide a warranty required by the Contract Documents and where the Contractor certifies that the proposed substitution provides the required warranty.
 10. Where a proposed substitution involves more than one prime contractor, each contractor shall cooperate with the other contractors involved to coordinate the Work, provide uniformity and consistency, and assure compatibility of products.
- B. The Contractor's submittal and the Engineer's acceptance of Shop Drawings, Product Data, or Samples for construction activities not complying with the Contract Documents do not constitute an acceptable or valid request for substitution, nor do they constitute approval.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 01631

SECTION 01700 - CONTRACT CLOSEOUT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for contract closeout including, but not limited to, the following:
 - 1. Inspection procedures.
 - 2. Project record document submittal.
 - 3. Operation and maintenance manual submittal.
 - 4. Submittal of warranties.
 - 5. Final cleaning.
- B. Closeout requirements for specific construction activities are included in the appropriate Sections in Divisions 2 through 16.

1.3 SUBSTANTIAL COMPLETION

(Refer to State Construction Office General Conditions Article 24.)

- A. Preliminary Procedures: Before requesting inspection for certification of Substantial Completion, complete the following. List exceptions in the request.
 - 1. In the Application for Payment that coincides with, or first follows, the date Substantial Completion is claimed, show 100 percent completion for the portion of the Work claimed as substantially complete.
 - a) Include supporting documentation for completion as indicated in these Contract Documents and a statement showing an accounting of changes to the Contract Sum.
 - b) If 100 percent completion cannot be shown, include a list of incomplete items, the value of incomplete construction, and reasons the Work is not complete.
 - 2. Advise the Owner of pending insurance changeover requirements.
 - 3. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications, and similar documents.

4. Obtain and submit releases enabling the Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 5. Submit record drawings, maintenance manuals, damage or settlement claims, and similar final record information.
 6. Deliver tools, spare parts, extra stock, and similar items.
 7. Make final changeover of permanent locks and transmit keys to the Owner. Advise the Owner's personnel of changeover in security provisions.
 8. Complete startup testing of systems and instruction of the Owner's operation and maintenance personnel. Discontinue and remove temporary facilities from the site, along with mockups, construction tools, and similar elements.
 9. Complete final cleanup requirements, including touchup painting.
 10. Touch up and otherwise repair and restore marred, exposed finishes.
- B. Inspection Procedures: On receipt of a request for inspection, the Engineer will either proceed with inspection or advise the Contractor of unfilled requirements. The Engineer will prepare the Certificate of Substantial Completion following inspection or advise the Contractor of construction that must be completed or corrected before the certificate will be issued.
1. The Engineer will repeat inspection when, in the Engineer's opinion, the Work is substantially complete.
 2. Results of the completed inspection will form the basis of requirements for final acceptance.

1.4 FINAL ACCEPTANCE

- A. Preliminary Procedures: Before requesting final inspection for certification of final acceptance and final payment, complete the following. List exceptions in the request.
1. Submit the final payment request with releases and supporting documentation not previously submitted and accepted. Include insurance certificates for products and completed operations where required.
 2. Submit an updated final statement, accounting for final additional changes to the Contract Sum.
 3. Submit a certified copy of the Engineer's final inspection list of items to be completed or corrected. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.

4. Submit final meter readings for utilities, a measured record of stored fuel, and similar data as of the date of Substantial Completion or when the Owner took possession of and assumed responsibility for corresponding elements of the Work.
 5. Submit a final liquidated damages settlement statement.
 6. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 7. Submit consent of surety to final payment.
 8. Submit contractor's and subcontractor's Affidavit of Release of Liens
 9. Submit contractor's Affidavit of Payment of Debts and Claims
 10. Submit Release of Liens from material and equipment suppliers.
- B. Reinspection Procedure: The Engineer will reinspect the Work upon receipt of notice that the Work, including inspection list items from earlier inspections, has been completed, except for items whose completion is delayed under circumstances acceptable to the Engineer.
1. Upon completion of reinspection, the Engineer will prepare a certificate of final acceptance. If the Work is incomplete, the Engineer will advise the Contractor of Work that is incomplete or of obligations that have not been fulfilled but are required for final acceptance.

1.5 RECORD DOCUMENT SUBMITTALS

- A. General: Do not use record documents for construction purposes. Protect record documents from deterioration and loss in a secure, fire-resistant location. Provide access to record documents for the Engineer's reference during normal working hours.
- B. Record Drawings: Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark which drawing is most capable of showing conditions fully and accurately. Where Shop Drawings are used, record a cross-reference at the corresponding location on the Contract Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date.
1. Mark record sets with red erasable pencil. Use other colors to distinguish between variations in separate categories of the Work.
 2. Mark new information that is important to the Owner but was not shown on Contract Drawings or Shop Drawings.

3. Note related change-order numbers where applicable.
 4. Organize record drawing sheets into manageable sets. Bind sets with durable-paper cover sheets; print suitable titles, dates, and other identification on the cover of each set.
 5. Provided signed/sealed as-built drawings as specified in Section 01300.
- C. Maintenance Manuals: Equipment manufacturers shall furnish 6 copies of an operating and maintenance manual covering their equipment. (To include, but not limited to, instrumentation, valves, piping materials, air release valves, electrical equipment, pumps, filters, hydropneumatic tanks.) Manuals shall be submitted within 60 days of final shop drawing approval. Organize operation and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual, heavy-duty, 2-inch, 3-ring, vinyl-covered binders, with pocket folders for folded sheet information. Mark appropriate identification on front and spine of each binder. Include the following types of information:
1. Emergency instructions.
 2. Spare parts list.
 3. Copies of warranties.
 4. Wiring diagrams.
 5. Recommended "turn-around" cycles.
 6. Inspection procedures.
 7. Shop Drawings and Product Data.
 8. Fixture lamping schedule.
 9. Manufacturer's Name, Address and Phone Number.
 10. Supplier's Name, Address and Phone Number.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 CLOSEOUT PROCEDURES

- A. Operation and Maintenance Instructions: Arrange for each Installer of equipment that requires regular maintenance to meet with the Owner's personnel to provide instruction in proper operation and maintenance. Provide instruction by manufacturer's representatives if installers are not experienced in operation and maintenance procedures. Include a detailed review of the following items:
1. Maintenance manuals.
 2. Record documents.
 3. Spare parts and materials.
 4. Tools.
 5. Lubricants.
 6. Fuels.
 7. Identification systems.
 8. Control sequences.
 9. Hazards.

10. Cleaning.
 11. Warranties and bonds.
 12. Maintenance agreements and similar continuing commitments.
- B. As part of instruction for operating equipment, demonstrate the following procedures:
1. Startup.
 2. Shutdown.
 3. Emergency operations.
 4. Noise and vibration adjustments.
 5. Safety procedures.
 6. Economy and efficiency adjustments.
 7. Effective energy utilization.

3.2 FINAL CLEANING

- A. General: The General Conditions require general cleaning during construction. Regular site cleaning is included in Division 1 Section "Construction Facilities and Temporary Controls."
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in a normal, commercial building cleaning and maintenance program. Comply with manufacturer's instructions.
1. Clean-up operations shall consistently be carried on by the Contractor at all time to keep the premises free from accumulation of waste materials and rubbish. Upon completion of the work, he shall remove all rubbish, tools, scaffolding, surplus materials, etc., from the building and shall leave his work in a condition satisfactory to the Engineer.
 2. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion.
 - a) Remove labels that are not permanent labels.
 - b) Remove all surplus and discarded materials, excavated material and rubbish from the roadways, sidewalks, parking areas, lawns and all adjacent property; restore, in an acceptable manner, all property, both public and private, which has been disturbed or damaged during the prosecution of the work; and shall leave the whole site in a neat and presentable condition.
 - c) Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials.
 - d) Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films, and similar foreign substances. Restore reflective surfaces to their original condition. Leave concrete floors broom clean. Vacuum carpeted surfaces.

- e) Wipe surfaces of mechanical and electrical equipment. Remove excess lubrication and other substances. Clean plumbing fixtures to a sanitary condition. Clean light fixtures and lamps.
 - f) Clean the site, including landscape development areas, of rubbish, litter, and other foreign substances. Sweep paved areas broom clean; remove stains, spills, and other foreign deposits. Rake grounds that are neither paved nor planted to a smooth, even-textured surface.
- C. Removal of Protection: Remove temporary protection and facilities installed for protection of the Work during construction.
- D. Compliance: Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from the site and dispose of lawfully.
- 1. Where extra materials of value remain after completion of associated Work, they become the Owner's property. Dispose of these materials as directed by the Owner.
 - 2. In case of dispute, the Owner may remove the rubbish and charge the cost to the several contractors as the Engineer shall determine to be just.

END OF SECTION 01700

SECTION 01720 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 MAINTENANCE OF DOCUMENTS

- A. Maintain at job site, one copy of:
 - 1. Contract Drawings
 - 2. Specifications
 - 3. Addenda
 - 4. Review Shop Drawings
 - 5. Change Orders
 - 6. Other Modifications to Contract
 - 7. All Test Records
- B. Store documents in approved location in addition to and apart from documents used for construction.
- C. Provide files and racks for storage of documents.
- D. File documents in accordance with Engineer approved format.
- E. Maintain documents in clean, dry, legible condition.
- F. Do not use record documents for construction purposes.
- G. Make documents available at all times for inspection by the Engineer, Owner, State or Federal Representative.

1.2 RECORDING BY CONTRACTOR

- A. Label each document "PROJECT RECORD" in 2-inch high printed letters.
- B. Keep Record Documents current and orderly.
 - 1. Keep complete index with document name and location; number each document.
- C. Do not permanently cover or conceal any work until required information has been recorded.
- D. Contract Drawings
- E. Specifications and Addenda
 - 1. Legibly mark up each section to record:

- a) Manufacturer, trade name, catalogue number, and Supplier of each product and item of equipment actually installed.
- b) Changes made by Change Order or Field Order.
- c) Other matters not originally specified.

F. Shop Drawings

1. Maintain as Record Documents; legibly annotate on a set of contract drawings the actual construction conditions.

1.3 SUBMITTAL

- A. At monthly project meetings present progress drawings with Contractor's invoice. **No payment will be made on Contractor's monthly invoices until Contractor demonstrates to the Engineer or Owner's Authorized Representative that Record Drawings are up to date.**
- B. At completion of project, deliver Final Record Documents to Engineer.
- C. Accompany Record Documents with transmittal letter in duplicate containing:
 1. Date.
 2. Project title and number.
 3. Contractor's name and address.
 4. Title and number of each Record Document.
 5. Certification that each document as submitted is complete and accurate.
 6. Signature of Contractor, or his authorized representative.

PART 2 - PRODUCTS

2.1 AS-BUILT DRAWING REQUIREMENTS

- A. As-built drawings must document all important deviations from original Drawings made during construction.

2.2 TITLE SHEET

- A. Prime Contractor - Name and Address
- B. All major Subcontractors - Name and Address
- C. Resident Project Representative
- D. Buried or concealed materials used on Project.
- E. For all valves, indicate the number of turns to open and indicate direction to open (clockwise or counter-clockwise).
- F. A bold note to indicate that the set of plans are "As-built Drawings".

2.3 SEWER AND WATER LINES

- A. Accurately record final routing of all pipelines, manholes, valves, and appurtenances locations including dimensions from buildings or other fixed objects as reference points.
- B. Indicate changes to all pipeline, manholes or other infrastructure locations as applicable.
- C. Show actual locations and at least three ties to manholes, valves, vaults and associated appurtenances. Show as-built rim and invert elevations.
- D. Revise the following construction drawings to indicate as-built conditions:
 - 1. Overall Site Plan and/or Index.
 - 2. Plan & Profile Drawings.
 - 3. Construction Details.

2.4 ELECTRICAL/CONTROLS WORK

- A. Show actual locations of all electric and control devices.
- B. Show routing at all electrical and control conduit/wire.
- C. Label the breaker number and electrical panel designation for each circuit installed or connected to.
- D. Label the control panel number and control descriptor for each signal wire.

2.5 DETAIL SHEETS

- A. Indicate when any details are not used or not applicable. Example - If three alternates for pavement are on detail sheet, the two not used shall be so noted. (Box and cross out unused details).
- B. Indicate if any details were modified by OWASA or UNC inspector requirements.

2.6 GENERAL CONSTRUCTION

- A. Denote all areas where any existing utility was repaired, replaced or relocated. Show correct location if plan location was incorrect.
- B. Note and accurately locate all existing underground utilities encountered during construction, whether shown on the Drawings or not.

PART 3 – EXECUTION

3.1 AFFIDAVIT

- A. Complete and execute the attached affidavit when submitting final copies of as-built drawings. Final payment will be withheld until such time as the As-built Drawings are complete and the Contractor has submitted the Affidavit.

**AFFIDAVIT
FOR RECORD DRAWINGS**

_____, the CONTRACTOR on _____
(Contractor) (Project title per Contract Documents)

_____ hereby certifies that the enclosed record drawings show all changes made during construction, as specified under RECORD DOCUMENTS in Section 01700 of the Contract Documents.

By: _____
CONTRACTOR (Authorized Signature)

Sworn to and subscribed before me this _____ day of _____.

NOTARY PUBLIC

Valves, fittings, appurtenances, structures, and existing utilities have been surveyed by _____, a North Carolina licensed land surveyor. This firm completed the post construction surveys and hereby certifies that the information presented on the final record drawing is true and accurate as verified by field surveys.

END OF SECTION 01720

SECTION 01730 – OPERATION AND MAINTENANCE MANUALS

PART 1 – GENERAL

1.1 REQUIREMENTS INCLUDED

- A. Compiling of product data and related information required for maintenance of products.
- B. Preparing of operation and maintenance data and instructions for systems and equipment.
- C. Schedule of required submittals.

1.2 QUALITY ASSURANCE

- A. Prepare instructions and data using personnel experienced in maintenance and operation of described products.

1.3 FORMAT

- A. Prepare data in the form of an instructional manual.
- B. Binders: Commercial quality, 8 1/2 X 11 inch three-ring binders with hardback, cleanable, plastic covers; two inch maximum ring size. When multiple binders are used, correlate data into related consistent groupings.
- C. Cover Identify each binder with typed or printed title, "OPERATION AND MAINTENANCE INSTRUCTIONS"; list title of Project and identify equipment covered by manual.
- D. Arrange content by section numbers and provide a table of contents.
- E. Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.
- F. Text: manufacturer's printed data or type written data on 20-pound paper.
- G. Drawings: Provide with reinforced, punched binder tabs. Bind with text; fold larger Drawings with to size of text pages.

1.4 CONTENTS, EACH VOLUME

- A. Table of Contents: Provide title of project; schedule of products and systems, indexed to content of the volume.
- B. For each product or system: List names, addresses and telephone numbers of subcontractors, manufacturers and suppliers, including local source of supplies and replacement parts.

- C. Product Data: Mark each sheet to clearly identify specific products and components parts, and data applicable to installation; delete inapplicable information.
- D. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use Project record Documents as maintenance drawings.
- E. Typed Text: Prepare as required to supplement product data. Provide logical sequence of instructions for each procedure. Incorporate manufacturer's instructions for each procedure. Incorporate manufacturer's instructions for delivery, storage, assemble, installation, start-up, adjusting, finishing, operation and maintenance.

1.5 MANUAL FOR MATERIALS AND FINISHES

- A. Building products, Applied Materials and Finishes: Include product data with catalog number, size, composition, color and texture designations. Provide information for reordering custom manufactured products.
- B. Instructions for Care and Maintenance: Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental cleaning agents and methods, and recommended schedule for cleaning and maintenance.
- C. Moisture-protection and Weather-exposed Products: Include product data listing applicable reference standards, chemical composition, and details of installation. Provide recommendations for inspections, maintenance, and repair.
- D. Additional Requirements: As specified in individual specification sections.

1.6 MANUFACTURER'S MANUALS FOR EQUIPMENT AND SYSTEMS

- A. Each Item of Equipment and each System: Include a description of unit or system, and component parts. Give function, normal operating characteristics, and limiting tests and certifications where appropriate and complete nomenclature and commercial number of replaceable parts, where applicable.
- B. Panel Board Circuit Directories: Provide electrical service characteristics and name of load on each branch circuit breaker.
- C. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences; including regulation, control, stopping, shut-down, emergency instructions. Include summer, winter and any special operating instructions.
- D. Maintenance Requirements: Include routine procedures and guide for troubleshooting, disassembly, repair, and reassemble instructions, alignment, adjusting, balancing, and checking instructions. Provide servicing and lubrication schedule, and list of lubricants repaired.

- E. Controls: Provide the Following:
1. Sequence of operation
 2. Original parts list, illustrations, assembly drawings and diagrams required for maintenance.
 3. As-installed control diagrams.
 4. Contractor's coordination drawings, with as-installed color coded piping diagrams.
 5. Charts of valve tag numbers with location and function of each valve, keyed to flow and control diagrams.
 6. As-installed color-coded wiring.
- F. Additional Requirements: As specified in individual specification sections.

1.7 SUBMITTALS

- A. Submit four (4) copies of draft Operation and Maintenance Manual for equipment and component parts within 30 days after shop drawing acceptance. Manuals shall include all materials complying with the presentation and format requirements of this section. One (1) copy will be returned with the Engineer's comments.
- B. Submit six (6) copies of revised manual (if required) in final form complying with Engineer's comments within 30 days from the return of the reviewed manual. One (1) copy of the final manual will be returned. Revise content of documents as required until final submittal.

1.8 SCHEDULE OF SUBMITTALS

- A. Operation and Maintenance manuals conforming to this specification shall be submitted for the following equipment or as required by specific equipment specifications:

Section Number	Equipment Description
11232	Chemical storage and metering pump equipment
11310	Submersible wastewater pumps
11315	Submersible well pumps (Irrigation)
11950	Irrigation controller, control valves, sprinklers, electrical control equipment

The above schedule is not inclusive of individual sections requiring operation and maintenance manuals. The Contractor remains responsible for operation and maintenance manuals for equipment both on the schedule and not on the schedule but called for in the individual specifications.

PART 2 – PRODUCTS (Not Applicable)

PART 3 – EXECUTION (Not Applicable)

END OF SECTION 01730

SECTION 01740 - WARRANTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for warranties required by the Contract Documents, including manufacturers' standard warranties on products and special warranties.
 - 1. Refer to the General Conditions for terms of the Contractor's period for correction of the Work.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 1 Section "Submittals" specifies procedures for submitting warranties.
 - 2. Division 1 Section "Contract Closeout" specifies contract closeout procedures.
 - 3. Divisions 2 through 16 Sections for specific requirements for warranties on products and installations specified to be warranted.
 - 4. Certifications and other commitments and agreements for continuing services to Owner are specified elsewhere in the Contract Documents.
- C. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products. Manufacturer's disclaimers and limitations on product warranties do not relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.

1.3 DEFINITIONS

- A. Standard product warranties are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.
- B. Special warranties are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.

1.4 WARRANTY REQUIREMENTS

- A. **Equipment Warranty:** All equipment shall have a one-year warranty period from the date of substantial completion and acceptance by the Owner. The warranty period shall cover the full cost of repairs and replacement to include all labor, travel expenses, parts, taxes and freight so as to be no cost to the Owner. If the equipment in need of repair and replacement is critical to the function of the Owner's facility, then the Contractor shall expedite this replacement to include express freight charges and additional cost for labor.
- B. **Related Damages and Losses:** When correcting failed or damaged warranted construction, remove and replace construction that has been damaged as a result of such failure or must be removed and replaced to provide access for correction of warranted construction.
- C. **Reinstatement of Warranty:** When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
- D. **Replacement Cost:** Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of the Contract Documents. The Contractor is responsible for the full cost **(including labor if straight time or overtime is required, travel expenses, parts, taxes and freight)** of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life. Equipment that the Owner or Engineer deem critical to the Work shall be replaced immediately or the Contractor shall be held responsible for the damaged caused by not replacing the equipment. Contractor shall expedite the replacement of critical items to include express freight charges and additional cost for labor.
- E. **Owner's Recourse:** Expressed warranties made to the Owner are in addition to implied warranties and shall not limit the duties, obligations, rights, and remedies otherwise available under the law. Expressed warranty periods shall not be interpreted as limitations on the time in which the Owner can enforce such other duties, obligations, rights, or remedies.
 - 1. **Rejection of Warranties:** The Owner reserves the right to reject warranties and to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
- F. Where the Contract Documents require a special warranty, or similar commitment on the Work or part of the Work, the Owner reserves the right to refuse to accept the Work, until the Contractor presents evidence that entities required to countersign such commitments are willing to do so.

1.5 SUBMITTALS

- A. Submit written warranties to the Engineer prior to the date certified for Substantial Completion. If the Engineer's Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the Engineer.
 - 1. When a designated portion of the Work is completed and occupied or used by the Owner, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Engineer within 15 days of completion of that designated portion of the Work.
- B. When the Contract Documents require the Contractor, or the Contractor and a subcontractor, supplier or manufacturer to execute a special warranty, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the Owner, through the Engineer, for approval prior to final execution.
- C. Refer to Divisions 2 through 16 Sections for specific content requirements and particular requirements for submitting special warranties.
- D. Form of Submittal: At Final Completion compile 3 copies of each required warranty properly executed by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer.
- E. Bind warranties and bonds in heavy-duty, commercial-quality, durable 3-ring, vinyl-covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch (115-by-280-mm) paper.
 - 1. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product, and the name, address, and telephone number of the Installer.
 - 2. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project title or name, and name of the Contractor.
 - 3. When warranted construction requires operation and maintenance manuals, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 01740

SECTION 02050 - DEMOLITION AND REMOVAL

PART 1 - GENERAL

- 1.1 Work under this section includes furnishing labor, equipment and materials for demolition, removal and proper disposal of certain structures, piping, equipment, all stripping, trees, existing pavement, existing sidewalk and curb and gutter, existing buried steel package wastewater treatment plant and filter as indicated or specified. Do not begin demolition until authorization is received from the Engineer, refer to paragraph "Title to Materials", hereinafter. Remove rubbish and debris daily, unless otherwise directed; do not allow accumulations. Store materials that cannot be removed daily in areas approved by the Engineer. All insulation removed shall be tested for the presence of asbestos. The demolition and removal of materials containing asbestos, including asbestos cement pipe, shall be in accordance with State and Federal regulations.
- 1.2 Contractor shall provide potable water or approved reclaimed water in tanker trucks for use in spray washing and cleaning the existing septic tank, septic tank effluent pump station, Advantex blend tank, and other existing equipment.
- 1.3 It will also be the responsibility of the Contractor to contract with licensed waste haulers to pump out these existing basins, tanks, and other equipment for disposal of the wastewater in a proper and approved manner.
- 1.4 Under the current pump and haul permit, UNC is providing pump and haul of **facility generated wastewater** discharged to the existing Capetown wastewater treatment system. Also, under this pump and haul permit, UNC will provide the initial pump down of the two existing wet weather storage basins that are to be refurbished.
- 1.5 The general sequence of construction is based on the requirement to keep the pump and haul activities on-going until renovations to the existing domestic wastewater treatment system are complete. After these renovations are complete, all the domestic wastewater will be diverted to the existing Advantex domestic wastewater treatment system for treatment to secondary standards. The effluent from the domestic treatment system will be pumped to the refurbished wet weather storage basin for disposal by on-site spray irrigation.
- 1.6 All wastewater from Building #1 currently flows by gravity to the existing 8,000 gallon septic tank. The effluent from the septic tank is pumped via the existing septic tank effluent pump station to the existing "Capetown" animal wastewater treatment system. The discharge piping from the effluent pump station is temporarily interconnected with the forcemain from the grinder pump station to pump all wastewater to the "Capetown" system.
- 1.7 The wastewater from Building #2 flows by gravity to the existing grinder pump station, where it is pumped to the "Capetown" system. All the wastewater collected in the "Capetown" system is pumped to tanker trucks and hauled to the Orange Water & Sewer Authority (OWASA) Mason Farm Water Reclamation Facility for treatment.

- 1.8 Building #3 is currently not occupied and wastewater discharges are minimal; therefore, gravity sewer collection system improvements will proceed from manhole MH 004-D-009 to manhole MH 004-D-004. This will allow gravity flow of all the domestic wastewater from Buildings #3 and #1 to flow to the existing 8,000 septic tank. The existing 4 inch PVC lateral from Building #2 will be re-routed as required and connected to the existing 8 inch sewer line from Building #1. Sewer line plugs and temporary bypass pumping shall be provided as necessary to accommodate existing sewer discharges.
- 1.9 A portion of the existing "animal" wastewater gravity sewer line is constructed within the NCDENR 100 ft. setback from the existing potable water supply well. This line must be removed in its entirety. Decommissioning the remainder of this gravity sewer line includes removing the existing cast iron frames, covers, and top precast riser sections from the manholes. Each of these manholes will then be filled with flowable fill material (including the invert channel) and then backfilled with clean fill material and compacted in 12 inch lifts to grade.
- 1.10 After completion of the improvements to the gravity sewer system and the existing domestic wastewater treatment system, wet weather storage basin, and irrigation pump station, the existing grinder pump station will be decommissioned by removing the influent and effluent piping connections and removing the prefabricated FRP pump station. After permanently capping the buried pipe connections, the excavation will be backfilled and compacted in place with clean fill material.
- 1.11 After refurbishing and commissioning the domestic wastewater treatment system and diverting all the wastewater flow to the domestic treatment system, decommission the existing *Capetown* animal wastewater treatment system including the *Capetown* package wastewater treatment system, deep bed denitrification filter system, ultraviolet disinfection system, chemical feed system, and effluent pump station. Pump the liquid contents from the *Capetown* system into tanker trucks for disposal at OWASA in accordance with the current pump and haul permit. Pressure wash the inside of the *Capetown* tanks to clean the tanks, and pump and haul the wash water to OWASA. Remove and dispose of the filter sand in a solid waste landfill facility. Excavate around the outside of the buried steel tanks, and cut and cap all buried piping connections. Remove the tank anchors to the concrete ballast, and remove the steel tanks, railing, electrical panels, etc. Equipment to be removed from site by the contractor shall be disposed of in a proper and approved manner. Backfill and compact the excavation with fill material.
- 1.12 Prior to refurbishing the existing wet weather storage basin and the emergency effluent holding basin, the contents of the basins shall be pumped to tanker trucks and properly disposed of by hauling to OWASA in accordance with the current pump and haul permit.
- 1.13 The existing plastic liners in these basins shall be removed and properly disposed of in the landfill.
- 1.14 Decommission the existing domestic and animal wastewater spray irrigation systems by cutting spray irrigation risers at least 6 inches below grade and backfilling to existing grade.

- 1.15 Pipe demolition shall consist of cutting, plugging, and removal as required in accordance with the contract drawings.
- 1.16 Pavement demolition shall consist of cutting and removing existing pavement and curb and gutter.
- 1.17 Related Work in Other Sections:
- A. Clearing, Grading and Excavation: Section 02200
- 1.18 Requirements:
- A. Dust Control: Take appropriate action to check the spread of dust to occupied portions of any nearby buildings and avoid the creation of a nuisance in the surrounding area. Do not use water if it results in hazardous or objectionable conditions, such as ice, flooding, or pollution. Comply with all dust regulations imposed by local air pollution agencies. Contractor shall comply with all OWASA drought restrictions when using OWASA water for dust control.
- B. Protection: Protect existing work which is to remain in place, that is to be reused, or which is to remain the property of Owner by temporary covers, shoring, bracing and supports. Items which are to remain and which are damaged during performance of the work shall be repaired to their original condition or replaced. Do not overload structural elements. Provide new supports and reinforcement for existing construction weakened by demolition or removal work.
- C. Facilities: Protect all electrical and mechanical services and utilities. Where removal of existing utilities and pavement is specified or indicated, provide approved barricades, temporary covering of exposed areas, and temporary services or connections for electrical and mechanical utilities.
- D. Explosives: Use of explosives will not be permitted.
- E. Burning: Burning will not be permitted.
- F. Regulations: Comply with federal, state, and local hauling and disposal regulations.
- 1.19 Submittals: Submit proposed demolition and removal procedures to the Engineer for approval before work is started. Procedures shall provide for coordination with other work in progress, a disconnection schedule of utility services, a detailed description of methods and equipment to be used for each operation of the sequence of operations.

PART 2 - EXECUTION

- 2.1 Existing Structures and Facilities to be Removed: Concrete and masonry structures such as manholes and wetwells which are shown to be demolished on the plans, shall be cut off to a point at least 12" below finished grade level and backfilled and covered

with unclassified excavation. Compaction shall be 95% of Standard Proctor at optimum moisture content.

- A. Existing concrete and masonry structures to be cut for installation of conduit and piping shall be neatly cut using core drills. After installation of conduit or pipe the annular space shall be filled with non-shrink grout.
- B. Items such as concrete sidewalk, stairs, curb and gutter and pavements shall be removed as necessary to complete the project as shown on the plans. All concrete and asphalt items to be removed shall be saw cut with a neat clean line then removed. The Contractor shall remove to nearest control joint if within 4' of saw cut. The Contractor shall take care as to not damage adjacent structures during removal. Any damage to adjacent facilities will be the Contractor's responsibility.
- C. Remove all structures as indicated on the plans which can be removed without damaging existing trees, stone walls, or other utilities or structures to remain.

2.2 Utilities, Piping and Equipment to be Removed: Remove all existing utilities and related equipment as shown in the demolition plan and terminate in a manner conforming to the nationally recognized code covering the specific utility. Equipment to be removed shall be removed with as little damage to the equipment as possible.

- A. Piping shown on the plans to be removed shall be disassembled where possible (and cut where required) and removed. All piping stub-outs indicated to remain shall be blind flanged, covered with a cap or closed with a permanent mechanical plug, as appropriate.
- B. Remove all underground piping as indicated on the plans which can be removed without damaging existing trees, stone walls, or other utilities to remain.

2.3 Disposition of Material: Title to all materials resulting from demolition, and all materials and equipment to be removed, is vested in the Owner unless otherwise directed by the Owner through the Engineer. The Owner will not be responsible for the condition or loss of, or damage to, materials and equipment vested to the contractor by the Owner after Notice to Proceed. Materials and equipment shall not be viewed by prospective purchasers or sold on the site.

- A. Reuse of materials and equipment - Carefully remove and store materials and equipment to be reused or relocated to prevent damage, and reinstall as the work progresses.
- B. Salvaged materials and equipment as specified by the Owner - Carefully remove materials that are to be removed by the Contractor and that are to remain the property of the Owner, and deliver to a storage site as directed within 20 miles of the work site.

2.4 Cleanup: Remove and transport debris and rubbish in a manner that will prevent spillage on streets or adjacent areas. Cleanup any spillage from streets and adjacent areas that occur during transportation operations. The site shall have all debris removed and shall be graded to conform to the adjacent area in such a manner to

provide proper drainage. The site shall be properly seeded and mulched after completion of demolition operations.

PART 3 – WORK WITHIN AND/OR NEAR OCCUPIED BUILDINGS

3.1 BACKGROUND

- A. Campus construction projects impact many people in diverse ways. The people affected include students, visitors, faculty and staff, nearby community neighbors, the City and the State of North Carolina. Once a construction project is underway, Environment, Health and Safety is primarily concerned with potential soil and water contamination in and around the site and the health and safety risks for personnel outside the construction zone. The health and safety activities and practices within the construction area are the sole responsibility of the contractor until they affect personnel outside.
- B. The Engineers are responsible for anticipating and planning for the EHS aspects of the construction project. They incorporate these controls as part of the construction documents with special notes and specification requirements. However, not every contingency has been anticipated and addressed. Consequently, any unspecified activities, which could result in environment, health or safety impacts outside the construction area, must be communicated to and through the Project Manager. The EHS Department is available for consultation on these issues.
- C. Any imminent threats or occurrences that impact the environment (spills, leaks, releases to the soil, stream, storm system, or sewer) or the health or safety of personnel outside of the construction area must be communicated immediately to EHS (962-5507). If someone is not available, a phone message directs the caller to an alternate number, 24 hours per day. It is expected that the Contractor will take quick action to address the problem. However, the EHS Office needs to be notified quickly when these situations arise to ensure University resources are brought to bear when appropriate.
- D. In summary: In an emergency, take prudent action immediately and call EHS (962-5507).
 - 1. General Requirements for Contractors on all construction projects (critical issue recap):
 - a) Establish a list of building representative contacts for buildings that will be impacted by the construction project
 - b) Keep the fire lanes, hydrants and fire department connections clear at all times. (Should be specified on the drawings.)
 - c) Provide and maintain directional signs around construction fences, barricades and at blocked exits.
 - d) Maintain pedestrian walkway protection near the project.(From overhead falling objects, projectiles and construction material which may protrude through the fence)

- e) Maintain erosion control devices. Dust, mud and silt are not to escape from the site by surface or stormwater system during a rainstorm. The Contractor must inspect the run-off at the beginning and during a storm event to ensure compliance. Corrective action must be put in place immediately when a deficiency is discovered.
- f) Provide covered chemical secondary containment and spill response equipment.
- g) Protect streams, storm drains, sanitary sewer - no chemicals, dirt or construction chemicals or debris.
- h) Exposures to:
 - (1) Noise: equipment placement, mufflers, other noise control techniques such as constructing enclosures
 - (2) Dust: ensure dust control techniques are used routinely including wet drilling/cutting of masonry materials, wet cleaning methods
 - (3) Fumes: locate welding/cutting, heated tar pots etc. away from building air intakes
 - (4) Engine exhausts- Turn off vehicles, or equipment when not in use. Idling creates a great deal of pollution. Keep IC engines away from air intakes.
- i) Lay down areas must occur in designated areas only to prevent pedestrian slips, trips and falls and to keep fire lanes open.
- j) Maintain MSD sheets on site for rapid access in the event of an emergency.
- k) Repair vehicle and equipment leaks immediately to prevent fuel, coolants, and oils (hydraulics and gear box) spills.
- l) "Maintain access and clearance for service vehicles, including trash and recycling collection vehicles."

2. Protecting Adjacent Building

- a) Protect building air intakes from vehicle and construction equipment exhaust. Consider feasibility of the following:
 - (1) Blocking potentially contaminated intakes and provide building makeup air from other clean air intakes (may not be possible to maintain any building balance.)
 - (2) Filter intake air for dust and exhaust
 - (3) Provide physical barriers to restrict traffic and deflect exhaust
 - (4) Use low emission equipment-electrically powered in most circumstances
 - (5) Position portable IC generators/compressors away from building intakes.
 - (6) Locate hot tar units away from windows, doors air intakes
 - (7) Keep road and drive accesses clear at all times as per the construction drawings. Fire lanes must never be blocked.

- (8) Disruption of utility services must be coordinated in advance with building representatives with contingencies provided for fire alarms, security and critical equipment operations.

3. Protection in Occupied Building under Construction

- a) Wherever possible, occupants will be moved out of the buildings during renovation projects. Construction in an occupied building requires more planning and the development of contingency plans to deal with construction inconveniences as well as health and safety risks. When buildings must be occupied during construction, the architect is responsible for incorporating the occupancy mitigation features into the design specifications for the construction project. After construction begins, unforeseen, issues must be resolved between the architect, construction manager and the general contractor. These issues and their resolution are to be added to the construction logbook. It is expected that occupant concerns will be addressed rapidly (within 24 hours preferably but no longer than 1 week).

(1) Communication

- (a) Issue: Once construction begins, occupants feel that they their work environment is out of their control. They are subject to risks and inconveniences that occur often without warning for an undetermined amount of time. Preplanned weekly meetings should forewarn occupants of what to expect as well as allow them to provide feedback and suggestions on how to improve their work environment.

(b) Controls:

- (i) Identify the primary and secondary building contact person for contractors and occupants
- (ii) Weekly meetings with the building occupants lead by the building liaison with the construction manager in attendance.
- (iii) Record minutes for the meeting
- (iv) Minutes should indicate what the construction plans are for the coming week and any changes to building access and services.
- (v) Minutes should reflect employee concerns and resolution completed
- (vi) Copies of the minutes should be sent to EHS for review.

- (vii) Any unresolved issues after 1 week need to be raised to Ed Willis

(2) Life/Fire Safety

- (a) Issue: During construction, exits may be blocked for days or months at a time. Nevertheless, in an emergency, occupants must have access to emergency evacuation routes so they can safely leave the building in the event of a fire or other emergency. Also, when electrical systems are shut off, the fire alarm systems may be lost. Similarly, when plumbing lines are disconnected, the sprinkler system may be disabled as well.

If the fire alarm system requires re-programming to accommodate extensive renovations to an occupied facility or major additions to an occupied facility, that constitutes a 10% or greater change to the system database, the fire alarm vendor and/or contractor will assume all and full responsibility and liability of the entire system. Upon completion of the project a 100% inspection by the Owner will be scheduled and performed. Assumption of responsibility and liability for the system will return to the Owner after the system inspection items have been satisfactorily addressed.

(b) Controls:

- (i) Maintaining life safety features
- (ii) Means of egress
- (iii) Alternate means of egress
- (iv) Clear directional signs to alternate exits
- (v) Sprinklers/Fire alarm systems/fire watch provisions
- (vi) Additional fire extinguishers where required
- (vii) Emergency communication method

(3) Interior Building Separation of Construction Traffic/Work Areas:

Construction traffic carrying demolition debris and new construction materials (pipes, studs, wire etc.) could injure the occupants of a building due to lack of protective equipment or lack of awareness of construction hazards.

(a) Controls:

Physical Barriers

- (i) Each project phase shall have designated on the drawings.
- (ii) Temporary wall locations and sound insulation requirements-sealed air tight.
- (iii) Locations to seal off wall and floor penetrations to be dust tight.
- (iv) Designated construction worker travel paths in the building separate from occupants.
- (v) Designated building occupant paths with barriers at the construction zone.
- (vi) Areas around floor and walls to be penetrated to be blocked with barricades to keep occupants out when the penetrations are made.
- (vii) All floor penetrations to be covered with steel plate, fixed in place to prevent objects from falling through to the floors below.
- (viii) Which occupied areas must be secured and vacated before wiring, pipes and conduit are run overhead through walls or ceilings.
- (ix) Which occupied areas are below unprotected openings in the ceiling which must be vacated and barricaded to prevent falling objects from the construction area hitting occupants. Physical barriers are to be inspected and repaired and repaired at least daily.

(4) Warning and Directional Signs

Warning and directional signs shall be specified in the construction documents to indicate the paths off safe egress through the building. The architects will specify the appropriate number and location of these exit paths for the entire construction project according to building code requirements. Signs must comply with OSHA standards. The contractor must maintain these signs at all times throughout the project.

(5) Indoor Air Quality

(a) Issues:

- (i) Every construction project generates dust and odors at various points throughout the project that may include:
- (ii) Masonry dust (cutting, jack hammering, blasting)
- (iii) Sheet rock and spackle dust- sanding

- (iv) Solvents- adhesives, caulks, finishes, sealants, resins
- (v) Metal fumes/dust (welding and cutting)
- (vi) Fungi (mold and mildew)
- (vii) Asphalt fumes

(b) Controls:

- (i) Block and seal off any ductwork shared with occupied areas.
- (ii) Protect all active building air intakes from external contaminants (dust, exhaust, chemicals etc.)
- (iii) Maintain a continuous negative air pressure in the construction zone
- (iv) Use of exhaust fans (include filters for dust)
- (v) Pressurize the occupied areas with excess clean outside air
- (vi) Demonstrate negative pressure in the construction zone with smoke tests at low and high openings (watch for thermal gradients) or through the use of a pressure differential meter.
- (vii) Use wet methods for masonry cutting
- (viii) Use wet methods or HEPA vacuum for cleaning (no compressed air or dry sweeping)
- (ix) Stop work if exposures exceed specified limits outside of the construction area (see the monitoring section).
- (x) Use low or no VOC content in paints, adhesives and finishes
- (xi) Avoid the use of isocyanates and urea formaldehyde resin containing materials.
- (xii) Perform certain tasks when the building is unoccupied including extremely loud activity, overhead crane work etc.
- (xiii) Use covered chutes to drop materials from upper levels to the ground
- (xiv) Use of propane heaters or IC engine powered equipment shall not be used in the building without multiple CO monitors within and outside of the construction zone.
- (xv) Facilities services must check HVAC filters more frequently to avoid plugging with dust and debris.

(6) Noise

- (a) Issue: Noise levels within an office environment directly affect one's ability to use the telephone. The average sound levels for the speech frequencies (500, 1000, 2000 and 4000 Hz) constitute the speech interference level (SIL). SILs greater than 80 make telephone use impossible. SILs down to 60 make phone conversation difficult. Below 60, telephone conversation is acceptable.
- (b) Controls:
 - (i) Restrict high noise operations to unoccupied periods.
 - (ii) Provide suitable mufflers for air operated tools and engine powered equipment
 - (iii) Provide acoustical enclosures for noisy fixed equipment
 - (iv) Prefab building components outside or offsite.
 - (v) Incorporate sound insulation in construction barriers

(7) Maintenance of Building Mechanical Systems

- (a) Issues: The building occupants need access to restroom facilities, and the regular utilities. Disruption of these services can be a hardship particularly for individuals with significant personal health issues or disabilities.
- (b) Controls:

The engineer will provide alternate plans in the specifications to address scheduled disruptions in the following services:

- (i) HVAC
- (ii) Plumbing
- (iii) Electrical/lighting
- (iv) Telephone
- (v) Data lines

(8) Inclement Weather

- (a) Issues: Roof work and the creation of openings in the building envelope can result in water intrusion into the occupied areas resulting in water damage to the building and equipment. In addition, slip hazards and electrical shock hazards could be introduced.

- (b) Controls: Provide barriers and water diverters to control water in the building. These devices must be checked carefully at the beginning and periodically throughout a rain event to ensure they function properly.

- (9) Housekeeping
 - (a) Issues: Areas in and around construction sites are often characterized by the accumulation of dust and dirt, trash and debris.
 - (b) Controls: The Contractor is responsible for keeping his work area clean. If the dust barriers and negative air units are performing properly, little dust will migrate outside the construction zone. Even so, the University is responsible for keeping the occupied areas clean as well. Contractors should be working and traveling only within the confines of the construction zone. Restricting contract employee access to owner occupied areas should reduce the amount of trash and debris accumulating outside the construction zone. Wet cleaning and/or HEPA vacuuming should be used within and outside of the construction zone. Contractors are responsible for their work areas. University housekeeping maintains the occupied areas. Compressed air must not be used for cleaning purposes.

- (10) Exposure Monitoring
 - (a) Issue: Building occupants tend to have a low tolerance for exposures to dust and chemicals because they do not control the exposures and often do not know what the exposures are.
 - (b) Control:

The Contractor is responsible for monitoring exposures outside the construction zone. He/she must have a trained and qualified individual on site at all time with the capability to monitor for noise, dust and vapor emissions escaping from the project. The Contractor will ensure that the instrumentation is properly calibrated and zeroed in a clean air environment prior to use, using the manufacturer's instructions. Calibration procedures must be documented in an equipment logbook.

(c) At least weekly, the Contractor shall select random times to monitor these exposures for a minimum of 4 hours using direct reading instrumentation. Average and peak readings, sample times, locations and instrumentation shall be recorded in the construction logbook. When a building occupant registers an exposure complaint with the University Construction Manager, all the exposure parameters will be checked at the complainant's workstation and documented in the construction logbook. The University Construction Manager will notify the EHS Office of this concern whether the exposures register above the specified limits or not. If exposures exceed the limits, work must stop until the source of the problem is found and fixed. The following list contains the exposure guidelines for building occupants outside of the construction zone:

- (i) Total dust: 1 mg/M3
- (ii) Carbon monoxide: 10 PPM
- (iii) Noise: < 60 dB averaging the speech frequencies (500, 1000, 2000, 4000 Hz) and < 80 dB using the A weighted scale
- (iv) Total Hydrocarbon: 10 PPM
- (v) 25% of the TLV for other specific compounds. These levels are more stringent than industrial standards in order to provide a greater safety margin for the general public. If these levels are exceeded over a 4- hour averaging period, work must stop and corrective action must be taken. Sampling frequencies must be increased if the exposure limits are exceeded based upon consultation with the EHS Department.
- (vi) The EHS Department will review the construction logbook data and will perform additional assessments as needed.

END OF SECTION 02050

SECTION 02070 – SELECTIVE DEMOLITION

1.1 DEMOLITION

- A. Proper coordination for the shutoff of utility services and control measures for dust and noise must occur prior to commencement of any demolition work. Considerations must be given to ongoing University activities in adjacent areas. In confined areas of selective demolition, install and maintain dust and noise control barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove these protection measures after demolition operations are completed.
- B. Maintain and protect existing building services which transit the area affected by selective demolition. Demolition activities that affect parking, vehicle or pedestrian traffic must be approved by UNC Department of Public Safety at (919) 9628100 prior to work commencing.
- C. Completely remove all equipment noted for removal including all associated devices, controls, conduit, wiring, etc. Remove all exposed conduit and wiring back to the panel from which it is served. Mark all disassociated breakers "spare". Unless otherwise noted, the Contractor shall fill and patch all wall, floor, and ceiling openings resulting from this demolition work with materials and finishes identical to adjacent materials and finished.
- D. Unless otherwise noted, remove all wiring devices, fixtures, controls, circuitry (conduit and wiring), etc., made obsolete by the demolition within or around the building.
- E. The Contractor shall relocate all existing piping, circuitry (conduit and wiring), ductwork, etc., which impedes the installation of new materials and equipment, unless otherwise noted.
- F. Demolish, remove, demount, and disconnect the following:
 - 1. Inactive and obsolete piping, truing and specialties, equipment, ductwork, controls, fixtures, and insulation.
 - 2. Piping and ducts embedded in floors, wall, and ceiling may remain if such materials do not interfere with new installation. Remove materials above accessible ceilings. Drain and cap piping and ducts allowed to remain.
- G. All demolition which involves the removal or disturbance of Asbestos Containing fire proofing, finish material, insulation or other asbestos containing material shall be performed in strict accordance with the Division of State Construction "Specifications for Asbestos Abatement" and must be approved by the University's Department of Environment, Health and Safety.
- H. Notify the Department of Environment, Health and Safety (919) 962-5507 if any underground tanks are removed from the ground on the construction site.

- I. Notify the Department of Environment, Health and Safety at (919) 9629752 for information on proper disposal of ballasts and fluorescent light bulbs.
- J. Prior to building demolition, the Department of Environment, Health and Safety should be contacted at (919) 9625507 to review the project for potential mercury containing equipment such as piping, thermostats, and switches.

1.2 DISPOSAL OF EQUIPMENT AND MATERIALS

- A. The Contractor shall remove all generated trash, recyclables and debris (including, for example, old carpeting) at their expense. The Contractor may not place this trash and debris in University dumpsters. The Owner, acting through the Engineer, shall retain the right to direct the disposal of salvageable equipment and materials (such as mechanical equipment, piping, electrical equipment, tanks, buried steel basins, etc. The Contractor will comply with all requirements as outlined in 01505 (Construction Waste Management) and 01060 Regulatory Requirements). After selective demolition is complete, submit a list of items that have been removed and salvaged.
- B. The University, as a State institution, is accountable for controlled property and equipment including electrical, mechanical, and plumbing equipment. No equipment is given to the Contractor unless specifically listed in the job specifications prior to contract award. The Contractor shall deliver any surplus equipment to the Surplus Property Warehouse and return a receipt for the equipment to the Facilities Services Data Control Office.
- C. For equipment retained by the Contractor under the contract, the Contractor shall remove the equipment control decals and return them to the Facilities Services preventive maintenance shop or the University's Asset Manager. Do not disturb equipment or fixtures bearing a hazardous, biological or radiological warning sign in any way until authorized by the University Department of Environment, Health and Safety Office who will remove or obliterate the warning sign.

1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them offsite, unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Salvage: Detach items from existing construction and deliver them to Owner ready for reuse.
- C. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
- D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 EXECUTION

- A. Removed and Salvaged Items:
 - 1. Clean salvaged items.
 - 2. Pack or crate items after cleaning. Identify contents of containers.
 - 3. Store items in a secure area until delivery to Owner.
 - 4. Transport items to storage area designated by Owner, Contractor or other authorized party.
 - 5. Protect items from damage during transport and storage.

- B. Removed and Reinstalled Items:
 - 1. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.
 - 2. Pack or crate items after cleaning and repairing. Identify contents of containers. Protect items from damage during transport and storage.
 - 3. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

- C. Existing Items to Remain:
 - 1. Protect construction indicated to remain against damage and soiling during selective demolition.

- D. When permitted by Engineer, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

END OF SECTION 02070

SECTION 02200 - CLEARING, GRADING, AND EXCAVATION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division I Specification Sections, apply to this Section.
- B. This item shall consist of the removal and satisfactory disposal of all materials excavated within the limits specified by the Engineer including unsuitable subgrade material, and the replacement with satisfactory materials and such excavation as is necessary for berms, inlet, outlet, and lateral drainage ditches and for the formation, compaction, and shaping of all embankments, fills, subgrade, shoulders, slopes, and roadways to conform to the lines and grades and typical cross-sections shown on the Plans.
- C. It shall also include the removal and proper disposal of all stripping, fence, trees, hedge rows, pipes, walls, steps and existing asphalt and concrete surfaces, existing sidewalk and curb and gutter, raising and/or adjusting the tops of all existing valve boxes and manhole tops, as required.

1.2 RELATED WORK IN OTHER SECTIONS:

- A. Aggregate Base Course: Section 02231
- B. Control of Erosion, Siltation, and Pollution: Section 02476
- C. Seeding and Mulching: Section 02480

1.3 QUALITY ASSURANCE:

- A. Contractor shall consult with the Owner and the Engineer prior to beginning clearing. A full understanding shall be reached as to procedure. The Contractor shall then conduct clearing and/or grubbing operations in strict accordance with these agreements.
- B. Compaction shall be completed in accordance with the standards of ASTM D-698 as amended.
- C. The Contractor shall retain the services of a testing laboratory to perform all tests required at the project site. In areas of fill and backfill, field density tests shall be performed in sufficient numbers to insure that the specified density is obtained. These tests shall be made at no cost to the Contractor, except as follows.
 - 1. Areas in which testing reveals compaction below the specified density shall be reworked, or removed and replaced by the Contractor until specified compaction is obtained. In the event results fail after reworking material, the Contractor shall be liable for retesting.

2. The Contractor shall be responsible for the cost of testing of borrow material which shall include standard density tests (Proctor curves).

1.4 CLASSIFICATION OF EXCAVATION:

A. Classification of Excavation

1. All excavation shall be unclassified including borrow material off-site, removal and disposal of vegetation, topsoil, ornamental work, pipes, concrete slabs, asphalt, pavement, debris, and all other surplus materials.

- ##### B. Undercut excavation shall consist of the excavation and disposal of unsuitable materials below the proposed subgrade and replacement with select material as directed by the Engineer, and the proper disposal of the unsuitable material at designated areas on-site or off-site as provided by the Contractor.

1.5 GEOTECHNICAL DATA:

- ##### A. Limited subsurface investigations have not been performed at the site and the results are available from the Engineer. It shall be the Contractor's responsibility to determine the actual subsurface conditions before submitting a bid.

PART 2 - PRODUCTS

2.1 BORROW MATERIAL:

- ##### A. Borrow material shall consist of a sandy-clay, or clayey-sand soil which shall be free from trash, debris, soil clumps or stones greater than 2" in diameter, vegetative matter, or other indigenous material. It shall have an optimum, compacted dry unit weight of approximately 120 pcf or greater. The source of borrow materials shall be approved by the Engineer. The Contractor shall submit Proctor density curves for each source of borrow material for approval. Any borrow material submitted by the Contractor shall be capable of achieving the required compaction.

2.2 CRUSHED STONE:

- ##### A. Crushed stone for foundation preparation or for use as backfill in event of over excavation, shall be uniform, clean and shall conform to ASTM C-33, size no. 57, or size no. 67 as directed by the Engineer.

2.3 CONCRETE:

- ##### A. Concrete for use as backfill in event of over excavation, as directed by the Engineer, shall have a compressive strength of 2,000 psi or greater.

2.4 TOPSOIL:

- A. Topsoil shall consist of natural loamy soil suitable as surfacing for lawns or roads, occurring usually in a surface layer of 6" to 18" thick. Topsoil shall be removed from the work sites and shall be stockpiled for subsequent use.

PART 3 - EXECUTION

3.1 PRELIMINARY WORK:

- A. Key sedimentation and soil erosion control measures shall be installed prior to beginning significant clearing operations.

3.2 CLEARING, GRUBBING, AND STRIPPING:

- A. Where trees or brush exist at the site of the work, the construction areas shall be cleared and trees, stumps, and roots grubbed. All areas shall be stripped to such depth as to remove turf, roots, organic matter, and other objectionable materials. Only those trees that seriously interfere with construction and have been identified and verified by the Owner shall be cut and care shall be exercised to protect remaining trees and adjacent property. All brush, stumps, laps, roots, and logs shall be removed from the entire construction area and disposed of offsite to the Engineer's satisfaction. Marketable wood mass shall be harvested and sold with revenue belonging to the Contractor. No open burning shall be allowed. Minor debris, pipes, and debris that may be on the site shall be removed and disposed of to the satisfaction of the Engineer.
- B. The operations of the Contractor shall be conducted with full consideration of all the proper and legal rights of the Owner, and of adjacent property owners and the public, and with the least possible amount of inconvenience to them.
- C. All pollutable waste material shall be properly disposed in a legal manner in the nearest landfill unless otherwise approved by the Engineer. Other wastes shall be removed from University property and disposed of in a legal manner. See Specification Section 01505 "Construction Waste Management".
- D. The contractor shall demolish the existing southern and eastern embankments and part of the western embankment of the existing wet weather storage basin, and reconstruct the embankments with suitable natural materials to the dimensions and slopes as shown in the drawings. The excavated materials shall be segregated and all unsuitable material for reconstruction of the embankment shall be removed from the site. Grading shall begin by proof rolling existing grade to remove additional unsuitable subgrade material.

3.3 GENERAL:

- A. Excavation and grading shall include all site grading, roadway and driveway, trench and structure excavation, backfill, dike, and embankment construction. Excavation and grading shall also include borrow, disposal of excess material off-site as indicated, procuring and placing topsoil, cleanup, and dressing off. This

item shall also include all necessary dewatering, soil aeration (drying), sheathing, bracing, cofferdam work, pumping, blasting, and protection.

- B. All excavation and grading shall be confined to the construction area, as shown on the Plans, and shall be done in an approved manner, with proper equipment.
- C. Comply with local codes, ordinances, and requirements of agencies having jurisdiction.
- D. All construction operations shall be accomplished in accordance with applicable regulations of the North Carolina Department of Labor, Occupational Safety and Health Division. Copies of these standards may be obtained from the North Carolina Department of Labor, 413 North Salisbury Street, Raleigh, North Carolina.
- E. Slope sides of excavations are to comply with codes, ordinances, and requirements of agencies having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated. Maintain side slopes of excavations in a safe condition until completion of backfilling.
- F. The Contractor shall be responsible for any dewatering required for site grading. The Contractor shall provide and maintain whatever means required for dewatering including ditching, drains, pumping, bailing, and well pointing.
- G. Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
 - 1. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.
 - 2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or runoff areas. Do not use trench excavations as temporary drainage ditches.
- H. Site grading shall conform to the grades indicated by the finish contours, cross-sections, and/or spot elevations on the Plans. Accuracy of finished grades shall be ± 0.1 ft. Where topsoil, stone base, or other items are shown or called for, the rough grade shall be finished to such depth below finish grade as is necessary to accommodate these items. Excavation shall be made to the elevations, slopes, and limits called for on the Plans.
- I. All exposed soils in areas of cuts shall be proof rolled with a 15 to 20 ton pneumatic roller to locate any unconsolidated material. Should soft or unsuitable material be encountered at subgrade elevation, such material shall be removed

and replaced with acceptable compacted borrow material, as directed by the Engineer.

- J. Fills, berms, dikes, and embankments shall be constructed of material that is free from grass, roots, rock, or other objectionable material. Side slopes of basins shall be 3:1 slopes.
- K. Fills shall be formed of acceptable material placed in successive layers of not over 8 inches loose thickness for the full width of section, where practical.
- L. Materials for fills shall be spread evenly and the compaction equipment routed over the work to obtain uniform compaction. Fills under areas designated for structures and in dikes shall be compacted by approved equipment, to ninety-five percent (95%) of the Standard Proctor Maximum Dry Density as defined by ASTM D-698 as amended, except within two feet of subgrade where the fill shall be compacted to at least ninety-eight percent (98%) of Standard Proctor Maximum Dry Density.
- M. Compaction moisture control shall be maintained between 2 and 3 percent optimum moisture content as determined by ASTM D-698, or as directed by the Engineer. Material that is too dry for proper compaction shall be moistened by suitable watering devices, turned and harrowed to distribute the moisture, and then properly compacted. When material is too wet for proper compaction, fill soils shall be dried prior to compaction. The soils shall be dried by aeration discing, harrowing, or other methods until the materials can be compacted to the specified density. Select material, as needed, will be provided from the work site or other acceptable source.
- N. All cuts, fills, and slopes shall be neatly dressed off to the required grade or subgrade, as indicated on the Plans.
- O. At locations designated on the Plans and/or as designated by the Engineer, the Contractor shall remove unsuitable material within the limits as directed and backfill with suitable material properly compacted to the finished subgrade. Undercut material may be used elsewhere on the project if the Engineer determines that it is suitable for the purpose. If it cannot be used, the Contractor shall dispose of it as directed herein before.
- P. Foundation excavations shall be made at the locations shown on the plans and to the exact subgrade required. Bottoms of excavations are to be level and in firm, solid, material, with soft material or voids treated as specified below. Excavated area shall be kept free of water during the construction period. Space shall be provided outside of footings and walls for placing forms and pointing masonry.
- Q. Where necessary, the sides of excavation shall be shored and sheathed, or cofferdams built, as required for protection of the work and employees.
- R. Should soft or unsuitable material be encountered at subgrade elevation, such material shall be removed and replaced with acceptable compacted select material, obtained on-site or off-site at the direction of the Engineer. Any other

excavation below grade shall be replaced with good material, without additional compensation therefor.

- S. Backfill around structures and other facilities shall be completed as soon as possible, in conformance with the following:

Backfill not required for structural fill shall consist of clean acceptable earth. Backfill shall be free from trash, brick bats, wood, rocks, vegetative matter and other injurious material. It shall be placed in 8" layers and thoroughly compacted by mechanical tamps to 95% of the Standard Proctor Maximum Density as defined by ASTM D-698 as amended for trenches 5 ft. deep or less. For trenches greater than 5 ft. in depth and for all backfill under pavement, 95% of the Standard Proctor Maximum Density as defined by ASTM D-698 as amended. All subsequent settlement shall be refilled. Care shall be taken to protect piping or other utilities during backfill operations. Excessively wet, soupy or mucky material shall be removed from the area around structures prior to backfill being placed and no such material shall be used for backfill purposes.

Backfill around non-waterholding structures shall be completed upon completion of the structure above finish grade, and all piping has been properly installed and tested. Unless approved by the Engineer, structures that are to contain liquids shall not be backfilled until successfully tested for leakage. It shall be the responsibility of the Contractor to protect all structures from damage due to floatation prior to backfill being placed.

3.4 FINE GRADING, PLACEMENT OF TOPSOIL, AND CLEANUP:

- A. Upon completion of excavation, grading, and backfill, the entire work area shall be fine graded and dressed off to the indicated grades. At least 4" of topsoil shall be placed on all disturbed non-paved areas with the final level of topsoil conforming to the design finished elevations. Topsoil shall be obtained from off-site sources if required. Topsoil shall be free of debris, sticks, excessive amounts of weeds, and other deleterious substances.
- B. Upon completion of the fine grading and placement of topsoil, the entire site shall be cleaned up and dressed off and all excess material and debris disposed of to the Owner's and the Engineer's satisfaction. All areas to be seeded shall be "broom dragged" and/or hand raked.
- C. Where excavation is required that will entail the use of a tracked machinery on paved areas, wood boards must be placed between the tracks and the paved surface to prevent damage.

END OF SECTION 02200

SECTION 02210 – BASIN CLAY LINERS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division I Specification Sections, apply to this Section.
- B. This item shall consist of providing all labor, materials, and equipment necessary for the construction of the compacted clay liners and cement stabilized soil liners in the wet weather storage basin and the effluent storage basin. The liners shall conform to the lines and grades and typical cross-sections shown on the Plans.

1.2 RELATED WORK IN OTHER SECTIONS:

- A. Clearing, Grading, and Excavation: Section 02200
- B. Control of Erosion, Siltation, and Pollution: Section 02476

1.3 QUALITY ASSURANCE:

- A. Contractor shall consult with the Engineer prior to beginning construction of the compacted clay liners and the cement stabilized soil liners. A full understanding and agreement shall be reached as to methods and procedures. The Contractor shall construct compacted clay liners and cement stabilized soil liners in strict accordance with these specifications and in accordance with the understanding and agreements reached with the Engineer.
- B. Compaction shall be completed in accordance with ASTM D-698 as amended.
- C. The Contractor shall retain the services of a testing laboratory to perform all tests required at the project site. In areas of fill and backfill, field density tests shall be performed in sufficient numbers to insure that the specified density is obtained. These tests shall be made at no cost to the Contractor, except as follows.
 - 1. Areas in which testing reveals noncompliance with compaction and permeability testing shall be reworked, or removed and replaced by the Contractor until compliance with specifications. In the event results fail after reworking material, the Contractor shall be liable for retesting.
- D. The required maximum hydraulic permeability of the clay liner shall be 1×10^{-6} cm/sec.
- E. The cement stabilized soil layer shall be placed over the compacted clay liner to protect the clay liner from erosion by wave action and rainfall.

PART 2 – PRODUCTS

2.1 MATERIALS:

- A. Soils: Suitable soil materials for construction of the clay liner shall consist of sandy and silty clays or clayey silts with Unified Soil Classifications of CL, CH, ML, and MH. Acceptable soil particle size ranges, defined as the soil fraction passing a No. 200 US standard sieve: percent fines - greater than 50%, clay content - greater than 20%, and sand content - less than 45%. Soils shall not contain sod, brush, roots, frozen soil, or other organic materials.
- B. Bentonite Clay: Augment existing soils with 2% bentonite clay by weight.
- C. Cement: The stabilizing layer shall consist of a ratio of 4% cement to soil and shall be placed over the compacted clay liner.

PART 3 - EXECUTION

3.1 FOUNDATION PREPARATION:

- A. Foundation preparation for the compacted clay liner shall be in accordance with Section 02200.

3.2 MIXING

- A. Approved methods of mixing include a pug mill or rotary mixer.

3.3 COMPACTED CLAY LINER PLACEMENT

- A. The clay liner shall be placed in 6 inch lifts and compacted with a suitable compactor such as a Sheepsfoot compaction roller. The distribution of material throughout the clay liner shall be uniform and free of lenses, pockets, streaks or layers differing substantially in texture, moisture content, or gradation.
- B. The overall thickness of the finished compacted clay liner shall be 18 inches.
- C. The clay liner shall be compacted to 95% Standard Proctor maximum dry density at a moisture content of 2% to 3%.

3.4 CEMENT STABILIZED SOIL LINER PLACEMENT

- A. The cement stabilized soil liner shall consist of suitable soil as defined above mixed with 4% by cement by weight. The soil cement shall be mixed outside the basin, to prevent damage to the clay liner, using a pug mill or rotary mixer. The mixture shall be compacted on the inside slopes and basin bottom to a minimum of 95% standard Proctor maximum dry density and an optimum of 1% over optimum moisture content.
- B. The cement stabilized soil liner shall have a minimum thickness of 12 inches.

3.4 TESTING AND DOCUMENTATION

- A. Acceptance of the clay liner shall be based on passing the density and hydraulic conductivity tests. Any failing areas shall be reworked by the contractor including addition of more bentonite if necessary.
- B. Field and laboratory soil tests shall be completed for the compacted clay liner and cement stabilized soil liner by the approved testing agency to document compliance with this specification. Testing shall be completed as the liner is being placed. Testing shall be completed as directed by the licensed geotechnical engineer with the testing agency.
- C. Tests shall be completed on undisturbed samples obtained from the constructed clay liner. All test holes shall be backfilled using powdered bentonite mixed with clay soil used in liner construction and compacted by hand tamping. A minimum of 25% of the backfilled test hole shall be filled with powdered bentonite after backfilling.

END OF SECTION 02210

SECTION 02222 - SUBGRADE PREPARATION FOR ROADS, DRIVES, AND PARKING AREAS

PART 1 - GENERAL

1.1 SCOPE

- A. Work specified under this section shall consist of furnishing all plant, labor, materials, and equipment, for the construction and preparation of the subgrade for roads, drives and parking areas. The limits of the subgrade shall be as indicated on the plans.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division I Specification Sections, apply to this Section.

1.2 RELATED WORK IN OTHER SECTIONS

- A. Clearing, Grubbing, Grading, Excavation and Filling: Section 02200
- B. Aggregate Base Course: Section 02231

PART 2 – PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 GENERAL

- A. After the earthwork has been substantially completed and related work has been completed, the subgrade shall be brought to the lines, grades, and typical cross-section shown on the plans, and finished in accordance with these specifications.
- B. The subgrade shall be properly shaped and thoroughly compacted so that it conforms to the lines and yielding condition before any base course or curbs and gutters are placed thereon. If the subgrade does not contain sufficient moisture for compaction, it shall be wetted to optimum moisture content.
- C. All soft and yielding material, boulders, loose stones or any other unsuitable material in the subgrade which will not compact readily shall be removed and replaced with suitable material which shall be thoroughly compacted. All submerged roots, stumps, or other degradable matter encountered in the preparation of the subgrade shall be removed.
- D. In preparing the subgrade, the material excavated shall not be piled or windrowed in such a manner as to interfere with the proper drainage of the subgrade.

3.2 ROLLING OF SUBGRADE

- A. The subgrade for roads and drives shall be rolled as required by the Engineer for the entire length of the project with a 10-ton or heavier three-wheel power-driven roller.
- B. During the rolling of the subgrade, the surface shall be maintained smooth by blading or other approved means. Rolling shall be continued until the subgrade has been compacted throughout to its maximum practical density as determined by the Engineer. A density of at least 95% Standard Proctor Maximum Dry Density of optimum moisture content shall be obtained in accordance with ASTM C-698 as amended. Any portion of the subgrade inaccessible to rolling operations shall be thoroughly compacted with hand or mechanical tamps.

3.3 PROTECTION OF SUBGRADE

- A. Ditches and drains shall be provided and maintained to satisfactorily drain the subgrade. In no case shall any aggregate base course be placed on frozen or muddy subgrade. Frost crystals or mud caused by freezing and thawing shall be removed and replaced with suitable material or allowed to dry before placing any base course or curb and gutters. If ruts are formed in the prepared subgrade, the subgrade shall be scarified and thoroughly compacted.

END OF SECTION 02222

SECTION 02231 - AGGREGATE BASE COURSE

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Work under this section consists of furnishing all plant, labor, materials, and equipment for the construction of an aggregate base composed of approved aggregate materials hauled to the parking/drive area, placed on the prepared subgrade, compacted, and shaped to conform to the lines, grade, depths, and typical cross-sections indicated on the plans.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division I Specification Sections, apply to this Section.

1.2 RELATED WORK IN OTHER SECTIONS

- A. Clearing, Grubbing, Grading, Excavation, and Filling: Section 02200
- B. Subgrade Preparation for Roads, Drives, and Parking Areas: Section 02222

1.3 QUALITY ASSURANCE

- A. The source and type of aggregate base course shall be approved by the Engineer prior to placement. If requested, samples of the materials shall be submitted to the Engineer for approval.

PART 2 - PRODUCTS

- 2.1 Aggregate base course shall consist of crushed stone or crushed gravel and shall conform to the requirements of Section 520 of the N.C. Department of Transportation Standard Specifications for Roads and Structures.

PART 3 - EXECUTION

3.1 HAULING AND PLACING MATERIALS

- A. The aggregate material shall be placed on the subgrade to the specified depth and in such a manner as to prevent segregation. Where the required compacted thickness of base is 8 inches or less, the base material may be spread and compacted in one layer. Where the compacted thickness is more than 8 inches, the base material shall be spread and compacted in two or more lifts approximately 4-6 inches. Each layer of material shall be compacted tested, and approved before placing succeeding layers of base material or pavement.
- B. No material shall be placed on frozen subgrade or base. Hauling equipment shall not be operated on subgrade or a previously completed layer of base material soft enough to rut or weave beneath the equipment. The maximum

speed of trucks traveling over any part of the subgrade or base shall be 20 miles per hour.

- C. The Contractor shall utilize methods of handling, hauling, and placing material which will minimize segregation and contamination. If segregation occurs, the Engineer may require that changes be made in the Contractor's methods to minimize segregation, and may also require mixing in place which may be necessary to correct any segregated material. No additional compensation will be allowed for work of in-place mixing as may be required. Aggregate which is contaminated with foreign materials to the extent the base course will not adequately serve its intended use shall be removed and replaced by the Contractor at no additional cost to the Owner regardless of prior acceptance.

3.2 SHAPING AND COMPACTION

- A. Immediately after the placing of a layer of the base, the Contractor shall begin machining and compacting the layer. Each layer shall be maintained to the required cross-section during compacting and each layer shall be compacted to the required density prior to placing the next layer. Each layer of the base shall be compacted to a density equal to at least 100% of that obtained by compacting a sample of the material in accordance with AASHTO T99. The base material shall be compacted at a moisture content which is approximately that required to produce the maximum density indicated by the above test method. The Contractor shall dry or add mixture to the material when required to provide a uniformly compacted and acceptable base.
- B. The final layer (or top surface for a single layer) of the base material shall be shaped to conform to the lines, grade, and typical sections shown on the plans or established by the Engineer. When completed, the base course shall be smooth, hard, dense, unyielding, and well bonded. A broom drag shall be used in connection with the final finishing and conditioning of the surface of the base course. After final shaping and compacting of the base, the Engineer will check the surface of the base for conformance to grade and typical section and will determine the base thickness. The thickness of the base shall be within a tolerance of plus or minus 1/2 inch of the base thick specified.

3.3 MAINTENANCE

- A. Where the base material is placed in a trench section, the Contractor shall provide adequate drainage through the shoulders to protect the subgrade and base until such time as the shoulders are completed. The Contractor shall maintain the surface of the base by watering, machining and rolling or dragging where necessary to prevent damage to the base by weather or traffic. Where the base or subgrade is damaged, the Contractor shall repair the damaged area; reshape the base to the required lines, grades, and typical sections; and recompact the base to the required density at no additional cost to the Owner.

END OF SECTION 02231

SECTION 02476 - CONTROL OF EROSION, SILTATION, AND POLLUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplemental Conditions and Special Project Sections, apply to this Section.

1.2 SUMMARY

- A. This section covers the furnishing of materials, labor, and equipment necessary to minimize erosion, siltation, and pollution on the project or projects covered by these specifications.
- B. The Contractor shall take whatever measures are necessary to minimize soil erosion and siltation, water pollution, and air pollution. The Contractor shall also comply with the applicable regulations of all legally constituted authorities relating to pollution prevention and control. The Contractor shall keep themselves fully informed of all such regulations which in any way affect the conduct of the work. In the event of conflict between such regulations and the requirements of these specifications, the more restrictive requirements shall apply.
- C. Failure on the part of the Contractor to perform the necessary measures to control erosion, siltation, and pollution will result in the Engineer notifying the Contractor to take such measures. In the event that the Contractor fails to perform such measures within 24 hours after receipt of such notice, the Engineer may suspend the work with no extension of contract time, or may proceed to have such measures performed by others at the Contractor's expense, or both.
- D. Related Work in Other Sections:

Clearing, Grading, and Excavation	Section 02200
Seeding and Mulching	Section 02480

1.3 QUALITY ASSURANCE

- A. Quality Assurance: Erosion and sedimentation control shall conform to the requirements of the North Carolina Sedimentation Pollution Control Act of 1973.

PART 2 - PRODUCTS

- 2.1 Seeding and mulching materials shall conform to the requirements of Section 02480.
- 2.2 Silt fences shall conform to the details shown on plans.
- 2.3 Check dams and jute mat shall conform to the details shown on the plans.

- 2.4 Temporary sediment traps shall conform to the details shown on the drawings.

PART 3 - EXECUTION

- 3.1 The Contractor shall exercise every reasonable precaution throughout the life of the project to prevent the eroding of soil and the siltation of rivers, streams, lakes, reservoirs, ditches, ground surfaces, or other property. Should any erosion or siltation occur, the Contractor shall take immediate action to correct the situation. The Contractor shall remove and properly dispose of any material washed into rivers, streams, lakes, reservoirs, ditches, storm sewers, or other property. The Contractor shall be liable for any damage to private or public property resulting from insufficient erosion and siltation control measures.
- 3.2 Construction operations in rivers, streams, ditches, and water impoundments shall be restricted to those areas which must be entered for the performance of work shown on the plans. Excavated materials shall not be deposited in rivers, streams, ditches, or impoundments except that temporary earth dikes may be used when approved by the Engineer, but such dikes shall be completely removed in such manner as to prevent siltation. Frequent fording of flowing streams with equipment will not be permitted. Temporary bridges or other structures shall be used wherever frequent stream crossings are necessary.
- 3.3 Temporary and permanent erosion control measures shall be provided as shown on the plans or as directed by the Engineer. Temporary sediment control devices must be installed to the extent possible prior to initiation of grading and excavation. The devices must be maintained at a minimum of 50% of the original sediment storage capacity and may not be removed until the areas they serve have been stabilized. Temporary erosion control measures shall include, but not be limited to, the use of temporary berms, dikes, drainage ditches, silt basins, silt ditches, slope drains, structures, stone check dams, vegetation, mulches, mats, netting, gravel, or other necessary methods. Temporary erosion control may include work outside the construction limits.
- 3.4 The Engineer may limit the area over which excavation, embankment, and grading operations are performed whenever the Contractor's operations are not effectively minimizing erosion and/or siltation.
- 3.5 All disturbed, non-paved areas shall be seeded and fertilized, mulched, and tacked as soon as practical after cleanup in accordance with the detailed technical specifications therefore. In no case shall any ungrassed area be left inactive with a total area of one acre or more for a period of fifteen (15) working days or thirty (30) calendar days, whichever is shorter. When construction has been completed in an area, provisions for ground cover in an area with a total area of one acre or more must be completed within twenty-one (21) calendar days on exposed slopes, and in remaining areas within fifteen (15) working days or ninety (90) calendar days, whichever is shorter.
- 3.6 The Contractor shall take every precaution throughout the life of the project to prevent the pollution of stormwater, rivers, streams, and water impoundments. Pollutants such as chemicals, fuels, lubricants, bitumens, sewage, and other harmful waste shall not be

discharged into or alongside rivers, streams, or impoundments, or into natural or manmade channels leading thereto. The Contractor shall also comply with all Federal, State, and local water and air pollution laws.

- 3.7 Contractor shall maintain all erosion control measures until such time as the appropriate State authority approves and releases the site at which time the Contractor shall remove all erosion control measures as directed by the Engineer.

END OF SECTION 02476

SECTION 02480 - SEEDING AND MULCHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Special Project Sections, apply to this Section.

1.2 SUMMARY

- A. The work of seeding and mulching shall be performed immediately upon completion of grading. The Contractor shall adapt his operations to variations in weather or soil conditions as necessary for the establishment and growth of the grasses or legumes. In all operations, care shall be taken to preserve the required line, grade, and cross-section of the area.
- B. Related Work in Other Sections:
 - 1. Control of Erosion, Siltation, and Pollution Section 02476

PART 2 - PRODUCTS

2.1 SEED

- A. Seed shall be certified by and comply with the rules and regulations of the NC Department of Agriculture. Only high quality seed shall be used. Wet, moldy, or otherwise damaged seed or seed containing an excess of noxious weeds will not be acceptable. Each variety of seed shall be furnished and delivered in separate bags. If seed is to be mixed before sowing, it shall be mixed by methods which will mix the seed thoroughly and uniformly without causing damage to the seed. During handling and storage, seed shall be protected from damage from any cause.

2.2 FERTILIZER

- A. Fertilizer shall comply with the rules and regulations of the NC Department of Agriculture. It shall be manufactured from cured stock and have an analysis of 10-10-10. During handling and storage, the fertilizer shall be protected against hardening, caking, or loss of plant food values. Any hardened or caked fertilizer shall be pulverized to its original condition before being used.

2.3 LIME

- A. Lime shall comply with the rules and regulations of the NC Department of Agriculture. It shall be agricultural grade ground dolomitic limestone containing not less than 85% of combined calcium and magnesium carbonates. It shall be so graded that 100% will pass a No. 10 sieve and 40% will pass a No. 100 sieve. During handling and storage, lime shall be protected against hardening and

caking. Any hardened or caked lime shall be pulverized to its original condition before being used.

2.4 MULCH

- A. Mulch shall consist of clean grain straw reasonably free from mature seedbearing stalks, roots, or bulblets of Johnson Grass, Nutgrass, Sanbur, Wild Garlic, Wild Onion, Bermuda Grass, Crotalaria, Witchweed, and restricted noxious weeds as defined by the NC Department of Agriculture at the time of use. Mulch that is matted or lumpy shall be loosened and separated before being used.

PART 3 - EXECUTION

- 3.1 The Contractor shall be responsible for providing topsoil. A minimum of 4 inches of top soil shall be applied to all disturbed areas and a minimum of 12 inches in all landscape plant beds.
- 3.2 The Contractor shall provide soil tests for any top soil brought on site. This topsoil shall be free of any debris larger than 1-inch and free of noxious weeds. Prior to delivery of the top soil, the Contractor must obtain approval from the University.
- 3.3 Prior to placement of the topsoil, these areas shall be scarified to a depth of 1-foot. No scarification or subsoiling shall be done within the dripline of any existing trees. The seed bed shall be properly prepared and true to line and grade with lime and fertilizer worked into the soil 4" to 6" deep. All weeds and other unacceptable growth shall be cut and disposed of properly. Uneven and rough areas shall be smoothed to provide a uniform surface. The soil shall be loosened to a minimum depth of 6 inch and all clods shall be broken up. The top 2" or 3" of soil shall be worked into an acceptable seedbed by the use of approved methods. On cut slopes greater the 2:1, the Engineer may permit the depth of preparation to be reduced, but in all cases the slope surface shall be scarified, grooved, trenched, or punctured so as to provide places in which the seeding materials can lodge.
- 3.4 Lime and fertilizer shall be distributed uniformly over the prepared seedbed at the specified rates and then harrowed, raked, or otherwise thoroughly worked or mixed into seedbed. Seed shall be distributed uniformly over the prepared seedbed at the specified rate and immediately harrowed, dragged, raked, or otherwise worked so as to cover the seed with a layer of soil. Immediately after seed has been properly covered, the seedbed shall be compacted by means approved by the Engineer.
- 3.5 Immediately after the completion of seeding, all areas shall be mulched. Mulch shall be spread uniformly by hand or by approved mechanical spreaders with a minimum cover of 1 inch of clean straw as an acceptable application. An acceptable application will be that which will allow some sunlight to penetrate and air to circulate but also partially shade the ground, reduce erosion, and conserve soil moisture.
- 3.6 Mulch shall be held in place by applying a sufficient amount of asphalt emulsion or other approved binding material. The rate and method of application shall meet the approval of the Engineer. When the binding material is not applied directly with the mulch, it shall be applied immediately following the mulch application. During the application of the

binding material, adequate precautions shall be taken to prevent damage to traffic, structures, traffic control devices, and other appurtenances. When any damage does occur, the Contractor shall repair it, including any necessary cleaning. The Contractor shall take precautions to prevent mulch from entering drainage structures and shall promptly remove any blockages which may occur.

END OF SECTION 02480

SECTION 02733 – SUBMERSIBLE PUMP STATION, PIPING, CONTROLS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. This section gives the requirements for installation of piping, valves, precast concrete structures, and other appurtenances related to the secondary wastewater submersible pump station.
- B. Pumps and pump mounting rails shall be by the same manufacturer so as to insure suitability and assurance of experience in matching the equipment together and to insure single source responsibility for the equipment.

1.2 RELATED WORK

- A. Section 02200 - "Clearing, Grading, and Excavation"
- B. Section 15730 - "Wastewater Piping Systems"
- C. Section 11310 – "Submersible Wastewater Pumps"
- D. Division 16 - All Sections

1.3 REFERENCES

- A. ASTM D1785 - Poly (Vinyl Chloride) (PVC) Plastic Pipe.
- B. ASTM D2467 - Socket - Type Poly (Vinyl Chloride) PVC plastic pipe fittings, schedule 80.
- C. ASTM C478 - Precast Concrete Manhole Risers and Tops.
- D. ANSI / AWWA C150/A21.50 Thickness Design of Ductile Iron Pipe

PART 2 - PRODUCTS

2.1 PIPING AND VALVES

- A. Piping: All ductile iron pipe and fittings shall be Class 350 ductile iron conforming to ANSI/AWWA C150/A21.50. Pipe shall be flanged inside station structures and valve vaults and mechanical with restrained joint below grade as shown in the plans.

- B. Plug Valves (raw wastewater service): All valves shall be of the non-lubricated eccentric type with resilient faced plugs and shall be furnished with flanged joint connections on lines above grade.

Port areas for valves through 20" shall be minimum 80% of full pipe area and port areas of 24" and larger valves shall be minimum 70% of full pipe area.

Valve pressure ratings shall be 175 PSI through 12" and 150 PSI through 72".

Each valve shall be given a hydrostatic and seat test with test results being certified by the specifications. Certified copies of proof-of-design test reports shall be furnished as outlined in AWWA C504-80, Section 5.5.

All valves 8" and larger shall be equipped with gear actuators. All gearing shall be enclosed in a semi-steel housing and be suitable for running in a lubricant with seals provided on all shafts to prevent entry of dirt and water into the actuator. The actuator shaft and the quadrant shall be supported on permanently lubricated bronze bearings. Actuators shall clearly indicate valve position and an adjustable stop shall be provided to set closing torque. All exposed nuts, bolts and washers shall be type 316 stainless steel or better.

Valves and gear actuators for buried or submerged service shall have seals on all shafts and gasket on the valve and actuator covers to prevent the entry of water. Actuator mounting brackets for buried or submerged service shall be totally enclosed and shall have gasket seals. All exposed nuts, bolts, springs and washers shall be stainless steel. Valves 6" and smaller shall be quarter-turn. All vaulted valves shall have flanged joint connections with 4" hand wheel and non-rising stem.

Valve bodies shall be of cast iron (ASTM 126 Grade). Bodies in 3" and larger valves shall be furnished with a welded overlay seat of not less than 90% pure nickel in accordance with AWWA C507 Section 7.2. Seat area shall be raised, with raised surface completely covered with weld to insure that the plug face contacts only nickel. Valves utilizing resilient seats attached to the body shall not be acceptable. As per AWWA C-504-80 Section 325.3 and AWWA C507-73 Section 7.2, sprayed or plated seats are not acceptable, nor shall screwed-in seats be acceptable.

Plugs shall be cast iron (ASTM 126 Grade B). The plug shall be of one piece construction and shall be capable of withstanding the full pressure rating of the valve without the use of additional structural reinforcing ribs that extend beyond the profile of the plug itself. Plugs shall be resilient faced with hypalon suitable for use with chemical applications. Plugs with cast inlays shall not be acceptable. Valves shall be sleeve type metal bearings conforming to AWWA C504-80, Section 3.6 and AWWA C507.73, Section 8. Bearings shall be of sintered, oil impregnated and permanently lubricated type 316 ASTM A743 Grade CF-8M or AISI Type 317L stainless steel in ½" - 24" sizes. Non-metallic bearings shall not be acceptable.

Valve shaft seals shall be of the multiple V-ring type and shall be externally adjustable, repackable without removing the bonnet or actuator from the valve,

and repackable under pressure. Shaft seals shall conform with AWWA C504-80, Section 3.7 and AWWA C507-73, Section 10.2. Valves utilizing o-ring seals or non-adjustable packing shall not be acceptable. All exposed nuts, bolts, springs, washers, etc., shall be type 316 stainless steel or better for buried and above ground valves.

DeZurik (figure 118) eccentric plug valves and actuators shall be the basis for design or approved equal.

- C. Check valves shall be suitable for mounting in the horizontal or vertical position, Class 30 cast iron, bronze mounted, swing check valves designed for 175 psi differential pressure. All materials in contact with liquid shall be resistant to sanitary sewage. Provide with Class 125, ANSI B16.1 flanged connections. Hinge shaft shall be 316 or better stainless steel. Valve shall be provided with a weighted lever for water hammer prevention. Valves shall be manufactured by Mueller or equal and furnished by the pump manufacturer.
- D. Gate valves (treated secondary wastewater service) shall be installed at the effluent pump station as shown on the plans. Iron body, bronze mounted, double disc, parallel seat type meeting the full requirements of AWWA C500, or resilient seated in conformance with AWWA C509 or C515, with a minimum working pressure of 150 psi. Exposed flanged iron gate valves 3" to 16" shall be non-rising stem with malleable iron handwheels. Valve body shall be ductile iron construction. Exposed valves 18" or larger shall be flanged, non-rising stem with handwheels. Buried valves 4" to 16" shall be resilient seat non-rising stem gate valves with ANSI/AWWA C111/A21.11 mechanical joints. Buried valves larger than 16" shall be iron valves with rollers and tracks, fully ported, mechanical joints, and enclosed gear operators. Provide buried valves with valve boxes of cast iron construction, screw adjustment type with a cast iron cover and concrete collars. Gate valves shall be as manufactured by Kennedy, Mueller, or approved equal.

2.2 WET WELL, VALVE VAULTS, AND METER VAULTS

- A. Wet well, valve vaults, and meter vaults shall be precast concrete conforming to ASTM C478 with tops and base sections as shown on the drawings. Joints between sections shall be tongue and groove with elastomeric gaskets. Provide steel reinforced copolymer polypropylene rungs as shown on drawings meeting ASTM C478. Connections for jointing pipe to the manhole shall conform to ASTM C923. All fasteners, anchors, bolts, etc. shall be type 316 stainless steel or better, no mild steel will be allowed in wet well or valve vault. A support grip shall be supplied and installed for each float and power cord. Support grip shall be "Hubbell" closed mesh series properly sized for each cord.
- B. Hatches: Single leaf lockable with matching eye and padlock, raintight aluminum hatch of size and dimension as shown on drawings and in any event must allow unrestricted maintenance access for pump retrieval and reset. Hatches shall be manufactured by Halliday Products, Inc., Bilco, or approved equal. Hatches shall be designed for H2O traffic loading.

- C. Manufacturer shall core drill or cast all openings greater than 2 inches diameter through the precast concrete walls and provide an approved elastomeric boot, sleeve or adapter for connecting sewers and force main indicated on the drawings.
- D. Concrete compression strength shall be 5,000 psi at 28 days. Minimum wall thickness shall be 8 inches for 8 foot diameter sections, and 6 inches for smaller diameter sections. Minimum wall thickness for valve vaults and meter vaults shall be 6 inches. Provide minimum 3/4 inch cover over all steel reinforcing. Wetwell base section shall include a 1' extended base unless otherwise specified.
- E. Interior of wetwell shall be coated with Zebron 386, Duramar 1030 as manufactured by Sewerkote or approved equal. Coal tar epoxy linings or Raven Lining Systems are not acceptable. The lining shall be applied after the wetwell has been installed. The interior surface of the wetwell shall be clean, dry, and free of all oil, grease, or other contaminants as required by the manufacturer of the lining product. Coat the outside of the wetwell with a coal tar coating prior to testing and backfilling.

PART 3 - EXECUTION

3.1 SHOP DRAWINGS AND O&M MANUALS

- A. Submit shop drawing as specified in Division 1, Section 01300.
- B. Certified pump curves shall be provided showing total dynamic head versus flow, efficiency, brake horsepower, NPSH required by pump, and minimum submergence required over pump suction.
- C. Provide O&M Manuals as required per Division 1, Section 01730. O&M Manual shall be indexed and shall contain spare parts list, installation instructions, lubrication instructions, operating instructions, and repair and service manual for each pump furnished. All manuals must be specific for all equipment furnished. Generic manuals will not be allowed.
- D. Contractor shall provide any special tools specific to the equipment provided which is needed to perform maintenance and as recommended by the equipment manufacturer.

3.2 INSTALLATION

- A. General: The Contractor shall receive, handle and store all equipment and materials to be installed, being careful to prevent any damage during transport and storage. All equipment stored shall be protected from weather in a manner recommended by the manufacturer.
 - 1. All equipment shall be handled and installed in accordance with written instructions and approved shop drawing details of the manufacturer and as required by the drawings.

2. Anchor bolts shall be carefully placed in exact position using template or other approved method.
 3. Aluminum access door frame, where to be in contact with concrete, shall be shop primed or field coated with zinc chromate, or equal, primer immediately upon delivery to the job.
 4. If the Contractor determines that existing conditions do not permit proper installation, he shall immediately notify the Engineer.
 5. Pipe work shall be carefully assembled and placed so as not to put strain on the pumping equipment and support elbow. All joints shall be gasketed gradually and evenly tightened watertight. Pipe work will be tested in accordance with these specifications. All pipelines through walls of station shall be installed absolutely watertight, showing no visible signs of seepage or infiltration.
- B. The Contractor shall provide all recommended lubricants for start-up of each item of equipment.
- C. All pumps, control panels and accessory equipment shall be installed in strict accordance with the manufacturer's instructions and good practice in a workmanship manner.

3.3 START-UP SERVICES AND TESTING

- A. The pump manufacturer shall provide the services of a representative for a minimum of three (3) days to provide start-up and follow up advisory service, including O&M instructions to the operating personnel. The Owner shall be notified when manufacturer's representative is to be at the work site one week in advance to be present during start-up of equipment.
- B. Pump Test: Secure from the pump manufacturer performance of following inspections and tests on each pump before shipment from factory:
1. Impeller, motor rating and electrical connections shall first be checked for compliance with the job requirements.
 2. Motor and cable insulation test for moisture content to insure integrity of insulation.
 3. Prior to submergence, run pump dry to establish correct rotation and mechanical integrity.
 4. Run pump for 30 minutes submerged, a minimum of six (6) feet under water.
 5. After operational test No. 4, Perform insulation test (No. 2) again.

Seal pump cable end with a high quality protective covering to make it impervious to moisture or water seepage prior to electrical installation.

Test pumps, motors, and controls in operation in accordance with the standards of the Hydraulic Institute. Certified records of the test shall substantiate the operation of the equipment at the design head, capacity, and horsepower as specified.

- C. LEAKAGE TESTING

1. Prior to testing, wetwell shall be coated as specified.
2. Conduct a visual inspection of concrete wet wells and valve vaults. Repair all visible and detectable leaks.
3. Leakage Testing for Wet Wells. Wet wells shall be leakage tested prior to backfilling by the following procedures:
 - a. Temporarily plug all wall sleeves, piping entrances, and other openings during test period.
 - b. Fill structure to overflow level.
 - c. Allow to stand for a minimum of four (4) hours.
 - d. Refill to overflow level.
 - e. Allow to stand for 24 hours.
 - f. Examine exterior surfaces and joints for leakage. Measure drop in surface water.
 - g. Allowable leakage is a drop of ½ inch or less during the test period and no visible signs of leakage.
 - h. Repair all visible and detectable leaks. If leakage exceeds the allowable limit, the structure shall be repaired by method approved by the Engineer.

END OF SECTION 02733

SECTION 03300 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 REFERENCES

- A. ACI 302 - Guide for Concrete Floor and Slab Construction.
- B. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
- C. ACI 305R - Hot Weather Concreting.
- D. ACI 308 - Standard Practice for Curing Concrete.
- E. ASTM C33 - Concrete Aggregates.
- F. ASTM C94 - Ready-Mixed Concrete.
- G. ASTM C150 - Portland Cement.
- H. ASTM C260 - Air Entraining Admixtures for Concrete.
- I. ASTM C494 - Chemicals Admixtures for Concrete.

1.2 SUBMITTALS

- A. Submit under provisions of Section 01300 - Submittals.

1.3 STORAGE

- A. Immediately upon receipt at the site, cement that is to be site mixed shall be stored in a dry, weather tight building, properly ventilated and with provisions for prevention of moisture absorption.
- B. Reinforcing shall be protected from the weather.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

- A. Cement: Cement shall conform to standard specifications for "Portland Cement", ASTM C150, Type II.
- B. Aggregate: Concrete aggregate shall conform to the current specifications for "Concrete Aggregate", ASTM Designation C33.
- C. Water: Water used in mixing concrete shall be fresh, clean, and free from

injurious amounts of oil, acid, alkali or organic matter, conforming to ASTM C 94.

- D. Ready-Mix Concrete: Ready-mixed concrete may be used at the option of the Contractor provided that such concrete meets the requirements of these specifications and of ASTM Designation C94 for "Ready-Mixed Concrete".

2.2 RELATED MATERIALS

- A. Reinforcing: Deformed Reinforcing Bars, ASTM A615; Grade 60 unless otherwise indicated.
- B. Form Materials:
 - 1. Forms for concrete work shall be either wood or metal. They shall be free from warps or bends, shall have a depth equal to the dimensions required for the depth of the concrete deposited against them and shall be of sufficient strength when staked to resist the pressure of concrete without moving or springing.

2.3 QUALITY

- A. Reinforced Concrete: The minimum 28-day compressive strength of reinforced concrete shall be 4,000 psi, unless shown otherwise on the drawings. Each cubic yard of 4,000 psi concrete shall contain no less than 480 lbs. of cement. The water to cement ratio shall not exceed 0.45.
- B. Concrete shall be air entrained at 4.5%, plus or minus 1.5%.
- D. Non- Reinforced Concrete: The minimum 28-day compressive strength of non-reinforced concrete shall be 2,500 psi, unless shown otherwise on the drawings. Each cubic yard of 2,500 psi concrete shall contain no less than 440 lbs. of cement. The total water content per bag shall not exceed 7.5 gallons.
- E. Mix Proportions: All concrete materials shall be proportioned so as to produce a workable mixture with a slump between 2" and 4".
- F. Tests:
 - 1. The Contractor shall provide, for test purposes, one set of three cylinders taken from each day's pour or each 100 yards placed, whichever is least or as directed by the Engineer. The Contractor at his expense shall supply test samples and an independent testing laboratory at the Contractor's expense will perform tests. The standard age of test shall be 28 days; but, when approved by the Engineer, 7 day tests may be used provided that the relation between the 7 and 28-day strengths of the concrete is established by test for materials and proportions used. If the test strength of the cylinders falls below the minimum allowable compressive strength, the Engineer shall have the right to order the Contractor to remove and renew that day's pour of concrete or the Contractor shall accept such deductions in the final payment as the County may deem reasonable.

2. Sampling and testing of concrete materials shall be made in accordance with ASTM Designations. The Contractor at his expense shall supply test samples, and an independent testing laboratory at the Contractor's expense shall make tests. The source from which concrete aggregates are to be obtained shall be selected by the Contractor well in advance of the time when they will be required in the work; and suitable samples, as they are to be used in the concrete, shall be furnished in advance of the time when the placing of the concrete is expected to begin.

PART 3 - EXECUTION

3.1 FORMING AND PLACING CONCRETE

- A. Formwork: Construct so that concrete members and structures are of correct size, shape, alignment, elevation and position, complying with ACI 347.
- B. Clean and adjust forms prior to concrete placement. Apply form release agents for wet forms, as required. Retighten forms during and after concrete placement if required to eliminate mortar leaks.

3.2 REINFORCEMENT

- A. Position, support and secure reinforcement against displacement. Locate and support with metal chairs, runners, bolsters, spacers and hangers, as required. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
- B. Install welded wire fabric in lengths as long as possible, lapping at least one complete mesh.
- C. Installation of Embedded Items: Set and build into the work anchorage devices and other embedded items required for other work that is attached to, or supported by cast-in-place concrete. Use setting diagrams, templates and instructions provided by others for locating and setting.

3.3 CONCRETE PLACEMENT

- A. Comply with ACI 304, placing concrete in a continuous operation within planned joints or sections. Do not begin placement until work of other trades affecting concrete is completed.
- B. Consolidate placed concrete using mechanical vibrating equipment with hand rodding and tamping, so that concrete is worked around reinforcement and other embedded items and into all parts of the forms.
- C. Protect concrete from physical damage or reduced strength due to weather extremes during mixing, placement and curing. Concrete shall not be placed when the surrounding air temperature is below 40 degrees F and dropping.
 1. In cold weather comply with ACI 306.

2. In hot weather comply with ACI 305.

3.4 CONCRETE FINISHES

- A. Nonslip Broom Finish: Apply nonslip broom finish to exterior concrete, sidewalks and pump station top slab.
 1. Immediately after trowel finishing, slightly roughen concrete surface by brooming with fiber bristle broom perpendicular to main traffic route. Coordinate required final finish with the Engineer before application.
- B. Monolithic Trowel Finish: For all slab and flatwork surfaces not otherwise indicated or specified. After surface water disappears and floated surface is sufficiently hardened, steel trowel and retrowel to smooth surface. After concrete has set enough to ring trowel, retrowel to a smooth uniform finish free free of trowel marks or other blemishes. Avoid excessive trowelling that produces burnished areas.

3.5 BONDING AND GROUTING

- A. Before depositing new concrete on or against concrete that has set, existing surfaces shall be thoroughly roughened and cleaned of glaze, foreign matter, and loose particles. An epoxy coating, as approved by the Engineer, shall be applied for bonding the new concrete to the old.

3.6 CURING

- A. Concrete shall be kept continuously (not periodically) wet for a period of at least five consecutive days by covering with water or with an approved water saturated covering. Water for curing shall be clean and free from any elements, which might cause staining, or discoloration of the concrete surface.
- B. Sidewalks and floor slabs may be cured by spraying with a Membrane-Forming curing compound, applied as per manufacturer's recommendations and as approved by the Engineer. This material shall not be used on any interior slabs to which an applied finish is to be bonded.

3.7 PATCHING

- A. Any concrete which is not formed as shown on the drawings, or is out of alignment or level or shows a defective surface, shall be considered as not conforming with the intent of these specifications and shall be removed from the job by the Contractor at his expense, unless the Engineer grants permission to patch the defective area. This shall be done in accordance with the procedures above. Honeycomb consisting of 3/4" diameter holes or greater shall be considered a defective surface. Permission to patch any such area shall not be considered a waiver of the Engineer's right to require complete removal of the defective work if the patching does not, in his opinion, satisfactorily restore the quality of the concrete and appearance of the surface.
- B. As the forms are removed, fins, rough edges, and offsets shall be ground smooth.

Holes to 3/4", slight honeycomb, and minor defects shall be wet and filled with a 1:2 mix of cement mortar, matching color of surrounding concrete, and then troweled to a uniform plane. As soon as they have been troweled, the patched areas shall be sprayed with a curing compound, which will not destroy future bonding properties. Three days after application of curing compound, the entire surface shall be finished by wetting and applying a 1:2 mix of cement mortar with a cement brick. Using the brick, mortar shall be rubbed into pits or indentations and excess mortar rubbed off to provide a uniformly textured surface. When the surface has dried, all loose sand and dust shall be removed and the surface then hosed down with water.

3.8 TOLERANCES

- A. Tolerances for concrete work shall be in accordance with ACI 347.

END OF SECTION

SECTION 03420 - PRECAST STRUCTURAL CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. This work consists of furnishing all plant, labor, materials, and equipment for the manufacture, transportation, and erection and installation in place, complete with welded and grouted connections of all precast concrete construction as shown, specified and/or reasonably implied for a complete, first class job.
- B. Reference in the Specifications to any article, device, product, material, fixture, form or type of construction, by name, make or catalog number, shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition, and the Contractor, in such case, may at his option use any article, device, product, material, fixture, form or type of construction which in the judgement of the Engineer, expressed in writing, is equal to that specified. Any bidder desiring to offer substitute product must submit his request, together with full data, not less than 10 days prior to the date together with full data, not less than 10 days prior to the date for receipt of bids.

1.2 MATERIALS:

A. Precast Members:

- 1. Precast reinforcing concrete refers to members carrying structural loads and designated on structural plans as precast reinforced concrete, reinforced with mild steel reinforcing steel.
- 2. The precast concrete manufacturer shall prepare and submit to the Engineer shop drawings for approval and shall not proceed with manufacturing prior to receiving approval of the Engineer and Contractor.
- 3. Shop drawings shall be complete and shall include a layout plan, fabrication details, estimated camber, connections and anchorage details, and member identification marks. The identification mark shall appear on the manufactured units to facilitate correct field placement.
- 4. Three copies of shop drawings are required.

B. Quality Assurance:

- 1. Concrete tests and inspection: A testing laboratory to provide inspection and testing services for all precast work shall be selected by Contractor, subject to approval by the Engineer. The laboratory shall perform testing and inspection services at the precast plant.
- 2. The testing laboratory shall forward test reports directly to the Engineer as soon as possible after testing.

3. The cost of all services of the laboratory for precast work shall be borne by the precast concrete producer.
4. Before shipment, all precast concrete members may be inspected by a representative of the Engineer to make certain that materials and workmanship conform to the requirements of these specifications and approved samples.
5. Concrete test and inspection: The testing laboratory shall provide the following services.
 - a) Analysis and testing of all aggregates to be used on the project shall be done in accordance with this specification.
 - b) Verification of concrete mixtures submitted by the precaster to provide specified strength form aggregates as delivered.
 - c) Continuous supervision of mixing, placing, air content control, and slump testing of all concrete.
 - d) Occasional inspecting and checking operations at the mixing or batching plant.
 - e) Fabrication, transporting, storage and compression testing of test cylinders taken from the concrete actually placed in the work.
 - f) Inspection of formwork and placing of reinforcement.
 - g) Complete information on materials and proportions of all concrete mixes shall be submitted to the Engineer and the testing laboratory at least thirty (30) days before any concrete is placed. At the same time the testing laboratory shall be sent enough materials for all tests necessary to establish conformity will all specifications requirements, including quality of material and strength of proposed mixes.
 - h) The laboratory shall make at least 2 separate trial batches of the mixtures and material submitted. Five test cylinders shall be made for each bath. Two cylinders shall be tested at 7 days and 3 at 28 days. The mixtures shall develop a compressive strength in the laboratory 15% higher than the required minimum strength. Laboratory test shall include any admixture to be used in fabrication. A separate mix shall be made and tested for each concrete mixture and combination of aggregate or admixtures to be used.
 - i) No concrete shall be placed until conformity of all material and concrete mixtures with specifications and tests, including 28 day

compressive strengths, has been established and approved by the Engineer.

- j) The source of supply of the aggregate and cement shall not be changed during the course of the job without previous notice to the Engineer, and the material from any new source shall be subject to acceptance or rejection based on additional tests made by the testing laboratory at the precaster's expense.
 - k) At least 4 test cylinders per casting bed shall be made for each casting. Two of these cylinders are to be tested to verify the strength of concrete at the time of stress transfer and 2 to indicate 28-day strength, or strength at an earlier age if specified. Cylinders to be used for judging stress transfer strength shall be made from concrete placed during the latter half of bed casting.
 - l) The testing laboratory inspector shall be provided whatever labor help he requires in the preparation of test cylinders. However, the actual making, handling and curing of test cylinders shall be the testing laboratory inspector only.
 - m) Cylinders to be used for judging stress transfer shall be tested by the testing laboratory.
 - n) The laboratory shall pick up the transport cylinders and provide adequate curing before testing. Two cylinders of each set shall be tested at time of stress transfer and 2 at 28 days. Compression tests shall be in accordance with ASTM C39. The laboratory shall forward test reports directly to the Engineer as soon as possible after testing.
- C. Conditions for Modification of Quality Control Requirements: The requirements for independent testing laboratory inspection as outlined above may be performed by the precaster's personnel if the precaster is a participating member in the Prestressed Concrete Institute Quality Control Testing Program and the plant is approved under the program.
- D. Standards:
- 1. American Concrete Institute
 - a) ANSI/ACI 318 building code requirements for reinforced concrete
 - b) ANSI/ACI 525 minimum requirements for thin-section precast concrete construction
 - c) ANSI/ACI 301 specifications for structural concrete for buildings
 - d) ANSI/ACI 315 manual of standard practice for detailing reinforced concrete structures
 - e) ANSI/ACI 347 recommended practice for concrete formwork
 - f) ANSI/ACI 435.1R deflections of prestressed members
 - g) ANSI/ACI 512.2R precast structural concrete

2. American Welding Society
 - a) ANSI/AWS D1.1-81 structural welding code - steel
 - b) ANSI/AWS D1.4-79 recommended practice for welding reinforcing steel, metal inserts and connections in reinforced concrete construction
 - c) ANSI/AWS D3.0 standard qualification procedure

- E. Product Delivery, Storage and Handling: Delivery and Handling: Protect units during transport and handling from dirt and damage. Do not over stress, warp or twist. Handle by means of inserts.

PART 2 - PRODUCTS

2.1 MILD STEEL REINFORCING:

- A. Reinforcing steel shall conform to ASTM Designation A615, latest edition. Bars shall be made from new billet steel and shall conform to strength grade 60, unless otherwise noted on the drawings. Where welding is required, reinforcing shall be cold-drawn, electrically welded.

- B. Welded wire mesh reinforcing shall be cold-drawn, electrically welded steel wire and shall conform to ASTM Designation A185, latest edition, wire spacing and gauge as shown on the plans.

END OF SECTION 03420

SECTION 09900 - PAINTING

PART 1 - GENERAL

1.1 DESCRIPTION:

- A. The work required under this section consists of all painting and finishing work and related items necessary to complete the work indicated on drawings, described in the specifications and listed in the painting schedule.

1.2 WORK TO BE PERFORMED UNDER THIS SECTION:

- A. Painting of all exposed woodwork, interior, and exterior.
- B. Painting of all exposed surfaces of all ferrous metal work (including galvanized) of the building exterior and interior, in whatever location found, not covered by other sections of the specifications. This specifically includes miscellaneous metal, ornamental metal, metal doors and frames, metal windows, mechanical trade work, and electrical trade work.
- C. Painting of exposed surfaces of masonry on the interior and exterior as indicated in the finish schedule.
- D. Painting of all bare and covered pipes (excluding stainless steel), anchors, and hangers; exposed steel and iron work; and copper metal surfaces and equipment installed under the 11000 Sections and under the electrical work sections.

1.3 RELATED WORK SPECIFIED IN OTHER SECTIONS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division I Specification Sections, apply to this Section.
- B. Shop priming and shop coat on machinery and equipment. All items of equipment furnished with prime coat finish shall be finish painted under this section. Refer to the sections under which various items of manufactured equipment with factory applied shop prime coat are furnished, including, but not necessarily limited to, the following section.

1. Mechanical: (All Division 15 Sections)

1.4 (NOT IN THIS CONTRACT)

1.5 MANUFACTURER:

- A. Paint materials will be supplied by a single manufacturer to the greatest extent possible. Proprietary designations of colors and materials are not intended to exclude equivalent products of other manufacturers. Manufacturer's numbers specified refer to products manufactured by the Tnemec Company, Inc. establishing quality standards to be equaled or surpassed as equals subject to compliance with

specifications. Painting materials and colors may be selected from the following or equal:

1. Carboline Company
2. Pittsburgh Paint Division of PPG Industries, Inc.
3. Ameron Corporation
4. Porter Paint Company
5. Tnemec Company, Inc.
6. Benjamin Moore & Co. (BM)

1.6 SUBMITTALS:

- A. In addition to manufacturer's data, application instructions, and label analysis for each coating material, submit samples for Engineer's review of color and texture only. Resubmit samples if requested until required sheen, color and texture are achieved.

1.7 STORAGE OF MATERIALS:

- A. Store all materials used on the job in a single place designated by the Contractor and Approved by the Owner. Such storage place shall be kept neat and clean and all damage thereto or its surroundings shall be restored. Soiled or used rags, waste and trash must be removed from the building every night and every precaution taken to avoid the danger of fire.

1.8 INSPECTION OF SURFACES:

- A. Before starting any work, surfaces to receive paint finishes shall be examined carefully for defects which cannot be corrected by the procedures specified herein under "PREPARATION OF SURFACES" and which might prevent satisfactory painting results. Work shall not proceed until such damages are corrected. The commencing of work in a specific area shall be construed as acceptance of the surfaces, and thereafter the contractor shall be fully responsible for satisfactory work as required herein.

1.9 JOB, WEATHER, AND TEMPERATURE CONDITIONS:

- A. Maintain temperature in building at constant 65°F or above during drying masonry, and providing adequate ventilation for escape of moisture from building in order to prevent mildew, damage to other work and improper drying of paint. Once painting has commenced, provide constant temperature of 65°F or above. Maintain surface temperatures at 5°F above the dew point temperature while preparing the surface and painting, and prevent variations in temperature which might result in condensation on freshly painted surfaces.
- B. Before painting is started in any area, broom clean and remove excessive dust.
- C. After painting operations begin in a given area, broom cleaning will not be allowed; cleaning shall then be done only with commercial vacuum cleaning equipment.

1.10 COOPERATION WITH OTHER TRADES:

- A. This work shall be scheduled and coordinated with other work and/or job conditions as required to achieve satisfactory results.
- B. The contractor shall examine the specifications for the various trades and shall thoroughly familiarize themselves with all their provisions regarding painting.

1.11 COLOR SELECTION:

- A. Colors shall be selected by the Owner from the manufacturers standard color range.

PART 2 - PRODUCTS

2.1. Provide following paint systems for the various substrates, as indicated:

EXTERIOR MATERIALS							
Material	System	Finish	Prime Coat	No. of Coats	Finish Coat	No. of Coats	Total Dry Mil Thickness
Concrete (Non-submerged)	Modified Epoxy	Sand Texture	_____	_____	52-Color Tneme-Crete	1	9.0
Concrete Masonry	Modified Epoxy	Sand Texture	52-Color Tneme-Crete	1	52-Color Tneme-Crete	1	18.0
Aluminum and Galvanized Metal	Aliphatic Polyurethane	Gloss	66-Color Hi-Build Epoxoline	1	70-Color Endura Shield	1	7.0
Ferrous Metals (Non-submerged)	Alkyd	Gloss	37-77 Chem-Prime	1	2-Color Tenem-Gloss	2	7.5
Ferrous Metals (Submerged intermittently submerged or within 5' of water surface)	Epoxy-Polyamide	Semi-Gloss	66-1211 Epoxoline Primer	1	66-Color Hi-Build Epoxoline	1	9.0
Wood	Alkyd	Gloss	36-603 Undercoater	1	2-Color Tneme-Gloss	2	7.5

INTERIOR MATERIALS							
Material	System	Finish	Prime Coat	No. of Coats	Finish Coat	No. of Coats	Total Dry Mil Thickness
Concrete (Non-Submerged)	Acrylic Latex	Low Sheen	6-Color Tneme-Cryl	1	6-Color Tneme-Cryl	1	5.0
Concrete Masonry	Epoxy Polyamide	Semi Gloss	54-660 Masonry Filler	1	66-Color Hi-Build Epoxoline	2	20.0
Gypsum Drywall	Acrylic Latex	Semi Gloss	Tneme-Cryl	1	Tneme-Cryl	1	4-6
Aluminum and Galvanized Metal	Aliphatic Polyurethane	Gloss	66-Color Hi-Build Epoxoline	1	70-Color Endura-Shield	1	8.0
Ferrous Metals (Non-submerged)	Alkyd	Gloss	37-77 Chem-Primer	1	2-Color Tneme Gloss	2	7.5
Ferrous Metals (Submerged, intermittently submerged, or within 5' of water surface)	Epoxy-Polyamide	Semi-Gloss	66-1211 Epoxoline Primer	1	66-Color Hi-Build Epoxoline	1	9.0

2.2 FINISHING SCHEDULE:

See Section 09999 and plans for finishing schedule.

2.3 PAINT MATERIALS:

- A. All paint, varnishes, enamels, lacquers, stains and similar materials must be delivered in the original containers with the seals unbroken and label intact and with the manufacturer's instructions printed thereon.
- B. All painting materials shall be of the best quality and shall be approved by the Engineer. They shall bear identifying labels on the containers with the manufacturer's instructions printed hereon.
- C. Paint shall not be badly settled, caked or thickened in the container, shall be readily dispersed with a paddle to a smooth consistency and shall have excellent application properties.
- D. Paint shall arrive on the job color-mixed except for tinting of undercoats and possible thinning.
- E. All thinning and tinting materials shall be as recommended by the manufacturer for the particular material thinned or tinted.
- F. It shall be the responsibility of the applicator to see that all mixed colors match the color selection made by the Engineer prior to application of the coating.

PART 3 - EXECUTION

3.1 GENERAL:

- A. Only skilled mechanics shall be employed. Application may be brush, roller, or spray, upon approval from the Engineer.
- B. The Contractor shall protect his work at all times, and shall protect all adjacent work and materials by suitable covering or other method during progress of his work. Upon completion of the work, he shall remove all paint and varnish spots from floors, glass, and other surfaces. He shall remove from the premises all rubbish and accumulated materials of whatever nature not caused by others and shall leave his part of the work in clean, orderly and acceptable condition.
- C. Remove and protect hardware, accessories, device plates, lighting fixtures, factory finished work, and similar items, provide ample in-place protection. Upon completion of each space, carefully replace all removed items.
- D. Remove electrical panel box covers and doors before painting walls. Paint separately and reinstall after all paint is dry.
- E. All materials shall be applied under adequate illumination, evenly spread and flowed-on smoothly to avoid runs, sags, holidays, brush marks, air bubbles and excessive roller stipple.
- F. Coverage and hide shall be complete. When color, stain, dirt or undercoats show through final coat of paint, the surface shall be covered by additional coats until the paint film is of uniform finish, color, appearance and coverage, at no additional cost to the Owner.
- G. All coats shall be dry to manufacturer's recommendations before applying succeeding coats.
- H. Where spray paint is specified the Contractor shall finish 100 square feet by spraying a sample of the finish upon the request of the Engineer. This shall be finished with materials specified or approved.
- I. Surfaces to be stained shall appear uniform in shading with color variations caused only by the natural wood grain.

3.2 PREPARATION OF SURFACES:

- A. General:
 - 1. Surfaces shall be clean, dry and adequately protected from dampness.
 - 2. Surfaces shall be free of any foreign materials which will adversely affect adhesion or appearance of applied coating.

3. Mildew shall be removed and the surface neutralized per the coating manufacturer's recommendations.
 4. Efflorescence on any area will be corrected before painting.
- B. Concrete:
1. Patch large openings and holes and finish flush with adjacent surface. After priming, fill any remaining small holes with prepared patching material.
 2. Acid etch concrete floor surfaces scheduled for painting with solution of one part 32% muriatic acid to three parts water. Flush floor with clean water and allow to dry thoroughly before painting. Check pH; if not neutral, then correct by using a 3% solution of T.S.P. or ammonium hydroxide. The etched surface should appear uniform in sheen and feel like 100 grit abrasive paper.
 3. Remove form oil from poured-in-place concrete by washing concrete with xylol or exempt-type form oil solvent, or as required for complete removal.
 4. All surfaces shall be dry. No painting shall be done until surfaces have cured for 28 days and are dry.
- C. Ferrous Metal Surfaces:
1. Remove dirt and grease with mineral spirits and wipe dry with clean cloths.
 2. Remove rust, mil scale and defective paint down to sound surfaces or bare metal using scraper, sandpaper, wire brush, or if necessary sandblasting. Grind, disc sand, sand blast, etc., if necessary to remove shoulders at edge of sound paint to prevent them from photographing through finish coats. Preparation shall meet or exceed an SSPC-SP 6 specification for non-submerged surfaces and a SSPC-SP10 specification for submerged surfaces or surface subject to high humidity.
 3. Touch up all bare metal and damaged shop coats with specified shop coat primer.
 4. For ferrous surfaces with shop coats touched up, as above required, the first coat as listed in the following schedule will be applied to the dry mil film thickness specified.
- D. Galvanized Metal Surfaces:
1. Remove dirt and grease with mineral spirits and wipe dry with clean cloths.

3.3 WORKMANSHIP FOR PAINTING:

- A. Exterior painting shall not be done when the surface temperature is below 50°F, while the surface is damp, or during cold, rainy or frosty weather. The substrate temperature must be 5°F or more above the dew point temperature while painting

and during the coating cure. Avoid painting surfaces while they are exposed to hot sun.

- B. Exterior doors shall have tops, bottoms and side edges finished the same as the exterior faces of these doors.

END OF SECTION 09900

SECTION 09999 - FINISH SCHEDULE

PART 1 - GENERAL

1.1 SCOPE:

- A. The work under this section consists of all labor, materials, methods, and applications for finishes to concrete, concrete masonry, wood, and metal surfaces, both interior and exterior, as described in the specifications and listed in the finish schedule included herein.

1.2 RELATED WORK IN OTHER SECTIONS:

- A. Painting: Section 09900
- B. Mechanical: Division 15 Sections

PART 2 - PRODUCTS

Products shall be as specified in other sections of the specifications, except as follows:

- 2.1 "Cementitious" coating shall consist of a light gray, heavy cementitious matrix (with or without perlite matrix), which shall be applied to clean concrete surfaces for sealing, water proofing, and for decorative purposes. Coating shall be brush or squeegee applied in accordance with manufacturer's instructions. Surface preparation prior to application shall consist of smooth form finish, plus stone rubbing of form marks, joints, and blemishes. Color shall be gray to closely match other concrete work. Coating shall be Onatex as manufactured by the Old North Manufacturing Company, ThoroSeal as manufactured by Thoro System Products, or equal.
- 2.2 Abrasive coating shall be a skid resistant wearing surface suitable for application on exterior above grade and on grade slabs. Coating system shall be a skid resistant broadcast system as manufactured by Sika Chemical Corporation or equal. Binder shall be applied at a minimum coverage of 1 gallon per 30 square feet with a minimum of 2 pounds of flintshop #20 aggregate per square feet. Application shall be in strict accordance with manufacturer's written instructions.
- 2.3 Concrete sealer shall be non-yellowing, low luster, acrylic polymer type. It shall be sprayed or brushed on in accordance with the manufacturer's recommendations. It shall be manufactured by Okon, Inc., CDS, Inc., Anti Hydro, Inc., or approved equal.

PART 3 - FINISHING SCHEDULE

- 3.1 All buildings shall have rooms finished as indicated on the architectural drawings in accordance with the finishing schedules.

3.2 All other structures shall be finished as follows:

- | | | |
|----|---|--|
| A. | Submerged Concrete Floor Slabs | Troweled |
| B. | Concrete Floor Slabs | Troweled with sealer hardener |
| C. | Concrete Exterior Walls | Smooth rubbed finish with cementitious coating 2' below finish grade; remainder of wall to have honeycombs reworked |
| D. | Interior Concrete Walls Exposed | Smooth rubbed finish with cementitious coating entire wall |
| E. | Interior Concrete Walls Submerged | Smooth rubbed finish with cementitious coating 2' below normal water; remainder of wall to have form marks removed and honeycombs reworked |
| F. | Concrete Walkways | Abrasive coating |
| G. | Concrete Sidewalls | Broom finish |
| H. | Precast Structures and Vault | All honeycomb and lift holes reworked and all exposed exterior surfaces shall be grouted with cementitious coating |
| I. | Masonry Walls, Ceilings, Structural Members, Wood Trim, Metal Doors and Frame, Piping (including pump piping submerged and in vault), Equipment, Electrical, and Misc. Metals | Paint |

END OF SECTION 09999

SECTION 11100 – EXISTING WASTEWATER TREATMENT EQUIPMENT REFURBISHMENT

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. This section covers the furnishing of all labor, materials, equipment, related components and accessories to complete maintenance on the existing wastewater treatment equipment as specified under this section and as shown on the drawings.
- B. This specification provides a general description of the maintenance requirements of the system, but does not cover all details. The Contractor is responsible for performing complete system maintenance, and shall provide all of the necessary components and accessories required to form a system which is practical and functional in its operation, appropriate from the point of view of generally accepted safety standards, and correctly designed for the application.

1.2 SUBMITTALS

- A. Shop drawings shall be submitted for components provided containing detailed information specific to the project requirements and shall be submitted as outlined in Specification Section 01300. Submit O&M manuals for the *AdvanTex* system and the existing flow transmitter.

1.3 RELATED WORK

- A. Division 1 – General Requirements

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 EXISTING SEPTIC TANK & SEPTIC TANK EFFLUENT PUMP STATION

- A. Pump out, clean, inspect, and repair as required the existing 8,000 gallon septic tank. Both compartments of the septic tank shall be pumped out and cleaned. Inspect the sanitary tee outlet filter in the existing septic tank. Verify that the tee is present, whole, and functioning. Clean and/or replace the tee as necessary. Apply an approved coating as required to prevent tank leakage.
- B. Pump out, clean, inspect, and repair as required the existing septic tank effluent pump station. Apply an approved coating as required to prevent leakage.
- C. Verify that the float assemblies are properly mounted, operating, and set in the septic tank effluent pump station. Adjust the floats to 1.0 ft. between the level “on” setting and the level “off” setting.
- D. Verify that the septic tank effluent pumps operate in both Manual and Automatic mode. Check the pump amperage and voltage. Verify that the pumps and discharge plumbing are compatible and properly installed.

3.2 EXISTING *AdvanTex* BIOLOGICAL TREATMENT SYSTEM

- A. Contractor shall secure the services of the existing treatment system manufacturer or manufacturer's authorized service provider (Steve Berry 252-243-7693) for consultation during the cleaning, inspection, and "re-startup" of the system. The system shall be re-started with fresh water in the recirculation tank.
- B. Clean, inspect, test, and refurbish the existing *AdvanTex* biological treatment system per the manufacturer's recommendations. The system includes the recirculation / blend tank, recirculation pumps, filters, and the recirculation splitter valve.
- C. Pump out, clean, inspect, and test the existing *AdvanTex* recirculation / blend tank.
- D. Verify that the float assemblies are properly mounted, operating, and set in the recirculation / blend tank.
- E. Verify that the recirculation pumps operate in both Manual and Automatic mode. Check the pump amp draw and voltage. Verify that the pumps and discharge plumbing are compatible and properly installed.
- F. Verify dose volume and flow rate of the recirculation pumps.
- G. Verify that filter pods are installed level, and that all piping is properly covered and compacted. Verify that the ventilation intakes are properly located, installed, and functioning.
- H. Inspect the orifice shields and clean the orifices in the filter pods.
- I. Inspect the textile sheets. If biomat is bridging across the sheets, gently clean the textile sheets per manufacturer's instructions.
- J. Verify residual head
 - 1. Open filter pod.
 - 2. Ensure ball valves at the end of the laterals are closed.
 - 3. Remove an orifice cover and measure the squirt height.
- K. Verify that the recirculation splitter valve is properly installed and operating. Clean the filter housing the valve. Check, clean, and replace as necessary the filter cage.
- L. Verify that the timer settings are adjusted properly. Adjust timer settings as necessary per the manufacturer's instructions to optimize nitrification of the wastewater to achieve an effluent limit of less than 15 mg/l ammonia.
- M. Install a relay and wiring as specified and approved by *AdvanTex* in the *AdvanTex* control panel to provide an isolated contact to alarm high water level in the blend tank to the central monitoring and alarm panel.

3.3 EXISTING FLUME AND FLOW METERING EQUIPMENT

- A. Contractor shall secure the services of the local service representative for the existing flow transmitter to inspect, repair as required, calibrate the existing flow transmitter, and assist with interlocking the 4-20 ma output control from the flow meter transmitter to the chemical feed pumps.

3.4 SERVICE REPORTS

- A. Written, dated report shall be prepared by the service technician for each start-up, calibration, troubleshooting or maintenance event which identifies the equipment serviced, defines procedures, describes the results of the testing, identifies witnesses, and provides conclusions. This shall include every instrument or system, and shall also apply to every visit by equipment suppliers and system subcontractors. The reports shall also document every wiring modification, warranty repair and problem analysis.
- B. All reports shall be distributed to the Engineer, the contractor, and the Owner's representative.

3.5 SPARE PARTS

- A. Provide spare motor contactors (2) for the control panel and a spare pump unit for the *AdvanTex* system.

3.6 TRAINING

- A. Manufacturer's representative shall provide one (1) day of training for the designated Operators of the system and shall include training on the operation, maintenance, and emergency procedure requirements of the *AdvanTex* system. The manufacturer's representative for the existing flow meter shall provide one (1) day of training on the operation, maintenance, and calibration of the flow meter.

END OF SECTION 11100

SECTION 11232 – CHEMICAL STORAGE AND FEED SYSTEMS

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. This section covers the furnishing of all labor, materials, equipment, related components and accessories for the chlorine chemical feed pumping system as specified under this section and as shown on the drawings. The work includes furnishing all equipment and related services and systems, and providing labor and materials to properly place all equipment into service, including interface, coordination, installation, start-up, calibration, operating, training, troubleshooting and warranty repair.
- B. These specifications provide a general description of the requirements of the system, but do not cover all details. The chemical feed system shall be provided as a complete system, and shall include all of the necessary components and accessories required to form a system which is practical and functional in its operation, appropriate from the point of view of generally accepted safety standards, correctly designed for the type of chemical used, well ordered and complete in every way.

1.2 DESCRIPTION OF WORK

- A. Work includes furnishing and installing a sodium hypochlorite chemical metering system consisting of a 55 gallon double wall containment high density crosslinked polyethylene chemical storage tank, tank accessories as specified in this section, positive displacement peristaltic type chemical metering pumps and accessories, pump manufacturer's standard polypropylene chemical containment basin and pump mounting platforms, heated and lockable insulated FRP enclosure, ½" I.D. braid-reinforced PVC flexible tubing (230 PSI rating), ½" solvent weld Sch. 80 PVC piping, 3" Sch. 80 PVC carrier piping, ½" Sch. 80 PVC ball valves, ½" PVC pressure relief valve 5-100 PSI setting range, appurtenances, digital control interface, sodium hypochlorite chemical as specified below, and all associated work to make a complete and fully operational sodium hypochlorite chemical storage and feed system.

1.3 CHEMICAL TO BE DELIVERED

- A. Contractor to furnish one fifty-five gallon drum of each chemical as specified below:
 - 1. Sodium Hypochlorite Solution (5.25%)

1.4 SUBMITTALS

- A. Shop drawing submittals containing detailed information specific to the project requirements shall be submitted as outlined in Specification Section 01300.
- B. Chemical Tank Submittals shall include:

1. Shop Drawings: Shop drawings shall be approved by the engineer or contractor prior to the manufacturing of the chemical storage tank. Submit the following as a single complete initial submittal.

Sufficient data shall be included to show that the product conforms to Specification requirements. Provide the following additional information:

- a) Double Wall Containment Tank and Fitting Material

- (1) Resin Manufacturer Data Sheet
- (2) Fitting Material
- (3) Gasket style and material
- (4) Bolt material

- b) Dimensioned Tank Drawings

- (1) Location and orientation of openings, fittings, accessories, restraints and supports.
- (2) Details of manways, flexible connections, and vents.
- (3) Electrical heat tracing installation details.
- (4) Insulation data.

2. Manufacturer's warranty

3. Manufacturer's unloading procedure

4. Manufacturer's installation instructions

5. Manufacturer's Qualifications: Submit to engineer a list of 5 installations in the same service as proof of manufacturer's qualifications.

6. Factory Test Report

- a) Wall thickness verification.
- b) Fitting placement verification.
- c) Visual inspection
- d) Impact test
- e) Gel test
- f) Hydrostatic test

- C. Chemical Pump Submittals shall include:

1. Certified shop drawings

2. Characteristic performance curve showing flow rate as a function of RPM and pressure.

3. Dimensional drawings.
4. Operating, maintenance, programming, and wiring instructions.
5. P/10 ratio calculation.

1.5 RELATED WORK

- A. Division 1 – General Requirements
- B. Division 16 – Electrical

1.6 REFERENCES, CODES, AND STANDARDS

- A. American Society of Testing Materials (ASTM)
 1. D638 Tensile Properties of Plastics
 2. D883 Standard Definitions of Terms Relating to Plastics
 3. D1505 Density of Plastics by the Density-Gradient Technique
 4. D1525 Test Method for Vicat Softening Temperature of Plastics
 5. D1693 ESCR Specification Thickness 0.125" F50-10% Igepal
 6. F412 Standard Terminology Relating to Plastic Piping Systems
- B. ANSI Standards: B-16.5, Pipe Flanges and Flanged Fittings
- C. Building Code: Uniform Building Code, [1997 J Edition] / IBC 2000
- D. ARM: Low Temperature Impact Resistance (Falling Dart Test Procedure)

1.7 QUALIFICATIONS OF SYSTEM SUPPLIER

- A. The Contractor shall designate a Qualified Supplier or subcontractor as having system responsibility for the chemical feed system. This "Chemical Feed System Supplier" shall be experienced in the special design considerations and safety requirements associated with the handling and feeding of the specific chemical, and shall be responsible for the proper design, installation and operation of the chemical feed system as described herein and as shown on the drawings.
- B. The items of equipment covered by these Specifications are intended to be standard equipment of proven ability as manufactured by a reputable, qualified manufacturer, having long experience in the production of such equipment. The equipment shall be designed, constructed and installed with the best methods, materials and practice, and shall operate satisfactorily when installed. All equipment shall be new and un-used, and shall be the standard product of manufacturers having a successful record of manufacturing and servicing equipment and systems as specified herein for a minimum of five years.
- C. The "Chemical Feed System Supplier" shall be responsible to the Contractor to assure that the chemical feed system is supplied and installed in keeping with the best available practices and using the most appropriate materials and equipment available.

1.8 WARRANTY

- A. The Contractor shall obtain a Manufacturer's one-year guarantee from the chemical feed systems manufacturer or supplier and furnish it to the Owner. The guarantee shall cover all necessary labor, equipment and replacement parts resulting from faulty or inadequate equipment, improper assembly or erection, defective workmanship and materials, leakage, breakage or other failure of all equipment and components furnished by the Manufacturer. The guarantee period shall commence on the date of the Engineers issue of certificate of substantial completion. The Owner shall incur no labor or equipment cost associated with work under warranty during the guarantee period.

1.9 DOCUMENTATION AND TRAINING

- A. The "Chemical Feed System Supplier" shall provide full documentation for all hardware, components, and equipment, including complete manuals for installation, operation, calibration, and troubleshooting. All documentation shall be neatly organized, readable and complete.
- B. Complete hardware installation, operation maintenance, and trouble shooting manuals shall be provided. Six (6) sets are required.
- C. Operation and maintenance manuals shall be prepared specifically for this project, and shall include all required cut sheets, drawings, equipment lists, descriptions, safety requirements, special handling practices, etc., which are required to instruct operators and maintenance personnel on the proper operation and maintenance of these systems.
- D. A factory representative of the chemical feed system manufacturer, who has complete knowledge of the proper operation and maintenance requirements for that system, shall be provided for a total of eight (8) hours, to instruct representatives of the Owner and the Engineer on proper operation and maintenance of each system. Training shall be organized, well structured and executed, so that the staff is well qualified and confident to operate these systems.
- E. If there are difficulties in the operation of the equipment, due to the inadequate level of training or the manufacturer's design or fabrication, additional training and/or services shall be provided to resolve the difficulties, at no cost to the owner.

1.10 TOOLS AND SPARE PARTS

- A. All special tools required for normal operation, adjustment, or maintenance of the equipment shall be furnished with the equipment by the manufacturer.
- B. As a minimum the following spare parts shall be furnished:
 - 1. Four (4) spare tube elements of the specified size per pump.
 - 2. One (1) spare pumphead assembly and rotor.

3. One (1) spare pressure gauge.
 4. One (1) spare pressure relief valve.
- C. The manufacturer shall provide a recommendation and supply all parts and accessories expected to be required for normal operation for the first year of operation.
- D. All tools and spare parts shall be furnished in containers clearly marked with indelible markings as to their contents. This inventory shall be provided in a manner which is well ordered and complete.

1.11 START-UP SERVICES

- A. Contractor shall furnish the services of a factory-trained service engineer for start-up of the system. Start-up shall include confirmation that the equipment has been installed in accordance with the requirements recommended by the manufacturer, installation certification, and training for the operation personnel.

1.12 QUALITY ASSURANCE

A. Chemical Storage Tank

1. The chemical storage tank shall be manufactured from virgin materials.
2. The chemical storage tank shall be of equal quality to those manufactured by Poly Processing Company or equal.

B. Chemical Feed Pumps

1. All pumps, whether named as an acceptable supplier or submitted as an equal must, at a minimum, meet the critical design requirements listed in this section.
2. To maximize pump efficiency and minimize tube fatigue that will impact life, performance, and accuracy, pumps must be designed not to exceed the P/10 ratio of 37,038 (Theoretical maximum number of occlusions per 10 gallons pumped). Pumps exceeding the specified P/10 ratio will not be considered suitable for the duty condition. The following criteria is set to maintain the P/10 of ratio for the tube size specified for this application:
 - a) Maximum two compressing rollers for two compressions per revolution.
 - b) Tube wall thickness of 2.4 mm and constructed of material suitable for chemical being used.
 - c) Large diameter spring-loaded roller set for 2.4mm wall thickness tubing.
 - d) Max base drive speed of 220 RPM for 2.4mm wall thickness tubing.

- e) Track geometry of no less than 180 degrees and rotor geometry with roller 180 degrees apart.
- 3. For quality assurance, all pump elements must be manufactured by the pump manufacturer in accordance with their specifications. Elements not manufactured by the pump manufacturer will not be acceptable.
- 4. Drive and pumpheads shall be 24 hr continuous duty rated and have a five-year manufacturer's warranty from date of shipment.
- 5. Pumps to be manufacturer's standard product. Manufacturer of tubing pumps must have at least 20 operating installations in domestic water or wastewater treatment plants located in the United States over a period of at least seven years pumping the same fluid as specified.
- 6. Pumps must be manufactured under ISO 9001-2000.
- 7. Pumps shall be meet all applicable CE and C ETL US standards per UL610101A
- 8. Chemical metering systems shall be as manufactured by Watson-Marlow or equal.

PART 2 - PRODUCTS

2.1 POLYETHYLENE CHEMICAL STORAGE TANK

A. General

- 1. Tank shall be rotationally-molded, high density crosslinked polyethylene, double wall, flat bottom. The assembly shall consist of one cylindrical, closed top inner primary tank and one cylindrical, open top containment outer tank. Each tank shall be a rotationally molded one-piece seamless constructed tank. The tank shall be designed for above-ground, vertical installation and shall be designed to store the proposed chemical at atmospheric pressures. The assembly shall be designed to prevent rainwater and debris from entering the containment tank. The tank shall be adequately vented. Where indicated, the tank shall be provided with ancillary mechanical fittings and accessories. The tank shall be marked to identify the manufacturer, date of manufacture and serial numbers must be permanently embossed into the tank.

B. Polyethylene Storage Tank

- 1. High Density Crosslinked Polyethylene resin used in the tank manufacture shall be by Exxon Mobil Chemicals or equal and shall contain ultraviolet stabilizer as recommended by resin manufacturer. The tank material shall be rotationally molded and meet or exceed the following properties:

Property	Type I XLPE	ASTM Test
Environmental Stress Cracking Resistance, F50, hours, 10% Igepal	>1,000	D1693
Tensile Strength, Ultimate psi, 2-inch/minimum	2,830	D638 Type IV Specimen
Elongation at Break, % ,2-inch minimum	700	D638 Type IV Specimen
Flexural Modulus, psi	86,780	D790

2. Wall thickness for a given hoop stress is to be calculated in accordance with ASTM D 1998. Tanks shall be designed using a hoop stress no greater than 600 psi. In NO case shall the tank thickness be less than design requirements per ASTM D 1998.

a) The wall thickness of any cylindrical portion at any fluid level shall be determined by the following equation:

$$T = P \times OD/2SD \quad \text{or} \quad 0.433 \times SG \times H \times OD/2SD$$

Where: T = wall thickness, in
P = pressure, psi
SG = specific gravity, gm/cc
H = fluid head, ft
OD = outside diameter, ft
SD = hydrostatic design stress, 600 psi

(1) The minimum wall thickness shall be sufficient to support its own weight in an upright position without external support but shall not be less than 0.187" thick.

b) On closed top tanks the top head shall be integrally molded with the cylindrical wall. Its minimum thickness shall be equal to the thickness of the top of the straight sidewall. Flat areas shall be provided for attachment of large fittings on the dome of the tank.

c) The bottom head shall be integrally molded with the cylindrical wall. Minimum knuckle radius shall be 1".

3. Tank color shall be natural (unpigmented).

C. Tank Accessories

1. Fittings

a) Tank fittings shall be according to the fitting schedule below. Fittings shall be constructed of a material that is compatible with the product being stored and shall be a minimum of ¼" thick. Threaded fittings shall use American Standard Pipe Threads.

Fittings shall be installed at the factory prior to application of the insulation. All bottom discharge connections must maintain and meet the requirements to support 110% secondary containment requirements.

Fitting	Location
7" Cap w/ Threaded Cover	Top of Tank
2" Bulkhead Fitting Assembly for Outlet	Sidewall of Tank 6" from Bottom
2" Vent w/ Insect Screen	Top of Tank

2. Tank Insulation and Heat Tracing

- a) Tank shall be provided from the manufacturer with heat trace and insulation sufficient to maintain the chemical at 60° F in a minimum ambient temperature of -30 °F installed. The only field connection that shall be required is supply power to the heating system. The heating system shall consist of tank heating pad(s), a temperature controller, and insulation.

The heating pad(s) shall be specifically designed for use with polyethylene tanks.

The temperature controller shall be mounted on the tank with heaters connected by the manufacturer and shall be suitable for outdoor installation.

Insulation shall be a minimum of 2" thick and shall cover the entire surface area of the tank. Insulation shall be closed cell foam and have a minimum density of 2.5 lb/ft³ as measured by ASTM D-1622.

- b) Heating system status indication shall be provided via a power on to heaters light. When heat is required and the heaters are energized the power on to heaters light shall be illuminated.

D. Factory Testing

1. Material Testing

- a) Perform gel and low temperature impact tests in accordance with ASTM D 1998 on condition samples cut from the polyethylene chemical storage tank.
- b) Degree of Crosslinking: Use Method C of ASTM D 1998-Section 11.4 to determine the ortho-xylene insoluble fraction of crosslinked polyethylene gel test. Samples shall test at no less than 60 percent.

2. Tank Testing
 - a) Dimensions: Take exterior dimensions with the tank empty, in the vertical position. Outside diameter tolerance, including out-of-roundness, shall be per ASTM D 1998. Fitting placement tolerance shall be +/- 1/2-in vertical and +/- 1 degree radial.
 - b) Visual: Inspect for foreign inclusions, air bubbles, pimples, crazing, cracking, and delamination.
 - c) Hydrostatic test: Following fabrication, the bottom tanks, including inlet and outlet fittings, shall be hydraulically tested with water by filling to the top sidewall for a minimum of 1/2 an hour and inspected for leaks. Following successful testing, the tank shall be emptied and cleaned prior to shipment.

2.2 SODIUM HYPOCHLORITE CHEMICAL METERING PUMPS

A. Basis for Design

1. Quantity: 2 Pumps
2. Chemical Service: 5.25% Sodium Hypochlorite Solution
3. Capacity: 7.1 gph @ 100 psi
4. Calculated Operating Capacity: 0.027 gph for 10 mg/L dosage

B. Description

1. Pumps shall be positive displacement peristaltic type complete with spring-loaded pumphead, self-contained variable speed drive, and flexible extruded tube as specified.
2. Peristaltic pumping action is created by the compression of the flexible tube between the pump head rollers and track, induced forward fluid displacement within the tube by the rotation of the pump rotor, and subsequent vacuum-creating restitution of the tube.
3. Pumps shall be dry self-priming, capable of being run dry without damaging effects to pump or tube, and shall have a maximum suction lift capability of up to 30' vertical water column. Maximum pressure rating: 100 psi.
4. Pump shall not require the use of check valves or diaphragms and shall not require dynamic seals in contact with the pumped fluid. Process fluid shall be contained within pump tubing and shall not directly contact any rotary or metallic components.
5. Flow shall be in the direction of the rotor rotation, which can be reversed and shall be proportional to rotor speed.

C. Pumphead

1. Pumphead shall consist of a fixed track, a hinged guard door, and spring-loaded roller rotor assembly. Pump tubing shall be in contact with the inside diameter of the track through an angle of 180 degrees. At all times, one roller shall be fully engaged with the tubing providing complete compression and preventing back flow or siphoning. Tube occlusion and spring tension shall be factory set to accommodate 2.4mm wall thickness tubing and shall not require adjustment.
2. Pumphead guard shall be transparent for the purpose of viewing direction of rotation. When closed, the pump head guard shall seal against the pump track for leak containment and controlled waste through the pump head waste port in the event of a tube failure. For operator and environmental safety, pumps in which the direction of rotation cannot be visually verified and/or do not have a controlled waste port are not acceptable.

a) Pumphead Assembly

- (1) Pump Track Geometry must have a minimum 96.6mm swept diameter through a minimum track angle of 180 degrees
- (2) Provide high corrosion/impact materials as specified
 - (a) Track Construction: polyphenylene sulfide (PPS)
 - (b) Guard Construction: hinged impact-resistant polycarbonate breakaway guard, tool un-lockable for operator safety.
 - (c) Rotor Construction: polyphenylene sulfide (PPS)

b) Rotor Assembly

- (1) Provide rotor assembly that ensures gradual tube occlusion and compensates for tube tolerance:
 - (a) Twin spring-loaded roller arms located 180 degrees apart, each fitted with stainless steel helical springs and compressing roller for occlusion of the tube twice per rotor revolution
 - (b) Compressing Rollers: 316SS with low friction stainless steel bearings and PTFE seals, minimum diameter of 18mm
 - (c) Provide non-compressing guide rollers constructed of corrosion resistant Nylatron
- (2) Clutch: Equip rotor with a central handgrip hub and manually activated clutch to disengage the rotor from the drive for manual rotor rotation during tube loading. Clutch

shall automatically reengage rotor to gearbox upon one complete revolution.

- (3) Mounting: To prevent slip, the rotor assembly shall be axially secured to the dogged output shaft of the gearmotor via a slotted collet and central retaining screw.
- (4) Pumpheads requiring disassembly or special tools for tube changing are not acceptable.

D. Tubing

1. Pump shall be supplied with a tubing element with molded fittings, which shall be self-locating when fitted into the pump head. Tube element shall be in contact with the inside diameter of the track (housing) through an angle of 180 degrees and be held in place on the suction and discharge by the element fittings. The tubing shall be replaceable without the use of tools and with no disassembly of the pump head. To achieve maximum service life, pumpheads with a track angle of less than 180 degrees and/or without tube elements are not acceptable.
2. Tubing element shall be constructed with material suitable for the chemical service. The tubing shall have male PVDF Quick Release Connectors.
3. Supply One (1) tube element of the specified size per pump.
4. Supply Two (2) one-meter long flexible reinforced PVC hoses for connection of pump to suction and discharge process lines. Flexible hose shall have a PVDF female Quick Release fitting for connection to the tubing element and male Quick Release fitting for connection to NPT adaptor with built in shut off valve for ease of maintenance and connection to process lines.
5. Supply Two (2) Quick Release to ½" NPT Adaptors.

E. Drive

1. Rating: Continuous 24 hour operation, 40° C ambient.
2. Supply: 110-120V 50/60 Hz and 220-240V 50/60 Hz, 1-Phase field switchable. Supply nine-foot length mains power cord with standard 115V three-prong plug.
3. Max drive power consumption: 135VA.
4. Enclosure: NEMA 4X
5. Housing: Pressure cast aluminum with Alocrom pre-treatment and exterior grade corrosion resistant polyester powder coat. By nature of the environmental conditions, unpainted housings, including 316SS, are not acceptable.

6. Pumps must meet the following minimum requirements for operator interface functionality. Pumps not meeting this minimum functionality will not be accepted.
 - a) Backlit graphical LCD capable of up to four lines of text with up to 16 characters per line to display pump speed, running status, flow rate, and programming instructions.
 - b) Keypad for start, stop, speed increment, speed decrement, forward/reverse direction, rapid prime, and programming.
 - c) Menu driven on screen programming of manual or auto control, flow and remote signal calibration, and general programming.
 - d) Programmable "Auto Restart" feature to resume pump status in the event of power outage interruption.
 - e) Programmable "Keypad Lock" to allow operator lockout of all keys except emergency start/stop.
 - f) Programmable "Maximum Speed" to allow operator to set the maximum speed of the pump within 0.1-220 rpm.
7. Supply auto control features to meet the following minimum functionality requirements for use with present local control and interface with a future SCADA system. All control signal features must be located internally to the pump. Pumps not meeting this minimum functionality or that require additional external control boxes are not acceptable.
 - a) Remote Control Inputs
 - (1) Local chemical feed control unit shall accept a 4-20 mA flow signal to set output rate of chemical per unit of flow. Controller shall have an adjustable low flow cutoff.
 - (2) Speed Control:
 - (a) Analog 4-20mA or 0-10VDC, with input signal trimmable and speed scaleable over any part of the drive speed range.
 - (b) Provisions for alternative remote accessory potentiometer (if supplied by others).
 - (3) Start/Stop Control via dry contact. Configurable command sense allowing open to equal run or open to equal stopped.
 - (4) Forward/Reverse Control via dry contact.
 - (5) Auto/Man Mode Control via dry contact.
 - (6) Leak Detector Run/Stop Control via dry contact.
 - b) Status Outputs

- (1) Four relay contacts rated for 30 VDC with maximum load of 30W, NO or NC software configurable to indicate the following:
 - (a) Running/Stopped status
 - (b) Forward/Reverse status
 - (c) Auto/Manual status
 - (d) General Alarm status
 - (e) Leak Detected status
 - (2) Speed output – Analog 0-10 VDC or 5V Square Wave Frequency output
 - c) Termination: supply screw down terminals suitable for up to 18 AWG field wire and accessible through four glanded cable entry points on the pump.
- 8. Drive motor- brushless DC motor with integral gearbox and tachometer feedback.
 - a) Speed Control Range of 2200:1 from 0.1 to 220 rpm +/- 0.1 rpm throughout the range.
 - b) Closed loop microprocessor controlled drive with pulse width modulation at speeds above 35 rpm and synchronous mode with magnetic field rotation control below 35 rpm
 - c) Circuitry complete with temperature and load compensation and protection.
- 9. Mounting: Drive shall be self-supporting and shall not require anchoring.
- 10. Leak Detection- Pump manufacturer shall supply float-type leak sensor mounted to the drain port of the pump head for leak detection and pump shut down in the event of a tubing failure.

F. Accessories

- 1. An in-line, 5-100 PSI adjustable-pressure setting range, ½” NPTF, PVC, diaphragm-type pressure relief valve, constructed of materials compatible with chemical to be used, shall be provided with each metering pump.

2.3 APPURTENANCES

- A. Any appurtenances shown on the contract drawings or which are otherwise necessary to establish a properly functioning chemical feed system shall be furnished and installed by the Contractor. All appurtenances shall be protected or compatible with the process chemicals.

- B. Contractor shall provide a portable pH meter equivalent to a HACH Model HQ11d, 2 to 14 pH range, Intellical pHC101 electrode with 1 meter cable, and instructions manual.
- C. Contractor shall provide a total chlorine test kit equivalent to a HACH Chlorine Colorimeter II test kit, 0.1 to 8.0 ppm total chlorine range, complete with 10 ml sample cell, total DPD chlorine reagent kit 0.1 to 0.8 ppm range, and instructions manual.
- D. Contractor shall provide electric drum pump set suitable for use with the sodium hypochlorite system. Drum pump set shall be as manufactured by ALSCO Industrial Products, Inc. or equal. Drum pump set shall include at a minimum a 39" sealless high volume rotor shaft, a barrel adaptor, 1" nozzle, 8' PVC hose, hose clamps, and wall hangers. Pump shall be designed to pump liquid with a maximum specific gravity of 1.6 and a maximum viscosity of 500 CPS. The pump shall have a maximum capacity of 42 GPM and be able to produce a maximum head of 26 feet.
- E. Contractor shall provide a heated and insulated FRP enclosure for the packaged chemical feed system. The enclosure shall provide adequate space for access to the metering pumps for routine calibration and maintenance. The FRP enclosure shall have hinged door panel and hinged roof panel with gas shock supports on both sides of the roof panel, 1.5 inch foam insulation, brackets to secure the enclosure to the concrete pad, and a 1900 watt, 120 volt heater. The enclosure shall be equivalent to a Hot Box, Designer series enclosure.

Heat shall protect the piping and equipment from exterior temperatures to -30° F and be thermostatically controlled. UL or ETL listed self-regulating cable(s) or wall mounted air heater(s) will be sized to maintain the equipment at +40° F, in accordance with N.F.P.A. 3-3.1.8 & 3-6.1.3.2. Heat source shall be mounted a minimum of 7" above the slab. Power source shall be installed inside the enclosure, protected with a ground fault interrupting (GFI) receptacle or GFI circuit, ref. U.L. 943, N.E.M.A.3R.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

- A. Chemical Storage Tanks
 1. Tanks shall be shipped upright or lying down on their sides with blocks and slings to keep them from moving. AVOID sharp objects on trailers.
 2. All fittings shall be installed and, if necessary, removed for shipping and shipped separately unless otherwise noted by the contractor.
 3. Upon arrival at the destination, inspect the tank(s) and accessories for damage in transit. If damage has occurred, notify tank manufacturer immediately.

B. Chemical Metering Pumps

1. Shipping

- a) Ship pumps and drives assembled complete. Ship tubing separately for field installation and process line connection by contractor.
- b) Pack all additional spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.
- c) Deliver spare parts at the same time as pertaining equipment.

2. Receiving

- a) Contractor to inspect and inventory items upon delivery to site.
- b) Contractor to store and safeguard equipment, material, instructions, and spare parts in accordance with manufacturer's written instructions.

3.2 INSTALLATION

- A. The contractor shall provide all labor, materials, equipment, and expertise required to carry out the installation, calibration, testing, operator training, and start-up of all equipment in a manner in keeping with the best standard practices available and in accordance with the manufacturer's recommendations for each piece of equipment supplied.

3.3 EQUIPMENT CALIBRATION

- A. Every analog instrument, control or related device shall be properly calibrated, tuned, adjusted and commissioned so that the accuracy and operation of the device equals the highest level of performance which that device can achieve.
- B. Accurate and appropriate test equipment and industry standard test procedures shall be used to demonstrate that the equipment operates within its expected tolerance of accuracy at various points throughout its operating range.
- C. The technician performing equipment calibration shall be fully familiar, trained and qualified to service and support the items which are being serviced.

3.4 CALIBRATION AND SERVICE REPORTS

- A. A written, dated report shall be prepared by the Chemical Feed System Supplier technician for each start-up, calibration, troubleshooting or maintenance event which identifies the equipment serviced, defines procedures, describes the results of the testing, identifies witnesses, and provides conclusions. This shall include every instrument or system provided in this project, and shall also apply to every visit by equipment suppliers and system subcontractors. The reports shall also document every wiring modification, warranty repair and problem analysis.

- B. All reports shall be distributed to the Engineer, the contractor and copied to the staff, and a copy shall be kept in a permanent file on site for future reference.

3.5 TRAINING

- A. Training shall be provided by the Chemical Feed System Supplier, appropriate for the systems and equipment being provided, as described in these specifications above. Training shall be well-structured, class-room style, and shall include lesson plans, handouts, teaching aids, hands-on training, and evaluation.
- B. Training sessions shall be scheduled at the convenience of the owner, so that the appropriate personnel can be available. All training shall be recorded and recordings shall be turned over to the staff for future use.

END OF SECTION 11232

SECTION 11310 – SUBMERSIBLE WASTEWATER PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Work under this Section consists of furnishing and installing non-clog submersible pumps as detailed on the drawings and as specified herein.
- B. The Contractor shall furnish and install all necessary piping, valves, pipe supports, electrical and appurtenances needed for a complete and operating pump station.

1.2 SUBMITTALS

- A. Shop Drawings shall be submitted for the following items:
 - 1. Pumps
 - 2. Drives
 - 3. Controls
- B. Six (6) sets of operation and maintenance manuals for the pump and controls shall be furnished.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Pump Manufacturer:
 - 1. The basis of design for non-clog submersible wastewater pumps is Flygt Pumps, or approved equal in performance. Fairbanks Morse, Grundfos, ABS, and Myers are approved manufacturers.

2.2 SUBMERSIBLE WASTEWATER PUMPS

- A. General:
 - 1. The Contractor shall furnish and install the submersible wastewater pumps with all components and appurtenances required for a complete, finished installation.
 - 2. Major pump components shall be of grey cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of holes or other irregularities.
 - 3. All exposed nuts or bolts shall be AISI type 304 stainless steel construction. All metal surfaces coming into contact with the pumpage, other than stainless steel or brass, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.

4. Sealing design shall incorporate metal-to-metal contact between machined surfaces. Critical mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific torque limit.
5. Rectangular cross sectioned gaskets requiring specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds, elliptical O-ring, grease or other devices shall be used.

B. Design:

1. Secondary Effluent Pump Station
 - a) Each pump shall be designed for the following operating conditions:
 - (1) Number of pumps: two (2)
 - (2) Location: Secondary Effluent Pump Station
 - (3) Pumping Capacity: 80 gpm @ 52 ft. TDH
 - (4) Maximum Speed: 3450 rpm
 - (5) Motor Size: 3 hp
 - (6) Electrical: 208 V, 3 Phase, 60 Hz

C. Pumps

1. Pumps shall be automatically and firmly connected to the discharge, guided by no less than two guide bars extending from the top of the station to the discharge connection. There shall be no need for personnel to enter the wet-well. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to metal watertight contact.
2. Pumps are submersible, centrifugal non-clog type capable of passing solids, complete with pump mounting plates and base elbows with bottom rail supports, stainless steel upper rail supports, stainless steel lifting cable, stainless steel guide rails, and stainless steel cable supports.
3. Pumps shall be heavy duty; electric submersible, centrifugal non-clog units designed for handling raw, unscreened sewage and wastewater and shall be fully guaranteed for this use.
4. Pumps provided shall be capable of operating in a liquid temperature up to 104 °C.
5. Pumps and motors units shall be suitable for continuous operation at full nameplate load while the motor is completely submerged, partially submerged or totally non-submerged.

6. Pumps, mechanical seals and motors units provided under this specification shall be from the same manufacturer in order to achieve standardization of operation, maintenance, spare parts, manufacturer's service and warranty.
7. The manufacturer shall warrant the pumps being supplied to the Owner against defects in workmanship and materials for a period of one year starting from the date of substantial completion. The warranty shall be in published form and apply to all similar units.

D. Motors

1. The pump motor shall be induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber, NEMA B type.
2. The stator windings and stator leads shall be insulated with moisture resistant Class F insulation rated for 155 °C (311 °F). The stator shall be dipped and baked three times in Class F varnish and shall be heat-shrink fitted into the stator housing.
3. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable.
4. The motor shall be designed for continuous duty handling pumped media of 40 °C (104 °F) and capable of up to 15 evenly spaced starts per hour.
5. The rotor bars and short circuit rings shall be made of cast aluminum. Thermal switches set to open at 125 °C (260 °F) shall be embedded in the stator lead coils to monitor the temperature of each phase winding. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel.
6. The junction chamber containing the terminal board shall be hermetically sealed from the motor by an elastomer compression seal. Connection between the cable conductors and stator leads shall be made with threaded compression type binding posts permanently affixed to a terminal board.
7. Wire nuts and crimping type connection devices are not acceptable. The motor and pump shall be designed and assembled by the same manufacturer.
8. The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15. The motor shall have a voltage tolerance of plus or minus 10%.
9. The motor shall be designed for operation up to 40 °C (104 °F) ambient and with a temperature rise not to exceed 80 C. A performance chart shall be provided showing curves for torque, current, power factor, input/output kW and efficiency. This chart shall also include data on starting and no-load characteristics.
10. The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box without the need of

any splices. The outer jacket of the cable shall be oil resistant chloroprene rubber.

11. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet.
12. The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from the shut-off through run-out.

E. Mechanical seal:

1. Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The seals shall operate in a lubricant reservoir that hydrodynamically lubricates the lapped seal faces at a constant rate.
2. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary and one positively driven rotating tungsten-carbide ring.
3. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, shall contain one stationary tungsten-carbide seal ring and one positively driven rotating carbon seal ring.
4. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment nor depend on direction of rotation for sealing.
5. The position of both mechanical seals shall depend on the shaft. Mounting of the lower mechanical seal on the impeller hub will not be acceptable. For special applications, other seal face materials shall be available.
6. Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and to provide lubricant expansion capacity. The drain and inspection plug, with positive anti-leak seal shall be easily accessible from the outside.
7. The seal system shall not rely upon the pumped media for lubrication. The motor shall be able to operate dry without damage while pumping under load.
8. Seal lubricant shall be FDA Approved, non-toxic

F. Cable entry seal:

1. The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal.
2. The cable entry shall consist of a single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable.

3. The assembly shall provide ease of changing the cable when necessary using the same entry seal.
4. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal board, which shall isolate the interior from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

G. Impeller:

1. The impeller (s) shall be of gray cast iron, Class 35B, dynamically balanced, and double shrouded non-clogging design having a long throughlet without acute turns.
2. The impeller (s) shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in wastewater.
3. When ever possible, a full vaned, not vortex, impeller shall be used for maximum hydraulic efficiency; thus, reducing operating costs.
4. Mass moment of inertia calculations shall be provided by the pump manufacturer upon request. Impeller (s) shall be, retained with an Allen head bolt and shall be capable of passing a minimum 2 inch diameter solid.
5. All impeller (s) shall be coated with an acrylic dispersion zinc phosphate primer.

H. Pump shaft:

1. Pump and motor shaft shall be the same unit. The pump shaft is an extension of the motor shaft. Coupling shall not be acceptable. The pump shaft shall be AISI type 420 stainless steel.
2. If a shaft material of lower quality than 420 stainless steel is used, a shaft sleeve of 420 stainless steel is used to protect the shaft material. However, shaft sleeves only protect the shaft around the lower mechanical seal. No protection is provided for in the oil housing and above. Therefore, the use of stainless steel sleeves will not be considered equal to stainless steel shafts.

I. Wear rings:

1. A wear ring system shall be used to provide efficient sealing between the volute and suction inlet of the impeller. Each pump shall be equipped with a brass, or nitrile rubber coated steel ring insert that is drive fitted to the volute inlet.

J. Volute:

1. Pump volute (s) shall be single-piece grey cast-iron, Class 35B, non-concentric design with smooth passages large enough to pass any solids that may enter the impeller. Minimum inlet and discharge size shall be as specified.

K. Cooling system:

1. Motors are sufficiently cooled by the surrounding environment or pumped media. A water jacket is not required.

L. Controls

1. Control panels to operate the submersible pumps shall be supplied as shown on the contract documents. Control levels shall be as specified on the drawings.
2. Assembled control panel shall be third party labeled, UL 508 or other listing agency acceptable to the North Carolina Department of Insurance. Refer to the electrical contract drawings for requirements.
3. Provide float switches for each control panel as shown on the drawings.

M. APPURTENANCES

1. LIFT-OUT RAIL SYSTEM:

- a) Each pump shall be provided with stainless steel sliding guide rails so that the motor and pump assembly can be raised and lowered in the pump station without unbolting or disturbing the discharge piping. Refer to plans for sizes.
- b) Each pump shall be furnished with a stationary cast-iron discharge base elbow with 125 lb. Discharge flange connection and two guide rail connections. The guide pipes shall be stainless steel pipe and shall be provided with a guide rail cap for attachment to the access frame. A slide assembly with yoke shall be supplied to allow each pump to slide freely between the guide rails. The design shall be arranged so that a minimum force of three times the pump discharge pressure shall be exerted between the stationary base elbow and the pump discharge to provide a positive seal without bolting or fastening. Lever action shall provide for easy breakaway when raising the pump.
- c) Each pump shall be provided with a SS lifting chain or cable of sufficient strength and length to permit easy removal for inspection or repair. There shall be no need for personnel to enter the pump station to remove pump.

2.3 PUMP CONTROLS:

- A. The pump manufacturer shall provide the pump control panel and accessory equipment. The Contractor shall install the controls as shown on the drawings and manufacturer's instructions. The control system shall include all motor starters, alternator, relay, level control switches, control panel, circuit breakers, alarm apparatus, and internal wiring. Control panel shall be designed to operate from a 208V, 3 phase power supply.
- B. Control panels shall be third party labeled per North Carolina D.O.I Regulations; UL 508A or equal.
- C. Control panels shall be supplied with input – output signal interfaces and controls to interface with future remote monitoring as specified.
- D. Control Sequence
 - 1. On rising liquid level in the wet well, a float switch shall start the lead pump. As the liquid level continues to rise, the second mercury float switch shall start the lag pump. The pump(s) will continue to operate until the liquid level recedes to the level of the third mercury float switch, which shall stop the pumps. The fourth mercury float switch shall energize the alarm circuit, should the liquid level rise above the lag pump cut-on elevation.
 - 2. The pumps shall automatically alternate between the "lead" and "lag" positions by means of an electric alternator in the panel.
 - 3. Provided with the pump and control equipment shall be electrical contacts, alarm light, which shall be mounted on the exterior of the station. The alarm equipment shall be interlocked with wet well controls to be actuated upon high wet well levels or loss of power. The alarm circuits shall be 120 volt.
- E. Control Panel
 - 1. General
 - a) The control system shall be designed to operate required number of submersible pumps at power characteristics as shown on the plans.
 - b) The control function shall provide for the operation of the pumps under normal conditions and shall alternate the pumps on each pump down cycle to equalize the run time. In the event the incoming flow exceeds the pumping capacity of the lead pump, subsequent pumps shall automatically start to handle the increased flow. As the flow decreases, the pumps shall cut off at the elevations as shown on the plans.
 - c) The control shall function as described. The equipment listed below is a guide and does not relieve the supplier from supplying a system that will function as required.
 - 2. Mechanical

- a) The enclosure shall be a NEMA4X rated enclosure manufactured from stainless steel. The enclosure shall be a wall mount type with a minimum depth of 10" sized to adequately house all the components. The door gasket shall be rubber composition and shall assure a positive weatherproof seal. The door shall open a minimum of 180 degrees.
- b) A brushed aluminum dead front shall be mounted on a continuous aircraft type hinge, shall contain cutouts for mounted equipment, and shall provide protection of personnel from live internal wiring. Cutouts for breaker handles shall be provided to allow operation of breakers without entering the compartment.
- c) All control switches, indicator pilot lights, elapsed time meters, duplex receptacle, and other operational devices shall be mounted on the external surface of the dead front. The dead front shall open a minimum of 150 degrees to allow access to equipment for maintenance. A 3/4" break shall be formed around the perimeter of the dead front to provide rigidity.
- d) The back plate shall be manufactured of 12 gauge sheet steel and be finished with a primer coat and two (2) coats of baked on white enamel. All hardware mounted to the sub panel shall be accomplished with machine thread tapped holes. Sheet metal screws are not acceptable. All devices shall be permanently identified.

3. Power Distribution

- a) The panel power distribution shall include all necessary components and be completely wired with stranded copper conductors rated at 90 degrees C. All conductor terminations shall be as recommended by the device manufacturer.
- b) Provide 120V circuit breakers and transformer capacity to power ancillary equipment.
- c) All circuit breakers shall be heavy-duty thermal magnetic or motor circuit protectors similar and equal to "Square D" type FAL.
- d) Each motor breaker shall be adequately sized to meet the pump motor operating characteristics and shall have a minimum of 10,000 amps interrupting capacity for 230VAC and 14,000 amps at 480 VAC. The control circuit, the duplex receptacle, and any other control breakers shall individually be controlled by heavy-duty breakers.
- e) Circuit breakers shall be indicating type, providing "On/Off/Trip" positions of the operating handle. When the breaker is tripped automatically, the handle shall assume a middle position indicating "Trip."
- f) Thermal magnetic breakers shall be quick-make and quick-break on manual and automatic operation and have inverse time

characteristics secured using bimetallic tripping elements supplemented by a magnetic trip.

- g) Breakers shall be designed so that an overload on one pole automatically trips and opens all legs. Field installed handle ties shall not be acceptable.
- h) Motor starters shall be open frame, across the line; NEMA rated with individual overload protection in each leg. Motor starter contact and coil shall be replaceable from the front of the starter without removing from its mounted position.
- i) Overload heaters shall be block type, utilizing melting alloy spindles and shall have visual trip indication. Overload shall be sized for the full load amperage draw of the pumps. Adjustable type overloads, definite purpose contactors, fractional size starters, and horsepower rated contactors or relays shall not be acceptable.
- j) Control transformers shall be provided to provide the 120 VAC and/or 24VAC for control circuits. Transformers shall be fused on the primary and secondary circuits. The secondaries shall be grounded.
- k) A lightning-transit protector with telltale warning lights on each phase to indicate loss of protection on the individual phases shall be provided. The device shall be solid state with a response time of less than five (5) nanoseconds withstanding surge capacity of 6500 amperes. Unit shall be instant recovery, long life and have no holdover currents.
- l) A line voltage rated, adjustable phase monitor shall be installed to sense low voltage, loss of power, reversed phasing, and loss of a phase and shall indicate each fault. Control circuit shall de-energize upon sensing any of the faults and shall automatically restore service upon return to normal power.

4. Pump Temperature and Leakage detection

- a) Furnish and install one Flygt MiniCAS (Mini Control and Status) or other monitoring device per the pump manufacturer's recommendation to monitor the temperature and leakage detectors installed in each pump. The pump monitor shall be capable of monitoring the thermal switches embedded in the stator end coils, the FLS (float switch type) water in the stator housing sensor, and the CLS (capacitive type) water in oil sensor. The pump monitor shall monitor both the thermal switches and leakage sensor(s).
- b) The pump monitor shall contain two sets of form C dry contacts, one for over temperature and one for leakage. The dry contacts shall change state upon occurrence of an over temperature or leakage condition to indicate that condition to other control components in the pump control panel. In the case of an over

temperature the over temperature dry contacts shall be used to trip the pump off line.

5. Alarm System

- a) The alarm light shall be a weatherproof-shatterproof red light fixture with a 40-watt bulb to indicate alarm conditions. The alarm light shall be turned on by the alarm level. The alarm light will flash until the alarm condition ceases to exist. At that time, the alarm reset function will reset for normal operation.

6. Control System

- a) The control system shall provide for the automatic and manual control and alternation of the pumps to maintain a pumped down condition of the wet well.
- b) If the level continues to rise, alarm functions shall be activated.

7. Ancillary Equipment

- a) The control system shall include, but not be limited to, the equipment listed below:
 - (1) A three-position Hand/Off/Auto switch shall be provided for each pump. The switch shall be NEMA 4X rated with 10 amp contacts. A position indicating legend plate shall be provided. The Hand/Off/Auto switches shall be mounted on the inner dead front door.
 - (2) Provide the following indicating lights mounted on the dead front door.
 - (a) Pump 1 Run
 - (b) Pump 1 Failed
 - (c) Pump 1 Moisture High
 - (d) Pump 2 Run
 - (e) Pump 2 Failed
 - (f) Pump 2 Moisture High
 - (g) High Level
 - (3) Panel indicators shall be oil-tight, heavy duty with LED lamps. Provide a red "running" lamp for each pump. Controller indicator lamps shall be 120V transformer type SQD (or app. equal).
 - (4) An elapsed time meter for each pump shall be mounted on the dead front door. The meter shall operate on 120 VAC,

shall indicate in hours (6 digits) and tenths, and shall be non-re-settable.

(5) The alternator shall be a plug-in solid-state unit with Lead/Lag/Auto selector and test switches. The unit shall operate on 120 VAC and provide dpdt ten amp rated contacts. Two LEDs shall indicate the next position to run as lead pump.

(6) Ground Fault Receptacle

8. Status and alarm contacts for remote monitoring.

a) Provide unpowered "dry" contacts to interface with remote monitoring for the following:

(1) High Level

(2) Power fail

(3) Pump 1 Run

(4) Pump 1 Failed

(5) Pump 2 Run

(6) Pump 2 Failed

9. Miscellaneous

a) A final as built drawing, laminated in Mylar, shall be attached to the inside of the front door. A list of all legends shall be included.

b) All component parts in the control panel shall be permanently marked and identified as they are indicated on the drawing. Marking shall be on the back plate adjacent to the component. All control conductors shall be identified with wire markers at each end as close as practical to the end of conductor.

c) All panels shall be tested to the power requirements as shown on the plans to assure proper operation of all the components. Each control function shall be activated to check for proper indication.

d) All equipment shall be guaranteed for a period of three (3) years from date of shipment. The guarantee is effective against all defects in workmanship and/or defective component. The warranty is limited to replacement or repair of the defective equipment.

e) The manufacturer shall be a UL listed shop for industrial control systems and shall provide evidence of such on request from the engineer or using authority.

F. Float Displacement Switches for Level Controls

1. Float switches shall be encapsulated in polyurethane or vinyl floats. The units shall be waterproof, shockproof, explosion-proof and equipped with sufficient Type SO neoprene submersible cable to extend to the control panel from the wet well without splicing. Any required weights shall be provided. Switches shall be suspended in the wet well on a suitable rack or rail of stainless steel construction.
- G. Automatic megging shall be provided for each submersible pump motor with alarm tie-in. All submersible pumps shall be furnished by the same manufacturer. Controls and pumps shall be by same supplier and covered by same warranty.
- H. All other components necessary for a completely operable system performing the functions required shall be supplied.
- I. Wiring: All wiring workmanship and schematic wiring diagrams shall be in compliance with applicable standards and specifications for industrial controls set forth by the Joint Industrial Council (JIC), National Machine Tool Builders Association (NMTBA), National Electrical Code (NEC), Division 16 of these specifications and other pertinent electrical codes and standards.

All control circuit wiring shall be MTW 14 ga. tinned red, white, and green. All conductors shall be copper, color coded and clearly numbered at each end in conformance with applicable schematic wiring diagrams, and of adequate size to safely carry required electrical loads. All control wires shall be marked using T&B Shur code sleeve markers. All wires on the back panel shall be contained in wire troughs with removable covers to facilitate field repairs and addition of optional/additional components. Splices shall not be used on any wires.
- J. Shop drawings adequate for control panel fabrication, installation and maintenance shall be submitted and approved prior to manufacture. Drawings shall include an elementary control (ladder) diagram, interconnection wiring (schematic) diagram, interior and exterior panel component layout drawings, component catalog cuts and Contractor's installation drawings. The adequacy of shop drawings shall be determined solely by the Owner.

PART 3 - EXECUTION

3.1 GENERAL

- A. Installation of all equipment shall be in accordance with the manufacturer's recommendations.
- B. The manufacturer's authorized representative shall inspect and check the installation after erection and prior to start-up and shall certify that the completed installation is ready for start-up. The manufacturer's field representative shall check the proper rotation, operating speed, and starting and running electrical characteristics of the operational pumping equipment and certify that they are correct. The field representative shall also make himself available to the Owner's operating staff in addressing operational and trouble-shooting concerns that they may have. The Contractor shall provide labor, testing water and shall assist the Engineer in performing field testing to check operating conditions of all pumps. Cost of pump manufacturer start-up and certificate inspections shall be paid by Owner, unless a second trip is required due to Contractor's failure to satisfy manufacturer's request for installation.

3.2 MANUFACTURER TESTING

- A. Testing performed upon each pump shall include the following inspections:
 - 1. Impeller, motor rating and electrical connections shall be checked for compliance with this specification.
 - 2. Prior to submergence, each pump shall be run dry to establish correct rotation.
 - 3. Each pump shall be run submerged in water.
 - 4. Motor and cable insulation shall be tested for moisture content or insulation defects.
- B. Upon request, a written quality assurance record confirming the above testing/inspections shall be supplied with each pump at the time of shipment.
- C. Each pump (when specified) shall be tested in accordance with the latest test code of the Hydraulic Institute (H.I.) at the manufacturer to determine head vs. capacity and kilowatt draw required. Witness tests shall be available at the factory upon request.
- D. Pumps shall be rejected if the above requirements are not satisfied.

3.3 WARRANTY

- A. In addition to the general guarantee required elsewhere in these specifications, the pump manufacturer shall furnish the Owner with a written warranty to cover the pumps and motors against defects in workmanship and material for a period of five (5) years or 10,000 hours of operation under normal use and service.
- B. The pump manufacturer will pay the following portion of the cost of all replacement parts and repair labor from the date of shipment of the pump unit. Pumps repaired under warranty will be returned to the owner freight prepaid.
- C. The pump manufacturer shall have a minimum of 10,000 heavy-duty submersible wastewater pumps installed and operating for no less than 5 years in the United States.

END OF SECTION 11310

SECTION 11315 - SUBMERSIBLE WELL PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section covers the furnishing of all labor, materials, equipment, related components and accessories for the complete installation of the stainless steel submersible well pump as specified under this section and as shown on the drawings. The work includes furnishing all equipment and related services and systems, and providing labor and materials to properly place all equipment into service, including interface, coordination, installation, start-up, calibration, operator training, troubleshooting and warranty repair.
- B. These specifications provide a general description of the requirements of the system, but do not cover all details. The submersible well pump shall be installed as a complete system, and shall include all of the necessary components and accessories required to form a system which is practical and functional in its operation, appropriate from the point of view of generally accepted safety standards, well ordered and complete in every way.

1.2 DESCRIPTION OF WORK

- A. Work includes furnishing and installing a stainless steel submersible well pump and all associated work to make a complete and fully operational system.
- B. The items of equipment covered by these Specifications are intended to be standard equipment of proven ability as manufactured by a reputable, qualified manufacturer, having long experience in the production of such equipment. The equipment shall be designed, constructed and installed with the best methods, materials and practice, and shall operate satisfactorily when installed. All equipment shall be new and un-used, and shall be the standard product of manufacturers having a successful record of manufacturing and servicing equipment and systems as specified herein for a minimum of five years.

1.3 SUBMITTALS

- A. Shop drawing submittals containing detailed information specific to the project requirements shall be submitted as outlined in Specification Section 01300.
- B. The pump manufacturer shall submit shop drawings for general review with copies of system dimensional drawings and pump curves.
- C. Equipment weights shall be included in the submittal package.

1.4 RELATED SECTIONS

- A. General Conditions, Supplementary Conditions and General Requirements Sections apply to work of this Section.

1.5 DOCUMENTATION AND TRAINING

- A. Furnish six (6) copies of a manual describing the recommended operation and maintenance of the pumps. The manual shall include descriptions of all components of the pump, all part numbers, model numbers and any other information necessary to identify, order and replace all components and/or subassemblies. Manuals shall be submitted within 60 days after final approval of shop drawings.
- B. Complete hardware installation and trouble shooting manuals shall also be provided. Six (6) sets of each are required.
- C. If there are difficulties in the operation of the equipment, due to the inadequate level of training or the manufacturer's design or fabrication, additional training and/or services shall be provided to resolve the difficulties, at no cost to the owner.

1.6 QUALIFICATIONS

- A. All pumping equipment furnished under this Section shall be of a design and manufacture that has been used in similar applications.
- B. Unit responsibility: Pumps, complete with motor and all other specified accessories and appurtenances, shall be furnished by the pump manufacturer to ensure compatibility and integrity of the individual components, and provide the specified warranty for all components.
- C. The submersible pumps specified in this section are to be furnished by and shall be the product of one (1) manufacturer.
- D. The Manufacturer shall submit a list of at least ten (10) installations similar to the one being proposed.

1.7 WARRANTY

- A. The Contractor shall obtain a Manufacturer's two-year guarantee from the pump manufacturer or supplier and furnish it to the Owner. The guarantee shall cover all necessary labor, equipment and replacement parts resulting from faulty or inadequate equipment, improper assembly or erection, defective workmanship and materials, leakage, breakage or other failure of all equipment and components. The guarantee period shall commence on the date of the Engineers issue of certificate of substantial completion. The Owner shall incur no labor or equipment cost associated with work under warranty during the guarantee period.
- B. The Contractor shall modify or replace at no additional cost to the Owner, any equipment that fails to perform as specified.

1.8 TOOLS AND SPARE PARTS

- A. All special tools required for normal operation, adjustment, or maintenance of the equipment shall be furnished with the equipment by the manufacturer.

- C. The dynamic water level shall always be more than 1 foot above the inlet strainer of the pump.
- D. The minimum submergence of the pump shall be in accordance with the pump performance curve and pump operation manual.
- E. The basis of design is a Model 150S75-4 as manufactured by Grundfos. Other approved manufacturers include Goulds, Simflo, or other approved equal.
- F. Materials of Construction
 - 1. The material of construction of the submersible pump shall be stainless steel. The major components shall be constructed of 304 stainless steel. Major components include the check valve with housing, inlet screen, impeller, sleeve and sleeve flange. The pump shaft shall be 431 stainless steel. Couplings shall be 316/329 stainless steel. The pump column pipe shall be 304 stainless steel pipe.
 - 2. Exterior stainless steel shall be corrosion resistance. Stator windings shall be hermetically encapsulated in stainless steel.
- G. Pump Motor
 - 1. The pump motor shall be water lubricated with internal water circulation system which enhances the motor cooling. No cooling sleeve shall be needed in water temperatures up to 85 °F. The motor shall be equipped with temperature sensor as standard.
 - 2. The motor shall be equipped with a pressure equalization diaphragm and epoxy coated bearing support.

2.2 VARIABLE FREQUENCY DRIVES

A. MANUFACTURERS

- 1. The AC Drive shall be provided by ABB, Square D/Groupe Schneider, Yaskawa/Magnatek, or as supplied as a brand labeled standard product by the well pump manufacturer.
- 2. Alternate control techniques other than pulse width modulated (PWM) are not acceptable.

B. GENERAL DESCRIPTION

- 1. The AC Drive shall convert the input AC mains power to an adjustable frequency and voltage as defined below.
- 2. The AC Drive manufacturer shall use a 6-Pulse bridge rectifier design with line reactors for effective harmonic mitigation. The diode rectifiers shall convert fixed voltage and frequency, AC line power to fixed DC

voltage. The power section shall be insensitive to phase rotation of the AC line.

3. The output power section shall change fixed DC voltage to adjustable frequency AC voltage. This section shall use insulated gate bipolar transistors (IGBT) or intelligent power modules (IPM) as required by the current rating of the motor.

C. CONSTRUCTION

1. AC Drives rated 25 Hp and less shall be supplied in wall mounted enclosures.
2. The AC Drive shall be mounted in a Type 1 enclosure.
3. All fans within an enclosed AC Drive including the AC Drive heatsink fans shall be front accessible and removable without removal the AC Drive power converter to facilitate maintenance and or fan replacement.

D. MOTOR DATA

1. The AC Drive shall be sized to operate motors as shown on the contract documents.
2. APPLICATION DATA

- a) The AC Drive shall be sized to operate a Variable Torque load.
- b) The speed range shall be from a minimum speed of 0.5 Hz to a maximum speed of 70 Hz.

E. ENVIRONMENTAL RATINGS

1. The AC Drive shall be of construction that allows operation in a pollution Degree 3 environment. The AC Drive shall meet IEC 60664-1 and NEMA ICS 1 Standards. AC Drives that are only rated for Pollution Degree 2 environment shall not be allowed.
2. The AC Drive shall be designed to operate in an ambient temperature from 0 to + 40 °C (+32 to 104 °F).
3. The storage temperature range shall be -25 to + 70 °C.
4. The maximum relative humidity shall be 95% at 40 °C, non-condensing.
5. The AC Drive shall be rated to operate at altitudes less than or equal to 3,300 ft (1000 m). For altitudes above 3,300 ft, de-rate the AC Drive by 1.2% for every 300 ft (100 m).
6. The AC Drive shall meet the IEC 60068-2 Operational Vibration Specification.

F. RATINGS

1. The AC Drive shall be designed to operate from an input voltage of and $460 \pm 10\%$ Vac.
2. The AC Drive shall operate from an input voltage frequency range of $60 \text{ Hz} \pm 2\%$.
3. The displacement power factor shall not be less than .95 lagging under any speed or load condition.

4. The efficiency of the AC Drive at 100% speed and load shall not be less than 96%.
5. The variable torque rated AC Drive overcurrent capacity shall be 110% for one minute.
6. The output carrier frequency of the AC Drive shall be randomly modulated and selectable at 2, 4, or 10 kHz depending on Drive rating for low noise operation.
7. The output frequency shall be from 0.1 to 400 Hz for AC Drives up to 75 hp. For horsepower ratings above 75 hp, the maximum output frequency will be 200 Hz.
8. The AC Drive will be able to develop rated motor torque at 0.5 Hz (60 Hz base) in a sensorless flux vector (SVC) mode using a standard induction motor without an encoder feedback signal.

G. PROTECTION

1. Upon power-up the AC Drive shall automatically test for valid operation of memory, option module, loss of analog reference input, loss of communication, dynamic brake failure, DC to DC power supply, control power and the pre-charge circuit.
2. The Power Converter shall be protected against short circuits, between output phases and ground; and the logic and analog outputs.
3. The AC drive shall have a minimum AC undervoltage power loss ride-through of 200 msec. The AC Drive shall have the user-defined option of frequency fold-back to allow motor torque production to continue to increase the duration of the powerloss ride-through.
4. The AC drive shall have a selectable ride through function that will allow the logic to maintain control for a minimum of one second without faulting.
5. For a fault condition other than a ground fault, short circuit or internal fault, an auto restart function will provide up to 255 programmable restart attempts. The programmable time delay before restart attempts will range from 1 second to 999 seconds.
6. The deceleration mode of the AC drive shall be programmable for normal and fault conditions. The stop modes shall include free-wheel stop, fast stop and DC injection braking.
7. Upon loss of the analog process follower reference signal, the AC Drive shall fault and/or operate at a user-defined speed set between software programmed speed settings or last speed.
8. The AC drive shall have solid state thermal protection that is UL Listed and meets UL 508C as a Class 20 overload protection and meets IEC 947. The minimum adjustment range shall be from .25 to 1.36% of the current output of the AC Drive.
9. There shall be three skip frequency ranges with a bandwidth of 5 Hz. The skip frequencies shall be programmed independently, back to back or overlapping.

H. ADJUSTMENTS AND CONFIGURATIONS

1. The AC Drive shall self-configure to the main operating supply voltage and frequency. No operator adjustments will be required.
2. Upon power-up, the AC Drive will automatically send a signal to the connected motor and store the resulting resistance data into memory. The inductance data will be measured during no-load operation when operating at a frequency between 20-60 Hz. The AC Drive shall automatically optimize the operating characteristics according to the stored data.
3. The AC Drive will be factory pre-set to operate most common applications.
4. The acceleration and deceleration ramp times shall be adjustable from 0.1 to 999.9 seconds.
5. The volts per frequency ratios shall be user selectable to meet variable torque loads, normal and high-torque machine applications.
6. The memory shall retain and record run status and fault type of the past eight faults.

I. AC DRIVE SEQUENCING REQUIREMENTS

1. All enclosed AC Drives shall have 115VAC interface and control sequencing.

J. SYSTEM CONTROL AND INTERFACE REQUIREMENTS

1. The following additional controls and interface requirements shall be provided:
 - a) 4- 20 mA analog input for external process setpoint or speed command signal.
 - b) 4 – 20 mA analog input for process sensor input.
 - c) 4 – 20 mA analog output for drive speed report-back.
 - d) 4 digital inputs
 - (1) Start-stop control
 - (2) Programmable input
 - (3) Programmable input
 - (4) Programmable input
2. Motor Interface: The AC Drive shall provide interfaces necessary to monitor the pump temperature sensors and other well pump protective devices as required.
3. Auxiliary Contacts – The AC Drive shall provide the following auxiliary contacts to indicate the following conditions:
 - a) 1 form C contact to indicate DRIVE RUN.
 - b) 1 form C Contact to indicate DRIVE FAULT

K. MESSAGE DISPLAY CENTER REQUIREMENTS

1. A The message display center / keypad display shall supplied and mounted to the front of the drive This unit shall be be menu based and offer the modification of AC Drive adjustments via a touch keypad. All electrical values, configuration parameters, I/O assignments, application

and activity function access, faults, local keypad control, and adjustment storage will be in plain English.

2. The display will be a high-resolution, backlit LCD screen capable of displaying 4 lines of 20 alphanumeric characters.
3. The AC Drive model number, torque type, software revision number, horsepower, output current, motor frequency and motor voltage shall all be listed on the drive identification display as viewed on the LCD display.
4. The keypad interface shall be configured to display selectable outputs such as speed reference, output frequency, output current, motor torque, output power, output voltage, line voltage, DC voltage, motor thermal state, drive thermal state, elapsed time, motor speed, machine speed reference and machine speed.
5. The operator terminal shall provide a main menu consisting of status, programming, drive configuration, and keypad operation. A hardware jumper lock shall protect drive setup from unauthorized personnel by limiting access to the programming and drive configuration menus. A software password shall be configured to limit access to all menus except status. The status menu shall show meters, I/O map, fault history and drive identification.
6. There will be arrow keys that will provide the ability to scroll through menus and screens, select or activate functions or increase the value of a selected parameter.
7. A data entry key will allow the user to confirm a selected menu, numeric value or allow selection between multiple choices.
8. An escape key will allow a parameter to return the existing value if adjustment is not required and the value is displayed. The escape function will also return to a previous menu display.
9. A RUN key and a STOP key will command a normal starting and stopping as programmed when the AC Drive is in keypad control mode. The STOP key must be programmable for active in all control modes.
10. The keypad interface shall have three backlight colors to indicate functional status. A green color backlight will verify that the AC Drive is running. A red color backlight will indicate an AC Drive fault. An orange color backlight color will designate and idle or drive ready status.

L. HARMONIC MITIGATION EQUIPMENT REQUIREMENTS

1. The AC Drive shall be provided with a 3% rated line reactor mounted inside the enclosure.
2. The AC drive Shall be supplied with an output filter if required to interface with and to protect to connected well pump

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The contractor shall provide all labor, materials, equipment, and expertise required to carry out the installation, calibration, testing, operator training, and start-up of all equipment in a manner in keeping with the best standard practices

available and in accordance with the manufacturer's recommendations for each piece of equipment supplied.

3.2 EQUIPMENT CALIBRATION

- A. Every analog instrument, control or related device shall be properly calibrated, tuned, adjusted and commissioned so that the accuracy and operation of the device equals the highest level of performance which that device can achieve.
- B. Accurate and appropriate test equipment and industry standard test procedures shall be used to demonstrate that the equipment operates within its expected tolerance of accuracy at various points throughout its operating range.
- C. The technician performing equipment calibration shall be fully familiar, trained and qualified to service and support the items which are being serviced.

3.3 CALIBRATION AND SERVICE REPORTS

- A. A written, dated report shall be prepared by the technician for each start-up, calibration, troubleshooting or maintenance event which identifies the equipment serviced, defines procedures, describes the results of the testing, identifies witnesses, and provides conclusions. This shall include every instrument or system provided in this project, and shall also apply to every visit by equipment suppliers and system subcontractors. The reports shall also document every wiring modification, warranty repair and problem analysis.
- B. All reports shall be distributed to the Engineer, the contractor and copied to the staff, and a copy shall be kept in a permanent file on site for future reference.

3.4 EXAMINATION

- A. The Contractor shall install the pumps and motors specified herein in accordance with the plans and as recommended by the manufacturer.
- B. The manufacturer's field engineer or representative shall inspect and check the installation after erection prior to start-up and shall certify that the completed installation is ready for start-up. The manufacturer's field representative shall check the proper rotation, operating speed, and starting and running electrical characteristics of the operational pumping equipment and certify that they are correct. The Contractor shall provide equipment and labor as required for field testing.

3.5 TESTING

- A. A certified factory hydrostatic and performance test shall be performed on each pump unit in accordance with Hydraulic Institute Standards, latest edition. Tests shall be sufficient to determine the characteristic curve, input horsepower, and efficiency relative to capacity from shutoff to one hundred fifty percent (150%) of design flow. A minimum of ten (10) points, including shutoff, shall be taken for each test. At least four (4) points of the ten (10) shall be taken as near as possible to each specified condition.

- B. Results of the performance tests shall be certified by a Registered Professional Engineer and submitted for approval before final shipment.

END OF SECTION 11315

SECTION 11335 – INTAKE SCREEN WITH AIR BACKWASH

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. This section covers the furnishing of all labor, materials, equipment, related components and accessories for the intake screen with air backwash system as specified under this section and as shown on the drawings. The work includes furnishing all equipment and related services and systems, and providing labor and materials to properly place all equipment into service, including interface, coordination, installation, start-up, calibration, operating, training, troubleshooting and warranty repair.
- B. These specifications provide a general description of the requirements of the system, but do not cover all details. The intake screen with air backwash system shall be provided as a complete system, and shall include all of the necessary components and accessories required to form a system which is practical and functional in its operation, appropriate from the point of view of generally accepted safety standards, correctly designed, well ordered and complete in every way.

1.2 DESCRIPTION OF WORK

- A. Work under this Section consists of furnishing and installing an intake screen with an air backwash system at the wet weather storage basin as specified herein and shown on the contract drawings.
- B. The Contractor shall install the new intake screen with an air backwash system in the wet weather storage basin and provide all necessary appurtenances to make a complete and fully operational system.

1.3 SUBMITTALS

- A. Shop drawings, manufacturer's data, and literature shall be submitted in accordance with Specification Section 01300 prior to manufacture of the screens.
- B. Submit intake screen drawings showing screen diameter, screen and assembly length, outlet size, air backwash connection size, slot opening, materials of construction, and assembly weight.
- C. Submittals shall include the following:
 - 1. Welder certifications
 - 2. Evidence of a statistical control program
 - 3. Supporting flow distribution data

1.4 RELATED WORK

- A. General Requirements Division 1

- | | | |
|----|---------------------------|---------------|
| B. | Cast-in-Place Concrete | Section 03300 |
| C. | Wastewater Piping Systems | Section 15730 |
| D. | Electrical | Division 16 |

1.5 DOCUMENTATION AND TRAINING

- A. Furnish six (6) copies of a manual describing the recommended operation and maintenance of the intake screen with air backwash system. The manual shall include descriptions of all components of the system, all part numbers, model numbers and any other information necessary to identify, order and replace all components and/or subassemblies. Manuals shall be submitted within 60 days after final approval of shop drawings.
- B. Complete hardware installation and trouble shooting manuals shall also be provided. Six (6) sets of each are required.
- C. If there are difficulties in the operation of the equipment, due to the inadequate level of training or the manufacturer's design or fabrication, additional training and/or services shall be provided to resolve the difficulties, at no cost to the owner.

1.6 QUALIFICATIONS

- A. All equipment furnished under this Section shall be of a design and manufacture that has been used in similar applications.
- B. All equipment furnished under this Section shall be furnished by and shall be the product of one (1) manufacturer.
- C. The intake screen shall be manufactured by an ISO 9000 Certified company, fabricated by ASME Section IX Certified welders and the manufacturer shall provide evidence of experience in having supplied at least five assemblies of similar designs which have been in successful service for at least three years.

1.7 WARRANTY

- A. The Contractor shall obtain a Manufacturer's one-year guarantee from the manufacturer or supplier and furnish it to the Owner. The guarantee shall cover all necessary labor, equipment and replacement parts resulting from faulty or inadequate equipment, improper assembly or erection, defective workmanship and materials, leakage, breakage or other failure of all equipment and components. The guarantee period shall commence on the date of the Engineers issue of certificate of substantial completion. The Owner shall incur no labor or equipment cost associated with work under warranty during the guarantee period.
- B. The Contractor shall modify or replace at no additional cost to the Owner, any equipment that fails to perform as specified.

1.8 TOOLS AND SPARE PARTS

- A. All special tools required for normal operation, adjustment, or maintenance of the equipment shall be furnished with the equipment by the manufacturer.

- B. The manufacturer shall provide a recommendation and supply all parts and accessories expected to be required for normal operation for the first year of operation.
- C. All tools and spare parts shall be furnished in containers clearly marked with indelible markings as to their contents. This inventory shall be provided in a manner which is well ordered and complete.

PART 2 - PRODUCTS

2.1 INTAKE SCREEN

A. General

- 1. The Contractor shall furnish and install the intake screen, and shall provide all incidentals and appurtenances required for a complete, finished, fully operational installation.

B. Construction

- 1. Intake Screen shall be cylindrical with circumferential slots that widen toward the inside of the cylinder. The screen surface wire shall be wedge wire cross-wire welded to an appropriate support member so as to provide necessary strength with minimal hydraulic resistance. The screen shall include an internal flow collector pipe designed to ensure a uniform flow distribution through the screen slots during water intake. Screen shall be equipped with 1 inch pipe size internal air burst manifold assembly and 6" flanged connection for supply piping.
- 2. The surface wire, support beam and stiffener structure shall be an all-welded matrix designed to provide the specified strength with minimal interference with the through screen flow pattern. End plates and screen body shall be a minimum of 0.15" thick. All structural butt welds shall be full penetration; structural fillet weld size shall be the thickness of the thinner component.

C. Wire and Slot

- 1. The surface wire shall be #69 wedge wire. The screen slot opening shall be .100 inches. The open area for this slot opening shall be 58.48%. Slot size shall be controlled and continuously monitored during manufacture. The mean slot size shall be within ± 0.003 " with a standard deviation no greater than 0.003" throughout the assembly.

D. Capacity

- 1. The intake screen capacity shall be 200 GPM at a maximum local through slot velocity, due to water removal not to exceed 0.5 feet per second and the screen manufacturer must provide actual test data. The corresponding average through-slot velocity shall be 80% - 90% of the maximum velocity. At the design flow rate, the pressure drop through the surface of the clean screen and complete screen assembly shall not exceed 0.1 psi. Hydraulic calculation verifying compliance to these criteria shall be provided upon request.

2. The total intake assembly capacity of 200 GPM shall be handled by one intake screen assembly.

E. Strength

1. Screen shall be capable of withstanding a differential hydrostatic pressure in excess of 4.5 pounds per square inch or a working depth of 10 feet of water. The design stress when determining strength shall be two thirds of the yield stress. Strength calculations verifying compliance to these criteria shall be provided upon request.

F. Materials and Fittings

1. The wire and supports shall be 304 stainless steel. The remainder of the assembly shall be manufactured of corrosion resistant metal, AISI type 304 stainless steel. The main outlet shall be a 6-inch plate flange with a bolt pattern equal to AWWA C-207, Table 2, Class D. The airburst cleaning connection shall be through a 1 inch ANSI Class 150 raised face slip on flange.

2.2 AIR BACKWASH SYSTEM

A. General

1. The intake screen supplier shall provide, as part of the overall intake screen system, an air backwash system designed to remove debris from the screen surface by delivering a suitable volume of compressed air to the inside of the screen body. The exiting air shall scour the screen surface to maintain adequate design flow and through slot velocity characteristics.

B. The air backwash system shall consist of a tank mounted integrated system of compressor, receiver tank, valves and control panel.

1. The compressor must deliver enough air to re-pressurize the tank within the required recharge time. The compressor shall be a 3 HP reciprocating type and shall be sized to recover from each backwash in 15 minutes. The compressor motor shall be suitable for use with 208 V 3 phase supply power.
2. The receiver tank shall store air for the burst cleaning of the screen. The tank shall be sized to deliver an adequate amount of air to the screen in a 2 to 3 second burst. The receiver shall be a 30 gallon receiver, ASME coded for 200 psig, sized for the system piping and to displace THREE SCREEN VOLUMES of air AT THE SCREEN during a backwash to provide suitable debris removal and cleaning. Two of three volumes shall be delivered in the first second of the backwash cycle.
3. The receiver tank shall be equipped with a 4 inch isolated pressure gauge, safety valve and automatic drain valve.
4. The system shall include one ball valve rated at 200 psi with standard ANSI class 125/150 flanges. The valve shall be sized to match the tank flange and the air backwash piping.

C. Automatic Operation:

1. The above ball valve shall be provided with a pneumatic actuator with direct mounted solenoid valves, position indicator and position switches.
2. The system shall include a suitably sized air receiver interconnected and charged by the main receiver to allow valve operation.
3. A NEMA 4 control panel shall be included that will contain as a minimum, the motor starter for the compressor, control power transformer and a PLC or relay logic to perform the specified control functions.
4. The controls shall allow timed automatic or manual initiated air cleaning cycles. A cycle consists of cleaning the intake screen.
5. The control system included shall allow a full week duration of programmed cycles.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The contractor shall provide all labor, materials, equipment, and expertise required to carry out the installation, calibration, testing, operator training, and start-up of all equipment in a manner in keeping with the best standard practices available and in accordance with the manufacturer's recommendations for each piece of equipment supplied.
- B. The manufacturer's authorized representative shall inspect and check the installation after erection and prior to start-up and shall certify that the completed installation is ready for start-up. The manufacturer's field representative shall check the proper installation, operation, and starting and running electrical characteristics of the operational screening and air backwash equipment and certify that they are correct. The field representative shall also make himself available to the Owner's operating staff in addressing operational and trouble-shooting concerns that they may have. The Contractor shall provide labor and equipment as required for field testing to check operating conditions of the screens and air backwash system. Cost of intake screen manufacturer start-up and certificate inspections shall be paid by the Contractor.

3.2 EQUIPMENT CALIBRATION

- A. Every analog instrument, control or related device shall be properly calibrated, tuned, adjusted and commissioned so that the accuracy and operation of the device equals the highest level of performance which that device can achieve.
- B. Accurate and appropriate test equipment and industry standard test procedures shall be used to demonstrate that the equipment operates within its expected tolerance of accuracy at various points throughout its operating range.
- C. The technician performing equipment calibration shall be fully familiar, trained and qualified to service and support the items which are being serviced.

3.3 CALIBRATION AND SERVICE REPORTS

- A. A written, dated report shall be prepared by the technician for each start-up, calibration, troubleshooting or maintenance event which identifies the equipment serviced, defines procedures, describes the results of the testing, identifies witnesses, and provides conclusions. This shall include every instrument or system provided in this project, and shall also apply to every visit by equipment suppliers and system subcontractors. The reports shall also document every wiring modification, warranty repair and problem analysis.
- B. All reports shall be distributed to the Engineer, the contractor and copied to the staff, and a copy shall be kept in a permanent file on site for future reference.

3.4 MANUFACTURER TESTING

- A. The manufacturer's representative shall perform testing on the intake screen and air backwash system before shipment from the factory. A written certified test report certifying system operation shall be supplied with the intake screen and air backwash system at the time of shipment.

END OF SECTION 11335

SECTION 11400 – AUTOMATIC SELF-CLEANING FILTERS

PART 1 – GENERAL

1.1 SCOPE OF WORK

- A. This section covers the furnishing of all labor, materials, equipment, related components and accessories for the automatic self-cleaning filter system as specified under this section and as shown on the drawings. The work includes furnishing all equipment and related services and systems, and providing labor and materials to properly place all equipment into service, including interface, coordination, installation, start-up, calibration, operator training, troubleshooting and warranty repair.
- B. These specifications provide a general description of the requirements of the system, but do not cover all details. The automatic self-cleaning filter system shall be constructed as a complete system, and shall include all of the necessary components and accessories required to form a system which is practical and functional in its operation, appropriate from the point of view of generally accepted safety standards, well ordered and complete in every way.

1.2 DESCRIPTION OF WORK

- A. Work includes furnishing and installing self-cleaning filters, motors, exhaust valves, system controls, accessories, and all associated work to make a complete and fully operational automatic self-cleaning filter system.
- B. The items of equipment covered by these Specifications are intended to be standard equipment of proven ability as manufactured by a reputable, qualified manufacturer, having long experience in the production of such equipment. The equipment shall be designed, constructed and installed with the best methods, materials and practice, and shall operate satisfactorily when installed. All equipment shall be new and un-used, and shall be the standard product of manufacturers having a successful record of manufacturing and servicing equipment and systems as specified herein for a minimum of five years.

1.3 SUBMITTALS

- A. Shop drawing submittals containing detailed information specific to the project requirements shall be submitted as outlined in Specification Section 01300.

1.4 RELATED WORK

- A. Division 1 – General Requirements
- B. Section 15730 – Wastewater Piping Systems
- C. Division 16 – Electrical

1.5 REFERENCES

- A. American Society of Mechanical Engineers (ASME): B15.5 , Pipe Fittings and Flange Fittings
- B. National Electrical Manufacturer's Association (NEMA): 250 Enclosures for Electrical Equipment (1,000 Volts Maximum).

1.6 WARRANTY

- A. The Contractor shall provide a one-year guarantee to the Owner. The guarantee shall cover all necessary labor, equipment and replacement parts resulting from faulty or inadequate equipment, improper assembly or erection, defective workmanship and materials, leakage, breakage or other failure of all equipment and components. The guarantee period shall commence on the date of the Engineers issue of certificate of substantial completion. The Owner shall incur no labor or equipment cost associated with work under warranty during the guarantee period.

1.7 DOCUMENTATION AND TRAINING

- A. Complete hardware installation, operation maintenance, and trouble shooting manuals shall be provided. Six (6) sets are required.
- B. If there are difficulties in the operation of the equipment, due to the inadequate level of training or the manufacturer's design or fabrication, additional training and/or services shall be provided to resolve the difficulties, at no cost to the owner.

1.8 TOOLS AND SPARE PARTS

- A. All special tools required for normal operation, adjustment, or maintenance of the equipment shall be furnished with the equipment by the manufacturer.
- B. The manufacturer shall provide a recommendation and supply all parts and accessories expected to be required for normal operation for the first year of operation.
- C. All tools and spare parts shall be furnished in containers clearly marked with indelible markings as to their contents. This inventory shall be provided in a manner which is well ordered and complete.

PART 2 – PRODUCTS

2.1 FILTER

- A. The self-cleaning filter system shall remove all particles larger than 130 microns from the influent throughout the entire operating range of the drip irrigation system. The filters shall fit in the space on the plans.
- B. The filter unit shall be an automatic, self-cleaning type. The body of the filter shall be carbon steel (ST 37-2). The filter cover shall be SMC polyester. The inside and outside of the body shall be coated with multi-layer polyester. The

body shall contain two raised face flange connections drilled with dimensions conforming to 150-pound ANSI. The cover shall be removable to facilitate maintenance. The maximum operating pressure of the filter body shall be 150 PSI and the maximum operating temperature shall be 120°F. Minimum operating pressure during the cleaning cycle shall be 50 PSI.

- C. Inlet and outlet flange connections shall be four inches in diameter.
- D. The filter system shall have a clean-screen pressure drop of no greater than 1 PSI at a flow rate of 155 GPM.
- E. Cleaning shall be accomplished by an electric motor driven rotating cleaning element made of Type 316L stainless steel that simultaneously moves linearly as a result of a threaded-shaft/fixed-threaded-bearing mechanism. This linear movement shall be limited by two normally closed limit switches and monitored by the PLC in the control panel. The cleaning element, called a "suction scanner," shall have three radially oriented nozzles of circular cross section, each of which shall have a thread mounted polyacetal nozzle cap with a circular orifice for sacrificial wear. The sum of the cross sectional areas of the three nozzle orifices shall not exceed 0.51 square inches. The velocity created at the nozzle head shall be 30 feet per second. The motor drive for the rotating cleaning element shall turn the cleaning element at no more than 24-rpm, shall be suitable for operation with 120-volt, 1-phase, 60-hertz current and shall be minimum 1/4-horsepower. The cleaning cycle shall last for no more than 20 seconds.
- F. The filter shall have a removable cylindrical four-layer filtration element made entirely of Type 316L stainless steel weave-wire screen with a 130 micron filtration degree. First, against the dirty liquid, shall be a 3000-micron square-weave woven-wire layer. Next shall be the fine weave-wire layer providing the solids removal. A second 3000-micron square-weave woven-wire layer shall make up the third layer. The fourth layer surrounding the entire cylinder is a welded wedge-wire grid providing structural strength. The total effective filtration area of the cylindrical filtration element shall be 465 square inches. Filtration elements with filtration degrees ranging from 500-microns to 10-microns shall be interchangeable in the same filter body.
- G. The cleaning system for the filter shall include a 2-inch hydraulic diaphragm valve operated by the pressurized liquid on the upstream side of the cleaning element. The body of this valve shall be polyester coated cast iron.

2.2 CONTROLS

- A. The filter control panel shall be complete factory wired. It shall contain all required control and power elements to provide automatic self-cleaning system operations as described herein. The filter control panel shall include main power disconnect switch, starters, transformer, Programmable Logic Control (PLC), relays, timers, alarm logic modules, Time & DP - DP Only - Continuous three position toggle selector switch (where DP = differential pressure), indicating lights, mounting brackets and accessories, wiring harnesses, terminal strips, wiring and an enclosure with keyed handle and hinged front door.

- B. The automatic self-cleaning system shall provide continuous or intermittent operation of the cleaning cycle based on the position of the Time & DP - DP Only - Continuous selector switch. The cleaning cycle shall open the hydraulic diaphragm exhaust valve and start the motor to rotate the cleaning element for the required cleaning interval. After the cleaning interval is completed, the cleaning cycle shall stop the motor of the rotating cleaning element, close the exhaust valve and reset the cleaning cycle for the next operation.
- C. With the selector switch in the CONTINUOUS mode, the cleaning cycle shall operate continuously to clean the filter. In the CONTINUOUS selector position the timers and differential pressure switch shall be overridden.
- D. With the selector switch in the TIME&DP position, timers shall intermittently initiate the cleaning cycle at preset adjustable intervals ranging from 0 to 24 hours for the length of time necessary to complete one cleaning cycle.
- E. A differential pressure switch shall be arranged on the filter or across the inlet and outlet piping of the filter to override the timer in the TIME&DP mode or acting alone in the DPONLY mode to initiate the cleaning cycle whenever a differential pressure across the filter exceeds a preset value. The differential pressure switch shall continue to operate the cleaning cycle until the differential pressure across the filter returns to normal or an adjustable timer inside the control panel elapses. If the cleaning cycle continues until this preset timer elapses, then the control panel shall shut down the cleaning operation completely causing the red alarm FAULT light to glow on the cover of the control panel and send a 24 volt AC alarm signal to terminals 12 and 13 inside the control panel.
- F. A "TEST" button shall be located on the control panel door that will initiate a cleaning cycle upon demand.
- G. A "RESET" button shall be located on the control panel door.
- H. Indicating lights for the control panel shall include a control circuit "energized" indicating light (green lens) and a "malfunction" indicating light (red lens) both located on the control panel door.
- I. The control panel enclosure shall be a NEMA 4 enclosure with interior backplate. The control panel shall be designed for wall mounting and shall only require conduit connections and lug wiring connections to the terminal strips in the field.
- J. Control panel shall be Underwriter's Laboratory approved.
- K. External Interfaces: Provide the following interfaces as a part of the control system for monitoring and control.
 - 1. Flush in progress – relay contact closure output
 - 2. System fault alarm – relay contact closure output

2.3 PRESSURE DIFFERENTIAL SWITCH

- A. The nonadjustable differential pressure switch shall be preset at 7-psi and enclosed in a NEMA 4 enclosure and shall be suitable for up to 240V AC/DC.. The differential pressure switch shall have an easy to read “pointer & dial” gauge and shall be the fully automatic diaphragm type differential pressure switch.

2.4 FINISHES

- A. Prepare, prime and finish coat in accordance with manufacturer’s standard coating.

2.5 SOURCE QUALITY CONTROL

- A. The filter shall conform to international quality code: ISO-90001.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. The contractor shall provide all labor, materials, equipment, and expertise required to carry out the installation, calibration, testing, operator training, and start-up of all equipment in a manner in keeping with the best standard practices available and in accordance with the manufacturer’s recommendations for each piece of equipment supplied.

3.2 FIELD QUALITY CONTROL

- A. Manufacturer’s Field Services: Provide one day(s) of service at the site by a qualified representative of the system manufacturer to inspect the installation of their respective unit, make any necessary adjustments, test the equipment, place the equipment in initial hands-free operation and instruct the operating personnel in its operation and maintenance.

END OF SECTION 11400

SECTION 11950 – DRIP IRRIGATION SYSTEM

PART 1 – GENERAL

1.1 SCOPE OF WORK

- A. This section covers the furnishing of all labor, materials, equipment, related components and accessories for the drip irrigation system as specified under this section and as shown on the drawings. The work includes furnishing all equipment and related services and systems, and providing labor and materials to properly place all equipment into service, including interface, coordination, installation, start-up, calibration, operator training, troubleshooting and warranty repair.
- B. These specifications provide a general description of the requirements of the system, but do not cover all details. The drip irrigation system shall be constructed as a complete system, and shall include all of the necessary components and accessories required to form a system which is practical and functional in its operation, appropriate from the point of view of generally accepted safety standards, well ordered and complete in every way.

1.2 DESCRIPTION OF WORK

- A. Work includes furnishing and installing a drip irrigation system consisting of an automatic, programmable irrigation controller, rain / freeze sensor, electric remote zone control valves, drip tubing with emitters, buried piping of various sizes and materials (covered in Section 15730 – Wastewater Piping Systems), and all associated work to make a complete and fully operational drip irrigation system.
- B. The items of equipment covered by these Specifications are intended to be standard equipment of proven ability as manufactured by a reputable, qualified manufacturer, having long experience in the production of such equipment. The equipment shall be designed, constructed and installed with the best methods, materials and practice, and shall operate satisfactorily when installed. All equipment shall be new and un-used, and shall be the standard product of manufacturers having a successful record of manufacturing and servicing equipment and systems as specified herein for a minimum of five years.

1.3 SUBMITTALS

- A. Shop drawing submittals containing detailed information specific to the project requirements shall be submitted as outlined in Specification Section 01300.

1.4 RELATED WORK

- A. Division 1 – General Requirements
- B. Section 15730 – Wastewater Piping Systems

C. Division 16 – Electrical

1.5 WARRANTY

- A. The Contractor shall provide a one-year guarantee to the Owner. The guarantee shall cover all necessary labor, equipment and replacement parts resulting from faulty or inadequate equipment, improper assembly or erection, defective workmanship and materials, leakage, breakage or other failure of all equipment and components. The guarantee period shall commence on the date of the Engineers issue of certificate of substantial completion. The Owner shall incur no labor or equipment cost associated with work under warranty during the guarantee period.

1.6 DOCUMENTATION AND TRAINING

- A. Complete hardware installation, operation maintenance, and trouble shooting manuals shall be provided. Six (6) sets are required.
- B. If there are difficulties in the operation of the equipment, due to the inadequate level of training or the manufacturer's design or fabrication, additional training and/or services shall be provided to resolve the difficulties, at no cost to the owner.

1.7 TOOLS AND SPARE PARTS

- A. All special tools required for normal operation, adjustment, or maintenance of the equipment shall be furnished with the equipment by the manufacturer.
- B. The manufacturer shall provide a recommendation and supply all parts and accessories expected to be required for normal operation for the first year of operation.
- C. All tools and spare parts shall be furnished in containers clearly marked with indelible markings as to their contents. This inventory shall be provided in a manner which is well ordered and complete.

PART 2 – PRODUCTS

2.1 IRRIGATION CONTROLLER

- A. General
1. An irrigation control panel shall be provided to provide the following control functions
- a) Provide programmable irrigation zone control and scheduling.
 - b) Provide control outputs to start selected VFD well pump and to enable the flow setpoint controller as required for operation for each of four zones.
 - c) Provide open-close control to irrigation valves.

2. Station timing shall be from 0 minutes to 6 hours. Run time resolution shall be in 1-minute increments from 0 to 59 minutes and 10 minutes from 1 to 6 hours.
3. The controller shall have three separate and independent programs which can have different start times, station timing and watering days. Each program shall have up to 4 start times available. The controller shall stack multiple start times in sequence to prevent hydraulic overload. The LCD shall display "No Start Times" or equivalent icon if no start time has been entered for any program.
4. The control system shall be capable of operating four 24 VAC solenoid valves as well as start stop control for the irrigation pumps and pump status to the PID pump speed controller.
5. The controller shall have a 365-day calendar with a permanent day off feature that allows a day(s) of the week to be turned OFF on any cycle. A day set to "Permanent Off" shall override the normal repeating schedule and shall display the words "Day Always Off/Day Off" in the LCD screen.
6. The controller shall have a seasonal adjust feature adjustable from 0% to 200% in increments of 10%. Seasonal adjust shall effect all programs simultaneously.
7. The controller shall have a 12-hour AM/PM or 24 hour military clock with a midnight day change over.
8. The controller shall have a sensor circuit for connection to a rain sensor that will interrupt a scheduled watering under "wet" or "moist" conditions. The controller shall have an indicator on the LCD screen and one LED light to indicate that a sensor is connected and active and that watering has been temporarily disabled.
9. The controller shall have additional adjustable features via the HMI as listed below.
 - a) Save a custom default irrigation program
 - b) Retrieve a custom default irrigation program
 - c) Bypass an active rain sensor on the Auxiliary Station
 - d) Allow the Auxiliary Station to be interrupted by an active rain sensor
 - e) Clear memory
 - f) Set a day as "Permanently Off"
 - g) Set master valve/pump start circuit by station

- h) Set programmable delay between stations.
- 10. The controller shall have the following manual operations and manual advances for semiautomatic control:
 - a) Run a single valve
 - b) Run multiple manually stacked valves
 - c) Run a semi-automatic program
 - d) Run a test on all valves (all stations with any time assigned regardless of the program) from 1 to 10 minutes
- 11. The controller shall have the capacity for an irrigation program to be erased allowing the user to start programming with a blank irrigation sequence.

B. Electrical

- 1. The controller shall operate on 120 VAC at 60Hz.

2.2 RAIN / FREEZE SENSOR

- A. The wireless rain or rain / freeze sensor shall employ an electro-mechanical actuating mechanism designed to cause a circuit interrupt if programmable low temperature or rainfall set points are satisfied. Satisfied set points shall cause the device to temporarily suspend the irrigation controller schedule. As environmental conditions return to a state that no longer satisfy the low temperature or rainfall set points, the controller's normal irrigation schedule shall resume. The sensor shall be wired to normally closed (N.C.) controllers – in series with the valve common, or alternately, wires shall be inserted into the appropriate controller sensor terminal ports.
- B. The device shall be of rugged construction to withstand the elements, including exposure to sunlight and precipitation. Antennas shall be concealed within the sensor and controller interface to improve aesthetics and product robustness.
- C. The device shall be used with 24VAC controllers and shall be of sufficient capacity to be used with a maximum of six 24VAC 7VA solenoids plus an additional master valve or pump start that does not exceed 53VA.
- D. The wireless rain sensor shall incorporate a provision that allows the installer to select from several rainfall or low temperature settings that can be programmed through the use of icons on a controller interface. A sensor LED shall communicate signal strength during the installation process.

2.3 ZONE CONTROL VALVES

- A. Contractor shall provide and install four (4) electric remote zone control valves located at each zone as shown on the contract drawings.

- B. The electric remote control valves shall be normally closed 24 VAC 60 Hz solenoid actuated globe pattern design. The valves pressure rating shall not be less than 200 psi. The valves shall have the following characteristics:
1. Flow rate:
 - a) Zone 1 153 gpm
 - b) Zone 2 155 gpm
 - c) Zone 3 155 gpm
 - d) Zone 4 109 gpm
 2. Pressure loss not to exceed:
 - a) Zone 1 1.95 psi
 - b) Zone 2 1.98 psi
 - c) Zone 3 1.95 psi
 - d) Zone 4 2.64 psi
- C. The valve body and bonnet shall be a combination of heavy cast red brass body and heavy-duty glass-filled UV-resistant nylon bonnet and have stainless steel bolts. The diaphragm shall be of nylon reinforced nitrile rubber.
- D. The valve shall have both internal and external manual open/close control (internal and external bleed) to manually open and close the valve without electrically energizing the solenoid. The valve's internal bleed shall prevent flooding of the valve box.
- E. The solenoid shall require 24 VAC 60 Hz power and open with 19.6 VAC minimum at 200 psi. At 24VAC, average inrush current shall not exceed 0.41 amps. Average holding current shall not exceed 0.28 amps.
- F. The valve shall have a brass flow control stem for accurate manual regulation and/or shut-off of outlet flow. The valve must open or close in less than 1 minute at 200 psi and less than 30 seconds at 20 psi.
- G. The valve shall have a self-cleaning stainless steel screen designed for use in dirty water applications.
- H. The valve construction shall be such as to provide for all internal parts to be removable from the top of the valve without disturbing the valve installation.

2.4 IRRIGATION DRAIN VALVES

- A. Provide electrically actuated drain valves for each zone as shown on the drawings.

2.5 DRIP TUBING

- A. Contractor shall provide and install ½" polyethylene drip tubing located within each zone as shown on the contract drawings.
- B. Drip tubing shall be ½" polyethylene tubing with 2 gph pressure compensating inline emitters pre-inserted at 18" spacing.
- C. Tubing shall be constructed of UV stabilized material, brown in color, and be self-cleaning with built-in filter slits and raised inlets to minimize clogging.
- D. Emitters shall be fully pressure compensating between 20 to 60 psi with silicone diaphragms and be spaced 180 degrees apart.
- E. Tubing shall be 0.600" ID x 0.700" OD with a wall thickness of 0.050" and come on a minimum 500' coil roll.
- F. Minimum bending radius of tubing shall be 7".
- G. The number of emitters per zone shall be as follows:
 - 1. Zone 1 5,100
 - 2. Zone 2 5,167
 - 3. Zone 3 5,167
 - 4. Zone 4 3,634

2.5 PRESSURE TRANSMITTERS

- A. Pressure transmitters shall be of the capacitance type, with a process isolated diaphragm with silicone oil fill, microprocessor based "smart" electronics, and a field adjustable 30:1 input range. A transmitter will be provided for monitoring pump station discharge pressure.
- B. Span and zero shall be continuously adjustable externally over the entire range. Span and zero adjustments shall be capable of being disabled internally. Calibrated range shall be 0-100 PSIG.
- C. Transmitters shall be NEMA 4X weatherproof and corrosion resistant construction with low copper aluminum body and 316 stainless steel process wetted parts.
- D. Accuracy, including nonlinearity, hysteresis, and repeatability errors shall be plus or minus 0.10 percent of calibrated span, zero based. The maximum zero elevation and maximum zero suppression shall be adjustable to anywhere within sensor limits.
- E. The transmitter output shall be linear isolated 4-20mA, 24 VDC, proportional to discharge pressure. Power supply shall be 24 VDC, two wire design.

- F. Each transmitter shall be furnished with a 4 digit LCD indicator capable of displaying engineering units and/or milliamps, and mounting hardware as required.
- G. Overload capacity shall be rated at a minimum of 25 MPa. Environmental limits shall be 40 to 85 °C at zero to one hundred percent (0-100%) relative humidity.
- H. Each transmitter shall have a stainless steel tag with calibration data, attached to the body.
- I. The capacitance pressure sensor shall be mechanically, electrically and thermally isolated from the process and the environment, shall include an integral temperature compensation sensor, and shall provide a digital signal to the transmitter's electronics for further processing.
- J. Factory set correction coefficients shall be stored in the sensor's non volatile memory for correction and linearization of the sensor output in the electronics section.
- K. The electronics section shall correct the digital signal from the sensor, and convert it into a 4-20 mA analog signal for transmission to receiving devices.
- L. The electronics section shall contain configuration parameters and diagnostic data in non volatile EEPROM memory, and shall be capable of communicating, via a digital signal superimposed on the 4-20 mA output signal, with a remote interface device. Output signal damping shall be provided, with an adjustable time constant of 0-36 seconds.
- M. Pressure indicating transmitters shall be Rosemount Model 3051CG or approved equal.

2.6 CIRCULAR CHART RECORDER /TOTALIZER / CONTROLLER

- A. Microprocessor controlled circular chart recorder shall include the following features
 - 1. 12 inch single head printhead driven chart recorder. Circular chart shall be configured to display pump station flow and pressure in process units. Chart rotation shall be adjustable and initially set for 7 days
 - 2. Process inputs: 4-20 mA, 250 Ohms
 - 3. Flow totalization in process units
 - 4. PID controller for pump pressure control with 4-20 mA output.
 - 5. Operator Interface shall include displays, indicators, bar-graph and keypad for operator interface.
 - 6. Recorder shall be user configurable to change inputs and calibration.

- B. Microprocessor circular chart recorder / totalizer/ controller shall be Honeywell DR4500A Truline series, or equal.

2.7 DRAIN VALVE ENCLOSURE

- A. A control panel shall be supplied to perform the following functions.
 - 1. Open-close control of 4 zone drain valves with OPEN indicating lights. Provide 24 VDC power supply to operate valves.
 - 2. Two position selector switch to select which pump is to be operated by the irrigation controller.
- B. The control panel shall be housed in a wall-mounted NEMA 12 enclosure for indoor installation.
- C. The control panel control switches shall be industrial oil-tight with legend plates. Indicating lights shall be industrial, oiltight with LED lamps.
- D. Assembled control panel shall be third party labeled, UL 508 or equal.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. The contractor shall provide all labor, materials, equipment, and expertise required to carry out the installation, calibration, testing, operator training, and start-up of all equipment in a manner in keeping with the best standard practices available and in accordance with the manufacturer's recommendations for each piece of equipment supplied.

3.2 EQUIPMENT CALIBRATION

- A. Every analog instrument, including the existing flow meter, control or related device shall be properly calibrated, tuned, adjusted and commissioned so that the accuracy and operation of the device equals the highest level of performance which that device can achieve.
- B. Accurate and appropriate test equipment and industry standard test procedures shall be used to demonstrate that the equipment operates within its expected tolerance of accuracy at various points throughout its operating range.
- C. The technician performing equipment calibration shall be fully familiar, trained and qualified to service and support the items which are being serviced.

3.3 CALIBRATION AND SERVICE REPORTS

- A. A written, dated report shall be prepared by the technician for each start-up, calibration, troubleshooting or maintenance event which identifies the equipment serviced, defines procedures, describes the results of the testing, identifies witnesses, and provides conclusions. This shall include every instrument or system provided in this project, and shall also apply to every visit by equipment

suppliers and system subcontractors. The reports shall also document every wiring modification, warranty repair and problem analysis.

- B. All reports shall be distributed to the Engineer, the contractor and copied to the staff, and a copy shall be kept in a permanent file on site for future reference.

3.4 IRRIGATION CONTROLLER PROGRAMMING

- A. Contractor shall program the controller in accordance with the manufacturer's instructions.
- B. The programming schedule for the irrigation zones shall be such that the application of water does not exceed the permit limits for daily, weekly, or seasonal application rates.

3.5 MANUFACTURER'S FIELD SERVICES

- A. Provide one day(s) of service at the site by a qualified representative of each system manufacturer to inspect the installation of their respective unit, make any necessary adjustments, test the equipment, place the equipment in initial hands-free operation and instruct the operating personnel in its operation and maintenance.

END OF SECTION 11950

SECTION 15060 – HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY:

- A. This Section includes hangers and supports for mechanical system piping and equipment.

1.3 DEFINITIONS:

- A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Pipe Hangers:
 - a) AAA Technology and Specialties Co., Inc.
 - b) B-Line Systems, Inc.
 - c) National Pipe Hanger Corp.

2.2 MANUFACTURED UNITS:

- A. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components. Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.
 - 1. Galvanized, Metallic Coatings: For piping and equipment that is not stainless steel or will not have field-applied finish shall be hot dipped galvanized after manufacture.
 - 2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.

2.3 MISCELLANEOUS MATERIALS:

- A. Structural Steel: ASTM A 36/A 36M, steel plates, 314 stainless steel, shapes, and bars, black and galvanized.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS:

- A. Specific hanger requirements are specified in Sections specifying equipment and systems.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification Sections.
- C. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
 - 1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes.
- D. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers.
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers if longer ends are required for riser clamps.
- E. Building Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
 - 1. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
 - 2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 - 3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 - 4. C-Clamps (MSS Type 23): For structural shapes.
 - 5. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 - 6. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 - 7. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
- F. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
 - 1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 - 2. Protection Shields (MSS Type 40): Of length recommended by manufacturer to prevent crushing insulation.

3.2 HANGER AND SUPPORT INSTALLATION:

- A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, and at changes in direction of piping.
- C. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- D. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- E. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- F. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," is not exceeded.
- G. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a) Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b) Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c) Do not exceed pipe stress limits according to ASME B31.9.
 - 2. Install MSS SP-58, Type 39 protection saddles, if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a) Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span arc of 180 degrees.
 - a) Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a) 12 inches long and 0.048 inch thick.
 - 5. Insert Material: Length at least as long as protective shield.
 - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS:

- A. Fabricate structural-steel stands to suspend equipment from structure above.

3.4 METAL FABRICATION:

- A. Cut, drill, and fit miscellaneous metal fabrications for equipment supports.
- B. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING:

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.6 PAINTING:

- A. Touching Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9 Section "Painting."
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 15060

SECTION 15075 – MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY:

- A. This Section includes the following mechanical identification materials and their installation:
 - 1. Equipment nameplates.
 - 2. Equipment markers.
 - 3. Access panel and door markers.
 - 4. Pipe markers.
 - 5. Valve tags.
 - 6. Warning tags.

1.3 SUBMITTALS:

- A. Product Data: For each type of product indicated.

1.4 QUALITY ASSURANCE:

- A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 COORDINATION:

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with location of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES:

- A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.

1. Data:
 - a) Manufacturer, product name, model number, and serial number.
 - b) Capacity, operating and power characteristics, and essential data.
 - c) Labels of tested compliances.
 2. Location: Accessible and visible.
 3. Fasteners: As required to mount on equipment.
- B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.
1. Terminology: Match schedules as closely as possible.
 2. Data:
 - a) Name and plan number.
 - b) Equipment service.
 - c) Design capacity.
 - d) Other design parameters such as pressure drop, entering and leaving conditions, and speed.
 3. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.
- C. Access Panel and Door Markers: 1/16-inch thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch center hole for attachment.
1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.2 PIPING IDENTIFICATION DEVICES:

- A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
1. Colors: Comply with ASME A13.1, unless otherwise indicated.
 2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
 3. Pipes with OD, Including Insulation: Full-band pipe markers extending 360 degrees around pipe at each location.
 4. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.
- B. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.
- C. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.
1. Width for Markers on Pipes with OD, Including Insulation 3/4 inch minimum.

2.3 VALVE TAGS:

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme. Provide 5/32-inch hole for fastener.
 - 1. Material: 0.032-inch- thick brass.
 - 2. Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook.

2.4 WARNING TAGS:

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.
 - 1. Size: Approximately 4 by 7 inches.
 - 2. Fasteners: Brass grommet and wire.
 - 3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
 - 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL:

- A. Products specified are for applications referenced in other Division 15 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION:

- A. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.
 - 1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
 - 3. Locate markers where accessible and visible.

3.3 PIPING IDENTIFICATION:

- A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
 - 1. Pipes with OD, Including Insulation: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 3/4 inch wide, lapped at

least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.

- B. Locate pipe markers and color bands where piping is exposed in finished spaces and accessible maintenance spaces as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.
 - 4. At access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 25 feet along each run.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

3.4 WARNING-TAG INSTALLATION:

- A. Write required message on, and attach warning tags to, equipment and other items where required.
- B. Permanent notification shall be provided to inform employees or the public of the use of reuse water (Non Potable Water) in the water closet and urinal systems and that the water is not intended for drinking.
- C. All reuse water valves and outlets shall be tagged or labeled to warn the public or employees that the water is not intended for drinking. All reuse water piping, valves, outlets and other appurtenances shall be color-coded, taped, and marked in accordance with Section 608 of the North Carolina Plumbing Code to identify the source of the water as being reuse water:
 - 1. All reclaimed water piping and appurtenances shall be colored yellow, and embossed or integrally stamped or marked "CAUTION: RECLAIMED WATER - DO NOT DRINK". The warning shall be stamped on opposite sides of the pipe and repeated every 10 feet or less.

3.5 ADJUSTING:

- A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.6 CLEANING:

- A. Clean faces of mechanical identification devices.

END OF SECTION 15075

SECTION 15211 – GENERAL-SERVICE COMPRESSED-AIR PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY:

- A. This Section includes piping and related specialties for general-service compressed-air systems operating at 200 psig and less.
- B. Related Sections include the following:
 - 1. Division 15 Section "Interior/Exposed Pipework and Appurtenances".

1.3 DEFINITIONS:

- A. Low-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures of 125 psig and less.

1.4 SUBMITTALS:

- A. Product Data: For the following:
 - 1. Pipes, tubes, and fittings.
 - 2. Flexible pipe connectors.
 - 3. Safety valves.
 - 4. Pressure regulators.
 - 5. Filters.
 - 6. Automatic drain valves.
 - 7. Quick couplings.
- B. Field quality-control test reports.

1.5 QUALITY ASSURANCE:

- A. Comply with ASME B31.9, "Building Services Piping," for low-pressure compressed-air piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 PIPING MATERIALS:

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 PIPES, TUBES, AND FITTINGS:

- A. 304/304L stainless steel seamless tubing, outside diameter as required by valve manufacturers. ASTM A450 tubing wall thickness shall be calculated from ASME B31.3 to supply required valve pressure as specified by the valve manufacturer. Tubing hardness shall be selected to allow the tubing material to be softer than the tubing fittings.

- B. Flexible Pipe Connectors: Corrugated tubing with wire-braid covering.

1. Manufacturers:

- a) ANAMET Inc.
- b) Flex-Hose Co., Inc.
- c) Flexicraft Industries.

2. Bronze-Hose Flexible Pipe Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

- a) Working-Pressure Rating: 200 psig minimum.
- b) End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.

3. Stainless-Steel-Hose/Steel Pipe Flexible Pipe Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

- a) Working-Pressure Rating: 200 psig minimum.
- b) End Connections NPS 2 and Smaller: Threaded steel pipe nipple.

2.4 JOINING MATERIALS:

- A. Piping shall be joined in a manner consistent with the manufacturer's recommendation.

2.5 VALVES:

- A. General-Duty Valves: Valves shall match valves currently in use by the Owner in each facility.

2.6 (NOT IN THIS CONTRACT)

2.7 IDENTIFICATION:

- A. Refer to Division 15 Section "Mechanical Identification" for identification of piping, valves, gages, and specialties.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS:

- A. Install nipples, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating required by valves, unless otherwise indicated.

3.2 PIPING INSTALLATION:

- A. Install air and drain piping with 1 percent slope downward in direction of airflow.
- B. Install eccentric reducers where piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
- C. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.
- D. Install flexible pipe connector on each connection to air compressors.

3.3 JOINT CONSTRUCTION:

- A. Compressed air piping joints shall be installed in accordance with the pipe manufacturer's recommendations.

3.4 HANGER AND SUPPORT INSTALLATION:

- A. Refer to Division 15 Section "Hangers and Supports" for pipe hanger and support devices. Install the following:
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - a) 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
- B. Install supports according to Division 15 Section "Hangers and Supports."
- C. Support horizontal piping within 12 inches of each fitting and coupling.
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- F. Install hangers for 304/304L stainless steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1/4 to NPS 1/2: 96 inches with 3/8-inch rod.
 - 2. NPS 3/4 to NPS 1-1/4: 84 inches with 3/8-inch rod.
 - 3. NPS 1-1/2: 12 feet with 3/8-inch rod.
- G. Install supports for vertical, 304/304L stainless steel piping every 15 feet.

3.5 CONNECTIONS:

- A. Drawings indicate general arrangement of valves requiring compressed air.
- B. Install piping from nearest compressed air line to valve requiring compressed air service.

3.6 LABELING AND IDENTIFICATION:

- A. Install identifying labels and devices for general-service compressed-air piping systems. Refer to Division 15 Section "Mechanical Identification" for labeling and identification materials.

3.7 FIELD QUALITY CONTROL:

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Test and adjust piping safety controls. Replace damaged and malfunctioning safety controls.
 - 2. Piping Leak Tests: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
 - a) Repair leaks and retest until no leaks exist.
 - 3. Report results in writing.

END OF SECTION 15211

SECTION 15730 – WASTEWATER PIPING SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section covers the installation of process wastewater piping, valves, and fittings as shown on the drawings.

1.2 RELATED SECTIONS

- A. Division 2 - Sitework
- B. Division 11 - Equipment

1.3 REFERENCES

A. ANSI/AWWA Standards

1. ANSI/AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Piping
2. ANSI/AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings 3-in. Through 48-in. for Water and Other Liquids
3. ANSI/AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings
4. ANSI/AWWA C115/A21.15 - Flanged Ductile-Iron Pipe With Threaded Flanges
5. ANSI/AWWA C150/A21.50 - Thickness Design of Ductile-Iron Pipe
6. ANSI/AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast, for Water and Other Liquids
7. ANSI/AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances
8. ANSI/AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe 4 In. and (PVC) Fittings Through 12 In. for Wastewater Piping
9. ANSI/AWWA C905 - Polyvinyl Chloride (PVC) Water Transmission Pipe, and (PVC) Fittings Nominal Diameters 14 In through 48 In

B. ASTM Standards

1. ASTM A193 - Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service

2. ASTM A194 - Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
3. ASTM D792 - Test Methods for Specific Gravity and Density of Plastics by Displacement
4. ASTM D1598 - Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure
5. ASTM D1599 - Test Method for Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings
6. ASTM D1784 - Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
7. ASTM D3139 - Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
8. ASTM D4024 - Specification for Reinforced Thermosetting Resin (RTR) Flanges
9. ASTM F477 - Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

C. AWWA Standards

1. AWWA Manual M23 - PVC Pipe - Design and Installation

1.4 DEFINITIONS

- A. Pipe, fittings and valve sizes and references to pipe diameter on the Drawings and in the Specifications are intended to be nominal size or diameter, and shall be interpreted as nominal size or diameter.

1.5 SYSTEM DESCRIPTION

- A. Pipe, fittings, joints accessories and wastewater piping appurtenances for wastewater piping systems.

1.6 SUBMITTALS

- A. General: As specified in:
1. General Conditions
 2. Section 01300, Submittals

1.7 QUALITY ASSURANCE

- A. Testing: Test pipe, fittings and wastewater piping appurtenances specified in this Section.

PART 2 - PRODUCTS

2.1 MATERIAL FOR WASTEWATER PIPING

A. Buried Piping

1. 4" through 8" Piping: Ductile Iron or PVC Schedule 80
2. Less than 4" Piping: PVC Schedule 80

B. Exposed Piping

1. 4" and Larger Piping: Ductile Iron or Sch 10, 304 stainless steel

2.2 MANUFACTURERS

A. Ductile Iron

1. Pipe

- a) American Cast Iron Pipe Company;
- b) McWane Cast Iron Pipe Company;
- c) United States Pipe & Foundry Company;
- d) Or equal US manufacture of ductile iron pipe.

2. Fittings

- a) American Cast Iron Pipe Company;
- b) Union Foundry Company;
- c) United States Pipe & Foundry Company; or equal US manufacturer of cast iron and ductile iron fittings.
- d) Griffin Pipe Company

B. PVC (Schedule 80) Pipe and Fittings

1. J-M Manufacturing Co., Inc.
2. Specified Fittings, Inc.
3. Or equal US manufacturer of Schedule 80 PVC pipe and fittings.

2.3 DUCTILE IRON PIPE, FITTINGS AND APPURTENANCES

A. Ductile Iron Pipe

1. Material Standard for Ductile Iron Pipe: ANSI/AWWA C151/A21.51.

2. Ductile Iron Pipe Standard: ANSI/AWWA C151/A21.51.
 3. Mechanical Joint Ductile Iron Pipe
 - a) Thickness Standard: ANSI/AWWA C150/A21.50
 - b) Minimum Pressure Class:
 - (1) 4" through 8" Pipe ; Class 350
 - (2) Flange Joint Ductile Iron Pipe
 - (a) Thickness Standard: ANSI/AWWA C115/A21.15, Table 15.1.
 - (b) Working Pressure Rating: 250 psi.
- B. Fittings for Ductile Iron Pipe
1. Material: Ductile iron.
 2. Material Standard: ANSI/AWWA C110/A21.10.
 3. Fitting Standard
 - a) 4" through 8" Fittings: ANSI/AWWA C110/A21.10.
 4. Pressure Rating: 150 psi.
- C. Ductile Iron Pipe and Fitting Joints
1. Joint Type
 - a) Joints for Buried Ductile Iron Pipe and Fittings
 - (1) Restrained Joints: Restrained push-on joints or mechanical joints with retainer glands.
 - b) Joints for Exposed Ductile Iron Pipe and Fittings: Flange joints.
 - (1) Joint Standard: ANSI/AWWA C111/A21.11
 - c) Restrained Push-on Joints for Ductile Iron Pipe
 - (1) American Cast Iron Pipe Company Fast-Grip gasket (4" - 8"), Flex-Ring, Field Flex-Ring, Lok-Ring, and Lok-Fast;
 - (2) McWane Cast Iron Pipe Company Super Lock;
 - (3) United States Pipe & Foundry Company Field Lok gasket (4" - 8") and TR-Flex;

- (4) Or equal restrained push-on joint by US manufacturer.
 - d) Restraining Mechanical Joints
 - (1) EBAA Iron Sales, Inc., Megalug Series 1100;
 - (2) Or equal retainer gland by US manufacturer.
 - e) Flanges for Ductile Iron Pipe and Fittings
 - f) Material for Ductile Iron Pipe and Fitting Flanges
 - (1) Pipe Flanges: Ductile iron.
 - (2) Fitting Flanges: Ductile iron or cast iron.
 - g) Flange Standard for Ductile Iron Pipe and Fittings
 - (1) Ductile Iron Pipe Flanges: ANSI/AWWA C115/A21.15.
 - (2) Ductile Iron Fitting Flanges: ANSI/AWWA C110/A21.10.
 - (3) Dimension Standard for Ductile Iron Flanges: ANSI B16.1, Class 125.
 - (4) Face Type for Ductile Iron Flanges: Flat.
 - (5) Coating for Machine Faces: Rust-inhibitive primer.
- D. Linings and Coatings for Ductile Iron Pipe and Fittings
- 1. Lining
 - a) Material: Protecto 401, Ceramic, Polyethylene.
 - b) Material Standard: ANSI/AWWA C104/A21.4
 - c) Lining Thickness: Double thickness.
 - 2. Coating
 - a) Buried Ductile Iron Pipe and Fittings
 - (1) Material: Asphaltic coating.
 - (2) Coating Standard: ANSI/AWWA C151/A21.51.
 - b) Exposed Ductile Iron Pipe and Fittings
 - (1) Material: Rust inhibitive primer.
- E. Encasement for Ductile Iron Pipe

1. Encasement Material for Ductile Iron Pipe: Polyethylene.
2. Standard for Ductile Iron Pipe Encasement: ANSI/AWWA C105/A21.5.

2.4 PVC PIPE, FITTINGS AND APPURTENANCES

A. PVC Pipe, 1-1/2" through 8"

1. Material and Pipe Standard for PVC Pipe: Schedule 80.

B. Fittings for PVC Pipe, 1-1/2" through 8"

1. Fitting Material for PVC Pipe: PVC Sch 80.

a) Joints for Buried PVC Pipe and Fittings

(1) Restrained Joints for Buried PVC Pipe and Fittings

(a) Solvent welded per manufacturer's recommendations.

(b) PVC Piping to Other Piping Materials: Mechanical restrained joint.

(2) Restraining Mechanical Joints

(a) JCM Industries, Series 600 Restrainer;

(b) Or equal restraining device with fusion epoxy coating by US manufacturer.

2.5 JOINT ACCESSORIES

A. Gaskets

1. Flange Joint Gaskets

2. Gasket Type

a) Gaskets for Ductile Iron and PVC Piping: Full face.

b) Gaskets for Stainless Steel Piping: Ring.

3. Gasket Material

a) All joints: 1/8" neoprene.

B. Bolts, Studs and Nuts

1. Bolts, Studs and Nuts for Flange Joints

2. Bolts for Flange Joints

- a) Type: semi-finished regular hexagon head cap screws.
 - b) Material: AISI 304 stainless steel.
 - c) Threads: UNC threads.
3. Studs for Flange Joints
- a) Material: AISI 304 stainless steel.
 - b) Threads: UNC threads.
 - c) Length: Extend through nuts a minimum of 1/4".
4. Nuts for Flange Joints
- a) Type: Semi-finished regular hexagon nuts.
 - b) Material: AISI 304 stainless steel.
 - c) Threads: UNC threads.
5. Bolts and Nuts for Mechanical Joints
6. Bolts for Mechanical Joints
- a) Type: Tee-head.
 - b) Material: Cast iron.
 - c) Standard: ANSI/AWWA C111/A21.11.
7. Nuts for Mechanical Joints
- a) Type: Hexagon
 - b) Material: Cast iron.
 - c) Standard: ANSI/AWWA C111.A21.11.

2.6 WASTEWATER PIPING VALVES

- A. General: Type as shown on the drawings.
- B. Raw Wastewater Piping Isolation Valves: plug valves
 - 1. Wastewater Piping Check Valves: swing check valves
- C. Wastewater Piping Isolation Valves (Filtered Effluent): Gate valves
- D. Wastewater Piping Check Valves (Filtered Effluent): Swing Check Valve

2.7 AIR RELEASE VALVES

- A. Air release valves for reclaimed water service shall be the long stem and body type designed to keep the valve operating mechanism as free from contact with the sewage as possible. Valves shall have 2" threaded inlet, with 1" blow off connection with 1" blow off valve (gate valve), ½" back flushing attachments with ½" outlet. Outlet and back flushing connections shall be quick couplings. Valve shall have a minimum of 5/16" diameter orifice.
- B. Valve body shall be cast iron; mechanism and seat, bronze; lever pins, stainless steel; and float, stainless steel. Valves shall be suitable for 150 psi working pressure. Valves shall be as manufactured by the Multiplex Mfg. Company, the Valve and Primer Company, Val-Matic Mfg. Corp., or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all piping, fittings, and valves in strict accordance with manufacturer's instructions.

3.2 HYDROSTATIC TEST

- A. Perform pressure testing of all wastewater piping as specified in ANSI/AWWA C600.
 - 1. Test pressure for wastewater piping at 125 psi for a duration not less than eight hours.
 - 2. Record test results. If pressure drop exceeds 5 psi, repair leaks and repeat test. Test will be considered successful when pressure drop over the test period is less than 5 psi.
 - 3. **Pressure test the existing 3 inch PVC forcemain from the new secondary effluent pump station to the wet weather storage basin. Repair the existing 3 inch forcemain as required and retest to insure integrity.**

3.3 FLUSHING AND CLEANING

- A. Flush all wastewater piping systems at a minimum of 4 ft/sec to remove debris.

3.4 MANUFACTURERS' REPRESENTATIVE

- A. Provide services of pipe and fitting manufacturers' representatives as required to obtain correct piping installation, jointing, connections to structures, connections to existing piping systems, and piping supports.

- B. Provide assistance of pipe and fitting manufacturers' representatives at no additional cost to the Owner.

END OF SECTION 02730

SECTION 15731 – GRAVITY SEWER SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section gives the requirements for installation of gravity sewer pipe and service laterals. Service laterals shall be installed where shown on the drawings. Excavation, trenching and back filling is covered in Section 02200: "Clearing, Grading, and Excavation".

1.2 SUBMITTALS

- A. Shop Drawings: Contractor shall submit shop drawings and material specification sheets of all material and items to be installed or delivered as specified in Section 01300: Submittals.

1.3 REFERENCES

- A. ASTM D1784 - Rigid Poly Vinyl Chloride (PVC) Compounds and Chlorinated Poly Vinyl Chloride (CPVC) Compounds.
- B. ASTM D1785 - Poly Vinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- C. ASTM D2241 - Poly Vinyl Chloride (PVC) Pressure-rated pipe (SDRSERIES).
- D. ASTM D2412 - External Loading Properties of Plastic Pipe by Parallel-Plate Loading.
- E. ASTM D-3212 - Elastomeric push-on joints for plastic pipe.
- F. AWWA C600 - Installation of Ductile Iron water mains and appurtenances.
- G. AWWA C900 - PVC Pressure Pipe 4 inch through 12 inch.
- H. AWWA C905 - PVC Pressure Pipe 14 inch through 36 inch.
- I. ASTM D2672 - Bell-End Poly Vinyl Chloride (PVC) Pipe.
- J. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- K. ASTM F478 - Precast Concrete Manhole Risers and Tops.
- L. ASTM C497 - Concrete Pipe, Manhole Sections, or Tile
- M. ASTM A746 - Ductile Iron Gravity Sewer Pipe

PART 2 - PRODUCTS

2.1 POLYVINYL CHLORIDE (PVC) PIPE

- A. Sewer mains with depth of earth cover greater than 3 feet.
 - 1. For pipe sizes 4" shall be SCH 80 conforming to the requirements of ASTM D1785 with solvent weld joints conforming to ASTM D2672.
 - 2. For pipe sizes 6" through 12", pipe shall be Class 150, DR18 conforming to the requirements of AWWA C900 with elastomeric push-on joints conforming to ASTM D3212 or ASTM D3139.
- B. Pipe and fittings used for sewer service laterals shall be 4" schedule 40 conforming to ASTM D1785 with solvent welded joints.
- C. Fasteners shall be 304 stainless steel or better where exposed to sewer or sewer gases.

2.2 MANHOLES (Refer to Section 02733)

PART 3 - EXECUTION

3.1 PIPE INSTALLATION

- A. Install PVC pipe in strict accordance with ASTM D2321. Install manholes as indicated on the plans. Excavation and backfill shall be accomplished as specified under Section 02200 - "Clearing, Grading, and Excavation".
- B. Pipe shall be kept clean at all times, and no pipe shall be used in the work that does not conform to the appropriate ASTM Specifications. The laying of pipe in finished trenches shall commence at the lowest point, with the spigot ends pointing in the direction of the flow. All pipe shall be laid with the ends abutting accurately to the lines and grades as shown on the plans. Preparatory to making pipe joints, all surfaces of the portion of the pipe to be jointed or of the factory made jointing material shall be clean and dry. Lubricants, primer, adhesives, etc., shall be used as recommended by the pipe or joint manufacturer's specifications. The jointing material or factory fabricated joints shall then be placed, fitted, and adjusted in a workmanlike manner as to obtain the degrees of water tightness required. Trenches shall be kept dry during bedding, laying and jointing and for as long a period as required. As soon as possible after the joint is made, sufficient backfill material shall be placed along each side of the pipe to offset conditions that might tend to move the pipe off line and grade.
- C. No superficial loads shall be placed on the exposed surface of the trench, unless the backfill is of non-cohesive material, is vibrated or is tamped in layers not exceeding 6-inches in depth. Any defects due to settlement shall be corrected by the Contractor. Bell holes shall be dug sufficiently large to insure the making of proper joints. Water shall not be allowed to rise in the excavation until the joint material has received its set. Great care shall be used to secure water tightness, and to prevent damage to or disturbing of the joints during the backfilling

process, or at any other time. Special precautions shall be exercised to prevent any pipe from resting on rock or any other hard projection which might cause breakage of pipe. During construction, the mouth of the completed pipe shall always be kept properly closed with a suitable plug to prevent the entrance therein of any water, earth, stones or other debris. The Contractor shall also take any and all measures to keep the pipe clean and free from deposits and protect the pipe from damage.

- D. Cleaning Pipe: The pipes shall be thoroughly cleaned before they are laid and shall be kept clean until acceptance of the completed work. The upper end of all pipe lines shall be provided with a header carefully fitted, so as to keep dirt and other substances from entering. This header shall be kept in the end of the pipe line at all times when pipe laying is not in actual progress.
- E. Shoring, Sheeting and Well-Pointing: The Contractor shall include in his price bid for pipe the placing of all necessary shoring, sheeting and well-pointing, gravel bedding, and any other dewatering devices to prevent damage to other installations and where required by the Engineer.
- F. Service piping shall be perpendicular with the main unless otherwise approved by the Engineer. Where new mains are being laid, the house service shall be connected to the main by means of a wye set in the main with the branch turned up in such manner that a good square connection will be made with the grade of the house service. Service pipe shall connect to the main at manholes when noted on the drawings or when requested by the Engineer by core boring the manhole and field installation of the proper size elastomeric boot mortared inside and outside of the manhole. Service lines that enter manholes shall enter on the shelf or at a minimum of crown to crown for the receiving pipe.

3.2 MANHOLE INSTALLATION

- A. General: Manholes shall be constructed of pre-cast concrete rings in accordance with the Drawings. The pre-cast concrete base shall be placed on a six inch (minimum) stone bedding foundation which shall extend up around the pipes to at least 3 inches above the top line of the pipes. Pipes entering the pre-cast sections of the manhole shall be inserted into the adaptor couplings provided. All pre-cast manhole components shall be lifted and moved by use of suitable lifting slings and plugs that will not damage the pre-cast manhole lip.

All damage to pre-cast sections shall be thoroughly repaired in the presence of the Engineer. Repair and patching of minor breaks shall be done by chipping and scarifying the defective area before application of grout. Pre-cast sections shall be subject to rejection on account of failure to conform to any of the specification requirements. In addition, individual sections of manhole sections may be rejected because of fractures or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint; defects that indicate imperfect proportioning, mixing, and molding; surface defects indicating honey-combed or open texture; damaged or cracked end, where such damage would prevent making a satisfactory joint; and/or any continuous crack having a surface

which width of 0.01 inches or more and extending for a length of 12 inches or more, regardless of position in the section wall.

- B. The Contractor is responsible for getting the manhole tops to proper grade. The top of the pre-cast manhole may be brought to proper grade for receiving manhole frames by using brick with a maximum adjustment of 12 inches from pre-cast cone to the cast iron ring. Masonry construction shall be preformed by experienced and qualified workmen. All work shall be laid plumb, straight, level, square, and true. The Contractor shall set and bond the manhole frame in a full bed of mortar. All manhole steps and miscellaneous items shall be properly bedded.
- C. Invert Channels: The invert channels shall be $\frac{3}{4}$ the depth of the largest pipe and shall be smooth and semicircular in shape conforming to the inside of the adjacent sewer section. Changes in direction of flow shall be made with a smooth curve of as large a radius as the size of the manhole will permit. Changes in size and grade of channels shall be made gradually and evenly. The invert channels shall be formed directly in the concrete of the manhole base or shall be built up with solid brick and Type S mortar.

All upstream pipes (including services) shall have sloped invert channel slides that provide smooth transitions to the downstream invert channel. Invert channel slides shall be the diameter of the entering pipe and be formed as a channel that is at least $\frac{3}{4}$ pipe deep. Upstream pipes that enter at the shelf shall have their invert channel slides smoothly cast into the shelf with a sloping transition to the downstream pipe invert.

The floor of the manhole outside the channels, or slides, shall be smooth and shall slope toward the channels not less than 1 inch per foot nor more than 2 inches per foot. No laser bowl invert manholes shall be permitted.

- D. Grade Rings: Manhole castings shall be installed to grade using 24 inch inside diameter pre-cast concrete grade rings, or brick grouted in place, for a maximum adjustment of 12 inches. Manhole sections shall be used for greater adjustment, unless approved otherwise. Flat top manholes shall not be adjusted by more than one course of brick.

3.3 CUTTING OF PIPE

Cut pipe in a neat manner without damage to the pipe or any fittings or specials.

3.4 ADJACENT FACILITIES

A. Water Mains

1. Horizontal and Vertical Separation

- a) Minimum horizontal separation between gravity sanitary sewer lines and existing or proposed water mains (measured edge of pipe to edge of pipe) shall be 10 feet for PVC pipe. Any deviation from the minimum separation shall involve the water main in a

separate trench or on an undisturbed earth shelf located on one side of the sewer at an elevation so the bottom of the water main is at least 18 inches above the top of sewer.

- b) If it is impossible to obtain proper horizontal and vertical separation as described above or anytime sewer must be laid above a water main, both the water main and sewer main must be constructed of class 350 ductile iron pipe and prepared for pressure testing to 150 psi to assure water-tightness before backfilling.

2. Crossings

- a) Sewers crossing water mains shall be laid to provide a minimum vertical separation of 18 inches between the bottom of the water main pipe and the top of the sewer pipe. The crossing shall be arranged perpendicularly so that the sewer joints will be equidistant and at least 10 feet from the crossing in each direction.
- b) When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the following methods must be specified:
 - (1) The sewer shall be designed and constructed of class 350 ductile iron pipe and prepared for pressure testing to 150 psi to assure water-tightness prior to backfilling.

B. Wells

- 1. No manhole shall be placed within 100 feet of a well utilized for potable water.
- 2. No sewer piping shall be placed within 100 feet of a well utilized for potable water.
- 3. Minimum specifications for sewer piping placed between 25 feet and 50 feet of a well utilized for potable water shall meet or exceed the requirements Class 350, ductile iron with push on joints conforming to ANSI A21.50/A21.51 lined with Protecto 401 ceramic epoxy or approved equal.

- C. Roads and Ditches: Provide 36 inch minimum cover for PVC beneath the roads and ditches. When a roadside ditch is perpendicular to the sewer service, a minimum cover of 24 inch will be allowed. Otherwise construct the sewer of ductile iron pipe or encase the pipe in concrete.

3.5 MINIMUM GRADE (Unless otherwise directed or shown on the plans)

- A. 4 INCH PIPE: One foot per 100 feet (1.0 percent).
- B. 6 INCH PIPE: 0.6 feet per 100 feet (0.6 percent).

C. 8 INCH PIPE: 0.4 feet per 100 feet (0.4 percent).

3.6 BACKFILL

Materials and installation of pipe bedding haunching and backfill shall be in accordance with Section 02200, "Clearing, Grading, and Excavation".

3.7 TESTING

A. General: The Contractor shall be responsible for providing all equipment necessary for tests of displacement, deflection, and leakage. Tests for deflection and leakage shall be performed by the Contractor and observed by the Engineer's resident observer. Each segment of line shall be tested:

1. After gravel has been installed on all roadways.
2. After forty-eight (48) hour notice is given.

The camera inspection must be performed upon completing of cleaning and potable water introduced into the system to be tested. All defects in the pipeline and appurtenances shall be remedied by the Contractor at no additional expense to the Owner and will be reinspected as outlined above.

B. Test for Deflection: Deflection tests may be performed on all sections of flexible pipe.

1. Maximum allowable deflection shall be 5 percent at any point.
2. Deflection shall be measured with a pin-type mandrel "Go/No Go" gauge. The gauge shall be pulled through the pipe by means of a strong cord or cable.
3. Any section of pipe not meeting the 5 percent maximum deflective requirement shall be excavated, backfilled, re-compacted and retested.

C. Test for Leakage: All segments of completed line may be tested for leakage by low pressure air test, except that the infiltration test may be used as approved by the Engineer.

1. The Contractor shall remedy all visible leaks in pipes, manholes, and appurtenances.
2. Maximum allowable leakage for the system shall be 0 gallons per inch pipe diameter per linear mile of pipe per 24 hours, including manhole infiltration. No single segment of line (manhole to manhole) shall exceed this requirement.
3. Air Testing: Air testing shall be required by the Engineer if conditions are such that infiltration measurements may be inconclusive. The test shall be

conducted in the presence of the Engineer's representative and shall conform to the following requirements:

- a) Test pressure shall be 3.5 psi increased by the ground water pressure above the top of the sewer.
- b) Pressure loss from 3.5 psi shall not exceed 0.5 psi during the required testing time.
- c) Testing time in minutes shall be calculated as $0.625 \times$ nominal pipe size (inches).

D. Testing Manholes:

1. Each manhole may be tested immediately after assembly and prior to backfilling.
2. All lift holes shall be plugged with an approved Type "S" grout.
3. All pipes entering the manhole shall be plugged, taking care to securely brace the plug from being drawn into the manhole. Unless plugs are mechanically restrained, it is recommended that the plugs are used with a minimum of 2 times safety factor above the test pressure.
4. The test head shall be placed at the inside of the top of the cone section and the seal inflated in accordance with the manufacturers' recommendations.
5. A vacuum of 10 inches (5 psig) of mercury shall be drawn and the vacuum pump shut off. With the valves closed, the time shall be measured for the vacuum to drop to 9 inches. The manhole shall pass if the time is greater than 60 seconds for 48 inch diameter, 75 seconds for 60 inch.
6. If the manhole fails the initial test, necessary repairs shall be made with a non-shrink grout while the vacuum is still being drawn. You shall retest until a satisfactory test is obtained.
7. After the gravity sewers and manholes have been installed and backfilled, the manholes shall be inspected for leakage. No visible leaks will be permitted.

E. Test Results: Certified copies of all test results shall be furnished to the Engineer within 1 week after the test.

END OF SECTION 02731

SECTION 16010 - ELECTRICAL BASIC REQUIREMENTS

PART 1 – GENERAL

1.1 THE REQUIREMENT

- A. Furnish all labor, materials, equipment and incidentals required for a complete electrical installation for the Work associated with the Contract Documents, as hereinafter specified and shown on the Contract Drawings.
- B. Provide functioning systems in compliance with manufacturer's instructions, performance requirements specified or shown on the Contract Drawings and modifications resulting from reviewed shop drawings and field coordinated drawings.
- C. The work, apparatus and materials which shall be furnished under these Specifications and accompanying Contract Drawings shall include all items listed hereinafter and/or shown on the Contract Drawings. Certain equipment will be furnished as specified in other sections of these Specifications which will require wiring thereto and/or complete installation as indicated. All materials necessary for the complete installation shall be furnished and installed by the Contractor to provide complete power, lighting, communication systems, instrumentation, wiring, and control systems as indicated on the Contract Drawings and/or as specified herein.
- D. Provide complete grounding systems for all equipment as specified herein, shown on the contract documents, and as required for specific pieces of equipment per manufacturer.
- E. The Contractor shall notify the Office of the State Electrical Inspector, Department of Insurance and notify local inspectors to schedule required inspections.
- F. The Contractor shall furnish and install the necessary cables, transformers, motor control centers, protective devices, conductors, exterior electrical system, etc., to serve motor loads, lighting loads and miscellaneous electrical loads as indicated on the Contract Drawings and/or as specified hereinafter.
- G. The work shall include complete testing of all equipment and wiring at the completion of the work and making any connection changes or adjustments necessary for the proper functioning of the system and equipment.
- H. Mount and wire control panels and process instruments furnished under other Divisions of these Specifications unless specifically stated otherwise. Mount and make all field connections to process instrument panels and other control panels furnished under other Divisions of these Specifications. For process instrumentation, furnish and install all conduit, wire and interconnections between primary elements, transmitters, local indicators, surge protection devices and receivers.
- I. Mount and wire isolation transformers, operator's stations, and power conversion equipment for all variable speed drive systems furnished under other Divisions of these specifications.
- J. Install and wire all thermostats, aqua-stats and other devices furnished under other Divisions of this Specification directly controlling HVAC equipment or fan motors.

- K. Mount and wire electric heaters, and heat tracing furnished under other Divisions of this Specification.
- L. All power interruptions to existing equipment shall be at the Owner's convenience. Each interruption shall have prior approval.
- M. It is the intent of these Specifications that the electrical system shall be suitable in every way for the service required. All material and all work which may be reasonably implied as being incidental to the work of this Section shall be furnished at no extra cost.
- N. Provide all temporary power as required to facilitate the Contract phased construction plan.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Related Sections include but are not necessarily limited to:
 - 1. Division 0 - Bidding, Contract and Conditions.
 - 2. Division 1 - General Requirements.
 - 3. Section 03300 – Cast-in-Place Concrete
 - 4. Section 13000 – Special Construction

1.3 AREA CLASSIFICATIONS

- A. Outdoor locations may contain wet, corrosive and hazardous areas:
 - 1. Corrosive and hazardous areas are identified on the Contract Drawings. Areas not identified as such shall be considered wet.
- B. Indoor locations may contain unclassified, damp, wet, corrosive and hazardous areas:
 - 1. Damp, wet, corrosive and hazardous areas are identified on the Contract Drawings. Areas not identified as such, but provided with heating shall be considered unclassified. Areas not identified as such, but provided without heating shall be considered damp.

1.4 DEFINITIONS

- A. Outdoor Areas:
 - 1. Those locations on the Project site where the equipment is normally exposed to wind, dust, rain, snow, etc. Outdoor areas include areas protected by a roof or rain/sun shields but not enclosed within a structure.

B. Indoor Areas:

1. Those locations on the Project site where the equipment is normally protected from wind, dust, rain, snow, etc.

1.5 QUALITY ASSURANCE

A. Referenced Standards:

1. American Iron and Steel Institute (AISI):
 - a) Steel Products Manual - Stainless and Heat Resisting Steel.
2. American National Standards Institute (ANSI):
 - a) C2, National Electrical Safety Code.
3. American Society for Testing and Materials (ASTM):
 - a) A36, Specification for Structural Steel.
 - b) A153, Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - c) D698, The Moisture-Density Relations of Soils using a 5.5LB Rammer and a 12IN Drop.
4. Factory Mutual System (FM):
 - a) A Guide to Equipment, Materials and Services.
5. Institute of Electrical and Electronics Engineers (IEEE):
 - a) 141, Recommended Practice for Electrical Power Distribution for Industrial Plants.
 - b) 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
6. National Electrical Contractors Association (NECA):
 - a) NECA 1, Good Workmanship in Electrical Construction
 - b) NECA 200, Recommended Practice for Installing and Maintaining Temporary Electrical Power at Construction Sites.
7. National Electrical Manufacturers Association (NEMA):
 - a) 250, Enclosures for Electrical Equipment (1000 V Maximum)
 - b) ICS 6, Enclosures for Industrial Control and Systems
8. National Fire Protection Association (NFPA):

- a) 70, National Electrical Code (NEC).
 - b) 70E, Standard for Electric Safety in the Workplace
 - c) 79, Electrical Standard for Industrial Machinery
 - d) 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities
9. Underwriters Laboratories, Inc (UL):
- a) 508, Industrial Control Equipment
 - b) 508A, Industrial Control
 - c) 698, Industrial Control Equipment for Use in Hazardous Locations.
- B. When a specific code or standard has not been cited, the applicable codes and standards of the following code-making authorities and standards organizations shall apply:
- 1. American Association of State Highway and Transportation Officials (AASHTO).
 - 2. American Iron and Steel Institute (AISI).
 - 3. American National Standard Institute (ANSI).
 - 4. American Society for Testing and Materials (ASTM).
 - 5. ETL Testing Laboratories, Inc (ETL).
 - 6. Insulated Cable Engineers Association (ICEA).
 - 7. Institute of Electrical and Electronic Engineers (IEEE).
 - 8. Illuminating Engineering Society of North America (IES).
 - 9. Instrument Society of America (ISA).
 - 10. Lightning Protection Institute (LPI).
 - 11. National Electrical Manufacturers Association (NEMA).
 - 12. National Fire Protection Association (NFPA).
 - 13. Occupational, Health and Safety Administration (OSHA).
 - 14. Underwriters Laboratories Inc (UL).

- C. In case of conflict or disagreement between codes, standards, laws, ordinances, rules, regulations, drawings and specifications, or within either document itself, the more stringent condition shall govern.

1.6 SUBMITTALS

A. Shop Drawings:

1. Shop drawings shall be arranged and labeled according to specification section and Contract Drawing.
2. Submit shop drawings prior to purchase or fabrication of equipment. See individual Division 16 sections for additional specific requirements.
3. Prior to submittals of shop drawings, coordinate electrical equipment, particularly motor control equipment, control panels, and instrumentation, with all applicable equipment and systems interfacing with that equipment.
4. Submittals shall be made in the following combinations:
 - a) Conduits, raceways, cable trays, ductbank details, wire and cable 600V and below, medium voltage cable, boxes and fittings.
 - b) Motor control centers and control equipment, low voltage switchboards, safety switches, dry-type (specialty) transformers, panelboards, power factor correction capacitors, grounding.
 - c) Lamps, interior lighting, exterior building lighting, site lighting.
 - d) Wiring devices.
 - e) Alarm systems, communication systems and telephone systems.
 - f) Provide a wire or cable identification schedule for all power, control, signal, process and protective circuits. The schedule shall be submitted in an electronic spreadsheet type Excel compatible file format and include the following information:
 - (1) Wire or Cable tag number.
 - (2) Number of conductors.
 - (3) Conductor size and type.
 - (4) Wire or Cable usage description.
 - (5) Conduit tag number
 - (6) Conduit routing (to and from).
 - (7) Conduit size and type.

(8) Additional notes

5. For each product, clearly identify manufacturer by name. When general data sheets are provided as part of the submittal, specifically identify the products to be used on this Project. Provide manufacturer's technical information on products to be used, including:
 - a) Product descriptive bulletin.
 - b) Electrical data pertinent to the Project and necessary to assure compliance with Specifications and Contract Drawings.
 - c) Equipment dimensions, where applicable.
 - d) Evidence that the products submitted meet the requirements of the standards referenced.
 - e) Specify part number with explanation of options selected.
 6. Ensure that all submittals clearly indicate the equipment is UL or ETL listed.
 7. For all equipment, provide manufacturer's installation instructions.
- B. When a quality standard has been established by identification of a specific manufacturer or catalog number, submittals for proposed alternates and substitutions shall include:
1. Alternate and substitute equipment cross-referenced to the equipment it is replacing. Submittal shall be marked to show how differences will be accommodated.
 2. Calculations and other detail data to allow determination of alternate and substitute equipment equivalency to the equipment it is replacing. Data supplied shall allow detailed comparison of all significant characteristics upon which the design equipment is based.
 3. Dimensioned drawings, of the same or larger scale as the Contract Drawings, for all alternate and substitute equipment, which differs in size, configuration, service accessibility or in any significant way from the equipment it is replacing.
 - a) Complete system layout, except that portion which is identical to the Contract Drawings.
 - b) Redesign and modifications to all work required by the alternate or substitute equipment.
- C. Operation and Maintenance Manuals.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. The Contractor shall unload and handle materials using methods, rigging, and equipment that will prevent damage to the materials. Care shall be used to prevent damage to painted and galvanized surfaces.
 - 1. Bare wire rope slings shall not be used for unloading and handling materials and equipment, except with the specific written permission of the Engineer.
- B. Equipment and materials, in accordance with the manufacturer's recommendations, shall be stored, supported and protected to prevent damage.
 - 1. Stored materials and equipment shall not be allowed to contact the ground.
 - 2. Equipment and materials which incorporate electrical equipment or which have finished painted surfaces, and other items which would be damaged by outdoor exposure, shall be stored indoors.
 - a) Provide covering and shielding for all equipment to protect from damage.
 - b) When such storage would present an unreasonable building space or volume requirement, the equipment or materials may, when acceptable to the Engineer, be stored under weatherproof coverings on shoring or platforms.
 - 3. All small loose items that could be easily lost, stolen, broken, or misused shall not be stored on open platforms or shoring.
 - 4. All storage methods and schedules shall be acceptable to the Engineer.
- C. Ensure that equipment is not used as steps, ladders, scaffolds, platforms, or for storage-either inside or on top of enclosures.
- D. Protect nameplates on electrical equipment to prevent defacing.
- E. Repair, restore or replace damaged, corroded and rejected items at no additional cost to the Owner.
- F. Record Drawings:
 - 1. The Contractor shall maintain a marked up set of Document Drawings showing actual installed circuit numbers, conduit sizes, cable tray routing, number of conductors, conductor sizes (other than #12AWG) and all other deviations from the design drawings.
 - 2. All underground conduit and concealed items shall be dimensioned on the Document Drawings from permanent, visible, building features.
 - 3. Provide actual motor size, starter size, and heater size, along with all other protective equipment for all motor circuits as part of the one-line record drawings.

4. Revise all wire/cable identification schedules to indicate as installed conditions.
5. Revise all panelboard schedules to indicate as installed conditions.

1.8 DIVISION OF WORK

The following delineates the division of work between Division 11/13/15 and Division 16. Specific work to be done under Division 16 is hereinafter listed or described. All other work necessary for the operation of Division 11/13/15 equipment shall be performed under Division 11/13/15.

- A. All individual motor starters for mechanical equipment (fans, pumps, etc.) shall be furnished and installed under Division 11/13/15 unless indicated as a part of a motor control center. Motor starters for mechanical equipment provided in motor control centers shall be furnished and installed under Division 16.
- B. Division 16 shall provide power wiring up to a termination point consisting of a junction box, trough, starter, VFD or disconnect switch. Line side terminations shall be provided. Wiring from the termination point to the mechanical equipment, including final connections, shall be provided under Division 11/13/15.
- C. Equipment less than 110Volt, all relays, actuators, timers, seven-day clocks, alternators, pressure, vacuum, float, flow, pneumatic-electric, and electric-pneumatic switches, aquastats, freesestats, line and low voltage thermostats, thermals, remote selector switches, remote push-button stations, emergency break-glass stations, emergency break-glass stations, interlocking, disconnect switches beyond termination point, and other appurtenances associated with equipment under Division 11/13/15 shall be furnished, installed and wired under Division 11/13/15.
- D. All wiring required for controls and instrumentation not indicated on the drawings shall be furnished and installed by Division 11/13/15.
- E. Where electrical wiring is required by trades other than covered by Division 16, those trades shall refer to same wiring materials and methods as specified under Division 16.
- F. Duct smoke detectors, if provided per NFPA 90A requirements, shall be furnished and wired by Division 16, installed by Division 11/13/15. Fire alarm AHU shutdown circuits shall be wired from the fire alarm control panel to a termination point, adjacent to the AHU control under Division 16. AHU control wiring from the termination point to the equipment shall be under Division 11/13/15.
- G. Roof exhaust fans with built-in disconnects provided under Division 11/13/15, or doors provided with built-in outlets shall be wired under Division 16 to the line side of the disconnect switch or the outlet. A disconnect switch shall be provided under Division 16 if the fan is not provided with a built-in disconnect switch. In this case wiring from the switch to the fan shall be under Division 11/13/15.
- H. The sequence of control for all equipment shall be as indicated on the Division 11/13/15 Drawings and specified in the Division 11/13/15, Control Systems.

- I. All sprinkler flow and tamper switches shall be furnished and installed under Division 11/13/15, and wired under Division 16.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Refer to related Division 16 sections. All equipment of a similar type shall be by one manufacturer unless otherwise noted in the Specifications.

2.2 MATERIALS

- A. Trade names and catalog numbers may be used in the Contract Drawings or Specifications to establish quality standards and basics of design.
 - 1. Other listed manufacturers in the applicable specification sections with equal equipment may be acceptable.
 - 2. If no other manufacturer is listed then any manufacturer of equal equipment may be acceptable.
- B. Listed: Where UL test procedures have been established for the product type, electrical equipment shall be approved by UL or ETL and shall be provided with the UL or ETL label.

2.3 FABRICATION

- A. When equipment is shop fabricated for the Project, the electrical devices and enclosures utilized shall be UL or ETL listed and labeled or shall be UL recognized.
- B. Shop or Factory Finishes: Interiors of other painted equipment shall be white.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Equipment shall be installed in accordance with the requirements of the NEC.
- B. Surge Protection/Transient Voltage Suppression: The System shall meet the following Standards:
 - 1. IEEE C62.41 & IEEE C62.45, NEMA LS 1, UL 1449, NEC ARTICLE 285. The TVSS shall be installed on the load side of the overcurrent protective device. TVSS category “C” shall be mounted at the service equipment, category “B” shall be mounted at the branch panel, and category “A” shall be mounted at the load. The peak single-impulse ratings for non-modular assembly shall be 240KA, 160KA, or 120KA. The modular assembly ratings shall be 320KA or 480KA.
 - 2. Reference UL 1449, the second edition. Also reference the ANSI/IEEE C62.34.

- C. Enclosures for Use with Electrical Equipment unless specifically shown or specified elsewhere in the Contract Documents:
 - 1. NEMA 1/12:
 - a) Acceptable in unclassified indoor locations.
 - 2. NEMA 3/3R:
 - a) Acceptable in damp or wet indoor/outdoor non-corrosive locations
 - 3. NEMA 4X:
 - a) Use in wet indoor/outdoor corrosive locations.
 - b) Enclosures shall be 304-Stainless-Steel minimum. Enclosures constructed of 316-Stainless Steel may be required in extremely corrosive areas as shown on the Contract Drawings
 - c) Nonmetallic enclosures shall not be used in areas subject to physical damage or sunlight. Nonmetallic enclosures may be used in interior locations.
 - 4. Exceptions:
 - a) As modified in other Division 16 sections.
 - b) As otherwise indicated on the Contract Drawings.
- D. Coordinate the installation of electrical equipment with other trades.
 - 1. Arrange for the building in of equipment during structure construction.
 - 2. Where equipment cannot be built-in during construction, arrange for sleeves, box-outs, openings, etc., as required to allow installation of equipment after structure construction is complete.
- E. Verify that equipment will fit support layouts indicated.
- F. Equipment Dimensions and Clearances:
 - 1. Equipment shall fit in the locations shown on the Contract Drawings.
 - 2. Do not use equipment or arrangements of equipment that reduce required clearances or exceed the space allocation.
- G. Install equipment in accordance with the manufacturer's instructions.
- H. Equipment Access:
 - 1. Install equipment so it is readily accessible for operation and maintenance.

2. Equipment shall not be blocked or concealed.
 3. Do not install electrical equipment such that it interferes with normal maintenance requirements of other equipment.
- I. Equipment shall be installed plumbed, square and true with the building construction and shall be securely fastened.
 - J. Outdoor wall-mounted equipment and indoor equipment mounted on earth or water bearing walls shall be provided with corrosion-resistant spacers to maintain 1/4 IN separation between the equipment and the wall.
 - K. Screen or seal all openings into outdoor equipment to prevent the entrance of rodents and insects.
 - L. Equipment fabricated from aluminum shall not be placed in direct contact with earth or concrete.
 - M. Provide all necessary anchoring devices and supports.
 1. Use supports as detailed on the Drawings and as specified. Where not detailed on the Drawings or specified, use supports and anchoring devices rated for the equipment load and as recommended by the manufacturer.
 2. Supports and anchoring devices shall be rated and sized based on dimensions and weights verified from approved equipment submittals.
 3. Hardware shall be malleable type, corrosion resistant and shall be supported by heavily plated machine screws or brass, bronze or stainless steel bolts.
 4. Do not cut, or weld to, building structural members without written approval by the Engineer.
 5. Do not mount safety switches and external equipment to other equipment enclosures, unless enclosure-mounting surface is properly braced to accept mounting of external equipment.
 - N. Contractor shall verify exact rough-in location and dimensions for connection to electrical items to be installed under this Contract.
 1. Shop drawings shall be secured from those furnishing the equipment.
 2. Proceeding without proper information may require the Contractor to remove and replace work that does not meet the conditions imposed by the equipment supplied.
 3. Provide sleeves wherever openings are required through new concrete or masonry members. Place sleeves accurately and coordinate locations with the Engineer.

4. Should any cutting and patching be required on account of failure of the Contractor to coordinate penetrations, such cutting and patching shall be done at the expense of the Contractor.
 - a) Contractor shall not endanger the stability of any structural member by cutting, digging, chasing, or drilling and shall not, at any time, cut or alter the work without the Engineer's written consent.
 - (1) Provide additional reinforcing if required.
 - (2) Cutting shall be done neatly using proper tools and methods.
 - b) Subsequent patching to restore walls, ceilings, or floors to their original condition shall be done by workmen skilled in their particular field.
- O. Provide concrete foundations or pads required for electrical equipment as indicated or specified.
 1. Floor-mounted equipment shall be mounted on a 4IN high concrete housekeeping pad. Pad shall be poured on top of the finished floor or slab.
- P. Material that may cause rusting or streaking on a building surface shall not be used.
- Q. Perform excavation and backfill in accordance with Section 02210.
- R. Contractor shall coordinate the installation of the conduit and wire associated with the HVAC equipment supplied under this Contract.
- S. Enclosed electronic equipment located outdoors shall be provided with sun/rain shields and oriented to minimize sun exposure.
- T. Device Mounting:
 1. Dimensions are to top of item unless otherwise indicated.
 2. Mounting heights as indicated below unless otherwise indicated on the Contract Drawings:
 - a) Receptacle: 24IN. to center-line
 - b) Disconnect / Safety-Switch: 64IN to top of enclosure.
 - c) Meter Base: 64IN to top of enclosure

3.2 WIRING ELECTRICALLY OPERATED EQUIPMENT

- A. The Contractor shall be responsible for all electrical connections to all equipment requiring electrical power. This responsibility applies to equipment furnished under this and other Divisions and by the Owner.

- B. This Division is responsible for: (1) proper rotation, (2) observing that lubrication has been properly performed, (3) that motors operate within nameplate limits, and (4) adjustment of circuit breaker and MCP trip settings.

3.3 RECORD AND AS-BUILT DOCUMENTS

- A. Maintain at the job site a set of Contract Documents kept current by indicating thereon all changes, revisions and substitutions, between work as specified and as installed.
- B. Furnish Owner with 1 complete set of reproducible drawings and 2 complete, clean sets of Specifications showing installed locations, size, catalog numbers, etc., of all work and material as taken from record documents.
- C. For each piece of equipment, provide 4 sets of manufacturer's printed catalog pages, operating and maintenance instructions, and wiring and connections diagrams. Bind this information into 8½-inch by 11-inch booklets.

3.4 CLEANING AND PAINTING

- A. Fixtures, panels and equipment shall be thoroughly cleaned. All equipment shall be touched up or repainted as required to present a clean professional appearance. Paint all ferrous metal which is not otherwise protected against corrosion. Paint exposed pipe threads with Bitumastic No. 50.

3.5 IDENTIFICATION

- A. Furnish and install engraved laminated phenolic nameplates for all safety switches, panelboards, transformers, switchboards, motor control centers, contactors and other electrical equipment supplied for the project for identification. Nameplates shall be securely attached to equipment with self-tapping steel screws; if the screw sharp end is protected; otherwise Rivets shall be used. Letters shall be approximately 1/2IN high minimum. Embossed, self-adhesive plastic tape is not acceptable for marking equipment. Equipment tags shall indicate "name", system name, equipment controlled or served, voltage, phase, etc. Nameplate material colors shall be:
 - 1. Blue surface with white core for 120/208V Equipment
 - 2. Black surface with white core for 277/480V Equipment
- B. Switchboards and motor control centers shall have each circuit, load, compartment, section, etc. labeled with phenolic nameplates and shall be provided with a typed directory.
- E. Panels shall have nameplate on exterior of cabinet and a typed directory card inside the door.
- F. Update the nameplates and/or the directory cards to reflect changes to existing equipment/systems. Changes to directory card shall be typed or by hand if only a few changes are required.

- G. All empty conduit runs and conduit with conductors for future use shall be identified for use and shall indicate where they terminate. Identification shall be by tags with string or wire attached to conduit or outlet.

3.6 FIELD QUALITY CONTROL

- A. Do not remove or damage fireproofing materials.
 - 1. Install hangers, inserts, supports, and anchors prior to installation of fireproofing.
 - 2. Repair or replace fireproofing removed or damaged.
- B. Make all penetrations through roofs prior to installation of roofing.
- C. All penetrations required after installation of roofing, shall be completed by an authorized roofer to maintain the roof warranty.
- D. Make all penetrations of electrical work through walls water and weather-tight.
- E. Equipment furnished under this Contract for use on future work and all concealed equipment, including conduits, shall be dimensioned, on the Record Drawings, from visible and permanent building features.
- F. After installation, all equipment shall be tested as recommended by the manufacturer.
- G. Verify all components are operational.
- H. Perform ground-fault performance testing as required by NEC Article 230-95(c).
- I. Test Equipment Interface:
 - 1. Verify systems coordination and operation.
- J. Set all adjustable trip protective devices as required for system protection and coordination.
- K. Verify all system and equipment ground continuity.
- L. Adjust installed equipment for proper operation of all electrical and mechanical components.
- M. Replace equipment and systems found inoperative or defective and re-test.
 - 1. If equipment or system fails re-test, replace it with products that conform to Contract Documents.
 - 2. Continue remedial measures and re-tests until satisfactory results are obtained.
 - 3. Remedial measures and re-tests will be done at no cost to the Owner.

- N. The Engineer shall be notified of tests and Engineer may witness individual tests.
- O. Required certificates of testing and test reports shall be presented to the Engineer upon completion of the tests.
- P. At Completion of Installation:
 - 1. Test to ensure all equipment is free of short circuits and improper grounds.
 - 2. Test to ensure all equipment is operational.

3.7 ELECTRICAL TESTING AND START-UP

A. General

- 1. Complete installation shall be free of short circuits, grounds, open circuits, and other defects. Tests shall be made as required to prove that all parts of installation meet specified performances.
- 2. Prior to energizing any equipment, the electrical contractor shall thoroughly vacuum clean the equipment with an industrial type vacuum cleaner. The outside of all electrical equipment shall be cleaned and paint touched up as required to leave equipment in an "as purchased" condition.
- 3. During start-up of new equipment, the electrical contractor shall provide sufficient personnel to aid with start-up of the electrical equipment to remove any faults, and to make the necessary adjustment for proper operation of electrical equipment and installation. This includes sufficient personnel to aid equipment service personnel in their check-out of the electrical equipment and service.
- 4. All testing equipment, materials, fuses, etc. shall be furnished by the Contractor.
- 5. All failed tests due to defective material or poor workmanship shall be corrected by the Contractor at no expense to the Owner.

B. Grounding System

- 1. Upon completion of installation of the electrical grounding and bonding systems, the ground resistance shall be tested with a ground resistance tester. Where tests show resistance-to-ground is over 25 ohms, provide additional ground rods until the resistance is reduced to 25 ohms. The compliance should be demonstrated by retesting.

C. Conductor Testing

- 1. All current carrying phase conductors and neutrals shall be tested as installed, and before connections are made, for insulation resistance and accidental grounds. The contractor shall use a 500 volt megger to perform these tests. The procedures listed below shall be followed:

- a) Minimum readings shall be one million (1,000,000) or more ohms for #6 AWG wire and smaller, 250,000 ohms or more for #4 AWG wire or larger, between conductors and between conductor and the grounding conductor.
- b) After all fixtures, devices and equipment are installed and all connections completed to each panel, the contractor shall disconnect the neutral feeder conductor from the neutral bar and take a megger reading between the neutral bar and the grounded enclosure. If this reading is less than 250,000 ohms, the contractor shall disconnect the branch circuit neutral wires from this neutral bar. He shall then test each one separately to the panel and until the low readings are found. The contractor shall correct troubles, reconnect and retest until at least 250,000 ohms from the neutral bar to the grounded panel can be achieved with only the neutral feeder disconnected.
- c) The contractor shall send a letter to the engineer and the State Construction Office certifying that the above has been done and tabulate the megger readings for each panel. This shall be done at least four (4) days prior to final inspection.
- d) At final inspection, the contractor shall furnish a megger and show the engineers and State Construction Office representatives that the panels comply with the above requirements. He shall also furnish a hook-on type ammeter and voltmeter to take current and voltage readings as directed by the representatives.

D. Circuit Breaker Tests

- 1. For services 1000 amperes and larger, the following tests should be performed on the service circuit breakers and the distribution circuit breakers. Testing shall be performed by a qualified factory technician at the job site. The following readings shall be tabulated:
 - a) Phase tripping tolerance (within 20% of UL requirements).
 - b) Trip time (per phase) in seconds.
 - c) Instantaneous trip (amps) per phase.
 - d) Insulation resistance (in megaohms) at 100 volts (phase to phase, and line to load).

E. Ground Fault Protection System

- 1. Ground fault protection on the new circuit breakers (if provided) shall be performance tested in the field and properly calibrated and set in accordance with the coordination study.

F. Documentation

1. All tests specified shall be completely documented indicating time of day, date, temperature and all pertinent test information.
2. All required documentation of readings indicated above shall be submitted to the engineer prior to, and as one of the prerequisites for, final acceptance of the project.

3.8 MINOR ELECTRICAL DEMOLITION FOR REMODELING

- A. Abandoned conduit/boxes shall have all electrical wiring removed completely and not just made "safe." Conduit/boxes shall be removed where practical without creating additional demolition/restitution work for other trades.

3.9 DEMONSTRATION

- A. Demonstrate equipment in accordance with Contract Requirements.

END OF SECTION 16010

SECTION 16050 – MATERIALS AND METHODS

PART 1 – GENERAL

1.1 RELATED WORK SPECIFIED ELSEWHERE

- A. In addition to the requirements specified in this section, the requirements of specification Section 16010 – Electrical, Basic Requirements and the sections referenced therein shall be applied.
- B. Specification Section 03300 – Cast-in-Place Concrete

1.2 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the Contract requirements, the Contractor shall obtain from the equipment manufacturer and submit shop drawings. Each submittal shall be identified by the applicable Specification Section.
- B. Shop drawings shall include but not be limited to:
 - 1. Equipment specifications and product data sheets identifying all materials used and methods of fabrication.
 - 2. Complete assembly, layout, installation, and foundation drawings with clearly marked dimensions.

1.3 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of products for electrical related work of sizes, types, ratings, and materials required, whose products have been in satisfactory use in similar service for not less than three (3) years.

1.4 PROJECT CONDITIONS

- A. Protect property from any and all damage that might result from excavating and backfilling.
- B. Protect persons from injury at excavations, by barricades, warnings and illumination.
- C. Coordinate excavations with weather conditions, to minimize possibility of washouts, settlements and other damages and hazards.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 EXCAVATING FOR ELECTRICAL WORK

- A. General: Do not excavate for electrical work until the work is ready to proceed without delay, so that total time lapse from excavation to completion of backfilling will be minimized.
- B. Excavate with vertical-sided excavations to greatest extent possible, except where otherwise indicated. Where necessary, provide sheeting and cross-bracing to sustain sides of excavations. Remove sheeting and cross-bracing during backfilling wherever such removal would not endanger the work or other property. Where not removed, cut sheeting off at sufficient distance below finished grade to not interfere with other work.
- C. Depth for sub-base Support: Unless otherwise noted, provide installation of sub-base material(s). Excavate for installation of sub-base material in depth indicated or, if not otherwise indicated, 6 IN below bottom of work to be supported.
- D. Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross-braces, in good serviceable condition.
 - 1. Establish requirements for trench shoring and bracing to comply with local codes and authorities having jurisdiction.
 - 2. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Carry down shoring and bracing as excavation progresses.
- E. Excavate trenches to the uniform dimensions required for the particular item(s) to be installed and provide sufficient working clearances. Dig trenches to approximate depth and hand grade bottom to accurate elevation as required.
- F. Where rock is encountered, carry excavation 6IN below required elevation and backfill with a 6 IN layer of sand prior to installation of conduit.
- G. Where soil conditions at bottom of indicated excavation are unsatisfactory, excavate additional depth as directed to reach satisfactory soil-bearing condition. Backfill with sub-base material compacted as directed, to indicated excavation depth.
- H. Unless otherwise noted in the Contract Drawings, store excavated material (temporarily) near excavation, in manner that will not interfere with or damage excavation or other work. Do not store under trees (within drip-line).
- I. Retain excavated material that complies with requirements for backfill material.
- J. Dispose of excess or unsatisfactory excavated material(s) as directed by the Contract requirements and site conditions.
- K. Refer to the Contract requirements and site conditions for removal of large subsurface materials.

3.2 DEWATERING

- A. Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
- B. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.
- C. Maintain dry excavations for electrical work, by removing water. Protect excavations from inflow of surface water. Pump minor inflow of ground water from excavations; protect excavations from major inflow of ground water, by installing temporary sheeting and waterproofing. Provide adequate barriers that will protect other excavations and below-grade property from being damaged by water, sediment or erosion from or through electrical work excavations.

3.3 BASE PREPARATION

- A. Install subbase material to receive electrical work, and compact by tamping to form a firm base for the work.
- B. Provide finely-graded subbase material for equipment to be buried.
- C. Tamp fill to uniform compacted density.
- D. Where conduit crosses over areas which have been previously excavated to depths greater than required for conduit installation, provide suitable support that comply with details shown and Contract requirements.

3.4 BACKFILLING

- A. Backfill with approved backfill materials.
- B. Backfill with finely-graded subbase material to 6 IN above equipment to be buried. Backfill materials shall be soil materials free of clay, rock or gravel larger than 3/4IN, debris, waste, frozen materials, vegetation and other deleterious matter.
- C. Condition backfill material by either drying or adding water uniformly, to whatever extent may be necessary to facilitate compaction to required densities. Do not backfill with frozen soil materials.
- D. Backfill simultaneously on opposite sides of electrical work, and compact simultaneously; do not dislocate the work from installed positions.
- E. Backfill excavations in 8IN high courses of backfill material, uniformly compacted to the following densities (% of maximum density, ASTM D 1557), using power-driven hand-operated compaction equipment.
 - 1. Lawn/Landscaped Areas: 85% for cohesive soils; 90% for cohesionless soils.

2. Paved Areas, Other Than Roadways: 90% for cohesive soils; 95% for cohesionless soils.
 3. Roadways: 90% for cohesive soils; 95% for cohesionless soils.
- F. When backfilling excavations for electrical work, backfill to elevations matching finished grades.
- G. Backfill trenches with concrete where trench excavations pass within 18 IN of column or wall footings and which are carried below bottom of such footings, or which pass under wall footings. Place concrete to level of bottom of adjacent footing.
- H. Do not backfill trenches until tests and inspections have been made and backfilling authorized by the Engineer. Use care in backfilling to avoid damage or displacement of conduit systems.

3.5 INSTALLATION OF CONCRETE WORK

- A. Refer to Specification Section 03300 – Cast-in-Place Concrete
- B. Miscellaneous Concrete Work
1. Concrete Grouting: Grout openings and recesses as indicated on the Contract Drawings and around all electrical work and other work that penetrates or adjoins all concrete work. Provide formwork where required, and tamp, screed and trowel surfaces. Cure grout as specified for concrete work.
 2. Refer to Specification Sections for grouting of equipment base plates on foundations (with high-strength, non-shrinking grout), and similar grouting requirements not defined herein.
- C. Clean-Up: Upon completion of work, clean excess concrete and grout from adjacent areas and surfaces. Remove excess concrete and grout by proper methods of removal, using care not to scratch or otherwise damage finished surfaces.

3.6 SUPPORT AND FASTENERS

- A. The Contractor shall furnish and install structural supports and fasteners for mounting and installing all electrical, lighting, alarm systems, instrumentation, communications and other equipment furnished under this Contract.
- B. Where the weight of equipment exceeds 75LBS and is supported from walls, ceilings, columns and/or beams, such structural supports, methods, and locations shall be approved in writing by a professional engineer currently registered in the State of the projects location.
- C. Concrete or Masonry Inserts
1. The Contractor shall be responsible for the furnishing and installation of all conduit sleeves, anchor bolts, masonry inserts, and similar devices required for installation of equipment furnished under this Contract.
 2. The Contractor shall furnish leveling channels for all switchgear, switchboards, motor control centers, and similar equipment. The leveling

channels shall be provided for installation in the equipment supporting pads. Coordination of the installation of these channels with the concrete pad is essential and required. Pad height shall be as required to maintain coverage of the reinforcement bars while not exceeding the maximum mounting heights requirements of the NEC.

D. Support Fastening and Locations

1. All equipment fastened to structural steel; columns, beams, and trusses shall be made by approved clamps or welded. No holes shall be drilled in structural steel.
2. Where supports or hangers are required for heavy electrical equipment units exceeding 75LBS, a registered professional engineer shall check the structural members. Where required, additional sections shall be provided for a safe installation.
3. All holes in hung ceilings for support rods, conduits, and other equipment shall be made adjacent to ceiling supports where possible, to facilitate removal of ceiling panels.
4. For interior dry areas, a bracket and channel type support of galvanized steel construction shall be provided wherever required for the support of starters, switches, panels, and miscellaneous equipment.
5. For outdoor service or in indoor damp/wet process areas, the support system shall be made of either stainless steel, PVC coated rigid galvanized steel, aluminum or as indicated on the Contract Drawings.
6. All fastening hardware (bolts, nuts, washers, etc.) shall be approved stainless steel materials or as indicated on the Contract Drawings.
7. All supports shall be rigidly bolted together and braced to make a substantial supporting framework. Where possible, control equipment shall be grouped together and mounted on a single framework. Wherever this occurs, a provision shall be made for ready access to the wiring for connections to the equipment by means of boxes with screw covers.
8. Aluminum support members shall not be installed in direct contact with concrete. Stainless steel or non-metallic "spacers" shall be used to prevent contact of aluminum with concrete.
9. The Contractor is responsible for the design of supporting structures and shall submit design details to the Engineer for acceptance before proceeding with the fabrication and installation.
10. Wherever dissimilar metals come into contact, the Contractor shall isolate these metals as required with nylon washers, 9MIL polyethylene tape, or gaskets.

END OF SECTION 16050

SECTION 16111 – CONDUIT AND RACEWAY

PART 1 – GENERAL

1.1 THE REQUIREMENT:

- A. The Contractor shall furnish all labor, materials, tools and equipment necessary for furnishing, installing, connecting, testing and placing into service all raceway to include all conduits, conduit fittings, wireway, supports, etc. as required for a complete electric installation as specified herein and indicated on the Contract Drawings.
- B. Conduit home runs for lighting, receptacle and other misc. circuits are not necessarily indicated on the Contract Drawings; however, the circuit numbers are shown. Conduit shall be furnished and installed for these circuits.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. In addition to the requirements specified in this section, the requirements of specification Section 16010 – Electrical, Basic Requirements, and the sections referenced therein shall be applied.
- B. Additional raceway from what is shown on the Contract Drawings may be required. Coordinate with the requirements of equipment provided under other Divisions of the specifications.

1.3 CODES AND STANDARDS

- A. Raceway shall comply with the following applicable codes and standards as well as any others within the specifications and drawings. In the event of any conflict between these codes, regulations, standards, and Contract Documents, the most restrictive shall apply.
 - 1. American National Standards Institute (ANSI):
 - a) C80.1, Rigid Steel Conduit - Zinc-Coated.
 - b) C80.3, Electrical Metallic Tubing - Zinc-Coated.
 - c) C80.4 Fittings for Rigid Metal Conduit and Electrical Metallic Tubing.
 - d) C80.5 Electrical Rigid Aluminum Conduit.
 - e) C80.6 Electrical Intermediate Metal Conduit.
 - 2. American Society for Testing and Materials (ASTM):
 - a) A36, Standard Specification for Structural Steel.
 - b) A153, Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - c) A307, Carbon Steel Externally Threaded Standard Fasteners.
 - d) A563, Standard Specification for Carbon Steel Nuts.
 - e) A569, Steel Carbon, Hot-Rolled Sheet and Strip, Commercial Quality.
 - f) A570, Hot-Rolled Sheet and Strip, Structural Quality.
 - g) A575, Merchant Quality Hot-Rolled Carbon Steel Bars.

- h) A635, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot-Rolled.
 - i) D1784, Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
 - j) D1788, Standard Specification for Rigid Acrylonitrile-Butadiene-Styrene (ABS) Plastics.
 - k) D2564, Solvent Cements for (PVC) Plastic Pipe, Tubing, and Fittings.
 - l) F512, Standard Specification for Smooth-Wall Poly (Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation.
3. ETL Testing Laboratories, Inc (ETL).
 4. National Electric Manufacturers Association (NEMA):
 - a) RN-1, Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
 - b) TC-2, Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
 - c) TC-6, PVC and ABS Plastic Utilities Duct for Underground Installation.
 5. National Electric Contractors Association:
 - a) NECA 1: Standard Practices for Good Workmanship in Electrical Construction.
 6. National Fire Protection Association (NFPA):
 - a) 70, National Electric Code (NEC).
 - b) 79, Electrical Standard for Industrial Machinery
 7. Underwriters Laboratories Inc (UL):
 - a) 1, Flexible Metal Conduit.
 - b) 6, Rigid Metal Conduit.
 - c) 6A, Electrical Rigid Metal Conduit – Aluminum.
 - d) 209, Cellular Metal Floor Raceways and Fittings.
 - e) 360, Liquid-Tight Flexible Steel Conduit.
 - f) 467, Grounding and Bonding Equipment.
 - g) 514, Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.
 - h) 514B, Conduit, Tubing and Cable Fittings.
 - i) 651, Schedule 40 and 80 Rigid PVC Conduit.
 - j) 797, Electrical Metallic Tubing.
 - k) 870, Wireways, Auxiliary Gutters, and Associated Fittings.
 - l) 886, Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.
 - m) 1242, Intermediate Metal Conduit.
 - n) 1660, Liquid-Tight Flexible Non-Metallic Conduit.

1.4 SUBMITTALS

A. Shop Drawings:

1. See Sections 16010.
2. Proposed routing of all site conduits including direct buried, concrete encased, and long run above ground conduits.
3. Proposed routing of conduits buried under floor slabs.
4. Proposed routing and details of construction, including conduit and rebar, of conduits embedded in floor slabs, columns, etc.

B. Operation and Maintenance Manuals.

PART 2 – PRODUCTS

2.1 GENERAL REQUIREMENTS:

- A. The material covered by this Specification is intended to be standard material of proven performance as manufactured by reputable firms. Raceways and appurtenances shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.
- B. All equipment shall be UL listed and labeled for its intended service.
- C. Subject to compliance with the Contract Documents, the listed manufacturers are acceptable.

2.2 RIGID GALVANIZED STEEL CONDUIT (RGS)

A. Acceptable Manufacturers:

1. Allied Tube and Conduit Corporation.
2. Western Tube and Conduit Corporation.
3. Wheatland Tube Company.

- B. RGS shall be manufactured from high strength steel with continuous welded seam and shall have an external and internal metallic zinc coating applied by hot-dip galvanizing or electro-galvanizing.

- C. Threads: Galvanized after cutting.

D. Standards:

1. ANSI C80.1.

2.3 PVC-COATED RIGID GALVANIZED STEEL CONDUIT (PVC-RGS)

A. Acceptable Manufacturers:

1. Thomas & Betts.
2. Perma-Cote.

3. Rob-Roy Ind.

- B. PVC-RGS shall have a minimum 40MIL polyvinyl chloride exterior coating. The coating shall be bonded to hot-dipped galvanized rigid steel conduit conforming to ANSI C80.1. The bond between the polyvinyl chloride coating and the conduit surface shall be greater than the tensile strength of the coating. PVC-RGS shall have a nominal 2MIL, minimum, urethane interior coating and a urethane coating on threads. The RGS conduit: shall have an epoxy prime coating prior to application of polyvinyl chloride and urethane coatings.
- C. Female ends shall have a plastic sleeve extending a minimum of 1 pipe diameter or 2IN, whichever is less beyond the opening. The inside diameter of the sleeve shall be the same as the outside diameter of the conduit to be used with it.
- D. Standards:
 - 1. ANSI C80.1.
 - 2. NEMA RN-1.

2.4 RIGID POLYVINYL CHLORIDE CONDUIT (PVC)

- A. Acceptable Manufacturers:
 - 1. Allied Tube and Conduit Corporation
 - 2. Carlon
 - 3. Cantex
- B. PVC shall be either Schedule 40 or Schedule-80. The polyvinyl-chloride plastic compound shall meet, as a minimum, ASTM D1784 cell classification PVC 12233-A, B, or C. PVC shall be rated for direct sunlight exposure, 90°C wire, and fire retardant with low smoke emission.
- C. Standards:
 - 1. ANSI C33.91.
 - 2. NEMA TC-2.
 - 3. UL 651.

2.5 LIQUID-TIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Acceptable Manufacturers:
 - 1. Anamet, Inc.
 - 2. Electri-Flex Company.
 - 3. International Metal Hose Company.
- B. LFMC shall have a core formed of continuous, spiral wound, hot-dip galvanized steel strip with successive convolutions securely interlocked, contain an interwoven copper strip suitable as a grounding means, and have an extruded vapor and liquid tight polyvinyl chloride outer jacket positively locked to the steel core.
- C. Standard:

1. UL 360.

2.6 WIREWAY

A. Acceptable Manufacturers:

1. E.M. Wiegmann and Company, Inc.
2. Hoffman Engineering Company.
3. Stahlin
4. Square D.

B. Wireway shall have a minimum wall thickness of 0.040IN, be furnished without knockouts, be designed for continuous grounding, and suitable for lay-in conductors. Provide Solid and non-removable covers when passing through partitions and solid hinged covers with captive screw fasteners when accessible.

C. Wireway shall not be smaller than 4 x 4IN unless otherwise indicated on the Contract Drawings.

D. Types:

1. NEMA-1: Wireway shall be steel, finished with rust inhibiting phosphatizing coating and gray baked enamel finish on interior and exterior surfaces.
2. NEMA-3/3R/12: Wireway shall be steel, finished with rust inhibiting phosphatizing coating and gray baked enamel finish on interior and exterior surfaces. Cover shall be fully gasketed and provided with captive clamp type latches.
3. NEMA- 4/4X: Wireway shall be type 304 stainless steel for interior or exterior corrosive areas. Cover shall be fully gasketed and provided with captive external screw type clamps.
4. NEMA- 4/4X: Fiberglass or PVC may be utilized for interior corrosive areas only where specifically shown on the Contract Drawings.

E. Standards:

1. NFPA 79
2. UL 870.

2.7 CONDUIT FITTINGS AND ACCESSORIES

A. Terminations

1. RGS conduits shall terminate with double bonding type locknuts and bushings except when terminating in cast threaded hubs. All bushings shall be insulated grounding-type.

B. Couplings

1. Where conduits of any type pass over a building expansion joint, a standard "expansion joint fitting," compatible with the type of raceway being used, shall be provided.
2. GRS couplings shall be threaded type and in accordance with the NEC.

3. PVC couplings shall be in accordance with the NEC and be UL listed. Fittings, elbows and joint cement shall be produced by the same manufacturer as the conduit.

C. Acceptable Manufacturers:

1. Appleton.
2. Carlon.
3. Crouse-Hinds.
4. Killark.
5. OZ Gedney Company.
6. Perma-Cote.
7. RACO.
8. Rob-Roy Ind.
9. Steel City.
10. Thomas and Betts.
11. Western Plastics Company.

D. Fittings for Use with RGS:

1. Materials: Following minimum requirements unless otherwise noted.
 - a) Body: Malleable iron, zinc- or cadmium-plated; steel, hot-dipped galvanized; or steel zinc plated with aluminum lacquer or aluminum enamel finish.
 - b) Covers: Malleable iron, zinc plated and gasketed.
 - c) Gaskets: Neoprene or PVC.
 - d) Insulators-phenolic, thermosetting: minimum 105 Deg C UL rating.
 - e) Grounding saddles tin-plated copper or bronze suitable for use with copper and aluminum conductors.
 - f) Bonding jumpers: Tinned copper flexible braid.
 - g) Locknuts: Malleable iron, zinc plated.
2. All fittings: Threaded unless otherwise noted.
3. Conduit Hubs shall be cast aluminum with insulated throat.
4. Straight couplings: Same material and finish as the conduit with which they are used.
5. Expansion and/or Deflection couplings:
 - a) 2 or 4IN nominal straight-line conduit movement in either direction.
 - b) 30-degree nominal deflection from the normal in all directions.
 - c) Watertight.
 - d) Insulating bushing.
 - e) End couplings/hubs - bronze; or steel zinc-plated with aluminum cellulose lacquer finish.
 - f) Outer jacket-neoprene.
 - g) Jacket clamps-stainless steel.
 - h) Inner sleeve (when used) - molded plastic.
6. Service entrance heads:
 - a) Weather resistant.

- b) Body: Malleable iron, hot-dipped galvanized or copper-free aluminum.
- 7. Mogul pulling elbows and tees:
 - a) Die cast copper free aluminum.
 - b) Rain tight.
- 8. Conduit seals:
 - a) Drain and breather: Stainless steel or brass.
 - b) Fiber and sealing compound: UL listed for use with the sealing fitting.
- 9. Standards:
 - a) UL 6.
 - b) UL 467.
 - c) UL 514B.
 - d) UL 1242.
- E. Fittings for Use with PVC-RGS:
 - 1. The same material and construction as those fittings listed under paragraph "Fittings for Use with RGS "; and coated as defined under paragraph "PVC-RGS."
- F. Fittings for Use with PVC:
 - 1. Fittings shall be of the same material, thickness, and construction as the conduits with which they are used.
 - a) Standards:
 - (1) UL 651.
 - (2) NEMA TC-2-1978.
 - 2. Solvent cement for welding fittings shall be supplied by the same manufacturer as the conduit and fittings.
 - a) Shall not be more than 1 year past date of manufacture.
 - b) Standard: ASTM D2564.
- G. Fittings for Use with LFMC:
 - 1. Fittings shall meet the following minimum requirements unless otherwise noted:
 - a) Body: Malleable iron, zinc-plated.
 - b) Ferrule: Steel, zinc-plated.
 - c) Locknuts and compression nuts: Malleable iron, zinc-plated.
 - d) Sealing ring: Neoprene.

2. Fittings shall be compression type.
3. Standard: UL 514.

2.11 STRUT CHANNEL SUPPORT SYSTEMS

- A. Conduit shall be supported in a method and at spacing intervals as approved by the NEC, except as described herein.
- B. Conduit shall be supported by approved pipe straps or clamps.
- C. Pipe straps or clamps shall be secured by means of:
 1. Toggle bolts on hollow masonry.
 2. Metal expansion shields and machine screws, or standard pre-set inserts, on concrete or solid masonry.
 3. Machine screws or bolts on metal surfaces.
 4. Wood screws on wood construction.
- D. Acceptable manufacturers:
 - a) Allied Power-Strut Products
 - b) B-Line Systems
 - c) Rob-Roy Industries
 - d) Thomas & Betts
 - e) Unistrut Building Systems
- E. All strut-channel, clamps, fittings and fastener materials shall conform to the following unless otherwise noted on the Contract Drawings.
 1. Indoor/Dry Areas: Zinc-Chromate Steel (ASTM B633 SC3 Type-II)
 2. Indoor/Wet Areas: Hot-Dipped Galvanized Steel (ASTM A123)
 3. Indoor/Corrosive Areas: Fiberglass (ASTM D-4385)
 4. Outdoor/Wet Areas:
 - a) Stainless Steel Type-304 (ASTM A240)
 - b) Aluminum 6063-T6
 5. Outdoor/Corrosive Areas:
 - a) Stainless Steel Type-316 (ASTM A240)
 - b) PVC Coated Hot-Dipped Galvanized Steel (ASTM D1151, D2247)
- F. Strut-channel shall not be bent, drilled, cut or otherwise modified to produce fittings, braces or brackets for conduit and equipment supports.
- G. Manufactured strut-channel braces, brackets, fittings and post-bases shall be provided and installed with associated hardware and fasteners as a complete system for conduit and equipment supports.

PART 3 – EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

- A. All conduit, raceway, wireway and associated fittings shall be stored in accordance with the manufacturer recommendations and shall not be stored exposed to sunlight or other UV rays.

3.2 INSTALLATION

A. Underground Raceways:

1. Raceways run external to building foundation walls, with the exception of branch circuit raceways, shall be encased with a minimum of three (3) inches of concrete on all sides.
 - a) Encased raceways must have a minimum cover of eighteen (18) inches, except for raceways containing circuits with voltages above 600Volts, which must have a minimum cover of thirty (30) inches.
 - b) Encased raceways shall be of a type approved by the NEC as "Suitable for concrete encasement."
2. Branch circuit raceways run underground external to building foundation walls shall be run in raceways installed in accordance with the NEC, and shall be of a type approved by the NEC as "suitable for direct burial."
3. All underground raceways shall be identified by underground line marking tape located directly above raceway at 6 to 8 inches below finished grade. Tape shall be permanent, bright-colored, continuous printed, plastic tape compound for direct burial not less than 6 inches wide and 4 mils thick. Printed legend shall be indicative of general type of underground line below.
4. Raceways run underground internal to building foundation walls shall be of a type and installed by a method approved by the NEC.
5. Where underground raceways are required to turn up into cabinets, equipment, etc., and on to poles, the elbow required and stub-up out of the slab shall be of rigid steel.
6. The raceways system shall not be relied on for grounding continuity.
7. Where passing through a "below grade" wall from a conditioned interior building space, raceways shall be sealed utilizing fittings similar and equal to OZ/GEDNEY type "FSK" thru-wall fitting with "FSKA" membrane clamp adapter if required.

B. Above Ground Raceways:

1. Conduit shall be sized in accordance with the latest edition of the NEC unless shown otherwise. Flexible metal and watertight ("sealtight") conduit in size 3/4IN and larger are acceptable for motor, appliance and fixture connections provided green wire is installed and NEC is followed.

2. Conduit, exposed and concealed (except "in-slab"), shall be neatly installed parallel to, or at right angles to beams, walls and floors of building.
 3. The raceway system shall not be relied upon for grounding continuity.
 4. The use of "LB's" shall be limited where possible. Where necessary to use "LB's" sized larger than 2 inches, mogul units shall be installed.
- C. Minimum size conduit shall be 3/4 inch above grade and 1 inch for conduits below grade except where noted otherwise. No conduit shall have more than 40 percent of its internal area occupied by conductors in accordance with the NEC.
- D. During construction all installed conduits shall be temporarily plugged, capped, or otherwise protected from the entrance of dust, trash, moisture, etc., and any conduits which may become clogged shall be replaced. No conductor shall be pulled in until all work that might cause damage to the conduit or conductors has been completed.
- E. Conduit straps or brackets secured to concrete, brick, or masonry shall be by means of expansion bolts, toggle bolts, or approved drill anchors. No wood plugs will be permitted.
- F. The Contractor shall plan the layout of conduit and raceway systems so that when the work is complete it will exhibit good workmanship practices in accordance with NECA-1.
- G. Routing of Conduits and Raceways:
1. Conduit and Raceway runs, where shown, indicate the preferred location. Site conditions may affect actual routing. Contractor shall coordinate routing and measurement with other trades and with equipment suppliers.
 2. Shall not interfere with, or prevent access to, piping, valves, ductwork, or other equipment for operation, maintenance and repair.
 3. Wherever possible avoid routing conduits and raceways through areas of high ambient temperature or radiant heat.
- H. Size of Conduits and Raceways:
1. The size of conduits and raceways are normally shown on the Contract Drawings. If a size is not shown on the Contract Drawings, or if a minimum size is not stated in the Specifications, then the size of conduits and raceways shall be in accordance with the NEC.
 2. Conduits shall not be smaller than 1IN for underground installations and 3/4IN elsewhere, unless otherwise shown on the Contract Drawings.
- I. Types of Conduits and Raceways:
1. Shall be installed as defined in the Contract Drawings.
 2. As required by NFPA.
 3. Flexible Conduit:

- a) Install as the final conduit to motors, electrically operated valves, primary elements (instrumentation), and electrical equipment that is liable to vibrate.
 - b) Shall not be used as a conduit run:
 - c) Maximum length shall not exceed:
 - (1) 36IN to motors.
 - (2) 24IN to all other equipment.
4. PVC-RGS:
- a) Contractor shall use tools, clamps, dies, equipment, etc. designed specifically for the cutting, bending and threading of PVC-RGS.
 - b) Contractor shall follow the recommendations and methods of the manufacturer for installing PVC-RGS.
5. EMT shall not be installed:
6. Installation of Nonmetal Rigid Conduit (PVC):
- a) PVC schedule 40 shall not be used exposed or concealed in gypsum walls, but may be used in CMU walls. PVC schedule 40 may be used in elevated floor slabs and in foundation slabs. Minimum concrete cover shall be 3/4 inch at finished or formed surface and shall be 3 inches at concrete surface cast against earth or for slabs placed on-grade. Greater amounts of concrete cover shall be used in areas subject to damage. The placement of conduit in floor slabs must be thoroughly coordinated with the structural design. Potential conflicts with steel reinforcing bars and reductions in net concrete sections are among the issues that must be considered by the structural engineer.
- J. Provide all required openings in walls, floors, and ceilings for conduit penetration.
1. New construction:
- a) Sleeves and block outs: Set in masonry walls during erection.
 - b) Sleeves and block outs: Set in concrete during forming.
 - (1) Material: Not harmful to the concrete.
 - (2) Not considered to replace structurally the displaced concrete.
- K. Conduit Runs:
1. All conduits within a structure shall be installed concealed unless otherwise noted on the Contract Drawings.
2. Total of Bends in a Conduit Run:
- a) Less than 270 degrees.
 - b) Provide pull boxes, condulets, or pulling elbows or tees as needed.

3. Maintain minimum 2IN separation between all conduits.
4. Maintain minimum 6IN separation between instrumentation and power conduits.
5. Maintain minimum 12IN separation from process, gas, air and water pipes.
6. Conduits and accessories embedded in concrete:
 - a) Shall not be larger in outside diameter than one-third the thickness of the slab, column or beam.
 - b) Place conduit and accessories after reinforcing steel has been laid.
 - c) Shall not displace the reinforcement steel.
 - d) Provide a minimum of 1-1/2IN of concrete cover around conduit.
 - e) Do not run against reinforcing steel.
 - f) Provide 2IN minimum of spacing between conduits.
 - g) Install expansion/deflection fittings wherever conduit spans structural or expansion joint.

L. Field Bending of Conduits:

1. Utilize tools, equipment, methods and recommendations by the manufacturer to make all field bends.
2. The internal diameter of conduit shall not be reduced or distorted.

M. Field Cutting and Threading Conduits:

1. Utilize tools, equipment, methods and recommendations by the manufacturer to field cut and thread conduit.
2. All field cut conduit shall be smooth and evenly chamfered on the inside.
3. All field threaded conduit shall be clean and degreased before applying a zinc rich paint.

N. Terminating Conduits:

1. NEMA 1 enclosures:
 - a) Top: Locknuts and insulated bushings.
 - b) Side: Locknuts and insulated bushings.
 - c) Bottom: Locknuts and insulated bushings.
2. NEMA 2/12/12K enclosures:
 - a) Top: Sealing locknuts and insulated bushings.
 - b) Side: Locknuts and insulated bushings.
 - c) Bottom: Locknuts and insulated bushings.
3. NEMA 3/3R/3S/13 enclosures:
 - a) Top: Threaded conduit hubs with insulated throats.
 - b) Side: Sealing locknuts and insulated bushings.

- c) Bottom: Locknuts and insulated bushings.
- 4. NEMA 4/4X enclosures:
 - a) Top: Threaded conduit hubs with insulated throats or approved cable gland fittings.
 - b) Side: Threaded conduit hubs with insulated throats or approved cable gland fittings.
 - c) Bottom: Threaded conduit hubs with insulated throats or approved cable gland fittings.
- O. Conduit Seal Installation:
 - 1. Type as shown on the Contract Drawings.
 - 2. So that the filler plug and drain is accessible.
 - 3. Complete with approved sealing fiber and compound.
- P. Conduit Coatings:
 - 1. The protective coating of conduits, fittings, and accessories shall be maintained.
 - a) Repair RGS utilizing a zinc rich paint.
 - b) Repair PVC-RGS utilizing a patching compound, of the same material as the coating, provided by the manufacturer of the conduit.
 - (1) The total nominal thickness: 40MIL.
 - 2. Repair surfaces that will be inaccessible after installation prior to installation.
- Q. Power Cable Pulling Preparation
 - 1. Remove moisture and debris from conduit before power cables are pulled.
 - 2. Pull mandrel with diameter nominally 1/4IN smaller than the interior of the conduit, to remove obstructions.
 - 3. Swab conduit by pulling a clean, tight-fitting rag through the conduit.
 - 4. Tightly plug ends of conduit with tapered wood plugs or plastic inserts until power cables are pulled.
 - 5. Only nylon or polyethylene rope shall be used to pull power cables in rigid non-metallic conduit systems.

END OF SECTION 16111

SECTION 16115 - UNDERGROUND CONDUIT, DUCTS, AND MANHOLES AND HANDHOLES

PART 1 – GENERAL

1.1 SUMMARY

- A. Section Includes manholes; handholes; pull-boxes; and underground power, control, and instrumentation conduits and ductbanks.
- B. In addition to the requirements specified in this section, the requirements of specification Section 16010 – Electrical, Basic Requirements and the sections referenced therein shall be applied.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Association of State Highway & Transportation Officials (AASHTO).
 - 2. American Society for Testing Materials (ASTM):
 - a) A536, Standard Specification for Ductile Iron Castings.
 - 3. National Fire Protection Association (NFPA):
 - a) NFPA 70, National Electrical Code (NEC), 2008 Edition.
- B. Miscellaneous:
 - 1. Contract Drawings indicate the intended location of manholes, handholes and pull-boxes; and routing of ductbanks and direct buried conduit. Field conditions may affect actual routing.

1.3 DEFINITIONS

- A. Direct-buried conduit means individual (single) underground conduits without concrete encasement.
- B. Direct-buried ductbank means multiple underground conduits, in a common trench, without concrete encasement.
- C. Concrete encased ductbank means any underground conduit or combination of underground conduits encased in a common concrete envelope.

1.4 SUBMITTALS

- A. See Sections 01300 and 16010.
- B. Fabrication and layout drawings:

1. Provide cross-sectioned sketch of each ductbank.
 - a) Dimension spacing between conduits.
 - b) Dimension concrete envelope and reinforcing, where applicable.
 2. Provide ductbank and direct-buried conduit profile.
 - a) Dimension from grade to ductbank and direct buried conduit.
 - b) Dimension from ductbank and direct buried conduit to other utilities in the route.
 3. Certifications.
 4. Test reports.
- C. Operation and Maintenance Manuals:
1. See Section 01730.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Cable pulling irons:
 - a) Condux International, Inc.
 2. Ground rods and grounding equipment:
 - a) See Section 16450
 3. Ground wire:
 - a) See Section 16450
 4. Conduit:
 - a) See Section 16111
 5. Duct spacers:
 - a) Underground Devices, Inc.
 - b) Condux International, Inc.
 6. Warning Tape:
 - a) W. H. Brady Company
 - b) Seton Nameplate Company.

2.2 MATERIALS

1. Cable Pulling Irons:
 - a) Hot-dipped galvanized steel.
 - b) 6000LBS minimum pulling load.
2. Ground Rods and Grounding Equipment:
 - a) See Section 16450
3. Ground Wire:
 - a) See Section 16120
4. Conduit:
 - a) See Section 16111
5. Duct Spacers:
 - a) High density polyethylene or high impact polystyrene.
 - b) Interlocking
 - c) Provide 2IN minimum spacing between conduits.
6. Warning Tape:
 - a) Approved manufacturers and catalog numbers:
 - (1) W H Brady Company
 - (a) Material: Polyethylene
 - (b) Thickness: 3.5MIL
 - (c) Tensile strength: 1750PSI
 - (d) Size: 6IN wide (minimum)
 - (e) Legend: Preprinted and permanently imbedded:
 - (i) Message continuously printed.

PART 3 – EXECUTION

3.1 INSTALLATION

A. General:

1. Install products in accordance with manufacturer's instructions.

2. Excavation and backfill shall conform to "Divison 2" of the specifications except heavy-duty, hydraulic-operated compaction equipment shall not be used. In addition comply with Section 16050 for trenching, backfilling and compacting.
3. Trenches should be cut neatly and uniformly, sloping uniformly to required pitch.
4. Ducts should be pitched to drain toward manholes and handholes and away from building and equipment. Minimum slope shall be 4IN in 100FT. Where necessary to achieve this between manholes, ducts should be sloped from a high point in the run to drain in both directions.
5. Concrete encased nonmetallic ducts shall be supported on plastic separators coordinated with duct size and spacing. Separators shall be spaced close enough to prevent sagging and deforming of ducts. Separators to the earth and to ducts should be secured to prevent floating during placement of concrete. Steel or tie wires should not be used in such a way as to form conductive or magnetic loops around ducts of duct groups.
6. Waterproof marking cord should be installed 130-pound test (marked at least every foot), equivalent to Greenlee No. 435, in all ducts, including spares after thoroughly rodding, clearing and swabbing all lines free of any and all obstructions.
7. All ducts shall be sealed at terminations, using sealing compound and plugs, as required to withstand 15 psi minimum hydrostatic pressure.
8. The arrangement of conduit in ductbank should be in accordance with OSHA requirements.
9. Buried conductor warning tape:
 - a) See Section 16010.

B. Underground Conduits:

1. Concrete encased ductbank:
 - a) Provide electrical duct system consisting of conduits completely encased in minimum 2IN of concrete.
 - b) For circuits 600V and below, install so that top of concrete encased duct, at any point, is not less than the minimum depths established by the NEC (Table 300-5 and exceptions):
 - (1) RGS conduit: 24IN.
 - (2) PVC sch-40 conduit: 24IN.
 - (3) Under areas subject to vehicular traffic:
 - (a) All applications: 24IN.

- (4) Unless a greater depth is detailed on the Contract Drawings.
 - c) Under traffic areas (roadways, parking lots, etc.) and for a distance 10FT either side of the traffic area, and elsewhere as defined on the Contract Drawings or specified, the concrete shall be reinforced in accordance with Section 03300.
- 2. Direct-buried ductbank:
 - a) Provide electrical duct system consisting of conduits directly buried in earth.
 - (1) Lay conduits on minimum 2IN sand base completely encased by 2IN of selected backfill containing no stones or other hard material larger than 1/2IN diameter.
 - b) For circuits 600V and below, install so that the top selected backfill at any point, is not less than the minimum depths established by the NEC (Table 300-5 and exceptions).
 - (1) RGS conduit: 24IN.
 - (2) PVC sch-80 conduit: 24IN.
 - (3) Under areas subject to vehicular traffic:
 - (a) All applications: 24IN.
 - (4) Unless a greater depth is detailed on the Contract Drawings.
- 3. Direct-buried conduit:
 - a) Provide electrical duct system consisting of conduits directly buried in earth.
 - (1) Lay conduit on minimum 2IN sand base completely encased by 2IN of selected backfill containing no stones or other hard material larger than 1/2IN diameter.
 - b) For circuits 600V and below, install so that top of the selective backfill, at any point, is not less than the minimum depths established by the NEC (Table 300-5 and exceptions).
 - (1) RGS conduit: 24IN.
 - (2) PVC sch-80 conduit: 24IN.
 - (3) Under areas subject to vehicular traffic:
 - (a) All applications: 24IN.
 - (4) Unless a greater depth is detailed on the Contract Drawings.

4. Underground conduits and ductbanks shall comply with the following:
 - a) Minimum grade shall be 4IN per 100FT or as detailed on the Contract Drawings.
 - (1) Low point shall be at one end of the conduit run.
 - b) During construction and after conduit installation is complete; plug the ends of all conduits.
 - c) Provide conduit supports and separators of concrete, plastic, or other suitable nonmetallic, non-decaying material designed for that purpose.
 - (1) Concrete encasement supports shall provide a uniform minimum clearance of 2IN between the bottom of the trench and the bottom row of conduit.
 - (2) Separators shall provide a uniform minimum clearance of 2IN between conduits.
 - (3) Place supports and separators for PVC conduit on maximum centers as indicated for the following trade sizes:
 - (a) 1IN and less: 2FT.
 - (b) 1-1/4 to 3IN: 4FT.
 - (c) 3-1/2 to 6IN: 6FT.
 - (4) Place supports and separators for RGS conduit on maximum centers as indicated for the following trade sizes:
 - (a) 1IN and less: 8FT.
 - (b) 1-1/4 to 2-1/2IN: 10FT.
 - (c) 3IN and larger: 12FT.
 - (5) Securely anchor conduits to supports and separators to prevent movement during placement of concrete or soil.
 - (6) Do not place concrete or soil until conduits have been observed by the Engineer.
 - d) Stagger conduit joints at intervals of 6IN horizontally.
 - e) Make conduit joints watertight and in accordance with manufacturer's recommendations.
 - (1) Make plastic conduit joints by uniformly brushing a plastic solvent cement on inside of plastic coupling fitting and outside of conduit ends. Slip conduit and fitting together with a quick one-quarter turn twist to set joint tightly.

- (2) Accomplish changes in direction of runs exceeding a total of 5 degrees by long sweep bends having a minimum radius of 25IN.
- (3) Sweep bends shall be made up of one curved section.
- f) Furnish manufactured bends at end of runs.
 - (1) Minimum radius of 18IN for conduits less than 3IN trade size and 36IN for conduits 3IN trade size and larger.
- g) After the conduit run has been completed, pull a standard flexible mandrel having a length of not less than 12IN and a diameter approximately 1/4IN less than the inside diameter of the conduit through each conduit. Then pull a brush with stiff bristles through each conduit to remove any foreign material left in conduit.
- h) Pneumatic rodding may be used to draw in pull-cords.
 - (1) Install a 1/8IN polypropylene pull-cord free of kinks and splices in all unused new ducts.
 - (2) Extend pull-cord 3FT beyond ends of conduit and fasten to prevent loss of pull-cord in conduits.
- i) Transition from PVC to RGS conduit with a minimum of 3FT prior to entering a structure or going above ground.
 - (1) Unless otherwise indicated on the Contract Drawings.
 - (2) PVC conduit may be extended directly to pull, junction and transformer boxes; manholes and handholes.
- j) Where conduits enter transformer boxes; manholes and handholes:
 - (1) Terminate PVC conduits in end bells.
 - (2) Terminate RGS conduits in insulated bushings.

C. Warning Tape:

- 1. Place warning tape in trench directly over ductbanks, direct-buried conduit, and direct-buried wire and cable 6IN below finished grade.
- 2. Provide warning tape as follows:
 - a) Electrical trenches and ductbanks or directly buried conduit:
 - (1) Legend: "CAUTION CAUTION CAUTION" (1st line), "BURIED ELECTRIC LINE" (2nd line).
 - (2) Letters: 1-1/4IN minimum.

- (3) Interval: Continuous.
- (4) Color: Red and black letters.
- b) Trenches and direct-buried or conduit encased telephone lines:
 - (1) Legend: "CAUTION CAUTION CAUTION" (1st line), "BURIED TELEPHONE LINE" (2nd line).
 - (2) Letters: 1-1/4IN minimum.
 - (3) Interval: Continuous.
 - (4) Color: Orange with black letters.
- c) Trenches with direct-buried or conduit encased computer or SCADA system communications lines:
 - (1) Legend: "CAUTION CAUTION CAUTION" (1st line), "BURIED COMPUTER LINE" (2nd line).
 - (2) Letters: 1-1/4IN minimum.
 - (3) Interval: Continuous.
 - (4) Color: Orange with black letters.

3.2 MAINTENANCE

- A. Provide the Owner with (2) sets of man-hole cover, underground pull-box cover or precast cable trench cover removal tools.

END OF SECTION 16115

SECTION 16120 - WIRE AND CABLE: 600 VOLT AND BELOW

PART 1 – GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish, install, connect, test, and place in satisfactory operating condition, ready for service, all cables and wires indicated on the Contract Drawings and as specified herein or required for proper operation of the installation, with the exception of internal wiring provided by electrical equipment manufacturers. The work of connecting cables to equipment, machinery, and devices shall be considered a part of this Section. All hardware, junction boxes, bolts, clamps, insulators, and fittings required for the installation of cable and wires system shall be furnished and installed by the Contractor
- B. The Contractor shall submit Shop Drawings and other material required to substantiate conformance with the requirements set forth on the Contract Drawings and in Section 16010 – Electrical: Basic Requirements, and Section 01300 - Submittals. Shop drawings shall include, but not be limited to, detailed specifications and product data sheets for the power, control, and instrumentation cable required for this project.
- C. The wire and cable to be furnished and installed for this project shall be the product of manufacturers who have been in the business of manufacturing wire and cable for a minimum of ten (10) years.
- D. Reference Section 16010 – Electrical: Basic Requirements.

1.2 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, SUBMITTALS, the Contractor shall obtain from the wire and cable manufacturer and submit the following:
 - 1. Shop Drawings
 - 2. Reports of Certified Shop and Field Tests
 - 3. Wiring Identification Methods.

Each submittal shall be identified by the applicable specification section.

1.3 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed material's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible Submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:

1. Material specifications and product data sheets identifying all materials used and methods of fabrication.
2. Cable and wire identification methods and materials.

1.4 IDENTIFICATION

- A. Each cable or wire shall be identified as specified in Part 3, EXECUTION, of this Specification.

PART 2 – PRODUCTS

2.1 CONDUCTORS, WIRE AND CABLE

- A. All conductors, wires and cables shall be UL listed and NEC approved for their intended purpose.
- B. For service entrance, motor branch, and feeder circuits operating at 240 and 480 volts, the conductors shall be single-conductor, cable rated, 600 volts. The single-conductor cable shall consist of uncoated annealed copper, Class B stranded per ASTM B 8 and insulated with corona, ozone, heat and moisture resisting cross-linked polyethylene insulation rated to withstand a copper temperature of 90 °C, UL listed and approved Type XHHW. Maximum conductor size allowed shall be 500kcmil.
- C. For general interior lighting and receptacle branch circuits operating at 115, 208, 230 and 277 volts, the conductor shall be single-conductor cable rated 600 volts. The single-conductor cable shall be uncoated annealed copper minimum No. 12 AWG. No. 12 and No. 10 AWG shall be solid. No. 8 AWG and larger cables shall be stranded Class B per ASTM B 8 and insulated with polyvinyl chloride insulation rated to withstand a copper temperature of 75 °C, UL listed and approved Type dual rated THHN/THWN or XHHW. Maximum conductor size allowed shall be 500kcmil.
- D. Cable specified for use in tray shall be multi-conductor and shall have an outer jacket of flame retarding, moisture and sunlight resistant polyvinyl chloride (PVC) and shall be UL listed and NEC approved for tray installation.
- E. Conductors for branch circuits shall be sized to prevent a voltage drop exceeding three percent (3%) at the farthest outlet of power, heating and lighting loads, or any combination of such loads. The maximum total voltage drop on both feeders and branch circuits to the farthest outlet shall not exceed five percent (5%).
- F. Where the conductor length from the panel to the first outlet on a 277 volt circuit exceeds 125 feet, the branch circuit conductors from the panel to the first outlet shall not be smaller than #10 AWG.
- G. Where the conductor length from the panel to the first outlet on a 120 volt circuit exceeds 50 feet, the branch circuit conductors from the panel to the first outlet shall not be smaller than #10 AWG.
- H. For No. 10 AWG and smaller solid branch circuits and fixture conductors operating at 277 volts or less, live spring pressure connectors (wirenuts) rated for 600 volts may be used for splices in junction boxes, outlet boxes and fixtures. When installed

in a fixture, connectors shall be rated for 1,000 volts. Permanent type crimp connectors shall not be used for branch circuit connections.

- I. Splices, taps, and terminations of cable rated 600 volts and less requiring tape shall be half lap and at least 3 layers. Taping shall be neatly done and form a permanent insulation equal in mechanical and electrical strength to the original insulation of the conductor. Taping shall be gum rubber or thermoplastic friction tape. Solderless mechanical connectors for splices and taps, provided with UL approved insulating covers, may be used instead of mechanical connectors plus tape.

J. 600V POWER WIRE AND CABLE

- 1. All 600V rated power wire and cable not covered above shall consist of stranded, copper conductor with insulation type XHHW-2, 90°C
- 2. Conductors shall be stranded copper per ASTM-B8, B-33 and B-189, Class B or C stranding contingent on the size unless otherwise specified. Minimum size wire shall be #12AWG.
- 3. 600V rated individual or multi-conductor power wire and cable shall be manufactured by the Okonite Company, BICC Industrial Cable Company or approved equal.

K. 600V CONTROL CABLE

- 1. All 600V rated control cable shall consist of stranded, copper conductor with insulation type XHHW-2, 90°C.
- 2. The individual conductors of the multiple conductor cable shall be color coded for proper identification. Color coding shall be equal to ICEA S-68-514, Table K-1. Cables shall meet requirements of IEEE-383.
- 3. Conductors shall be stranded copper per ASTM B-8, B-33 and B-189, Class B or C stranding contingent on the size unless otherwise specified. Minimum wire size shall be #14AWG.
- 4. 600V rated individual or multi-conductor control wire shall be manufactured by the Okonite Company, BICC Industrial Cable Company or approved equal.

L. 600V SHIELDED MOTOR POWER CABLE FOR VARIABLE FREQUENCY DRIVES

- 1. Where indicated on the Contract Drawings, the power connection between the variable frequency drive (VFD) and the associated motor shall utilize a shielded three-conductor plus ground conductor VFD output cable.
- 2. Shielded motor power cables with #2AWG and smaller conductors shall have an overall polyvinyl chloride jacket, utilize XLPE conductor insulation with 100 percent rated ground conductor, overall foil shield, 85% TC braid and drain wire.
- 3. Shielded motor power cables with #1AWG and larger conductors shall have an overall polyvinyl chloride jacket, utilize XLPE conductor insulation with three-symmetrical BC grounds, two spiral copper tape shields.
- 4. Shielded Motor cable shall meet the following requirements.
 - a) Utilize high-strand tined copper conductors.
 - b) Lower capacitance suitable for longer runs
 - c) Sunlight and oil resistant.

- d) Suitable for Class I and II; Division 2 hazardous locations.
- e) Rated for 90 Deg. C temperature for wet or dry locations.
- f) Pass UL 1685 vertical tray flame test

- 5. 600V rated shielded motor power cable shall be Belden 29500 series, or approved equal by Okonite or Southwire.

B. INSTRUMENTATION SIGNAL CABLE (STP)

- 1. The instrumentation cable for analog signals shall be individually shielded twisted pair cable (STP) or individually shielded twisted multi-pair cable (M#STP, where # = number of pairs). Conductors shall be tin or alloy coated, soft, annealed copper, #16AWG minimum with a minimum of 19 strands with 600V rated insulation for 75°C. Pairs shall have 100% coverage foil shields with a #18AWG tinned copper drain wire. Outer jackets shall be chromed polyvinyl chloride.
- 2. The instrumentation cable shall be Belden, Okonite, Southwire or approved equal for single and multiple pair applications or approved equal.
- 3. Instrumentation cables shown on the Contract Drawings to be direct buried shall be UL labeled for direct buried service.

C. TELEPHONE/DATA CABLE (CAT-6)

- 1. All interior telephone / data cables shall be ANSI/TIA/EIA 568 (Category 6e), #24AWG copper, plenum rated and ETL Type-CMP.

PART 3 – EXECUTION

3.1 600V CABLE INSTALLATION

- A. The cable and wires shall be installed as specified herein and shown on the Contract Drawings.
- B. Individual neutral wire shall be provided for each circuit feeding electronic equipment.
- C. Full size neutral conductor shall be provided for each service panel and sub-panel.
- D. All wire and cable shall run in raceway. In special cases, type "MC" and type "NM" cable is permitted without raceway, provided the State Construction Office has approved the application.
- E. The cables shall be terminated in accordance with the cable and/or termination product manufacturer's instructions for the particular type of cable.
- F. To minimize oxidation and corrosion, wire and cable shall be terminated using an oxide-inhibiting joint compound recommended for "copper-to-copper" connections. The compound shall be Penetrox E as manufactured by Burndy Electrical, or approved equal.

- G. Splices are normally not permitted in the underground duct, manhole and handhole systems. If splices are required, the Contractor shall obtain approval in writing from the Engineer prior to splicing.
1. Splicing material shall be a two-part insulating and encapsulating resin.
- H. Cable and Wire Sizes
1. The sizes of cable and wire shall be as shown on the Contract Drawings, or if not shown, as approved by the Engineer. If required due to field routing, the size of conductors and respective conduit shall be shall be coordinated with and approved by the Engineer.
 2. Minimum wire size within control panels, motor control centers, switchboards and similar equipment shall be #12AWG for power and #14AWG for control.
- I. Number of Wires
1. The number of wires indicated on the Contract Drawings for the various control, indication, and metering circuits were determined for general schemes of control and for particular indication and metering systems.
 2. The actual number of wires installed for each circuit shall, in no case, be less than the number required; however, the Contractor shall add as many wires as may be required for control and indication of the actual equipment selected for installation at no additional cost to the Owner. The addition of conductors shall be coordinated with and approved by the Engineer.
- J. Wiring Identification
1. The Contractor shall meet with the Owner and/or Engineer to develop the cable and wire identification nomenclature prior to the Contractor developing the cable and wire schedule.
 2. All wiring shall be identified with a unique wire or cable tag number and shall be labeled at each termination. Tag numbers shall correspond with the accepted cable and wire schedule and shall not be duplicated.
 3. Cable and wire identification shall be accomplished through the use of a printer with white, polyolefin heat shrinkable wire marking sleeves.
 4. All single-phase and three-phase wiring shall be color coded at each termination. The color coding is applicable to all power, control, alarm, signal, and instrumentation cables, and conductors.
 5. Identify each cable (single or multi-conductor) and groups or bundles of individual single conductors in each manhole, pullbox, cable tray or other component of the raceway system.
- K. Cable Bundle Identification Tags
1. The Contractor shall furnish all labor and materials and affix to each cable bundle in manholes, cable compartments, vaults, and junction/pull boxes a bronze metal tag, 1 IN diameter, with a 1/8 IN diameter hole. The bronze tag shall be stamped with the cable bundle tag number and attached with stainless steel wire by permanent crimp seal. All cable bundles shall be tagged with its approved tag number immediately after it has been pulled.

L. Cable Installation

1. All interior cable not protected by a compartment enclosure shall be run in conduit.

M. Training of Cable

1. The Contractor shall furnish all labor and material required to train cables around cable vaults within buildings and in manholes in the outdoor underground duct system. Sufficient length of cable shall be provided in each manhole and vault so that the cable can be trained and racked in an approved manner. In training or racking, the radius of bend of any cable shall be not less than the manufacturer's recommendation. All manhole cables shall be arc and fire-proofed. The training shall be done in such a manner as to minimize chaffing.

N. Connections at Control Panels, Limit Switches, and Similar Devices

1. Where stranded wires are terminated at panels, and/or devices, connections shall be made by solderless lug, crimp type ferrule or solder dipped.
2. Where enclosure sizes and sizes of terminals at limit switches, solenoid valves, float switches, pressure switches, temperature switches, and other devices make 7-strand, #12AWG, wire terminations impractical, the Contractor shall terminate external circuits in an adjacent junction box of proper size and shall install #14AWG stranded wires from the device to the junction box in a conduit. The #12 AWG field wiring shall also be terminated in the same junction box to complete the circuit.

O. Pulling Temperature

1. Cable shall not be flexed or pulled when the temperature of the insulation or of the jacket is such that damage will occur due to low temperature embrittlement. When cable will be pulled with an ambient temperature within a three day period prior to pulling of 40°F or lower, cable reels shall be stored during the three day period prior to pulling in a protected storage area with an ambient temperature not lower than 55°F and pulling shall be completed during the work day for which the cable is removed from the protected storage.

P. Color Coding

1. Unless otherwise noted on the Contract Drawings, conductor insulation shall be color coded as follows:
 - a) 480V AC Power:
 - (1) Phase A - BROWN
 - (2) Phase B - ORANGE
 - (3) Phase C - YELLOW
 - (4) Neutral – NATURAL GREY
 - b) 120/208V or 120/240V AC Power:

- (1) Phase A - BLACK
 - (2) Phase B - RED
 - (3) Phase C - BLUE
 - (4) Neutral – WHITE
- c) 120VAC Control:
- (1) Ungrounded conductors – RED
 - (2) Ungrounded conductors, foreign source - YELLOW.
- d) 24VAC Control:
- (1) All wiring – ORANGE
- e) 24VDC Power:
- (1) Positive Lead – RED
 - (2) Negative Lead – BLACK
- f) 24VDC Control:
- (1) Ungrounded conductors – BLUE
 - (2) Grounded conductors – BLUE w/ WHITE stripe
- g) Equipment Grounding Conductor:
- (1) All wiring – GREEN
2. Conductors #4AWG and smaller shall be factory color coded with a separate color for each phase and neutral, which shall be used consistently throughout the system. Larger cables shall be coded by the use of colored tape.

Q. Splices:

- 1. Joints in solid conductors shall be spliced using Ideal “wirenuts”, 3M Company “Scotchlock” or T&B connectors in junction boxes, outlet boxes and lighting fixtures.
- 2. “Sta-kon” or other permanent type crimp connectors shall not be used for branch circuit connections.
- 3. Joints in stranded conductors shall be spliced by approved mechanical connectors and gum rubber tape or friction tape. Solderless mechanical connectors for splices and taps, provided with UL-approved insulating covers, may be used instead of mechanical connectors plus tape.
- 4. Unless otherwise specified, splices shall be made at outlet boxes, pull boxes, junction boxes, manholes, or vaults. No splice shall be drawn into a conduit. Splices in wiring rated 600 volts and below shall be made with enough spare wire for two splices to be remade with the wire at the same location.

R. Underground Conductors:

1. When conductors, or cables, are directly buried, install permanently colored polyethylene, 0.004-inch film marking tape, six inches wide, and at six inches below finished grade. Direct buried conductors or cables installed under roadways and paved areas shall be installed in rigid steel conduit sized per the NEC with minimum of one-inch-diameter conduit.
2. Inside all manholes, all cables are to have racks with insulator supports. Supports are to be within six inches of each side of a splice and spaced not farther than three feet apart.

3.2 INSTRUMENTATION / TELEPHONE / DATA CABLE INSTALLATION

- A. Grounding of cable shield shall be accomplished at one end point only.
- B. Raceways exceeding 5FT and containing instrumentation / telephone / data cable shall be installed to provide the following clearances:
 1. Raceway installed parallel to raceway conductors energized at 480 through 208V shall be 18IN and 208/120V shall be 12IN.
 2. Raceway installed at right angles to conductors energized at 480V or 120/208V shall be 6IN.
- C. Where practical, raceways containing instrumentation / telephone / data cable shall cross raceway containing conductors of other systems at right angles.
- D. Where instrumentation / telephone / data cables are installed in panels, etc., the Contractor shall arrange wiring to provide maximum clearance between cables and other conductors. Instrumentation / telephone / data cables shall not be installed in same bundle with conductors of other circuits.
- E. Additional pullboxes shall be furnished and installed for ease of cable pulling and the cable manufacturer's recommended conduit fill factor shall be followed.
- F. All cable, insulation and jacket shall have adequate strength to allow for it to be pulled through the conduit systems. Sufficient conductors shall be installed to provide space and serve future equipment where shown and specified. All conductors shall be color coded and all wires shall be suitably tagged with permanent markers at each end.

3.3 TESTING

- A. All testing shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:
 1. Shop Test
 - a) Prior to the first shipment of each size of power, control, and telephone / data cable to be furnished and installed under this Contract, samples of each size of cable shall be subjected to complete physical and electrical factory production tests at the manufacturer's plant. Other cable and wiring shall be tested in

accordance with the applicable ICEA Standards. Six copies of certified test data sheets shall be submitted to the Engineer for approval prior to installation at the site. Subsequent shipment of each size of wire shall be covered by certificates of compliance which shall list Contractor's name, point of delivery, reel numbers, size of wire, length of wire, and date of shipment. Certificates shall attest the wires and cables comply with specification requirements and that wires and cables are equal in every respect to wires and cables which have been successfully tested.

- b) All test data or certificates shall be notarized and submitted.

2. Field Tests

- a) Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and Section 16010, BASIC ELECTRICAL REQUIREMENTS.
- b) Prior to energizing electrical system, feeders, sub-feeders and service conductor cables shall be tested for electrical continuity and short circuits. A copy of these tests shall be sent to the State Construction Office, the Engineer and the Owner.
- c) After installation, all wires and cables shall be tested for insulation levels and continuity. Insulation resistance between conductors of the same circuit and between conductor and ground shall be tested. Testing for insulation levels shall be as follows:
 - (1) For 600V rated power and control cable, apply 1,000VDC from a Megaohmmeter for all 600V wires and cables installed in lighting, control, power, indication, alarm and motor feeder circuits. Testing for continuity shall be "test light" or "buzzer".
 - (2) 600V rated instrumentation signal cable shall be tested from conductor to conductor, conductor to shield, and conductor to ground using a 260 volt-ohmmeter, or approved equal. The resistance value shall be 200 megaohms or greater.
- B. Low voltage wires and cables shall be tested before being connected to motors, devices or terminal blocks.
- C. Voltage tests shall be made successively between each conductor of a circuit and all other conductors of the circuit grounded.
- D. If tests reveal defects or deficiencies, the Contractor shall make the necessary repairs or shall replace the cable as directed by the Engineer, without additional cost to the Owner.
- E. All tests shall be made by and at the expense of the Contractor who shall supply all testing equipment.

END OF SECTION 16120

SECTION 16130 - OUTLET, PULL AND JUNCTION BOXES

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:

1. Outlet, pull and junction boxes.

B. Related Sections include but are not necessarily limited to:

1. Contract and Bidding Requirements.
2. Section 09900 – Painting.
3. Section 16010 - Electrical: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Refer to Section 16010.

1.3 SUBMITTALS

A. Shop Drawings:

1. See Sections 16010.

B. Operation and Maintenance Manuals:

1. See Contract and Bidding Requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

A. See Section 16010.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Galvanized steel boxes:
2. Appleton Electric Co.
3. Steel City.
4. Raco.

B. Corrosion-resistant boxes:

1. Hoffman Engineering Co.

2. Crouse-Hinds.
- C. Hazardous location boxes (Class I, II & III):
 1. Appleton Electric Co.
 2. Crouse-Hinds.
 3. Killark.
 4. O-Z/Gedney.
- D. Raintight and watertight boxes:
 1. Appleton Electric Co.
 2. Crouse-Hinds.
- E. Terminal boxes:
 1. Hoffman Engineering Co.
- F. Exposed switch and receptacle boxes:
 1. Appleton Electric Co.
 2. Crouse-Hinds.
 3. Killark.

2.2 MATERIALS

- A. Pull and Junction Boxes for Wet Areas:
 1. Material: 14 GA steel with polyester powder coating inside and out over phosphatized surfaces.
 - a) Seams continuously welded, ground smooth, no knockouts.
 - b) Stainless steel clamps on four sides.
 - c) Flat cover with oil resistant gasket.
 - d) NEMA 4 classification.
 - e) UL listed.
 2. Pull and Junction Boxes for Corrosive Areas:
 - a) Material: 14 GA steel with powdered epoxy resin coating inside and out or fiberglass reinforced polyester material.
 3. Fiberglass-reinforced polyester boxes:
 - a) Hinged door with latch and lockout.
 - b) Neoprene door gasket.
 - c) Grounding bushing(s).
 - d) NEMA 4X classification.
 - e) UL listed.
 4. Pull and Junction Boxes for Hazardous Areas:

- a) Material: Cast gray iron alloy or copper-free cast aluminum.
 - b) Drilled and tapped openings or tapered threaded hub equipped.
 - c) Flat bolted-down or threaded cover with neoprene gasket.
 - d) Stainless steel hex head screws.
 - e) Explosionproof, UL listed for Class 1 Groups C and D.
5. Large Pull and Junction Boxes (100 CU IN and larger):
- a) Located in wet and corrosive areas:
 - (1) NEMA 4X with stainless steel screws.
 - b) Type 304 L welded stainless steel:
 - (1) Constructed of 14 GA steel with seams continuously welded, ground smooth, no knockouts.
 - (2) Rolled lip around all sides.
 - (3) Rigid handles for covers larger than 9 SF or heavier than 25 LBS.
 - (4) Split covers when heavier than 25 LBS.
6. Terminal Boxes:
- a) Galvanized 16 GA steel box provided with plain blank screw cover, subpanel, and terminal points.
 - b) Refer to Drawing for dimensions and number of terminals.
 - c) Terminal blocks shall be screw-post barrier-type with white marker strip.
 - d) Rated 20 ampere, minimum 600V.
7. Fiberglass Cable-Pulling Enclosure:
- a) Use: Access points to facilitate pulling of electrical cables in buried conduit runs.
 - b) Size and quantity: As shown on Drawings.
 - c) Type: Rectangular fiberglass composite, suitable for direct burial pedestrian traffic on top, -50 DegF, chemical, sunlight, and weather resistant.
 - d) Provide matching top with "ELECTRIC" logo.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Use cast metal boxes with threaded conduit hubs in hazardous areas.
- C. Use Type FS and FD boxes in wet areas and where exposed rigid steel conduit is required.

- D. Use epoxy resin coated, stainless steel, cast aluminum or fiberglass boxes for corrosive areas.
- E. Fill unused punched-out, tapped, or threaded hub openings with insert plugs of like material to maintain enclosure NEMA rating.
- F. Paint boxes in accordance with Section 09900 and 16050.
- G. Use outlet boxes sized to accommodate quantity of conductors enclosed.
- H. Use boxes sized to accommodate conduit tying into box.
- I. Install pull boxes or junction boxes in conduit runs where indicated or required to facilitate pulling of wires or making connections.
- J. Make covers of boxes accessible.
- K. Install pull boxes or junction boxes rated for the area classification.
- L. Install rigid conduit squarely into boxes that do not have hubs or are drilled and tapped.
- M. Install with locknut on the inside and outside with insulating bushing on inside.
- N. Install conduit into boxes with hubs, or that are tapped, using thread lubricant.
- O. Do not use back-to-back boxes on this Project.
- P. Seal all points of conduit entry into fiberglass cable-pulling enclosures for a waterproof installation.
- Q. Support outlet boxes for incandescent fixtures and other ceiling-mounted devices in lay-in acoustical tile ceilings by bar hangers anchored to ceiling construction members which do not interfere with tile removal.
- R. Do not use meter boxes for junction boxes.

END OF SECTION 16130

SECTION 16140 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Light switches, receptacles, device plates, dimmers, plug-in strips.

B. Related Sections include but are not necessarily limited to:

1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
2. Division 1 - General Requirements.
3. Section 16010 - Electrical: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Refer to Section 16010.

1.3 SUBMITTALS

A. Shop Drawings:

1. Refer to Sections 01300 and 16010.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Light switches:
 - a) Hubbell.
 - b) Slater.
 - c) P&S.
 - d) Arrow Hart.
 - e) General Electric.
 - f) Leviton.
2. Door switches:
 - a) General Electric.
 - b) Slater.

- c) P&S.
- d) Arrow Hart.
- e) Micro-switch.

3. Receptacles:

- a) Hubbell.
- b) Slater.
- c) P&S.
- d) Arrow Hart.
- e) General Electric.
- f) Leviton.

B. Submit requests for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Switches: 20A, 120/277V, heavy duty, specification grade, toggle type, single pole, three-way or four-way as indicated on drawings. Switches shall have quiet operating mechanism and be UL listed.

- 1. Pilot light toggles shall have neon bulbs of the correct voltage rating of the circuit indicated on the drawings.
- 2. Switch shall be grounding type with hex-head grounding screw.
- 3. Mercury type switches are not acceptable.

B. Receptacles: 20A, 125V, Two-pole, 3-wire, straight blade, heavy-duty, specification grade with grounding screw. Self grounding or automatic type grounding receptacles are not acceptable in lieu of receptacles with separate grounding screw lugs and a direct, green insulated conductor connection to the equipment grounding system. Receptacle shall have standard NEMA configuration and be UL labeled.

- 1. Provide GFI (Ground Fault Interrupting) type receptacles where indicated on drawings. All exterior receptacles shall be GFI type with weatherproof, while in use cover, unless otherwise noted on drawings. GFI receptacles shall be rated minimum 20Amp (NEMA 5-20R configuration)
- 2. Receptacles above counters with-in 6 feet of a sink shall be GFI type.
- 3. Receptacle face shall conform to WDI 101968.
- 4. Mounted receptacles vertically, except receptacles mounted above counters shall be horizontal.
- 5. Receptacles shall not be mounted back to back.
- 6. Receptacle shall be arranged for back and side wiring.
- 7. Provide green insulated ground from device to equipment grounding system. Self-grounding or automatic type grounding receptacles are not acceptable.

- C. Device Plates: Satin finished, Type 430 Stainless Steel - ganged as required for non-air conditioned areas. Cover plate mounting screws shall be slotted with oval head and shall match finish of plate. Provide quantity of 2% spare cover plates (minimum of 2) of each type to the owner.
 - 1. Cover plates for flush mounted devices and in finished spaces shall be type "302" stainless steel or impact resistant lexan/nylon – standard size, single or ganged as required on drawings. Cover plate mounting screws shall be slotted head oval screws and shall match the finish and material of the plate, and shall be furnished with the plate by the plate manufacturer. Quantity of 2% spare cover plates of each type shall be provided to the Owner.
 - 2. Cover plates for exposed work and in unfinished spaces shall be galvanized cast ferrous metal, standard size, single or ganged as required on drawings.
 - 3. Exterior plates shall be weatherproof and listed as "raintight while in use".

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Mount devices where indicated on the Drawings and as scheduled in Section 16010.
- C. Surface mount receptacles and light switches in concrete construction.
- D. In masonry and metal stud construction, recess mount receptacles and light switches unless device precludes recessed mounting or unless otherwise noted on the Drawings.
- E. Where more than one receptacle is installed in a room, they shall be symmetrically arranged.
- F. Set switches and receptacles plumb and vertical to the floor.
- G. Set recess-mounted switches and receptacles flush with face of walls.
- H. Do not connect dimmers to loads in excess of 80 percent of the rating of the dimmer.
- I. Provide blank plates for empty outlets.
- J. Securely attach top to ceiling grid and base to mating surface.

END OF SECTION 16140

SECTION 16450 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish and install grounding systems complete in accordance with the minimum requirements established by Article 250 of the NEC. Article 250 of the NEC shall be considered as a minimum requirement for compliance with this Specification.
- B. Grounding of all instrumentation and control systems shall be furnished and installed in accordance with the manufacturer/system requirements and IEEE 1100-92, Powering and Grounding of Sensitive Electronic Equipment. Conflicts shall be promptly brought to the attention of the Engineer.
- C. In addition to the NEC requirements, building structural steel columns shall be permanently and effectively grounded:
- D. Reference Section 16010 – Electrical, Basic Requirements.
- E. Additional requirements for grounding are shown on the Contract Drawings.

1.2 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:
 - 1. Witnessed Shop Tests
None required.
 - 2. Field Tests
Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and Section 16010 – Electrical: Basic Requirements.

1.3 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, SUBMITTALS, the Contractor shall obtain from the equipment manufacturer and submit the following:
 - 1. Shop Drawings
 - 2. Reports of certified field tests. Each submittal shall be identified by the applicable Specification section.

1.4 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
 - 1. Equipment specifications and product data sheets identifying all materials used and methods of fabrication.
 - 2. Drawings and written description of how the Contractor intends to furnish and install the grounding system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The equipment covered by these specifications shall be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

2.2 GROUND RODS AND GRID

- A. Ground rods shall be rolled to a commercially round shape from copper-clad steel manufactured by the molten-welding process or by the electro-formed process (molecularly bonded). They shall have an ultimate tensile strength of 75,000PSI and an elastic limit of 49,000PSI. The rods shall be not less than 3/4 IN diameter by 10 FT in length; and the proportion of copper shall be uniform throughout the length of the rod. The copper shall have a minimum wall thickness of 0.013 IN at any point on the rod.
- B. The maximum resistance to ground of a driven ground rod shall not exceed 10 OHM under normally dry conditions. Where the resistance obtained with one (1) ground rod exceeds 10 OHM, additional ground rods shall be installed not less than 10 FT on centers. Except where specifically indicated otherwise, all exposed non current-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductors in nonmetallic raceways and neutral conductors of wiring systems shall be grounded.

The ground connection shall be made at the main service equipment and shall be extended to the point of entrance of the metallic water service. Connection to the water pipe shall be made by a suitable ground clamp or lug connection to a plugged tee. If flanged pipes are encountered, connection shall be made with the lug bolted to the street side of the flanged connection. If there is not suitable metallic water service to the facility, the ground connection shall be made to the driven ground rods on the exterior of the building.

Where ground fault protection is employed, care shall be taken so that the connection of the ground and neutral does not interfere with the correct operation of the ground fault protection system.

2.3 FITTINGS

- A. Grounding connections to equipment shall be bolted. Cable end connections may be made by use of the crucible weld process or bolted type connectors. Bolted type connectors for this application shall consist of corrosion resistant copper alloy with silicone bronze bolts, nuts and lockwashers which are designed for this purpose.

2.4 GROUNDING CONDUCTORS

- A. When grounding conductors are insulated, insulation shall be colored solid green.
- B. A green, insulated equipment grounding conductor, which shall be separate from the electrical system neutral conductor, shall be furnished and installed for all circuits. Equipment grounding conductors shall be furnished and installed in all conduits. Use of conduits as the NEC required equipment grounding conductor is not acceptable.
- C. Where specified or shown a 3 IN strap shall be furnished and installed as the grounding conductor. Three inch strap shall be by Polyphasor or equal.

2.5 EQUIPMENT GROUNDS

- A. Equipment grounds shall be solid and continuous from a connection at earth to all distribution panelboards. Ground connections at panelboards, outlets, equipment, and apparatus shall be made in an approved and permanent manner.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Metal surfaces where grounding connections are to be made shall be clean and dry. Steel surfaces shall be ground or filed to remove all scale, rust, grease, and dirt. Copper and galvanized steel shall be cleaned with emery cloth to remove oxide before making connections.
- B. The raceway system shall not be relied on for ground continuity. A green grounding conductor, properly sized per NEC, shall be run in all raceways. The following exceptions apply:
 - 1. Raceways for telecommunications.
 - 2. Raceways for computer/data communications.
 - 3. Raceways for audio conductors.
- C. The electrical service shall be grounded by three (3) means in accordance with NEC Article 250:

1. To the metallic cold water pipe.
 2. To the steel frame of the building, provided the building frame is effectively grounded.
 3. To ground rod(s).
- D. Boxes with concentric, eccentric or over-sized knockouts shall be provided with bonding bushings and jumpers. The jumper shall be sized per NEC and lugged to the box.
- E. Ground Grid
1. A main ground ring or grid shall be provided for each structure and interconnecting structure rings/grids as shown on the Contract Drawings consisting of driven ground rods. The ground rods shall be driven deep enough to obtain a ground resistance of not more than 10 OHM and shall be interconnected by the use of copper cable bus (3 IN strap minimum), or a bare copper conductor sized to the largest service entrance ground, welded to the rods by the crucible weld process. The grounding cables shall be installed after the excavations for the building have been completed and prior to the pouring of concrete for the footings, mats, etc. Copper "pigtailed" shall be connected to the ground system and shall enter the buildings and structure from the outside and shall be connected to steel structures, and equipment as described in this Section and as required to provide a complete grounding system.
 2. Grounding conductors shall be continuous between points of connection; splices shall not be permitted.
 3. Where conductors are exposed and subject to damage from personnel, traffic, etc., conductors shall be installed in PVC sch-80 raceway.
 4. Connections to ground rods shall be exposed to permit maintenance and inspection for continuity and effectiveness of grounding system.
 5. Where subsurface conditions do not permit use of driven ground rods to obtain proper ground resistance, rods shall be installed in a trench or plate electrodes shall be provided, as applicable and necessary to obtain proper values of resistance.
- F. Raceways
1. Conduit which enters equipment such as motor control centers, switchboards, switchgear, variable frequency drives, instrument and control panels, and similar equipment shall be bonded to the ground bus, where provided, and as otherwise required by the NEC.

END OF SECTION 16450

SECTION 16475 – SAFETY / DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish and install separately mounted, individual disconnect switches as specified herein and indicated on the Contract Drawings.
- B. 16010 – Electrical: Basic Requirements.

1.2 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:
 - 1. Witnessed Shop Tests: None required.
 - 2. Field Tests: Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and Section 16010 – Electrical: Basic Requirements.

1.3 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, SUBMITTALS, the Contractor shall obtain from the equipment manufacturer and submit the following:
 - 1. Shop Drawings
 - 2. Spare Parts List

Each submittal shall be identified by the applicable specification section.

1.4 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
 - 1. Equipment specifications and product data sheets identifying all materials used and methods of fabrication.
 - 2. Complete layout and installation drawings with clearly marked dimensions for each type/size/rating of disconnect switch.
 - 3. Assembled weight of each unit.

- D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items that the Contractor intends to provide are acceptable and shall be submitted.

1.5 TOOLS, SUPPLIES, AND SPARE PARTS

- A. The equipment shall be furnished with all special tools necessary to disassemble, service, repair, and adjust the equipment, and with all spare parts as recommended by the equipment manufacturer.
- B. One complete set of spare fuses for each ampere rating installed shall be furnished and delivered to the Owner at the time of final inspection.
- C. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.
- D. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size shall have the same parts number.

1.6 IDENTIFICATION

- A. Each equipment item shall be identified with a nameplate. The nameplate shall be engraved indicating the circuit number and equipment name with which it is associated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Contract Drawings.
- B. Switches shall be manufactured by Square-D, Eaton/Cutler-Hammer, General Electric, Allen-Bradley, or Siemens.

2.2 DISCONNECT SWITCHES

- A. Disconnect switches shall be heavy-duty type and/or as specified in these Specifications. General duty switches are not acceptable. Switches shall be furnished and installed as shown on the Contract Drawings and as required by the NEC.

- B. Switches shall be single throw, externally operated, fused or non-fused as required. Switches shall be of the poles, voltage, and ampere ratings as shown on the Contract Drawings.
- C. Disconnect Switches shall be provided in following enclosures as a minimum based on their location. Multiple ratings of enclosures may apply.
 - 1. Indoor dry areas: NEMA 1A
 - 2. Indoor damp areas: NEMA 12
 - 3. Corrosive or indoor wet process areas: NEMA 4X 304 stainless steel or non-metallic
 - 4. Outdoor areas: NEMA 4X 304 stainless steel.
 - 5. Hazardous areas: suitable for the Class, Division, and Group to suit the application.
- D. Disconnect Switch mechanism shall be nonteasible, quick-make, quick-break.
- E. Switches shall have defeatable door interlocks that prevent the door from opening when the handle is in the "ON" position.
- F. Switches shall be NEMA Heavy Duty Type TH.
- G. Switches shall be UL listed.
- H. Switch handles shall be easily recognizable and padlockable in the "ON" or "OFF" position. Padlocks shall be provided for service entrance switches.
- I. A complete set of fuses for all switches shall be furnished and installed as required. Time-current characteristic curves of fuses serving motors or connected in series with circuit breakers shall be coordinated for proper operation. Fuses shall have voltage rating not less than the circuit voltage.
- J. Provide the following fuse types:

<u>Circuit Type</u>	<u>Fuse Type</u>
Service Entrance & Feeder circuits over 600A	Class L, UL listed, Current Limiting, 200 kAIC
Service Entrance & Feeder Circuits 600A and less	Class RK1 or J, UL listed, Current Limiting, 200 kAIC
Motor, Motor Controller & Transformer Circuits	Class RK5, UL listed, Current Limiting, Time Delay, 200 kAIC
Individual Equipment where fault current does not exceed 50 KA	Class K5, UL listed, 50 kaic

- K. Fuse holders shall have rejection or other features to permit only the insertion of the appropriate class fuse in accordance with NEC 240-60.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All disconnect switches to be mounted five 60 IN above the floor, at the equipment height where appropriate, or where shown otherwise.
- B. The Contractor shall furnish and install fuses of various types as required with the continuous ampere ratings as required or shown on the Contract Drawings.

END OF SECTION 16475

SECTION 16483 - VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. This section provides specification requirements for adjustable frequency drives, variable speed drives or herein identified as AC Drives for use with NEMA B design AC motors.
- B. The AC Drive manufacturer shall furnish, field test, adjust and certify all installed AC Drives for satisfactory operation.
- C. Any exceptions/deviations to this specification shall be indicated in writing to the specifying engineer in the submittal documentation.
- D. AC Drives shall fit in locations as shown in the contract documents.
- E. AC Drives shall operate auxiliary equipment such as seal water valves, motor space heaters, and include safety and equipment protection interlocks as shown in the contract documents.
- F. The AC Drive manufacturer shall be responsible for providing all equipment specified under this section, and furnishing the equipment to the Contractor for installation.

1.2 REFERENCES

- A. NFPA-70 "National Electric Code (NEC)"
- B. ANSI C84.1 "Electric Power Systems and Equipment - Voltage Ratings (60Hz)"
- C. CSA[®] C22.2 No.14-95 "Industrial Control Equipment"
- D. UL508A "Standard for Safety for Industrial Control Panels"
- E. UL508C "Standard for Safety for Power Conversion Equipment"
- F. NFPA 79 "Electrical Equipment of Industrial Machines/Industrial Machinery"
- G. NEMA ICS7 "Industrial Control and Systems: Adjustable Speed Drives"
- H. NEMA ICS7.1 "Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable Speed Drive Systems"
- I. NEMA 250 "Enclosures for Electrical Equipment (1000V maximum)"
- J. IEC 61800-2 "Adjustable speed electrical power drive systems - Part 2: General requirements - rating specifications for low voltage adjustable frequency AC power drive systems"

- K. IEC 61800-3 “Adjustable speed electrical power drive systems - Part 3: EMC product standard including specific test methods”
- L. IEC 61800-5-1 “Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy
- M. IEC 61800-6 "Adjustable speed electrical power drive systems - Part 6: Guide for determination of types of load duty and corresponding current ratings.”
- N. EGSA 101P “Engine Driven Generator Sets - Performance Standard”
- O. IEEE 519 “Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems”

1.3 SUBMITTALS

- A. All submittals shall be in accordance with Specification 01340 – Shop Drawings, Project Data and Samples.
- B. Approval drawings shall be furnished for Engineer’s approval prior to factory assembly of the AC Drives. These drawings shall consist of elementary power and control wiring diagrams and enclosure outline drawings. The enclosure drawings shall include front and side views of the enclosures with overall dimensions and weights shown, conduit entrance locations and nameplate legend details.
- C. Standard catalog sheets showing voltage, horsepower, maximum current ratings and recommended replacement parts with part numbers shall be furnished for each different horsepower rated AC Drive provided.

1.4 WARRANTY

- A. The equipment manufacturer shall provide a two (2) year warranty beginning from substantial completion of the project, and shall guarantee that the equipment furnished is suitable for the purpose intended and free from defects of design, material and workmanship. In the event the equipment fails to perform as specified, the equipment manufacturer shall promptly repair or replace the defective equipment without any cost to the Owner (including handling, shipment, labor, travel time and expense costs).

1.5 QUALITY ASSURANCE

- A. The manufacturer of the AC Drive shall be a certified ISO 9001 facility.
- B. The AC Drive and all associated optional equipment shall be UL LISTED according to UL508C Power Conversion Equipment. A UL label shall be attached inside each enclosure as verification.
- C. The AC Drive shall be designed constructed and tested in accordance with NEMA, NEC, VDE, IEC standards.

- D. Every power converter shall be tested with an actual ac induction motor, 100% load and temperature cycled within an environmental chamber at 104°F. Documentation shall be furnished to verify successful completion at the request of the engineer.
- E. All Drive door mounted pilot devices shall be tested to verify successful operation. Documentation shall be furnished upon written request of the engineer.
- F. The AC Drive shall undergo QA test procedures and be submitted to a hi-pot test with all enclosed devices mounted and wired, prior to shipment.

1.06 OPERATIONS AND MAINTENANCE MANUALS

- A. Operations and maintenance Manuals shall be submitted as outlined in Specification 01730 – Operation and Maintenance Data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The AC Drive shall be provided by ABB, Square-D, Danfoss, Cutler, Hammer, Gnenral Electric, Allen-Bradley or approved equal.
- B. AC drives for the spray irrigation pump station shall be series, direct torque controls, including the following features: Soft Start Bypass starter with service Switch, NEMA 12 enclosure, Input Circuit Breaker, 208 volt with factory authorized start-up.
- C. Drive output rating for the Buffalo Creek Pump Station shall be a minimum of 30 Amps Amps at 208 Volts for use with 7.5 HP pumps. Drives shall be capable of being adjusted to operate with the present 7.5 HP pumps.
- D. Drives shall include control interfaces as shown on the drawings and as specified. Each drive shall include PID control functions with adjustability as required to provide water pressure control from a pressure transmitter as shown on the contract draings
- E. Drive enclosure shall be a standard manufactured assembly by the drive manufacture, NEMA 12, with front ventilation. Drives assembled into an enclosure by an OEM are not acceptable. There shall be no restriction on space requirements between the sides and rear of the floor or wall mounted enclosures.
- F. Alternate control techniques other than pulse width modulated (PWM) are not acceptable.

2.2 GENERAL DESCRIPTION

- A. The Drive shall be solid state, with a Pulse Width Modulated (PWM) output. The Drive shall employ Direct Torque Control (DTC) inner loop torque control strategy that mathematically determines motor torque and flux every 25 microseconds

(μ s) (40,000 times per second). The drive must also provide an optional operational mode for scalar or V/Hz operation.

B. Ratings

1. The drive shall operate at continuous rated full load current from three phases 480 VAC power +10% / - 10% 48Hz to 63Hz. The Drive shall employ a full wave rectifier to prevent input line notching and operate at a fundamental (displacement) input power factor of 0.97 at all speeds and loads. The Drive efficiency shall be 98% or better at full speed and load. An internally mounted AC line reactor or DC choke shall be provided to reduce input current harmonic content, provide protection from power line transients such as utility power factor correction capacitor switching transients and reduce RFI emissions.
2. The overvoltage trip level shall be a minimum of 30% over nominal, and the undervoltage trip level shall be a minimum 35% under the nominal voltage.
3. Output voltage and current ratings shall match the adjustable frequency operating requirements of standard 460VAC, 3ph, 60Hz, NEMA design A or NEMA design B motors. The overload current capacity shall be 110% of rated current for one (1) minute out of five (5). Output frequency shall be adjustable between 0Hz and 90 Hz. Operation above motor nameplate shall require programming changes to prevent inadvertent high-speed operation. The drive's switching pattern shall be continually adjusted to provide optimum motor flux and avoid the high-pitched audible noise produced by motors energized by conventional PWM drives. The drive shall be furnished in a UL Type 1 listed enclosure rated for operation at ambient temperatures between 0° and 40°C at an altitude not exceeding 3300 feet, with relative humidity less than 95% and no condensation allowed. The drive shall be protected from atmospheric contamination by chemical gasses and solid particles per IEC 721-3-3, classes 3C2 and 3S2. The drive shall be protected from vibration per IEC 68-2-6 (max. sinusoidal displacement 1 mm, 5Hz to 13.2Hz and max. acceleration 7m/s², 13.2Hz to 100Hz).

C. Control Functions and Adjustments

1. An intelligent start-up assistant shall be provided as standard. The Start-up assistant will guide the user through all necessary adjustments to optimize operation and will include "plug and produce" operation, which recognizes the addition of options/fieldbus adapters and provides the necessary adjustment assistance.
2. Start-up data entries shall include motor nameplate power, speed, voltage, frequency and current.
3. A motor parameter ID function shall automatically define the motor equivalent circuit used by the sensorless vector torque controller.
4. A PID speed/torque loop regulator shall be provided with an autotune function as well as manual adjustments.

5. A selection of six (6) preprogrammed application macro parameter sets shall be provided to minimize the number of different parameters to be set during start-up. Macros included as standard are as follows: Factory Default, Hand/Auto, PID Control, Sequential Control, and Torque Control. A selection of two (2) user defined macros shall also be available.
6. Start/Stop control functions shall include two (2) or three-(3) wire start/stop, coast/ramp stop selections, optional dynamic braking and flux braking.
7. The AFD shall be capable of starting into a rotating load (forward or reverse) and accelerate or decelerate to reference without safety tripping or component damage (flying start). The AFD shall also be capable of flux braking at start to stop a reverse spinning motor prior to ramp.
8. The AFD shall have the ability to automatically restart after an overcurrent, overvoltage, undervoltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between reset attempts shall be programmable.
9. Accel/Decel control functions shall include two (2) sets of ramp time adjustments with linear and three (3) s-curve ramp selections.
10. Speed/Torque control functions shall include:
 - a) Adjustable min./max. speed and/or torque limits
 - b) Selection of up to 5 preset speed settings or external speed control
 - c) Three (3) sets of critical speed lockout adjustments.
 - d) A built-in PID controller to control a process variable such as pressure, flow or fluid level.
 - e) Reference signal processing shall include increase/decrease floating point control and control of both speed/torque and direction using a "joystick" reference signal. Two (2) analog inputs shall be programmable to form a reference by addition, subtraction, multiplication, minimum selection or maximum selection.
11. Output control functions shall include:
 - a) Flux optimization to limit the audible noise produced by the motor and to maximize efficiency by providing the optimum magnetic flux for any given speed/torque operating point.
 - b) Current and torque limit adjustments to limit the maximum Drive output current and the maximum torque produced by the motor. These limits shall govern the inner loop torque regulator to provide tight conformance with the limits with minimum overshoot.
 - c) A torque regulated operating mode with adjustable torque ramp up/down and speed/torque limits.
12. The Drive shall be capable of sensing a loss of load (broken belt / broken coupling) and signal the loss of load condition. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. Relay output shall include programmable time delays that will allow for drive acceleration from zero speed without signaling a false underload condition.

13. Two (3) programmable critical frequency lockout ranges to prevent the AFD from operating the load continuously at an unstable speed.

D. Static and Dynamic Performance

1. Open loop static speed regulation shall be 0.1% to 0.3% (10% of motor slip). When motor speed feedback is provided from a suitable encoder, closed loop speed regulation shall be 0.01% or better. Dynamic speed accuracy shall be 0.3-0.4 %-sec or better open loop and 0.1-0.2 %-sec or better-closed loop.
2. Torque response time shall be 5ms or less. In the torque regulating mode, torque regulating accuracy shall be 4% or better.

E. Operator Control Panel (Keypad)

1. Each Drive shall be equipped with a front mounted operator control panel (keypad) consisting of a four- (4-) line by 20-character back-lit alphanumeric display and a keypad with keys for Run/Stop, Local/Remote, Increase/Decrease, reset, menu navigation and parameter select/save.
2. All parameter names, fault messages, warnings and other information shall be displayed in complete English words or standard English abbreviations to allow the user to understand what is being displayed without the use of a manual or cross-reference table.
3. The Display shall have contrast adjustment provisions to optimize viewing at any angle.
4. The control panel shall include a feature for uploading parameter settings to control panel memory and downloading from the control panel to the same drive or to another drive.
5. All Drives throughout the entire power range shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating.
6. The keypad is to be used for local control, for setting all parameters, and for stepping through the displays and menus.
7. The keypad shall be removable and insertable under drive power, capable of remote mounting, and shall have it's own non-volatile memory.
8. During normal operation, one (1) line of the control panel shall display the speed reference, and run/stop forward/reverse and local/remote status. The remaining three (3) lines of the display shall be programmable to display the values of any three (3) operating parameters. At least 26 selections shall be available including the following:
 - a) Speed/torque in percent (%), RPM or user-scaled units
 - b) Output frequency, voltage, current and torque
 - c) Input voltage, power and kilowatt hours
 - d) Heatsink temperature and DC bus voltage
 - e) Status of discrete inputs and outputs
 - f) Values of analog input and output signals
 - g) Values of PID controller reference, feedback and error signals

h) Control interface inputs and outputs shall include:

F. I/O Capabilities

1. Six (6) discrete inputs, all independently programmable with at least 25 input function selections. Inputs shall be designed for "dry contact" inputs used with either an internal or external 24 VDC source.
2. A minimum of three (3) form C relay contact outputs, all independently programmable with at least 10 output function selections. Relay contacts shall be rated to switch 2 Amps at 24VDC or 115/230VAC. Function selections shall include indications that the drive is ready, running, reversed and at set speed/torque. General and specific warning and fault indications shall be available. Adjustable supervision limit indications shall be available to indicate programmed values of operating speed, speed reference, current, torque and PID feedback.
3. Three (3) analog inputs, one (1) +/- 0VAC - 10VAC and two (2) 4mA - 20mA, all independently programmable with at least ten (10) input function selections. A differential input isolation amplifier shall be provided for each input. Analog input signal processing functions shall include scaling adjustments, adjustable filtering and signal inversion. If the input reference (4-20mA or 2-10V) is lost, the AFD shall give the user the option of the following: (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the AFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus.
4. Two (2) analog outputs providing 4mA to 20mA signals. Outputs shall be independently programmable to provide signals proportional to at least 12 output function selections including output speed, frequency, voltage, current and power.

G. A fiber optic communication port shall also be provided for personal computer interface. Microsoft Windows®-based software shall be provided for drive setup, diagnostic analysis, monitoring and control. The software shall provide real time graphical displays of drive performance.

H. Protective Functions

1. For each programmed warning and fault protection function, the drive shall display a message in complete English words or Standard English abbreviations. The five (5) most recent fault messages and times shall be stored in the drive's fault history.
2. The drive shall include internal MOV's for phase to phase and phase to ground line voltage transient protection.
3. Output short circuit and ground fault protection rated for 65,000 amps shall be provided per UL508C without relying on line fuses. Motor phase loss protection shall be provided.
4. The drive shall provide electronic motor overload protection qualified per UL508C.

5. Protection shall be provided for AC line or DC bus overvoltage at 130% of maximum rated voltage or undervoltage at 65% of min. rated voltage and input phase loss.
6. A power loss ride through feature will allow the drive to remain fully operational after losing power as long as kinetic energy can be recovered from the rotating mass of the motor and load.
7. Stall protection shall be programmable to provide a warning or stop the drive after the motor has operated above a programmed torque level for a programmed time limit.
8. Underload protection shall be programmable to provide a warning or stop the drive after the motor has operated below a selected underload curve for a programmed time limit.
9. Over-temperature protection shall provide a warning if the power module temperature is less than 5°C below the over-temperature trip level.
10. Input terminals shall be provided for connecting a motor thermistor (PTC type) to the drive's protective monitoring circuitry. An input shall also be programmable to monitor an external relay or switch contact (klixon).

2.3 OPERATOR CONTROLS

- A. Industrial rated control operators and pilot devices shall be door mounted and used independently of the keypad display control modes of Hand-Off-Auto, VFD-OFF-BYPASS, etc. as required. The Keypad Display shall be mounted on front of the drive cabinet.

Control modes shall function as follows:

1. Hand – The Hand mode shall allow manual operation of start, stop and speed control. The AC drive shall start when the control operator is in the Hand mode and run at low speed setting of the drive or higher as required by the position of the manual speed potentiometer. This mode shall function as 2-wire control and automatically restart after a power outage or auto restart after fault.
 2. Off - The “Off” position of the control operator shall stop the AC drive and prevent it from restarting while in the “Off” position. This position shall also reset the AC Drive after a fault condition has occurred.
 3. Auto - The Automatic mode shall receive an auto start contact to control start and stop of the AC Drive. This contact shall also start and stop bypass (if used) when both the Automatic mode and Bypass modes of operations are selected. In Automatic mode the user shall remotely reset the AC Drive by opening and closing the Auto-start contact. Speed control shall be from a customer supplied 4-20mA signal.
- B. The AC Drive shall include door-mounted “VFD Run”, “VFD Fault”, “External/MOL Fault” and “Bypass Run” pilot lights. All pilot lights shall Utilize LED lamps.

2.4 SYSTEM CONTROL AND INTERFACE REQUIREMENTS

- A. The following additional controls and interface requirements shall be provided:
 - 1. Check Valve Sequencing – The AC Drive shall provide a circuit that shuts down the drive whenever a user supplied check valve limit switch does not open within a specified time. This circuit shall provide an illuminated reset push button to indicate improper sequence.
 - 2. Provide N.C. Contacts and 120V AC power source for motor winding space heater.
 - 3. Auxiliary Contacts – The AC Drive shall provide the following auxiliary contacts to indicate the following conditions:
 - 1 N.O. contact to indicate DRIVE RUN
 - 1 N.O. contact to indicate VFD FAULT
 - 1 N.O. contact to indicate AUTO MODE
 - 1 N.O. contact to indicate HAND MODE

2.06 HARMONIC MITIGATION EQUIPMENT REQUIREMENTS

- A. The AC Drive shall be provided with a line reactor mounted inside the enclosure.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Verify that the location is ready to receive work and the dimensions are as indicated.
- B. Do not install AC Drive equipment until the building environment can be maintained within the service conditions required by the manufacturer.

3.2 PROTECTION

- A. Before and during the installation, the AC Drive equipment shall be protected from site contaminants and debris in accordance with the manufacturer's recommendations.

3.3 INSTALLATION

- A. The Drive manufacturer shall provide adequate drawings and instruction material to facilitate installation of the Drive by the Contractor. Installation shall comply with manufacturer's instructions, drawings and recommendations.
- B. The AC Drive manufacturer shall provide a factory certified technical representative to supervise the Contractor's installation, testing and start-up of the AC Drives furnished under this specification as required. The technical representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations. A Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer. A copy

of all drive configuration parameters and their associated settings programmed into each VFD shall be provided to the Owner at the completion of start-up and shall be included in the final O&M.

3.4 TRAINING

- A. The AC Drive manufacturer shall arrange for an on-site training course of a minimum of 2 training days, provided by a representative of the AC Drive manufacturer plant and/or maintenance personnel.

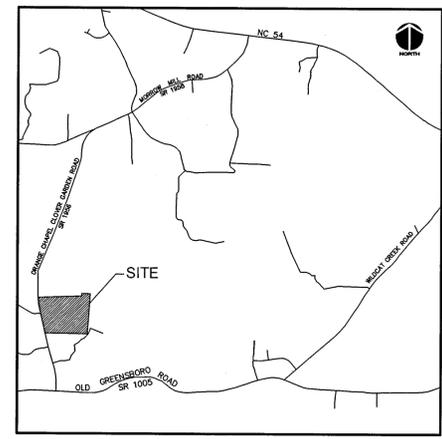
END OF SECTION 16483

BINGHAM FACILITY WASTEWATER SYSTEM IMPROVEMENTS

FOR THE UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL ORANGE COUNTY, NC JANUARY 2013

<u>GENERAL</u>	
COVER	G01
GENERAL NOTES & LEGEND	G02
HYDRAULIC PROFILE & PROCESS FLOW DIAGRAM	G03
<u>CIVIL</u>	
EXISTING OVERALL SITE PLAN	C01
EXISTING ENLARGED SITE PLAN	C02
OVERALL SITE DEMOLITION PLAN	C03
DEMOLITION DETAILS	C04
PROPOSED OVERALL SITE PLAN	C05
PROPOSED ENLARGED SITE PLAN	C06
PROPOSED SANITARY SEWER PLAN	C07
PROPOSED SANITARY SEWER PROFILE	C08
WASTEWATER TREATMENT SYSTEM YARD PIPING PLAN	C09
WASTEWATER TREATMENT SYSTEM GRADING PLAN	C10
WASTEWATER TREATMENT SYSTEM GRADING PLAN, SECTIONS & DETAILS	C11
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WET WEATHER STORAGE BASIN IMPROVEMENTS PLAN, SECTION & DETAILS	C12
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EROSION AND SEDIMENT CONTROL DETAILS	C18

SCO # 11-08872-01A



VICINITY MAP

<u>MECHANICAL</u>	
CHLORINE DISINFECTION SYSTEM PLANS, SECTIONS, & DETAILS	M01
EFFLUENT PUMP STATION PLAN, SECTIONS, & DETAILS	M02
IRRIGATION PUMP STATION PLAN, SECTIONS, & DETAILS	M03
<u>ELECTRICAL</u>	
ELECTRICAL LEGEND, ABBREVIATIONS AND NOTES	E01
PROPOSED OVERALL ELECTRICAL SITE PLAN	E02
EXISTING ELECTRICAL SITE PLAN	E03
ENLARGED PROPOSED ELECTRICAL SITE PLAN	E04
IRRIGATION PUMP STATION ELECTRICAL	E05
EFFLUENT PUMP STATION AND CHEMICAL FEED SYSTEM ELECTRICAL PLAN	E06
SINGLE LINE DIAGRAM	E07
SINGLE LINE DIAGRAM	E08
PANEL BOARD SCHEDULE	E09
ELECTRICAL DETAILS	E10
DRAIN VALVE CONTROL / PUMP SELECT CONTROL PANEL WIRING DIAGRAM	E11

FINAL DESIGN NOT FOR CONSTRUCTION



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THE UNIVERSITY
 of NORTH CAROLINA
 at CHAPEL HILL

GENERAL NOTES

1. SAFETY

- A. THE CONTRACTOR SHALL TAKE ALL NECESSARY PRECAUTIONS FOR THE SAFETY OF EMPLOYEES ON THE PROJECT AND SHALL COMPLY WITH ALL APPLICABLE PROVISIONS OF FEDERAL, STATE AND LOCAL SAFETY LAWS AND BUILDING CODES TO PREVENT ACCIDENTS OR INJURY. THE CONTRACTOR SHALL ERECT AND PROPERLY MAINTAIN AT ALL TIMES ALL NECESSARY SAFEGUARDS AND BARRICADES FOR THE PROTECTION OF EMPLOYEES ON THE WORK AND SAFETY OF OTHERS EMPLOYED NEAR THE WORK AND THE PUBLIC. FURTHER, THE CONTRACTOR SHALL POST DANGER SIGNS AND OTHER WARNING DEVICES TO PROTECT INDIVIDUALS FROM BEING INJURED IN THE VICINITY OF THE WORK.
- B. THE CONTRACTOR SHALL COMPLY WITH ALL APPLICABLE O.S.H.A. SAFETY REQUIREMENTS. THE CONTRACTOR SHALL INSURE ALL WORK PROCEEDS IN ACCORDANCE WITH O.S.H.A. REQUIREMENTS FOR SAFETY, TRENCHING, EXCAVATION, AND CONFINED SPACE ENTRY PROCEDURES.
- C. THE CONTRACTOR SHALL PROVIDE ADEQUATE EQUIPMENT AND FACILITIES AS ARE NECESSARY AND REQUIRED TO PROVIDE EMERGENCY FIRST AID TO ANY PERSON WHO MAY BE INJURED IN THE EXECUTION OF THE WORK UNDER THIS CONTRACT.

2. PROTECTION OF WORK

- A. THE CONTRACTOR SHALL ASSUME FULL RESPONSIBILITY FOR THE PROTECTION OF ALL BUILDINGS, STRUCTURES AND UTILITIES (BOTH PUBLIC AND PRIVATE) INCLUDING POWER POLES, SIGNS, UTILITY SERVICES, WATER MAINS, HYDRAENTS, SEWERS, FORCE MAINS, STORM DRAINS, BURIED ELECTRICAL OR CONTROL WIRES, AND TELEPHONE CABLES WHETHER OR NOT THEY ARE SHOWN ON THE CONTRACT DRAWINGS.
- B. THE CONTRACTOR SHALL CAREFULLY SUPPORT AND PROTECT ANY UTILITIES, STRUCTURES, PIPE LINES, AND CONDUITS WHICH MAY BE ENCOUNTERED DURING COMPLETION OF THE WORK. ANY DAMAGE RESULTING FROM THE CONTRACTOR'S OPERATIONS SHALL BE REPAIRED BY THE CONTRACTOR TO THE SATISFACTION OF THE ENGINEER AT CONTRACTOR'S EXPENSE.
- C. DEWATERING: THE CONTRACTOR SHALL AT ALL TIMES PROVIDE AND MAINTAIN AMPLE MEANS AND EQUIPMENT WITH WHICH TO REMOVE AND PROPERLY DISPOSE OF ANY AND ALL WATER ENTERING THE EXCAVATION OR OTHER PARTS OF THE WORK AND KEEP ALL EXCAVATIONS DRY UNTIL SUCH TIME AS PIPE LAYING AND GRADING IS COMPLETED AND STRUCTURES TO BE BUILT THEREIN ARE COMPLETED. NO WATER SHALL BE ALLOWED TO RISE AROUND THE PIPE IN UNBACKFILLED TRENCHES NOR SHALL IT BE ALLOWED TO RISE OVER CONCRETE OR MASONRY UNTIL THE CONCRETE OR MORTAR HAS SET (MIN. 24 HOURS). ALL WATER PUMPED OR DRAINED FROM THE WORK SHALL BE DISPOSED OF IN SUCH A MANNER AS TO PREVENT SILTATION AND EROSION TO ADJACENT PROPERTY OR OTHER CONSTRUCTION.

3. MAINTENANCE OF WATER AND WASTEWATER FLOWS

- A. THE CONTRACTOR SHALL AT THE CONTRACTOR'S OWN COST, MAKE PROVISION FOR MAINTAINING FLOW THROUGH EXISTING GRAVITY SEWERS, FORCE MAINS, POTABLE WATER LINES, STORM DRAINS, AND WATER COURSES WHICH ARE INTERRUPTED DURING THE PROGRESS OF THE WORK. UPON COMPLETION OF THE WORK, ALL TEMPORARY FLOW DIVERSIONS, STRUCTURES, AND PIPING SHALL BE REMOVED AND THE SITE SHALL BE RESTORED TO A CONDITION EQUAL TO OR BETTER THAN THE INITIAL CONDITION.

4. BURIED UTILITIES

- A. THE CONTRACTOR SHALL SECURE THE SERVICES OF A SUE COMPANY AND NOTIFY UNC ELECTRICAL DISTRIBUTION DEPARTMENT AT 919-962-8394 TWO WEEKS PRIOR TO EXCAVATING IN CONSTRUCTION AREAS IN ORDER TO LOCATE BURIED UTILITIES WHICH MAY OR MAY NOT BE PRESENT. NO EXCAVATION IS AUTHORIZED UNTIL AFTER UTILITY LOCATORS HAVE MARKED ALL EXISTING UTILITIES.
- B. UNDERGROUND UTILITIES LOCATIONS ARE APPROXIMATE ONLY. THOSE SHOWN ON THE DRAWINGS ARE BASED ON THE BEST AVAILABLE INFORMATION. PRIOR TO CONSTRUCTION, THE CONTRACTOR SHALL NOTIFY OWNERS OF ADJACENT UTILITIES WHEN PROSECUTION OF THE WORK MAY AFFECT THEM. ALL DAMAGE, INJURY OR LOSS TO ANY PROPERTY, BY THE CONTRACTOR, OR ANY SUBCONTRACTOR, TO THE FAULT OR NEGLIGENCE OF THE CONTRACTOR, SHALL BE REPAIRED OR RESTORED TO AT LEAST ORIGINAL CONDITION AT THE CONTRACTOR'S EXPENSE. THE CONTRACTOR'S DUTIES AND RESPONSIBILITIES FOR THE SAFETY AND PROTECTION OF THE WORK SHALL CONTINUE UNTIL SUCH TIME AS ALL THE WORK IS COMPLETED AND THE ENGINEER HAS ISSUED A NOTICE TO THE OWNER AND THE CONTRACTOR AS DESCRIBED HEREIN THAT WORK IS ACCEPTABLE.
- C. THE CONTRACTOR SHALL EXCAVATE TEST PITS AS REQUIRED TO LOCATE EXISTING UTILITIES. THESE SHALL BE EXCAVATED TO LOCATE BURIED UTILITIES AND TO DETERMINE EXACT LOCATIONS AND/OR MATERIALS OF EXISTING UTILITIES. SOME HAND EXCAVATION MAY BE NECESSARY TO PROTECT UTILITIES. TEST PITS SHALL BE EXCAVATED AT LEAST TWO (2) WEEKS PRIOR TO CONSTRUCTION OF A PARTICULAR ITEM OF WORK SO THAT DESIGN REVISIONS MAY BE MADE IF REQUIRED. ALL TEST PITS REQUIRED OR NECESSARY BY THE CONTRACTOR SHALL BE INCLUDED IN THE PRICE STATED FOR THE DESIGNATED BID ITEM.
- D. THE CONTRACTOR IS RESPONSIBLE FOR ALL DAMAGE TO EXISTING UTILITIES AND SHALL BE RESPONSIBLE FOR REPAIR OF ANY SUCH DAMAGE AS QUICKLY AS POSSIBLE AT HIS OWN EXPENSE. THE CONTRACTOR SHALL MAINTAIN A SUPPLY OF REPAIR MATERIALS AND PIPE ON THE JOB SITE AT ALL TIMES IN ORDER TO MINIMIZE THE INCONVENIENCE CAUSED BY SUCH DAMAGE.
- E. THE CONTRACTOR SHALL PERMANENTLY PLUG WITH GROUT FILL ALL EXISTING LINES WHICH ARE REPLACED BY NEW ONES AT THE POINT WHERE THEY ARE DISCONNECTED UNLESS THEY ARE TO REMAIN IN SERVICE.
- F. EXISTING CULVERTS LOCATED BELOW GRAVEL OR PAVED ENTRANCES AS WELL AS DROP INLETS, STORM DRAIN PIPING, STRUCTURES, SWALES, BMP'S, WETLANDS, AND ANY OTHER STORM WATER FACILITIES THAT ARE DAMAGED DURING LINE EXCAVATION, CONSTRUCTION, OR BACKFILL SHALL BE REMOVED AND REPLACED IN KIND IN ACCORDANCE WITH THE SPECIFICATIONS.
- G. ALL EXISTING UTILITIES LOCATED ABOVE OR IMPACTED BY THE PROPOSED ALIGNMENT SHALL BE PROPERLY SUPPORTED TO PROTECT UTILITY. COMPACT A MIN. 12" OF #7 STONE BELOW EXISTING UTILITY WHEN BACKFILLING OR USE FLOWABLE FILL IF PROPER COMPACTION CAN NOT BE OBTAINED TO THE OWNERS SATISFACTION. ANY DAMAGE TO EXISTING UTILITIES SHALL BE REPAIRED TO THE SATISFACTION OF THE OWNER AT THE CONTRACTORS EXPENSE.
- H. THE EXISTING UTILITIES WERE SHOWN ON RECORD DRAWINGS AND NOT FIELD LOCATED. CONTRACTOR SHALL TEST PIT THESE AREAS IN ADVANCE OF CONSTRUCTION TO DETERMINE THE PRESENCE AND DEPTH OF THESE UTILITIES. NOTIFY THE ENGINEER IMMEDIATELY IF THE LOCATION OF THE EXISTING UTILITIES REQUIRES ANY MODIFICATIONS TO THE HORIZONTAL OR VERTICAL LOCATION OF THE PROPOSED UTILITIES.

5. CONSTRUCTION

- A. THE CONTRACTOR SHALL USE ONLY DESIGNATED BENCH MARKS FOR REFERENCE ELEVATIONS.
- B. THE CONTRACTOR SHALL INSTALL A MECHANICAL PLUG IN THE END OF ALL PIPE WORK AT THE COMPLETION OF EACH WORK DAY TO SEAL IT FROM WATER AND SOIL.
- C. EROSION CONTROL SHALL BE PROVIDED BY THE CONTRACTOR IN ACCORDANCE WITH CONTRACT DOCUMENTS. EROSION CONTROLS SHALL BE IN PLACE PRIOR TO CONSTRUCTION. ALL DISTURBED AREAS ARE TO BE IMMEDIATELY STABILIZED. IT IS THE CONTRACTOR'S RESPONSIBILITY TO MAINTAIN THE EROSION CONTROL MEASURES AND CHECK MEASURES AFTER EVERY RAINFALL EVENT.
- D. THE CONTRACTOR SHALL SUPPORT UTILITY POLES AS NECESSARY. COST OF UTILITY POLE SUPPORT SHALL NOT BE PAID SEPARATELY. COST OF THIS WORK SHOULD BE INCLUDED AS PART OF OTHER BID ITEMS.
- E. UNIFORM TRAFFIC CONTROL SHALL BE PROVIDED BY CONTRACTOR AS REQUIRED OR AS SHOWN IN THE CONTRACT DOCUMENTS.
- F. AT LEAST ONE-WAY TRAFFIC SHALL BE MAINTAINED AT ALL TIMES ON PUBLIC ROADWAYS AND FACILITY ACCESS ROADS UNLESS OTHERWISE APPROVED IN WRITING.
- G. ACCESS TO UNC FACILITIES SHALL BE MAINTAINED AT ALL TIMES.
- H. CONTRACTOR SHALL MINIMIZE PLACEMENT OF EXCAVATED MATERIAL ON PAVED ROAD SURFACES DURING CONSTRUCTION AND ALL STREETS SHALL BE CLEANED DAILY.
- I. CONTRACTOR SHALL RESTORE ALL GRAVEL, CONCRETE AND PAVED DRIVEWAYS, ROADS, PARKING LOTS AND WALKWAYS TO A CONDITION EQUAL TO OR BETTER THAN EXISTING CONDITIONS AS DESCRIBED IN THE CONTRACT DOCUMENTS.
- J. ALL DISTURBED DITCH LINES, SWALES AND OPEN STORMWATER CONVEYANCES SHALL BE RESHAPED, RESEEDDED, MULCHED AND TACK COAT APPLIED.
- K. EXISTING POTABLE WATER AND SEWER SERVICES AND ALL OTHER UTILITIES SHALL BE MAINTAINED AT ALL TIMES DURING CONSTRUCTION. UPON COMPLETION OF CONSTRUCTION, THE NEW UTILITIES SHALL BE TESTED, INSPECTED, PERMITTED AND APPROVED PRIOR TO TRANSFERRING SERVICE.
- L. ANY BENDS, FITTINGS, OR SPECIAL DEVICES REQUIRED ON PROPOSED UTILITY LINES WHICH ARE NOT SHOWN ON THE DRAWINGS, BUT WHICH ARE REQUIRED TO MAKE A FULLY OPERATIONAL SYSTEM, SHALL BE PROVIDED BY THE CONTRACTOR. ANY APPURTENANCES (INCLUDING RESTRAINING RODS ETC.) NOT SPECIFICALLY INDICATED ON THE BID FORM SHALL BE INCLUDED IN THE LUMP SUM COST FOR THE UTILITY.
- M. ALL BURIED DUCTILE IRON PIPE SHALL BE CLASS 350, RESTRAINED JOINT UNLESS OTHERWISE NOTED. REFER TO SPECIFICATIONS FOR LINERS AND COATINGS. ALL UNDERGROUND FITTINGS AND APPURTENANCES SHALL BE RESTRAINED JOINT, PER SPECIFICATIONS, UNLESS SPECIFIED OTHERWISE ON THE DRAWINGS.

6. SITE WORK

- A. EXISTING FENCES, WALLS, LANDSCAPING, SIGNS, ETC. TEMPORARILY REMOVED BY THE CONTRACTOR SHALL BE REPLACED TO A CONDITION AT LEAST AS GOOD AS THEIR ORIGINAL CONDITION.
- B. ALL EXCESS MATERIAL SHALL BE DISPOSED OF OFF SITE UNLESS APPROVED BY THE OWNER. A COPY OF A WRITTEN AGREEMENT BETWEEN THE CONTRACTOR AND THE SITE OWNER SHALL BE SUBMITTED TO THE ENGINEER BEFORE ANY MATERIAL IS REMOVED FROM THE SITE. ALL EXCESS MATERIAL SHALL BE DISPOSED OF IN ACCORDANCE WITH ALL APPLICABLE UNC, LOCAL, STATE AND FEDERAL REGULATIONS. THE CONTRACTOR SHALL OBTAIN AN EROSION CONTROL PERMIT FROM THE DIVISION OF LAND QUALITY FOR ANY OFF-SITE BORROW OR FILL AREAS.
- C. THE CONTRACTOR IS RESPONSIBLE FOR RECORDING PRE-CONSTRUCTION CONDITIONS BY USE OF PHOTOGRAPHS, VIDEO TAPES, AND OTHER METHODS. THE COST OF THIS PRE-CONSTRUCTION DOCUMENTATION SHALL NOT BE PAID SEPARATELY BUT SHOULD BE INCLUDED AS PART OF OTHER BID ITEMS.
- D. POST THE NCDENR EROSION AND SEDIMENT CONTROL PERMIT ON SITE. SET UP AN ON-SITE PRE CONSTRUCTION CONFERENCE WITH EROSION CONTROL INSPECTOR OF NCDENR, 48 HOURS PRIOR TO CONSTRUCTION TO DISCUSS EROSION CONTROL MEASURES.
- E. COMPACTION TESTING IS REQUIRED IN ALL LOCATIONS WHERE SPECIFIED IN THE CONTRACT DOCUMENTS.
- F. CONTRACTOR TO INSTALL EROSION CONTROL MEASURES PRIOR TO THE START OF CONSTRUCTION. INSTALL SILT FENCE, INLET PROTECTION, SEDIMENT TRAPS, DIVERSION DITCHES, TREE PROTECTION, AND OTHER MEASURES AS SHOWN ON PLANS, CLEARING ONLY AS NECESSARY TO INSTALL THESE DEVICES.
- G. ALL EROSION CONTROL MEASURES SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE NCDENR REGULATIONS AND IN ACCORDANCE WITH THE MEASURES SHOWN AND DESCRIBED IN THE CONTRACT DOCUMENTS.
- H. THE CONTRACTOR SHALL DILIGENTLY AND CONTINUOUSLY MAINTAIN ALL EROSION CONTROL DEVICES AND STRUCTURES TO MINIMIZE EROSION. THE CONTRACTOR SHALL MAINTAIN CLOSE CONTACT WITH THE EROSION INSPECTOR SO THAT PERIODIC INSPECTIONS CAN BE PERFORMED AT APPROPRIATE STAGES OF CONSTRUCTION.
- I. ALL SEDIMENT AND EROSION CONTROL DEVICES SHALL BE INSPECTED EVERY 7 DAYS OR AFTER EACH RAINFALL OCCURRENCE THAT EXCEEDS 1/2 INCH. DAMAGED OR INEFFECTIVE DEVICES SHALL BE REPAIRED OR REPLACED, AS NECESSARY. SEDIMENT ACCUMULATION SHALL BE CLEARED AS REQUIRED.
- J. ALL DISTURBED AREAS SHALL BE RESEEDDED AND MULCHED. DISTURBED AREAS LEFT INACTIVE BETWEEN ANY PHASE OF GRADING SHALL BE TEMPORARILY SEEDDED WITHIN 7 CALENDAR DAYS. PROVISIONS FOR PERMANENT GROUND COVER MUST BE ACCOMPLISHED ON ALL EXPOSED SLOPES WITHIN 21 CALENDAR DAYS, AND IN REMAINING AREAS WITHIN 15 WORKING DAYS OR 90 CALENDAR DAYS, WHICHEVER IS SHORTER.
- K. ADDITIONAL MEASURES TO CONTROL EROSION AND SEDIMENT MAY BE REQUIRED BY A REPRESENTATIVE OF NCDENR. ALL SUCH MEASURES SHALL BE INSTALLED AS DIRECTED AND AT NO ADDITIONAL COST TO THE OWNER.
- L. TEMPORARY CONSTRUCTION ENTRANCES SHALL BE INSTALLED AT EACH OF THE ACCESS POINTS REQUIRED BY THE CONTRACTOR AND AS SHOWN ON THE CONTRACT DRAWINGS. TEMPORARY CONSTRUCTION ENTRANCES SHALL BE INSTALLED PER THE DETAILS AND SHALL BE REMOVED AND THE AREA RESTORED UPON COMPLETION OF THAT SEGMENT OF WORK.
- M. CONTRACTOR SHALL TAKE ADEQUATE MEASURES TO CONTROL DUST WITHIN THE DISTURBED AREA. COST OF THIS ITEM SHALL BE INCLUDED IN THE CONTRACT BID.
- N. CONTRACTOR SHALL MAINTAIN VEHICULAR AND PEDESTRIAN TRAFFIC AS MUCH AS POSSIBLE. ALL ROADS AND SIDEWALKS CLOSED WHILE WORK IS IN PROGRESS SHALL BE REOPENED AT THE END OF EACH WORKING DAY.
- O. ALL TRENCHES SHALL BE FILLED OR COVERED WITH STEEL PLATING AT THE END OF EACH WORK DAY. STEEL PLATING SHALL BE SUITABLE FOR VEHICLE TRAFFIC AND PEDESTRIAN TRAFFIC (H-20 RATED) IF LOCATED IN A STREET OR WALKWAY. TRENCHES MAY BE LEFT OPEN IF A SECURED 6' CHAIN LINK CONSTRUCTION FENCE IS INSTALLED AROUND THE WORK ZONE AND PROVIDED THAT PEDESTRIAN AND VEHICULAR TRAFFIC IS NOT IMPACTED BY THE TEMPORARY FENCE.
- P. CONTRACTOR SHALL LIMIT DISTURBANCES OF EXISTING TREES, SIDEWALKS, DRIVEWAYS, LANDSCAPED AREA ETC. TO THE CORRIDOR SHOWN ON THE PLANS.
- Q. ALL TREES NOT SHOWN TO BE REMOVED SHALL BE PROTECTED BY THE CONTRACTOR.
- R. DISTURBED PAVEMENT, SIDEWALKS, LANDSCAPING, SIGNS, EXISTING UTILITIES AND ROOF DRAINS ETC. SHALL BE RESTORED IN ACCORDANCE WITH THE CONTRACT DOCUMENTS.

7. RECORD DOCUMENTS

- A. ALL BURIED UTILITIES ENCOUNTERED SHALL BE SURVEYED WHILE UNCOVERED AND DOCUMENTED WITH ELEVATION AND INCLUDED BY THE CONTRACTOR ON THE RECORD DRAWINGS.
- B. ACTUAL LOCATIONS FOR ALL NEW MANHOLES, PIPING, UTILITY LINES, METER VAULTS AND PIPING APPURTENANCES SHALL BE ACCURATELY SURVEYED WHILE UNCOVERED AND PLOTTED ON THE RECORD DRAWINGS WITH TIES TO STRUCTURES AND BUILDINGS.
- C. CONTRACTOR MONTHLY INVOICES WILL NOT BE APPROVED FOR PAYMENT UNTIL THE CONTRACTOR PROVIDES EVIDENCE THAT AS-BUILT DATA HAS BEEN UPDATED TO REFLECT ALL WORK TO DATE.
- D. CONTRACTOR SHALL SUBMIT FINAL RECORD DRAWINGS PRIOR TO THE PUNCH LIST WALK THROUGH AND THE ENGINEER'S ISSUANCE OF THE SUBSTANTIAL COMPLETION CERTIFICATE.
- E. ANY FIELD CHANGES SHALL BE APPROVED IN ADVANCE BY THE ENGINEER AND SHALL BE ACCURATELY REFLECTED ON THE CONTRACTOR'S RECORD DRAWINGS.

8. CONSTRUCTION LAYOUT

- A. THE ENGINEER WILL MARK ALL EXISTING SURVEY CONTROL POINTS IN THE FIELD AND PROVIDE ASSOCIATED SURVEY DATA FOR USE BY CONTRACTOR IN LAYING OUT NEW STRUCTURES AND UTILITIES.
- B. THE ENGINEER WILL ESTABLISH (2) HORIZONTAL AND VERTICAL SURVEY CONTROL POINTS ON-SITE FOR USE BY THE CONTRACTOR FOR LAYING OUT THE NEW STRUCTURES AND UTILITIES.
- C. CONTRACTOR SHALL RETAIN THE SERVICES OF A LICENSED PROFESSIONAL LAND SURVEYOR FOR CONSTRUCTION LAYOUT AND STAKING AND FOR AS-BUILT DOCUMENTATION.

9. SEQUENCE OF CONSTRUCTION

- A. CONTRACTOR IS RESPONSIBLE FOR COORDINATING ALL CONSTRUCTION ACTIVITIES WITH THE ENGINEER AND UNC PROJECT REPRESENTATIVE PRIOR TO STARTING WORK.
- B. CONTRACTOR MUST READ AND UNDERSTAND THEIR OBLIGATIONS AS DEFINED IN SECTION 01010 "SUMMARY OF WORK" OF THE SPECIFICATIONS.

10. WORK AROUND OVERHEAD ELECTRIC LINES

- A. THE CONTRACTOR SHALL COMPLY WITH THE FOLLOWING PROVISIONS AND REQUIREMENTS WHEN WORKING AROUND OVERHEAD OR HIGH VOLTAGE LINES:
 - 1) CONTACT THE ELECTRIC UTILITY AND UNC ELECTRIC DISTRIBUTION 48 HOURS PRIOR TO COMMENCING WORK IF THE CONTRACTOR'S TOOLS OR MATERIALS WILL INTRUDE TO WITHIN SIX (6) FEET OF AN OVERHEAD POWER LINE.
 - 2) CONTACT THE UTILITY 48 HOURS PRIOR TO COMMENCING WORK IF EQUIPMENT SUCH AS BACKHOES, TRACKHOES, CRANES OR DERRICKS WILL BE OPERATED WITHIN TEN (10) FEET OF AN OVERHEAD POWER LINE.
- B. POST AND MAINTAIN WARNING SIGNS WITHIN AND ON THE OUTSIDE OF EQUIPMENT OPERATING NEAR AN OVERHEAD HIGH VOLTAGE LINE.
- C. THE RESPONSIBLE PARTY FOR COORDINATING AND ADVISING THE POWER COMPANY SHALL BE THE CONTRACTOR.
- D. THE CONTRACTOR'S COST FOR UNDERTAKING THE ABOVE LISTED MEASURES AS WELL AS ANY ADDITIONAL MEASURES REQUIRED BY THE POWER COMPANY AND ASSOCIATED COSTS INVOICED BY THE POWER COMPANY SHALL BE CONSIDERED INCIDENTAL TO THE CONTRACT.

11. MOBILIZATION AND STAGING

- A. CONTRACTOR STAGING AREA AND VEHICULAR ACCESS TO THE SITE SHALL BE COORDINATED WITH THE ENGINEER AND UNC PROJECT REPRESENTATIVE PRIOR TO MOBILIZATION. A CONTRACTOR STAGING AREA HAS NOT BEEN PROVIDED ON THE PLANS BUT SHALL BE COORDINATED WITH THE UNC REPRESENTATIVE.

12. UNC DEPARTMENT OF PUBLIC SAFETY NOTES

- A. ANY EXISTING SIGNS, SIGN POSTS, BOLLARDS, AND ANY OTHER VEHICLE OR PEDESTRIAN TRAFFIC EQUIPMENT INCLUDING BUT NOT LIMITED TO GATES, BOOTHS AND SHELTERS THAT ARE WITHIN OR EFFECTED BY THE PROJECT SHALL BE DISMANTLED BY THE CONTRACTOR. THE CONTRACTOR IS RESPONSIBLE FOR RE-INSTALLING OR INSTALLING NEW ANY EQUIPMENT ADDED OR REMOVED FROM THE PROJECT. ANY COSTS ASSOCIATED WITH REPLACING, REPAIRING, OR INSTALLING SIGNS, SIGN POSTS, BOLLARDS, OR ANY OTHER PIECE OF EQUIPMENT THAT MAY GET DAMAGED OR LOST DURING THE CONSTRUCTION PROCESS SHALL BE PAID BY THE CONTRACTOR. ONLY PUBLIC SAFETY APPROVED SIGNS AND SIGNAGE SHALL BE INSTALLED ON THE PROJECT SITE.
- B. THE CONTRACTOR SHALL SCHEDULE DELIVERIES TO AVOID PEAK TRAFFIC HOURS WHICH ARE FROM 7:00 TO 9:00 AM AND FROM 3:00 TO 6:00 PM. THE CONTRACTOR SHALL NOTIFY UNC'S DEPT. OF PUBLIC SAFETY OF ANY DELIVERIES OF EQUIPMENT OR MATERIAL THAT WILL IMPEDE THE FLOW OF VEHICULAR OR PEDESTRIAN TRAFFIC. THE CONTRACTOR SHALL PROVIDE TRAFFIC CONTROL DURING THESE DELIVERIES. STAGING FOR MULTIPLE CONCRETE / STEEL / OTHER LARGE MATERIAL DELIVERIES, CRANE AND OTHER LARGE PIECES OF EQUIPMENT MUST BE COORDINATED WITH DPS. DELIVERIES INCLUDING ANY CONSTRUCTION EQUIPMENT MOVES AWAY FROM THE CONSTRUCTION SITE SHALL BE COORDINATED WITH PUBLIC SAFETY.
- C. ROADS, STREETS, FACILITY ACCESS DRIVES AND FIRE LANES MUST REMAIN OPEN AT ALL TIMES. ADEQUATE CLEARANCES MUST BE MAINTAINED FOR EMERGENCY VEHICLES. FIRE DEPARTMENT REQUIRES A MINIMUM OF 20 FEET FOR FIRE LANES. CONSTRUCTION VEHICLES ARE NOT ALLOWED TO BLOCK, PARK, OR STAGE IN A FIRE LANE.
- D. ANY EXISTING ELEMENTS (SIDEWALK, PARKING, CURB AND GUTTER, GRATE, ETC) REMOVED AND REPLACED OR RECONSTRUCTED AS PART OF THIS PROJECT SHALL MEET THE CURRENT ADAAG AND NCAC STANDARDS AS NEW CONSTRUCTION.

13. WASTE MANAGEMENT

- A. CONTRACTOR SHALL MAINTAIN ACCESS TO UNC SOLID WASTE FACILITIES SUCH AS DUMPSTERS AND RECYCLING CENTERS AT ALL TIMES. CONTRACTOR IS NOT PERMITTED TO USE UNC SOLID WASTE DISPOSAL FACILITIES AT ANY TIME.
- B. CONTRACTOR SHALL DISPOSE OF ALL CONSTRUCTION DEBRIS IN A MANNER CONSISTENT WITH THE SPECIFICATIONS AND IN ACCORDANCE WITH ALL LOCAL, COUNTY, STATE AND FEDERAL GUIDELINES.

LEGEND

	- EXISTING POTABLE WATER WELL		- EXISTING SANITARY SEWER
	- EXISTING MONITORING WELL		- PROPOSED SANITARY SEWER
	- PROPOSED MONITORING WELL		- PROPOSED SODIUM HYPOCHLORITE FEED LINE
	- PROPOSED SURFACE WATER MONITORING POINT		- EXISTING FENCE
	- EXISTING PIEZOMETER		- PROPOSED FENCE
	- EXISTING BORING		- EXISTING MINOR CONTOUR
	- EXISTING ELECTRICAL TRANSFORMER		- EXISTING MAJOR CONTOUR
	- EXISTING LIGHT POLE		- PROPOSED MINOR CONTOUR
	- EXISTING TELEPHONE PEDESTAL		- PROPOSED MAJOR CONTOUR
	- EXISTING TELEPHONE HAND HOLE		- EXISTING STREAM
	- EXISTING CABLE TV BOX		- EXISTING STORM DRAIN
	- EXISTING POTABLE WATER METER		- EXISTING BUSHES
	- EXISTING POTABLE WATER TREATMENT BACKWASH FORCEMAIN		- EXISTING WOODSLINE
	- PROPOSED POTABLE WATER TREATMENT BACKWASH FORCEMAIN		- EXISTING RIP RAP AREA
	- EXISTING FORCEMAIN		- EXISTING LANDSCAPED AREA
	- PROPOSED FORCEMAIN		- EXISTING WETLAND AREA
	- EXISTING POTABLE WATER		
	- PROPOSED POTABLE WATER		

REVNO.	DESCRIPTIONS	DATE
E	FINAL DESIGN - NOT FOR CONSTRUCTION	1/31/13
D	FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION	8/11/11
C	FINAL DESIGN SUBMITTAL	7/26/11
B	90% DESIGN SUBMITTAL	4/18/11
A	60% DESIGN SUBMITTAL	3/21/11

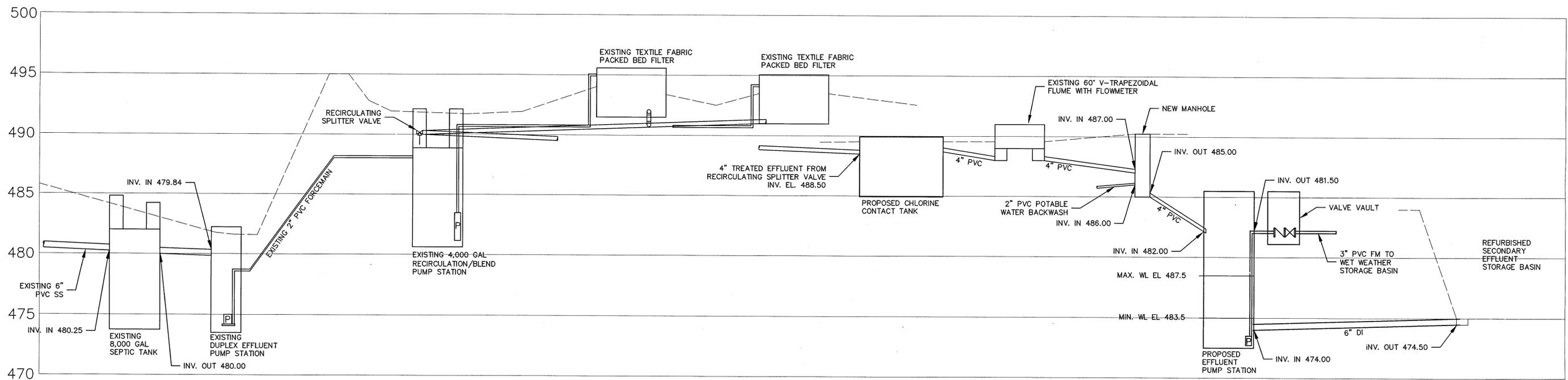


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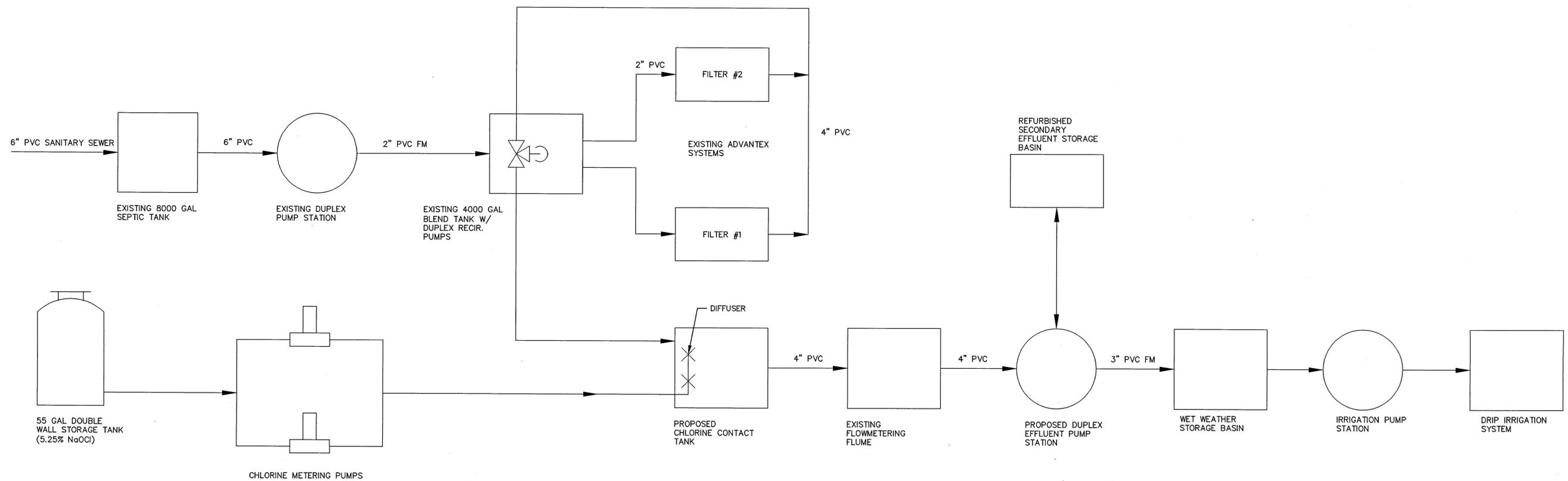
THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

BINGHAM FACILITY WASTEWATER SYSTEM IMPROVEMENTS
 GENERAL NOTES & LEGENDS

DATE: FEBRUARY 2011	SCALE	MAC FILE NUMBER
MCE PROJ. # 1488-0032	HORIZONTAL: NA	DRAWING NUMBER
DRAWN: SHK	VERTICAL: NA	G02
DESIGNED: CDR		
CHECKED: CDR		
PROJ. MGR: CDR		
STATUS: FINAL DESIGN - NOT FOR CONSTRUCTION	REVISION: E	

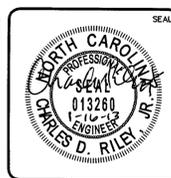
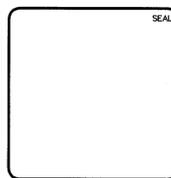


HYDRAULIC PROFILE
VERTICAL SCALE: 1/4"=1'



PROCESS WASTEWATER
SYSTEM FLOW DIAGRAM
SCALE: NOT TO SCALE

REV. NO.	DESCRIPTIONS REVISIONS	DATE
E	FINAL DESIGN - NOT FOR CONSTRUCTION	1/31/11
D	FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION	8/21/10
C	FINAL DESIGN SUBMITTAL	7/08/11
B	90% DESIGN SUBMITTAL	4/18/11
A	60% DESIGN SUBMITTAL	3/21/11



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**THE UNIVERSITY
of NORTH CAROLINA
at CHAPEL HILL**

**BINGHAM FACILITY
WASTEWATER SYSTEM IMPROVEMENTS**

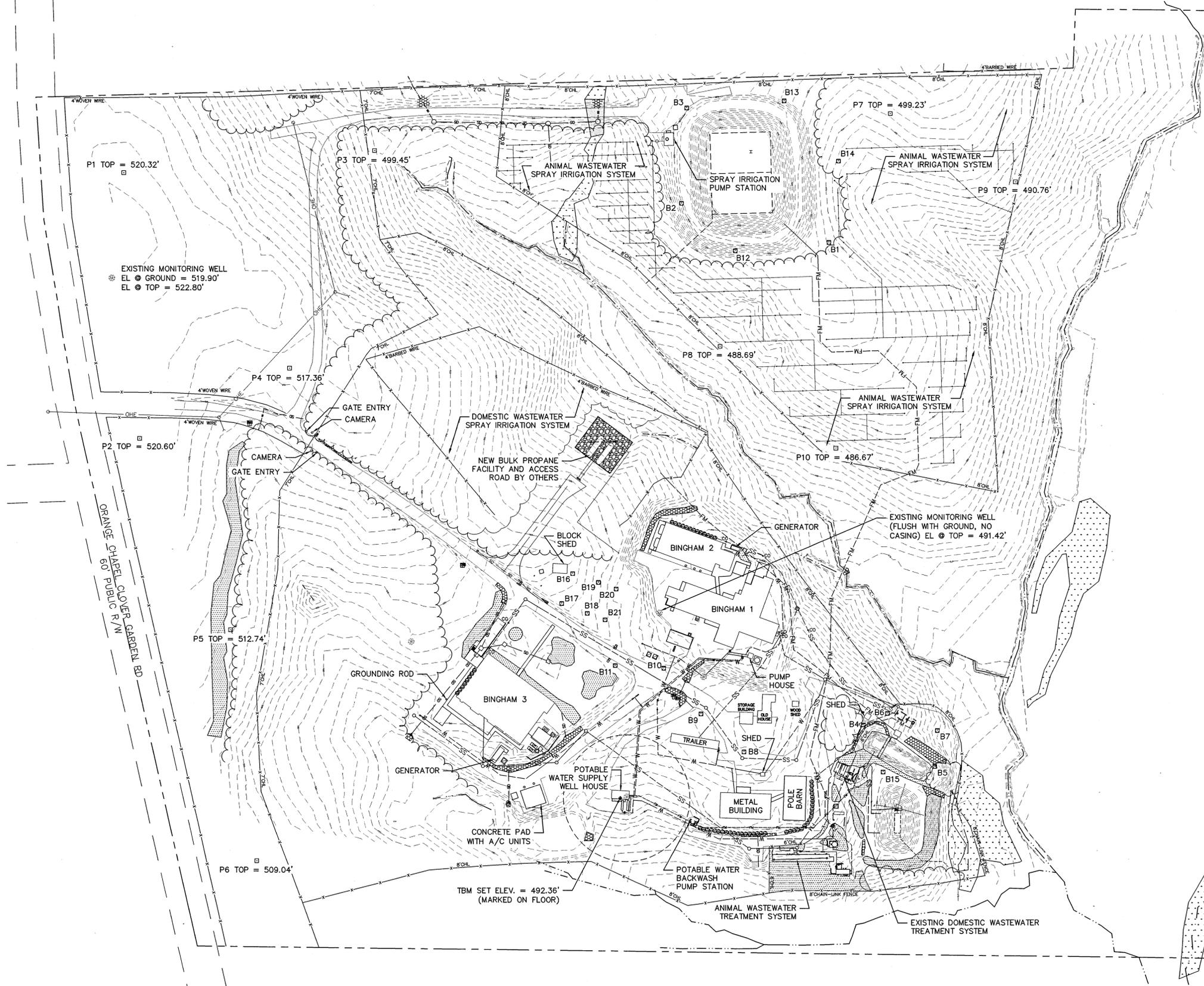
**HYDRAULIC PROFILE &
PROCESS FLOW DIAGRAM**

DATE: FEBRUARY 2011	SCALE: AS SHOWN	MAC FILE NUMBER: G03
MCE PROJ. # 1488-0032	HORIZONTAL: NA	DRAWING NUMBER: G03
DRAWN: LEG	DESIGNED: CDR	CHECKED: CDR
PROJ. MGR.: CDR	STATUS: FINAL DESIGN - NOT FOR CONSTRUCTION	REVISION: E



LEGEND

- EXISTING POTABLE WATER WELL
- EXISTING MONITORING WELL
- EXISTING PIEZOMETER
- EXISTING BORING
- EXISTING ELECTRICAL TRANSFORMER
- EXISTING LIGHT POLE
- EXISTING TELEPHONE PEDESTAL
- EXISTING TELEPHONE HAND HOLE
- EXISTING CABLE TV BOX
- EXISTING POTABLE WATER METER
- EXISTING POTABLE WATER TREATMENT BACKWASH FORCEMAIN
- EXISTING FORCEMAIN
- EXISTING POTABLE WATER
- EXISTING SANITARY SEWER
- EXISTING FENCE
- EXISTING MINOR CONTOUR
- EXISTING MAJOR CONTOUR
- EXISTING STREAM
- EXISTING PROPERTY LINE
- EXISTING OVERHEAD ELECTRIC
- EXISTING STORM DRAIN
- EXISTING BUSHES
- EXISTING WOODLINE
- EXISTING RIP RAP AREA
- EXISTING LANDSCAPED AREA
- EXISTING WETLAND AREA

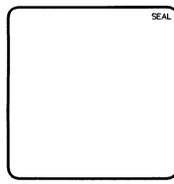


EXISTING OVERALL SITE PLAN
SCALE: 1" = 80'

NOTES

1. EXISTING UNDERGROUND UTILITIES ARE SHOWN BASED ON BEST AVAILABLE INFORMATION AT THE TIME OF DESIGN. IT IS THE CONTRACTOR'S RESPONSIBILITY TO LOCATE ALL EXISTING UTILITIES BEFORE PERFORMING WORK.
2. REFERENCE ELECTRICAL DRAWINGS FOR EXISTING UNDERGROUND ELECTRICAL UTILITIES.

REV. NO.	DESCRIPTIONS	DATE
E	FINAL DESIGN - NOT FOR CONSTRUCTION	1/31/13
D	FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION	8/11/11
C	FINAL DESIGN SUBMITTAL	7/26/11
B	60% DESIGN SUBMITTAL	4/26/11
A	30% DESIGN SUBMITTAL	3/21/11



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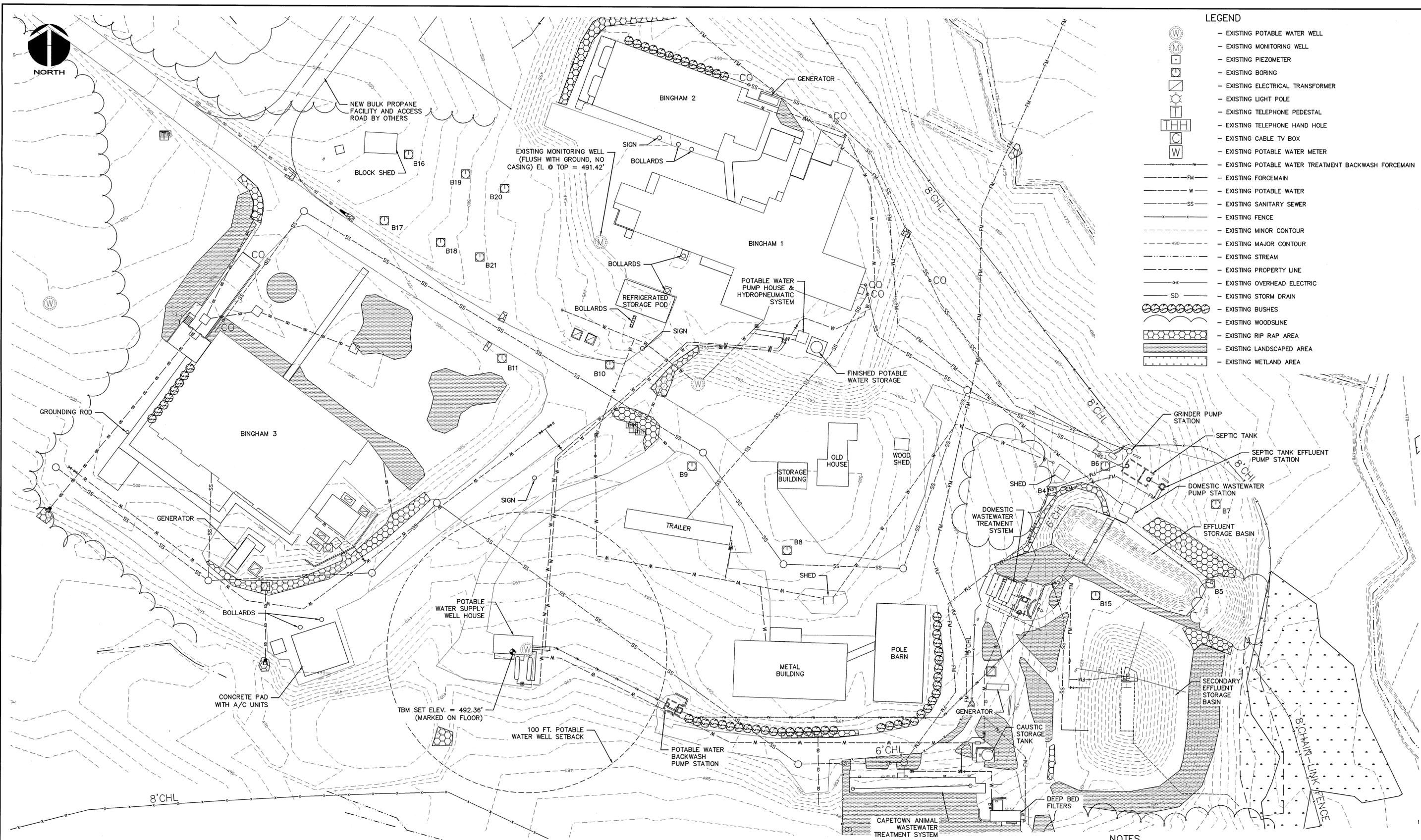
**BINGHAM FACILITY
WASTEWATER SYSTEM IMPROVEMENTS**
EXISTING OVERALL SITE PLAN

DATE: FEBRUARY 2011	SCALE: HORIZONTAL: 1" = 80'	MAC FILE NUMBER: C01
MCE PROJ. # 1488-0032	DESIGNED: CDR	REVISION: E
DRAWN: SHK	CHECKED: CDR	
PROJ. MGR: CDR		

File: S:\1488\0032\00-Drawings\DWG\C01_C01.dwg, Plot: Mon Jan 07, 2013 at 11:28am, Plotter: Mon Jan 07, 2013 at 11:28am, Plotter: Mon Jan 07, 2013 at 11:28am



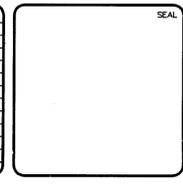
- LEGEND**
- EXISTING POTABLE WATER WELL
 - EXISTING MONITORING WELL
 - EXISTING PIEZOMETER
 - EXISTING BORING
 - EXISTING ELECTRICAL TRANSFORMER
 - EXISTING LIGHT POLE
 - EXISTING TELEPHONE PEDESTAL
 - EXISTING TELEPHONE HAND HOLE
 - EXISTING CABLE TV BOX
 - EXISTING POTABLE WATER METER
 - EXISTING POTABLE WATER TREATMENT BACKWASH FORCEMAIN
 - EXISTING FORCEMAIN
 - EXISTING POTABLE WATER
 - EXISTING SANITARY SEWER
 - EXISTING FENCE
 - EXISTING MINOR CONTOUR
 - EXISTING MAJOR CONTOUR
 - EXISTING STREAM
 - EXISTING PROPERTY LINE
 - EXISTING OVERHEAD ELECTRIC
 - EXISTING STORM DRAIN
 - EXISTING BUSHES
 - EXISTING WOODLINE
 - EXISTING RIP RAP AREA
 - EXISTING LANDSCAPED AREA
 - EXISTING WETLAND AREA



EXISTING ENLARGED SITE PLAN
SCALE: 1" = 30'

- NOTES**
- EXISTING UNDERGROUND UTILITIES ARE SHOWN BASED ON BEST AVAILABLE INFORMATION AT THE TIME OF DESIGN. IT IS THE CONTRACTOR'S RESPONSIBILITY TO LOCATE ALL EXISTING UTILITIES BEFORE PERFORMING WORK.
 - REFERENCE ELECTRICAL DRAWINGS FOR EXISTING UNDERGROUND ELECTRICAL UTILITIES.

REV. NO.	DESCRIPTIONS	DATE
E	FINAL DESIGN - NOT FOR CONSTRUCTION	1/31/13
D	FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION	8/11/11
C	FINAL DESIGN SUBMITTAL	7/28/11
B	90% DESIGN SUBMITTAL	4/18/11
A	60% DESIGN SUBMITTAL	3/21/11



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**BINGHAM FACILITY
WASTEWATER SYSTEM IMPROVEMENTS**
EXISTING ENLARGED SITE PLAN

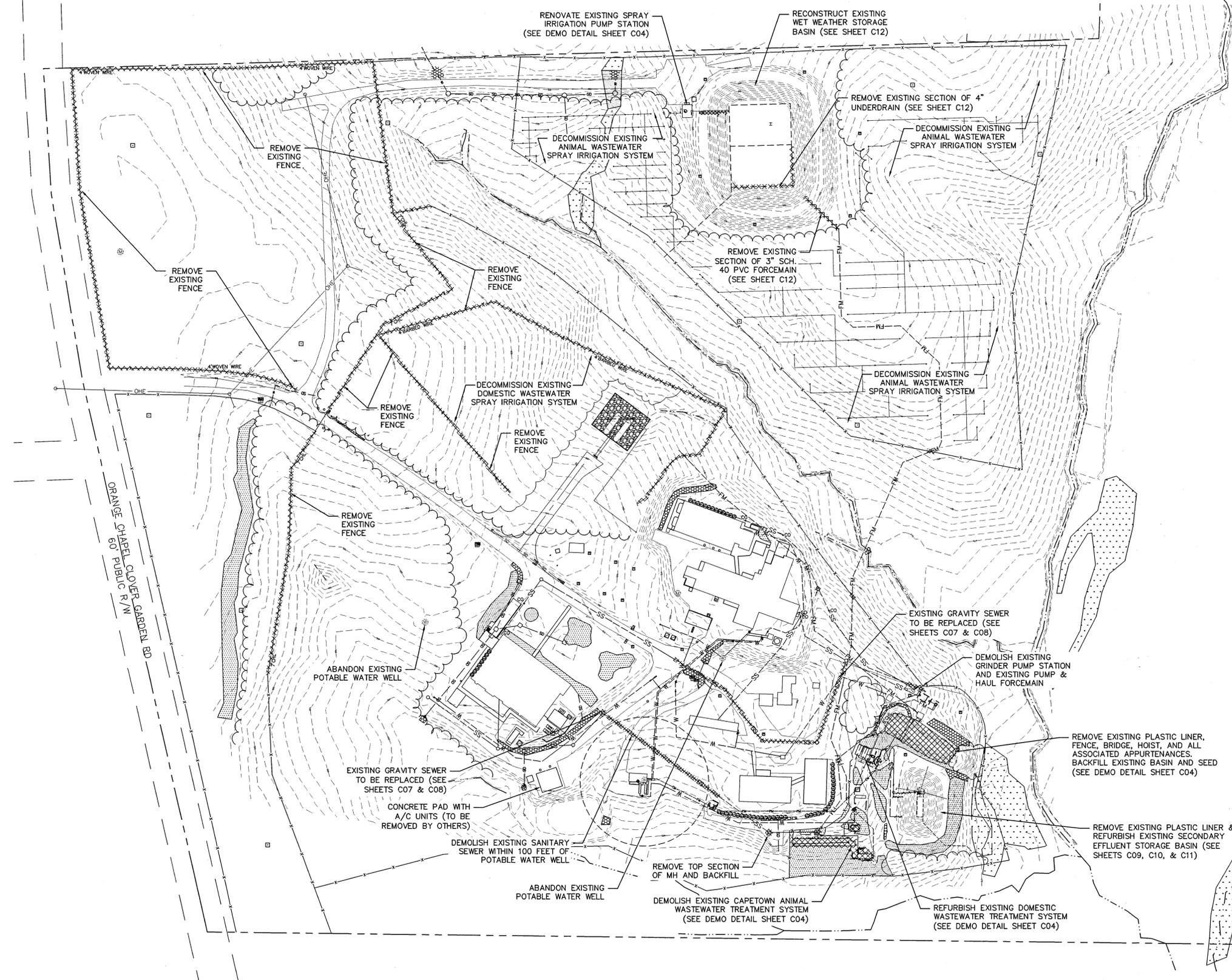
DATE: FEBRUARY 2011	SCALE: HORIZONTAL: 1" = 30'	MAC FILE NUMBER
MCE PROJ. # 1488-0032	VERTICAL: NA	DRAWING NUMBER
DRAWN: SHK		C02
DESIGNED: CDR		
CHECKED: CDR		
PROJ. MGR.: CDR		
STATUS: FINAL DESIGN - NOT FOR CONSTRUCTION	REVISION: E	

File: S:\1488\0032\BIP-Drawings\Civil\01_C02-14880032.dwg, Layout: C02, By: Johnson, Plotted: Mon, Jan 07, 2013, at 11:35am



LEGEND

- EXISTING POTABLE WATER WELL
- EXISTING MONITORING WELL
- EXISTING PIEZOMETER
- EXISTING BORING
- EXISTING ELECTRICAL TRANSFORMER
- EXISTING LIGHT POLE
- EXISTING TELEPHONE PEDESTAL
- EXISTING TELEPHONE HAND HOLE
- EXISTING CABLE TV BOX
- EXISTING POTABLE WATER METER
- EXISTING POTABLE WATER TREATMENT BACKWASH FORCEMAIN
- EXISTING FORCEMAIN
- EXISTING POTABLE WATER
- EXISTING SANITARY SEWER
- EXISTING FENCE
- EXISTING MINOR CONTOUR
- EXISTING MAJOR CONTOUR
- EXISTING STREAM
- EXISTING PROPERTY LINE
- EXISTING OVERHEAD ELECTRIC
- EXISTING STORM DRAIN
- EXISTING BUSHES
- EXISTING WOODSLINE
- EXISTING RIP RAP AREA
- EXISTING LANDSCAPED AREA
- EXISTING WETLAND AREA

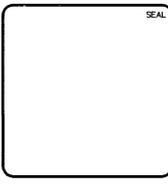


NOTES

1. REFER TO SPECIFICATIONS FOR DETAILED DEMOLITION PHASING.
2. EXISTING UNDERGROUND UTILITIES ARE SHOWN BASED ON BEST AVAILABLE INFORMATION AT THE TIME OF DESIGN. IT IS THE CONTRACTOR'S RESPONSIBILITY TO LOCATE ALL EXISTING UTILITIES BEFORE PERFORMING WORK.
3. REFERENCE ELECTRICAL DRAWINGS FOR EXISTING UNDERGROUND ELECTRICAL UTILITIES.

OVERALL SITE DEMOLITION PLAN
SCALE: 1" = 80'

REV. NO.	DESCRIPTIONS	DATE
E	FINAL DESIGN - NOT FOR CONSTRUCTION	1/31/13
D	FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION	8/17/11
C	FINAL DESIGN SUBMITTAL	7/28/11
B	90% DESIGN SUBMITTAL	4/18/11
A	60% DESIGN SUBMITTAL	3/21/11



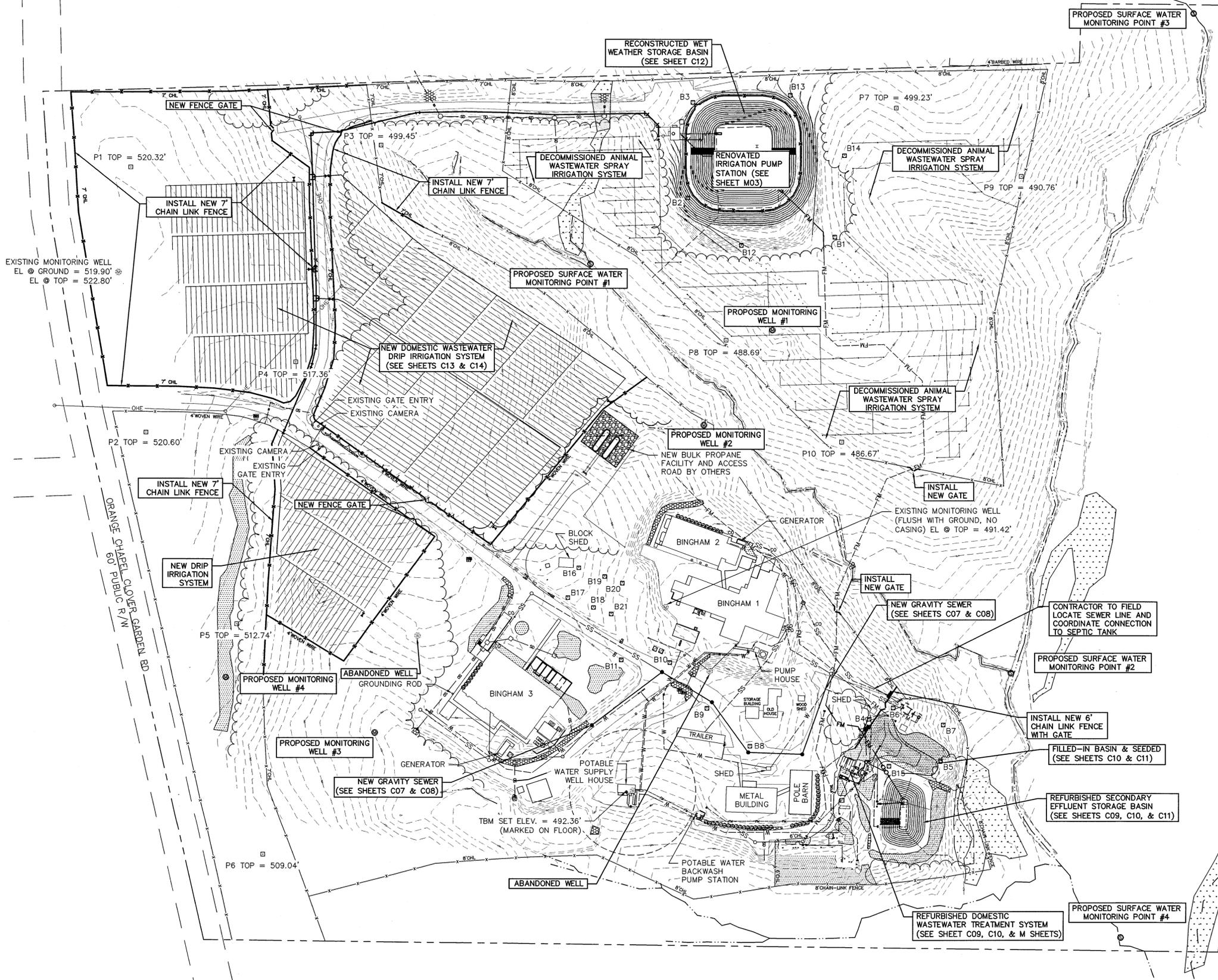
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**BINGHAM FACILITY
WASTEWATER SYSTEM IMPROVEMENTS**
OVERALL SITE DEMOLITION PLAN

DATE: FEBRUARY 2011	SCALE: 1" = 80'	MAC FILE NUMBER
MCE PROJ. # 1488-0032	HORIZONTAL: 1" = 80'	DRAWING NUMBER
DRAWN: SHK	VERTICAL: NA	C03
DESIGNED: CDR		
CHECKED: CDR		
PROJ. MGR: CDR		
STATUS: FINAL DESIGN - NOT FOR CONSTRUCTION		REVISION: E

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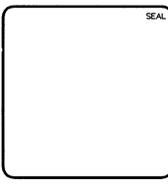


- LEGEND**
- ⊙ - EXISTING POTABLE WATER WELL
 - ⊙ - EXISTING MONITORING WELL
 - ⊙ - PROPOSED MONITORING WELL
 - ⊙ - PROPOSED SURFACE WATER MONITORING POINT
 - ⊙ - EXISTING PIEZOMETER
 - ⊙ - EXISTING BORING
 - ⊙ - EXISTING ELECTRICAL TRANSFORMER
 - ☆ - EXISTING LIGHT POLE
 - ⊙ - EXISTING TELEPHONE PEDESTAL
 - ⊙ - EXISTING TELEPHONE HAND HOLE
 - ⊙ - EXISTING CABLE TV BOX
 - ⊙ - EXISTING POTABLE WATER METER
 - — — — — - EXISTING POTABLE WATER TREATMENT BACKWASH FORCEMAIN
 - — — — — - PROPOSED POTABLE WATER TREATMENT BACKWASH FORCEMAIN
 - — — — — - EXISTING FORCEMAIN
 - — — — — - PROPOSED FORCEMAIN
 - — — — — - EXISTING POTABLE WATER
 - — — — — - PROPOSED POTABLE WATER
 - — — — — - EXISTING SANITARY SEWER
 - — — — — - PROPOSED SANITARY SEWER
 - — — — — - PROPOSED SODIUM HYPOCHLORITE FEED LINE
 - — — — — - EXISTING FENCE
 - — — — — - PROPOSED FENCE
 - — — — — - EXISTING MINOR CONTOUR
 - — — — — - EXISTING MAJOR CONTOUR
 - — — — — - PROPOSED MINOR CONTOUR
 - — — — — - PROPOSED MAJOR CONTOUR
 - — — — — - EXISTING STREAM
 - — — — — - EXISTING PROPERTY LINE
 - — — — — - EXISTING OVERHEAD ELECTRIC
 - — — — — - EXISTING STORM DRAIN
 - — — — — - EXISTING BUSHES
 - — — — — - EXISTING WOODSLINE
 - — — — — - EXISTING RIP RAP AREA
 - — — — — - EXISTING LANDSCAPED AREA
 - — — — — - EXISTING WETLAND AREA

PROPOSED OVERALL SITE PLAN
SCALE: 1" = 80'

- NOTES**
1. EXISTING UNDERGROUND UTILITIES ARE SHOWN BASED ON BEST AVAILABLE INFORMATION AT THE TIME OF DESIGN. IT IS THE CONTRACTOR'S RESPONSIBILITY TO LOCATE ALL EXISTING UTILITIES BEFORE PERFORMING WORK.
 2. REFERENCE ELECTRICAL DRAWINGS FOR EXISTING UNDERGROUND ELECTRICAL UTILITIES.

REV. NO.	DESCRIPTION	DATE
E	FINAL DESIGN - NOT FOR CONSTRUCTION	1/31/13
D	FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION	8/11/11
C	FINAL DESIGN SUBMITTAL	7/26/11
B	90% DESIGN SUBMITTAL	4/28/11
A	60% DESIGN SUBMITTAL	3/21/11



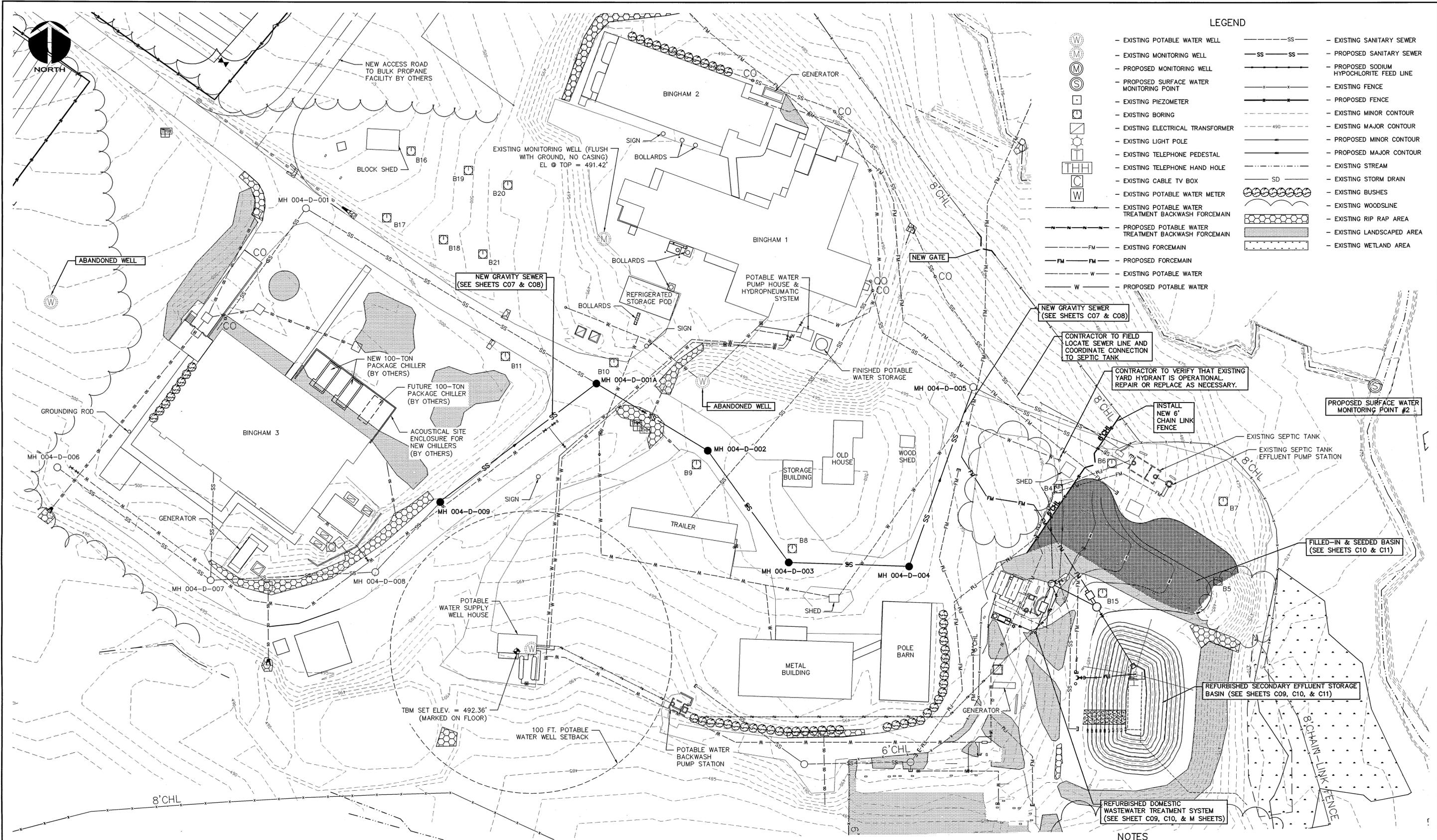
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**BINGHAM FACILITY
 WASTEWATER SYSTEM IMPROVEMENTS**
 PROPOSED OVERALL SITE PLAN

DATE: FEBRUARY 2011	SCALE: HORIZONTAL: 1" = 30'	MAC FILE NUMBER: C05
MCE PROJ. # 1488-0032	DESIGNED: CDR	DRAWING NUMBER: C05
DRAWN: SHK	CHECKED: CDR	VERTICAL: NA
PROJ. MGR: CDR	STATUS: FINAL DESIGN - NOT FOR CONSTRUCTION	REVISION: E

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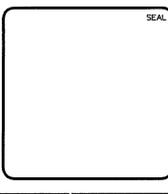
LEGEND

(W) - EXISTING POTABLE WATER WELL	--- SS ---	- EXISTING SANITARY SEWER
(M) - EXISTING MONITORING WELL	--- SS --- SS ---	- PROPOSED SANITARY SEWER
(S) - PROPOSED MONITORING WELL	--- SS ---	- PROPOSED SODIUM HYPOCHLORITE FEED LINE
(C) - PROPOSED SURFACE WATER MONITORING POINT	--- X --- X ---	- EXISTING FENCE
(P) - EXISTING PIEZOMETER	--- X --- X ---	- PROPOSED FENCE
(B) - EXISTING BORING	--- 490 ---	- EXISTING MINOR CONTOUR
(E) - EXISTING ELECTRICAL TRANSFORMER	--- 490 ---	- EXISTING MAJOR CONTOUR
(L) - EXISTING LIGHT POLE	--- 490 ---	- PROPOSED MAJOR CONTOUR
(T) - EXISTING TELEPHONE PEDESTAL	--- SD ---	- EXISTING STREAM
(H) - EXISTING TELEPHONE HAND HOLE	--- SD ---	- EXISTING STORM DRAIN
(V) - EXISTING CABLE TV BOX	(BUSHES)	- EXISTING BUSHES
(METER) - EXISTING POTABLE WATER METER	(WOODS)	- EXISTING WOODS
(FORC) - EXISTING POTABLE WATER TREATMENT BACKWASH FORCEMAIN	(RIP RAP)	- EXISTING RIP RAP AREA
(PROF) - PROPOSED POTABLE WATER TREATMENT BACKWASH FORCEMAIN	(LANDSCAPED)	- EXISTING LANDSCAPED AREA
(FM) - EXISTING FORCEMAIN	(WETLAND)	- EXISTING WETLAND AREA
(PROF) - PROPOSED FORCEMAIN		
(W) - EXISTING POTABLE WATER		
(PROF) - PROPOSED POTABLE WATER		

PROPOSED ENLARGED SITE PLAN
SCALE: 1" = 30'

- NOTES**
- EXISTING UNDERGROUND UTILITIES ARE SHOWN BASED ON BEST AVAILABLE INFORMATION AT THE TIME OF DESIGN. IT IS THE CONTRACTOR'S RESPONSIBILITY TO LOCATE ALL EXISTING UTILITIES BEFORE PERFORMING WORK.
 - REFERENCE ELECTRICAL DRAWINGS FOR EXISTING UNDERGROUND ELECTRICAL UTILITIES.

REV. NO.	DESCRIPTIONS	DATE
E	FINAL DESIGN - NOT FOR CONSTRUCTION	1/31/13
D	FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION	8/11/11
C	FINAL DESIGN SUBMITTAL	7/26/11
B	60% DESIGN SUBMITTAL	4/15/11
A	60% DESIGN SUBMITTAL	3/21/11



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BINGHAM FACILITY WASTEWATER SYSTEM IMPROVEMENTS
PROPOSED ENLARGED SITE PLAN

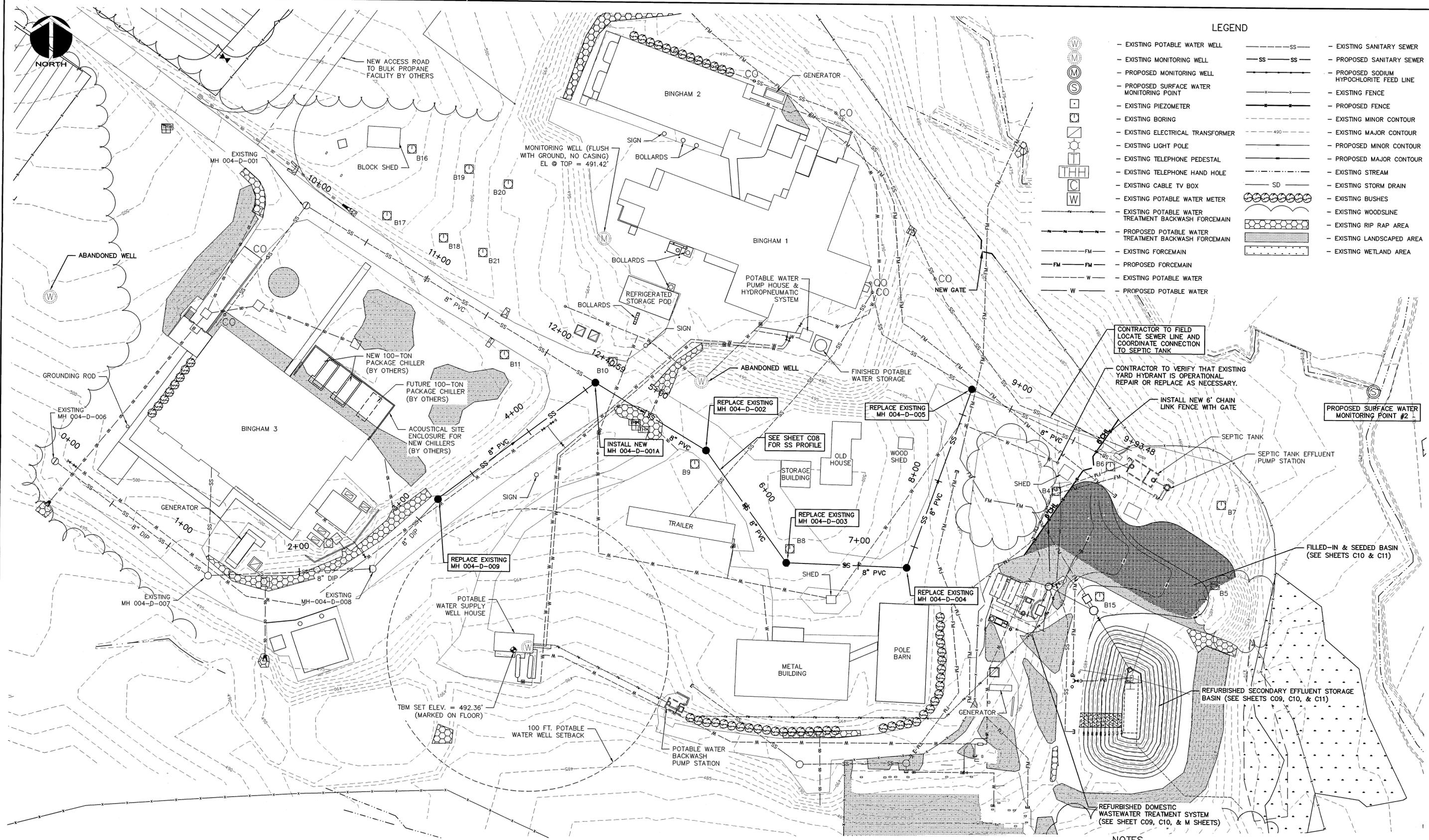
DATE: FEBRUARY 2011	SCALE: 1" = 30'	MAC FILE NUMBER
MCE PROJ. # 1488-0032	HORIZONTAL: 1" = 30'	DRAWING NUMBER
DRAWN: SHK	VERTICAL: NA	C06
DESIGNED: CDR		
CHECKED: CDR		
PROJ. MGR:		
STATUS: FINAL DESIGN - NOT FOR CONSTRUCTION	REVISION: E	

File: S:\1488\0032\00-Drawings\Civil\005_C06-14880032.dwg, Layout: 006, By: jpholman, Plotted: Fri Jan 11, 2013 at 1:00pm



LEGEND

- EXISTING POTABLE WATER WELL
- EXISTING MONITORING WELL
- PROPOSED MONITORING WELL
- PROPOSED SURFACE WATER MONITORING POINT
- EXISTING PIEZOMETER
- EXISTING BORING
- EXISTING ELECTRICAL TRANSFORMER
- EXISTING LIGHT POLE
- EXISTING TELEPHONE PEDESTAL
- EXISTING TELEPHONE HAND HOLE
- EXISTING CABLE TV BOX
- EXISTING POTABLE WATER METER
- EXISTING POTABLE WATER TREATMENT BACKWASH FORCEMAIN
- PROPOSED POTABLE WATER TREATMENT BACKWASH FORCEMAIN
- EXISTING FORCEMAIN
- PROPOSED FORCEMAIN
- EXISTING POTABLE WATER
- PROPOSED POTABLE WATER
- EXISTING SANITARY SEWER
- PROPOSED SANITARY SEWER
- PROPOSED SODIUM HYPOCHLORITE FEED LINE
- EXISTING FENCE
- PROPOSED FENCE
- EXISTING MINOR CONTOUR
- EXISTING MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- EXISTING STREAM
- EXISTING STORM DRAIN
- EXISTING BUSHES
- EXISTING WOODSLINE
- EXISTING RIP RAP AREA
- EXISTING LANDSCAPED AREA
- EXISTING WETLAND AREA



PROPOSED SANITARY SEWER PLAN
SCALE: 1" = 30'

- NOTES
- EXISTING UNDERGROUND UTILITIES ARE SHOWN BASED ON BEST AVAILABLE INFORMATION AT THE TIME OF DESIGN. IT IS THE CONTRACTOR'S RESPONSIBILITY TO LOCATE ALL EXISTING UTILITIES BEFORE PERFORMING WORK.
 - REFERENCE ELECTRICAL DRAWINGS FOR EXISTING UNDERGROUND ELECTRICAL UTILITIES.

REV. NO.	DESCRIPTIONS	DATE
E	FINAL DESIGN - NOT FOR CONSTRUCTION	1/31/13
D	FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION	8/11/11
C	FINAL DESIGN SUBMITTAL	7/08/11
B	20% DESIGN SUBMITTAL	4/18/11
A	60% DESIGN SUBMITTAL	3/21/11



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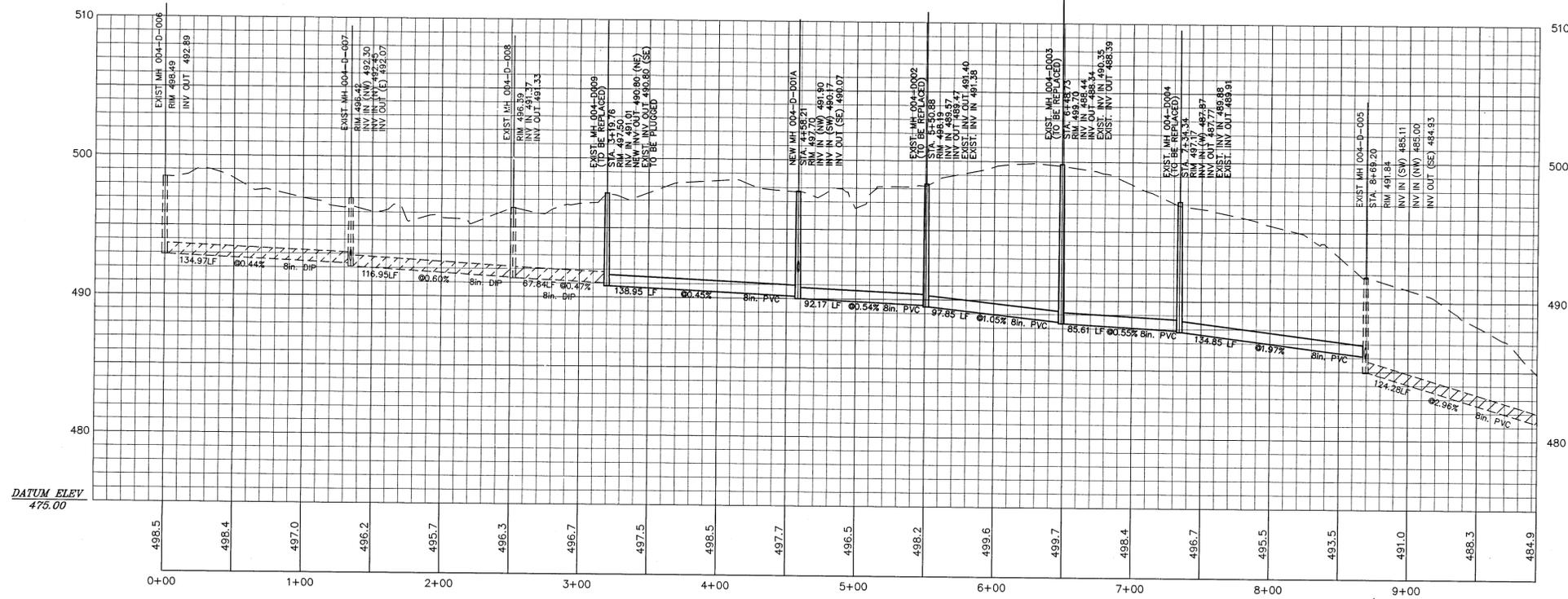
THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

BINGHAM FACILITY WASTEWATER SYSTEM IMPROVEMENTS
PROPOSED SANITARY SEWER PLAN

DATE: FEBRUARY 2011	SCALE: HORIZONTAL: 1" = 30'	M&C FILE NUMBER
MCE PROJ. # 1488-0032	VERTICAL: NA	DRAWING NUMBER
DRAWN: LEG		C07
DESIGNED: LEG		
CHECKED: CDR		
PROJ. MGR:		

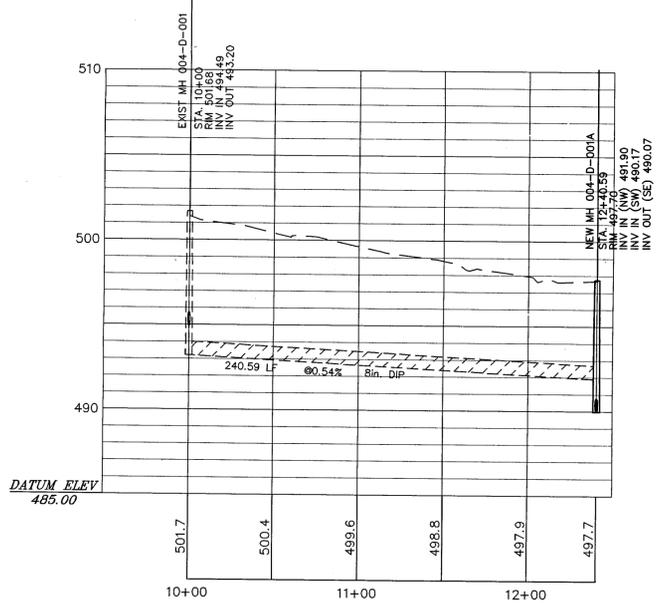
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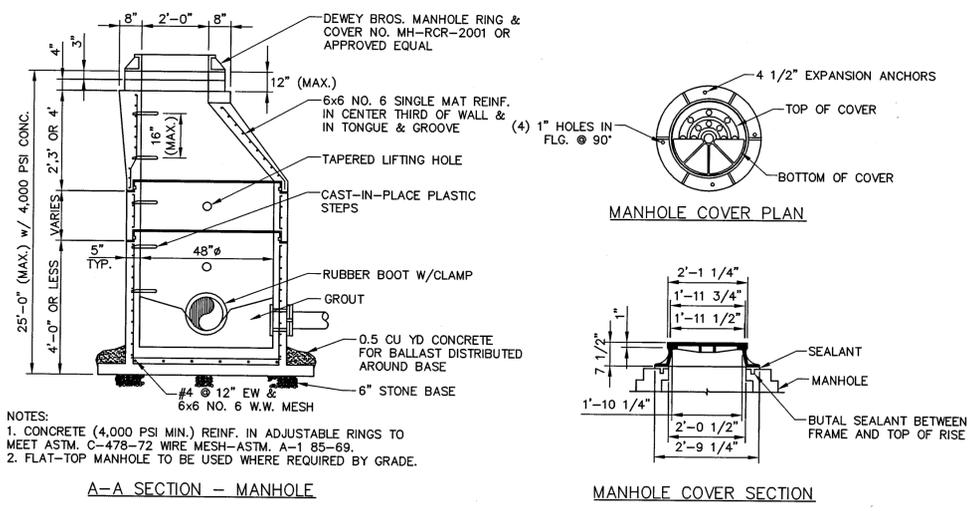
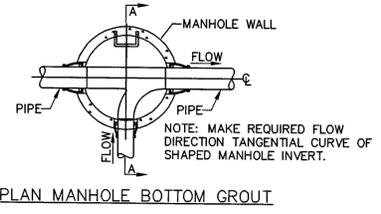


NOTE:
CONTRACTOR RESPONSIBLE FOR LOCATING & PROTECTING
ALL EXISTING UTILITIES BEFORE PERFORMING WORK.

SANITARY SEWER PROFILE
VERTICAL SCALE: 1" = 5'
HORIZONTAL SCALE: 1" = 50'



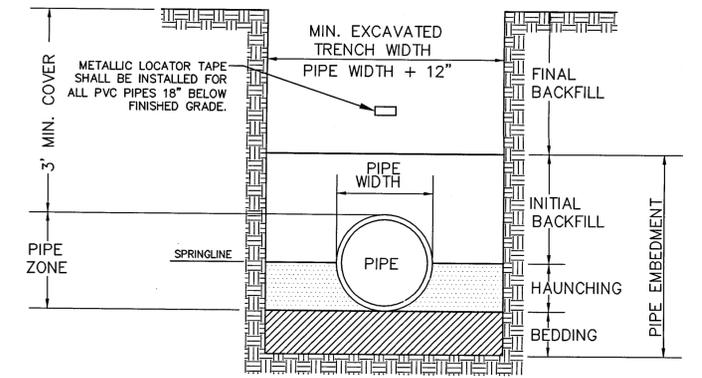
SANITARY SEWER PROFILE
VERTICAL SCALE: 1" = 5'
HORIZONTAL SCALE: 1" = 50'



- NOTES:
- CONCRETE (4,000 PSI MIN.) REINF. IN ADJUSTABLE RINGS TO MEET ASTM. C-478-72 WIRE MESH-ASTM. A-1 85-69.
 - FLAT-TOP MANHOLE TO BE USED WHERE REQUIRED BY GRADE.

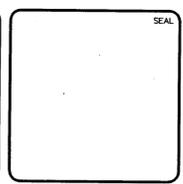
PRE-CAST MANHOLE DETAILS
NOT TO SCALE

- NOTE:
- BEDDING SHALL BE SMOOTH TRENCH BOTTOM, OR COMPACTED LOOSE FILL MATERIAL AS REQUIRED TO PROVIDE A FIRM, STABLE AND UNIFORM SUPPORT FOR THE FULL LENGTH OF PIPE.



TRENCH DETAIL
NOT TO SCALE

REV. NO.	DESCRIPTIONS	DATE
E	FINAL DESIGN - NOT FOR CONSTRUCTION	1/21/13
D	FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION	5/11/11
C	FINAL DESIGN SUBMITTAL	7/28/11
B	25% DESIGN SUBMITTAL	4/18/11
A	60% DESIGN SUBMITTAL	3/21/11



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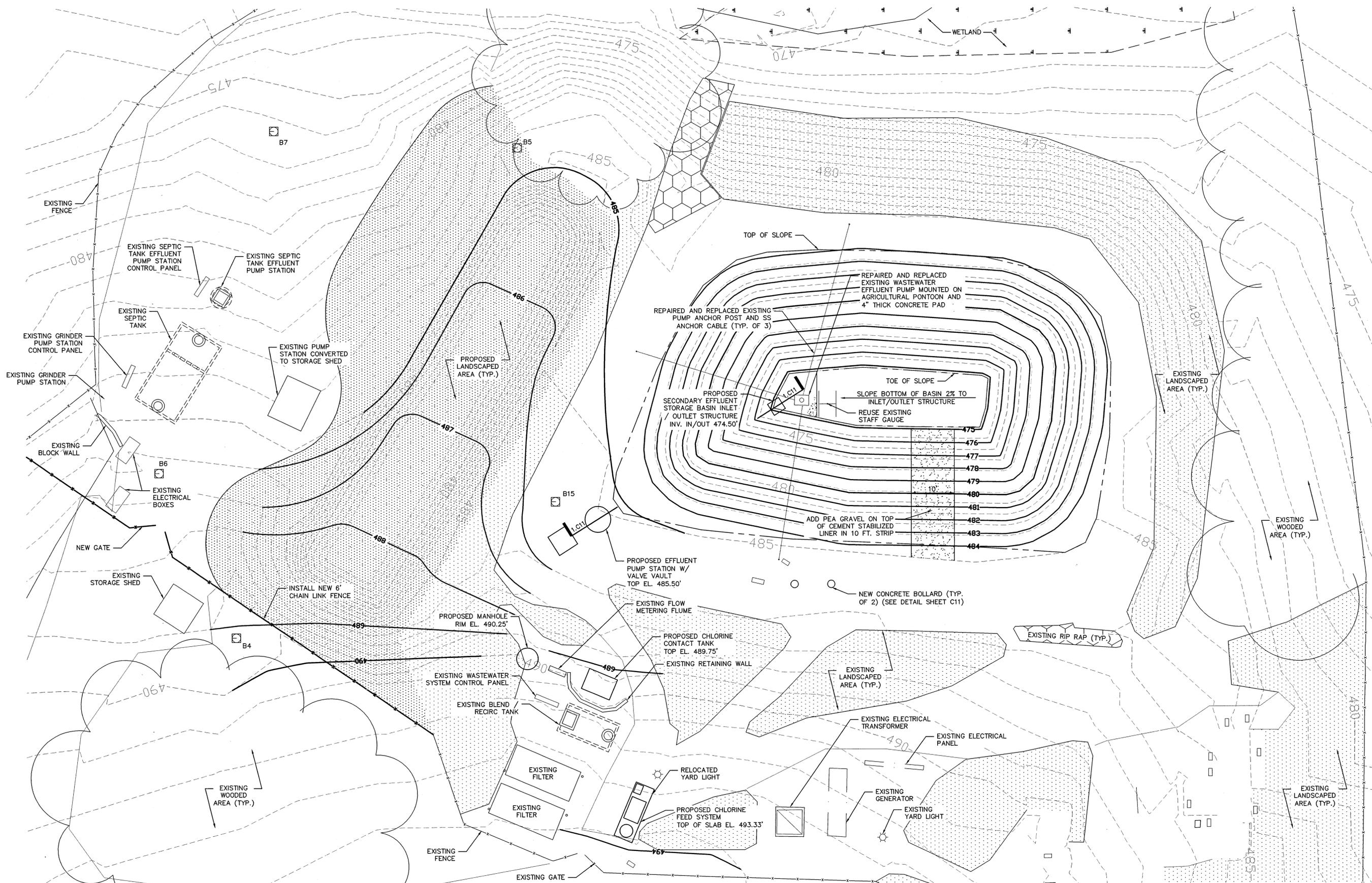
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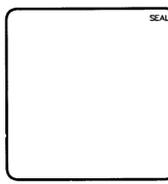
BINGHAM FACILITY WASTEWATER SYSTEM IMPROVEMENTS

PROPOSED SANITARY SEWER PROFILE

DATE: FEBRUARY 2011	SCALE: HORIZONTAL: 1" = 50' VERTICAL: 1" = 5'	M&C FILE NUMBER: C08
M&C PROJ. # 1488-0032	DESIGNED: LEG	DRAWING NUMBER: C08
CHECKED: CDR	DESIGNED: LEG	REVISION: E
PROJ. MGR.: CDR	STATUS: FINAL DESIGN - NOT FOR CONSTRUCTION	



REV. NO.	DESCRIPTIONS	DATE
E	FINAL DESIGN - NOT FOR CONSTRUCTION	1/31/13
D	FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION	8/11/11
C	FINAL DESIGN SUBMITTAL	7/26/11
B	50% DESIGN SUBMITTAL	4/16/11
A	30% DESIGN SUBMITTAL	3/21/11



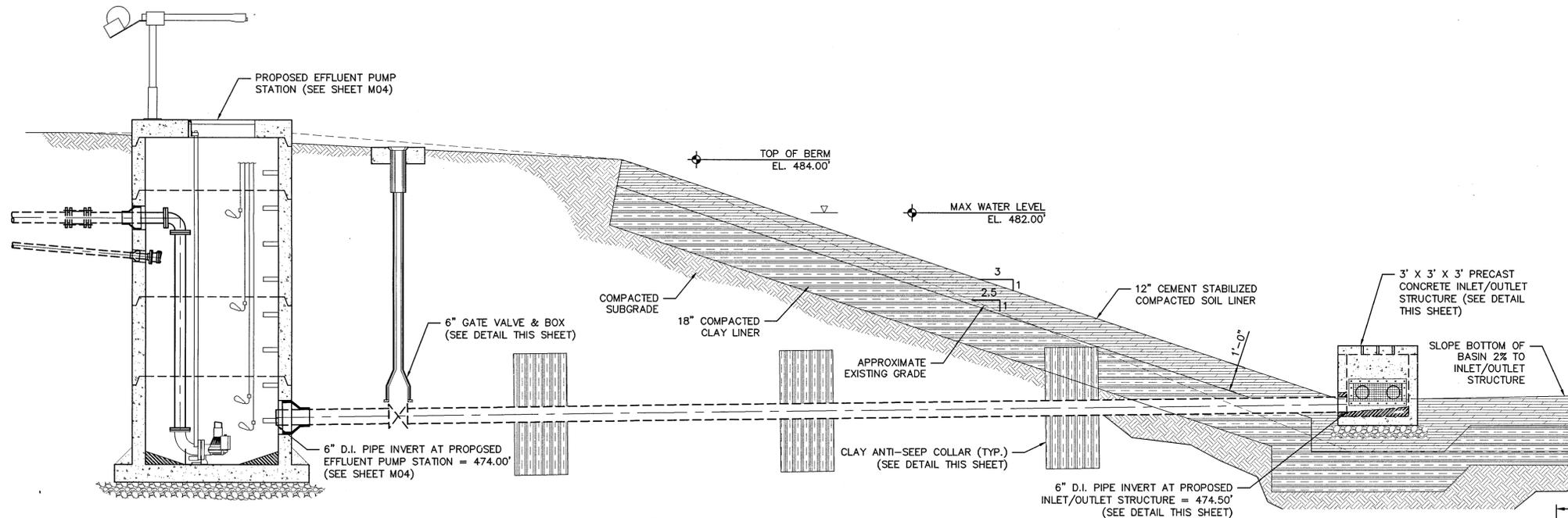
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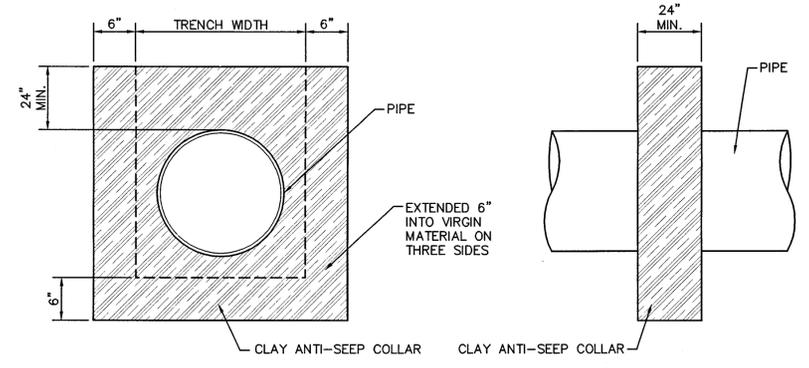
**BINGHAM FACILITY
 WASTEWATER SYSTEM IMPROVEMENTS**
**WASTEWATER TREATMENT SYSTEM
 GRADING PLAN**

DATE: FEBRUARY 2011	SCALE: HORIZONTAL: 1" = 10'	MAC FILE NUMBER: C10
MCE PROJ. # 1488-0032	VERTICAL: NA	DRAWING NUMBER: E
DRAWN: SHK		
DESIGNED: CDR		
CHECKED: CDR		
PROJ. MGR: CDR		
STATUS: FINAL DESIGN - NOT FOR CONSTRUCTION		

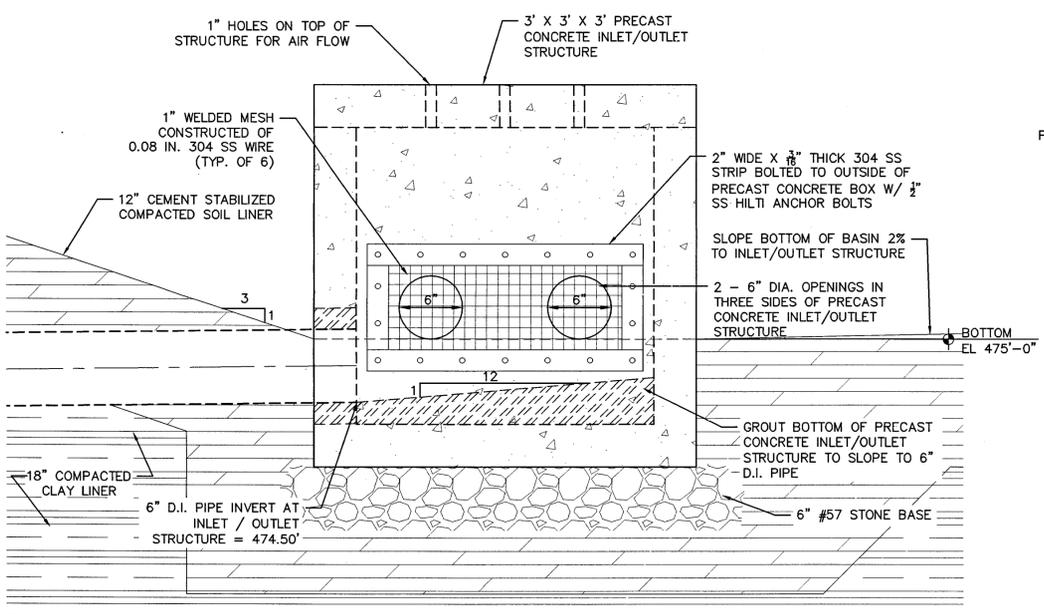
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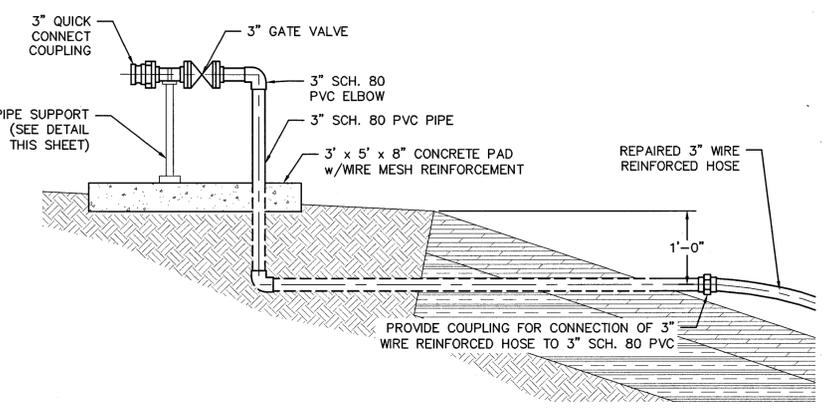
1.C10 - SECONDARY EFFLUENT STORAGE BASIN SECTION
SCALE: 1" = 30'



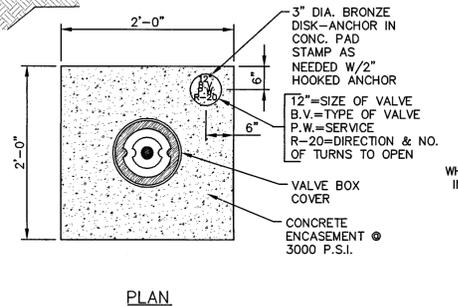
CLAY ANTI-SEEP COLLAR DETAIL
NOTE: TO BE INSTALLED AT 10' INTERVALS
NOT TO SCALE



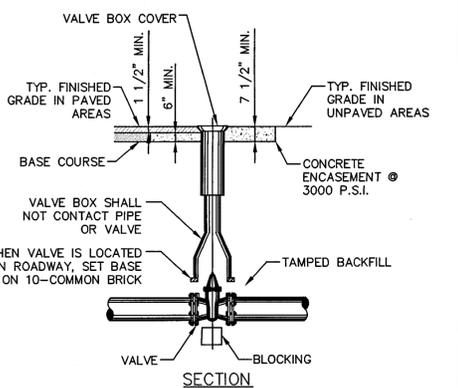
SECONDARY EFFLUENT STORAGE BASIN INLET/OUTLET STRUCTURE DETAIL
SCALE: 1 1/2" = 1'-0"



SECONDARY EFFLUENT STORAGE BASIN DRAIN STATION DETAIL
SCALE: 1/2" = 1'-0"



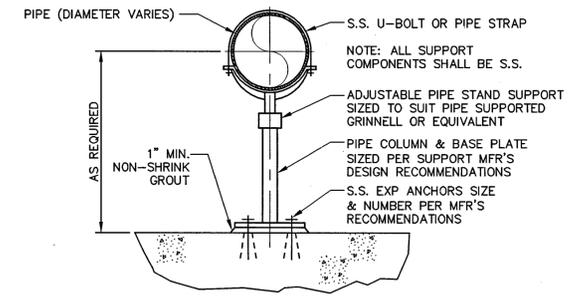
PLAN



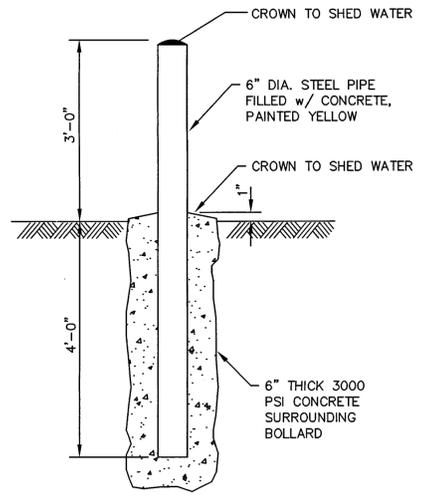
SECTION

NOTE: THE VALVE BOX SHALL BE CENTERED AND SET PLUMB WITH THE TOP OF THE BOX NEATLY TO GRADE OF THE SURFACE OF THE EXISTING GROUND, UNLESS OTHERWISE DIRECTED BY THE OWNER. SHOCK AND STRESS SHALL NOT BE TRANSFERRED FROM THE BOX TO THE VALVE. THE TOP OF THE OPERATING NUT SHALL BE NO MORE THAN 48-INCHES BELOW THE TOP RIM OF THE VALVE BOX (AS MEASURED FROM FINAL GRADE). THE CONTRACTOR SHALL INSTALL AN APPROVED VALVE STEM EXTENSION DEVICE WHERE NECESSARY TO COMPLY WITH THE 48-INCHES MAXIMUM DISTANCE.

VALVE BOX DETAIL
NOT TO SCALE

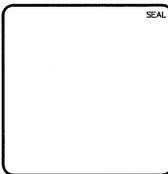


PIPE SUPPORT DETAIL
NOT TO SCALE



BOLLARD DETAIL
NOT TO SCALE

REV. NO.	DESCRIPTION	DATE
E	FINAL DESIGN - NOT FOR CONSTRUCTION	1/31/13
D	FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION	8/17/11
C	FINAL DESIGN SUBMITTAL	7/26/11
B	90% DESIGN SUBMITTAL	4/28/11
A	60% DESIGN SUBMITTAL	3/21/11



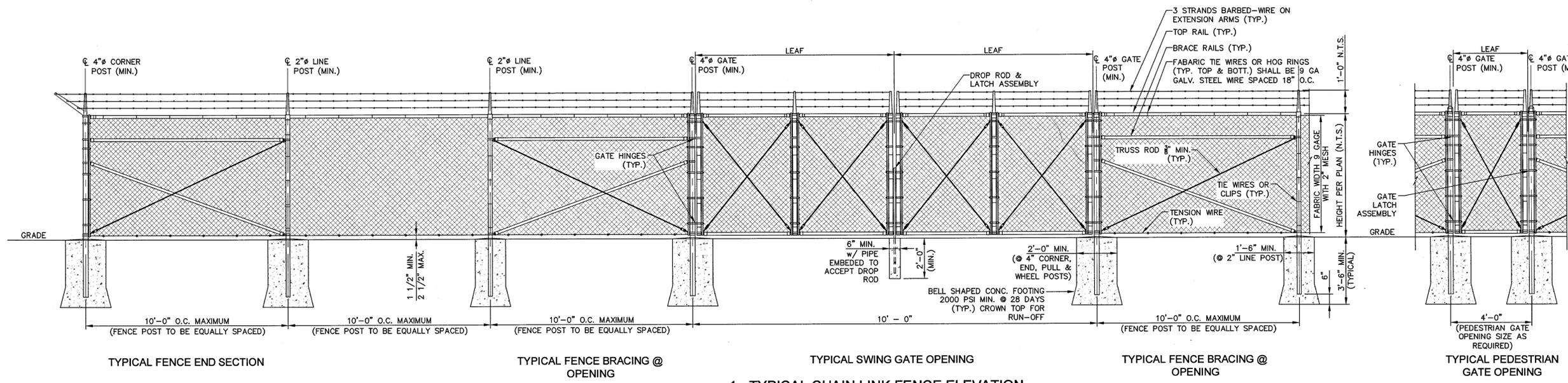
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THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

BINGHAM FACILITY WASTEWATER SYSTEM IMPROVEMENTS
WASTEWATER TREATMENT SYSTEM GRADING PLAN SECTIONS & DETAILS

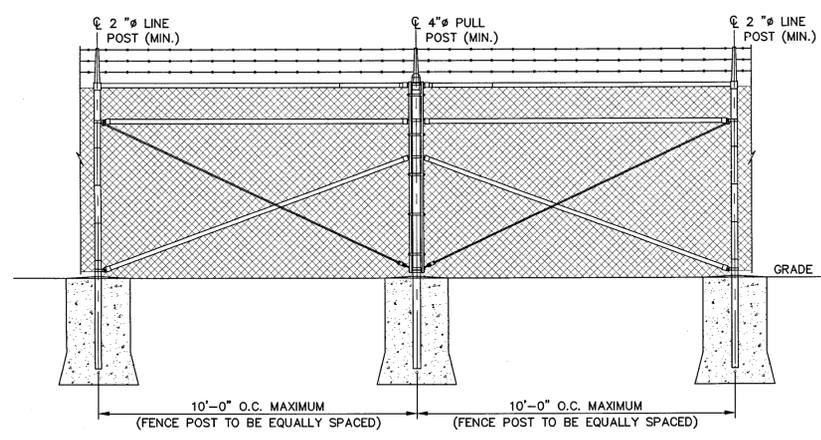
DATE: FEBRUARY 2011	SCALE: AS SHOWN	MAC FILE NUMBER: C11
MCE PROJ. # 1488-0032	HORIZONTAL: AS SHOWN	DRAWING NUMBER: C11
DRAWN: SHK	VERTICAL: NA	
DESIGNED: CDR		
CHECKED: CDR		
PROJ. MGR: CDR		
STATUS: FINAL DESIGN - NOT FOR CONSTRUCTION		REVISION: E

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- NOTES:**
1. SWING GATES SHALL BE CONSTRUCTED WITH DROP RODS, PAD LOCKS, LATCH ASSEMBLIES AND GATE KEEPERS UNLESS NOTED OTHERWISE (UNO).
 2. ALL GATE FRAMES SHALL MEET THE MINIMUM REQUIREMENTS OF ASTM F900 1.90" NOMINAL (ROUND). GATE FRAMES SHALL BE OF WELDED CONSTRUCTION OR SHALL BE ASSEMBLED USING HEAVY FITTINGS. AT CONTRACTOR'S OPTION A WELDED HORIZONTAL BRACE MAY BE USED IN LIEU OF TRUSS RODS TO BRACE ALL-WELDED GATE FRAMES. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PROPER RIGID CONSTRUCTION FOR ALL GATES SUPPLIED.
 3. PROVIDE BRACE PANELS WHENEVER STRAIGHT RUNS OF FENCING EXCEED 500 FEET.
 4. WIRE TIES, RAILS, POSTS, AND BRACES SHALL BE CONSTRUCTED ON THE SECURE SIDE OF THE FENCE ALIGNMENT. CHAIN-LINK FABRIC SHALL BE PLACED ON THE SIDE OPPOSITE THE SECURE AREA.
 5. ALL FENCING MATERIALS INCLUDING NUTS, BOLTS AND SCREWS ETC. SHALL BE HOT DIPPED GALVANIZED AFTER FABRICATION.
 6. FENCE COMPONENTS & FENCE FABRIC SHALL BE VINYL COATED BLACK IN COLOR.

1 - TYPICAL CHAIN LINK FENCE ELEVATION
N.T.S.



4 - TYPICAL BRACE PANEL ELEVATION
N.T.S.

POST & RAIL SCHEDULE					
POST/RAIL TYPE	FENCE FABRIC HEIGHT				
	UP TO 6'-0"	6'-0" TO 8'-0"	8'-0" TO 10'-0"	10'-0" TO 12'-0"	12'-0" TO 14'-0"
LINE POSTS	1 7/8" - 3 1/2"	2 3/8" - 4"	2 7/8" - 6 5/8"	2 7/8" - 6 5/8"	3 1/2" - 6 5/8"
TERMINAL POSTS - INCLUDES CORNER, END, PULL & WHEEL POSTS	2 3/8" - 4"	2 7/8" - 4 1/2"	3 1/2" - 8 5/8"	3 1/2" - 8 5/8"	4" - 8 5/8"
GATE POST	GATE LEAF WIDTH				
	6'-0" OR LESS	6'-0" - 12'-0"	12'-0" - 18'-0"	> THAN 18'-0"	
	2 7/8" O.D.	4" O.D.	6 5/8" O.D.	8 5/8" O.D.	
TOP, BOTTOM AND BRACE RAILS	1 5/8" OD	1 5/8" OD	1 5/8" OD	1 5/8" OD	

REV. NO.	DESCRIPTIONS	DATE
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D	FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION	8/11/11
C	FINAL DESIGN SUBMITTAL	7/28/11
B	50% DESIGN SUBMITTAL	4/18/11
A	60% DESIGN SUBMITTAL	3/21/11

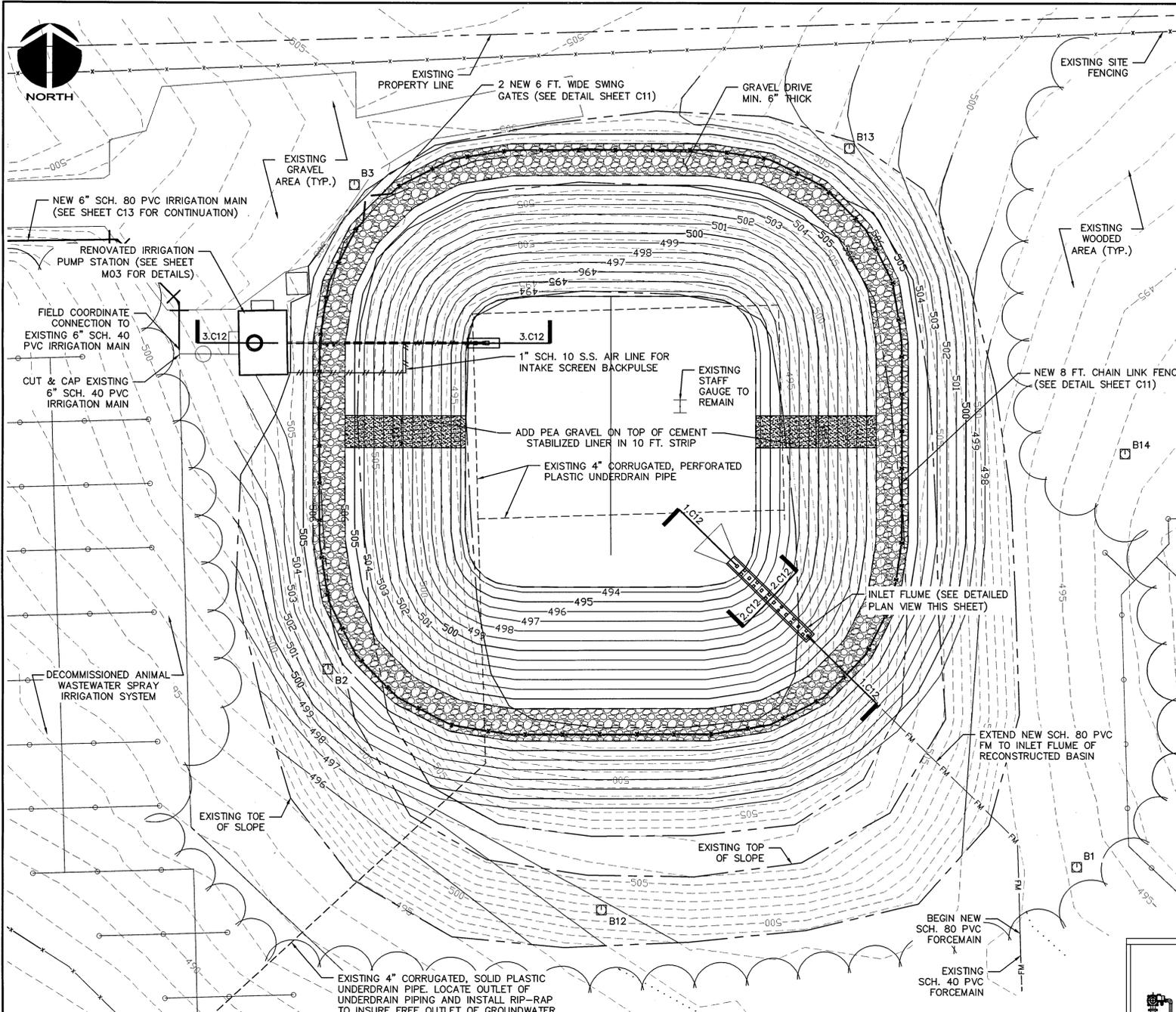


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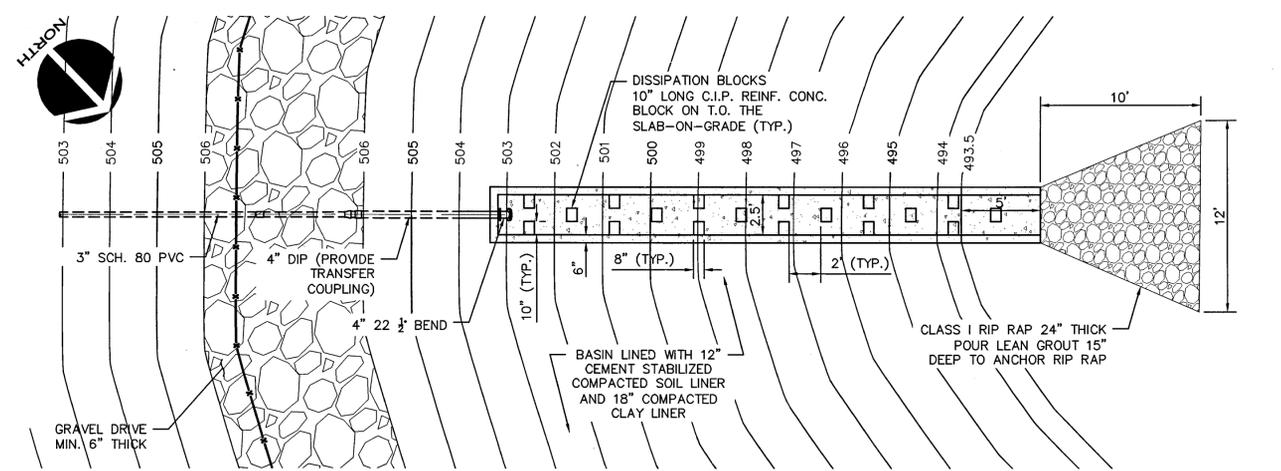
THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

BINGHAM FACILITY WASTEWATER SYSTEM IMPROVEMENTS
WASTEWATER TREATMENT SYSTEM DETAILS

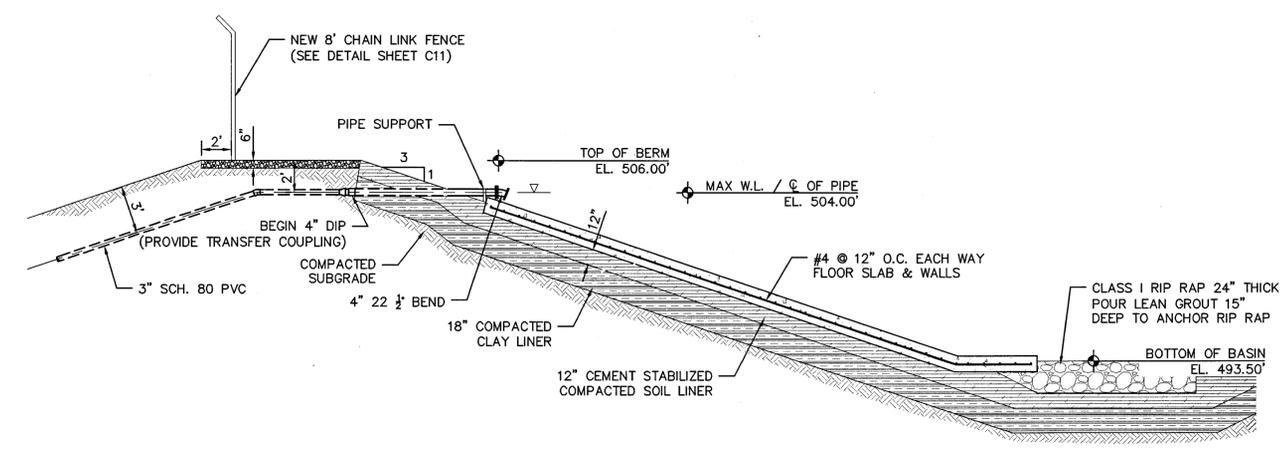
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MCE PROJ. # 1488-0032	HORIZONTAL:	DRAWING NUMBER
DRAWN: SHK	AS SHOWN	C11A
DESIGNED: CDR	VERTICAL:	
CHECKED: CDR	NA	
PROJ. MGR: CDR		
STATUS: FINAL DESIGN - NOT FOR CONSTRUCTION		REVISION: E



WET WEATHER STORAGE BASIN PLAN
SCALE: 1" = 20'

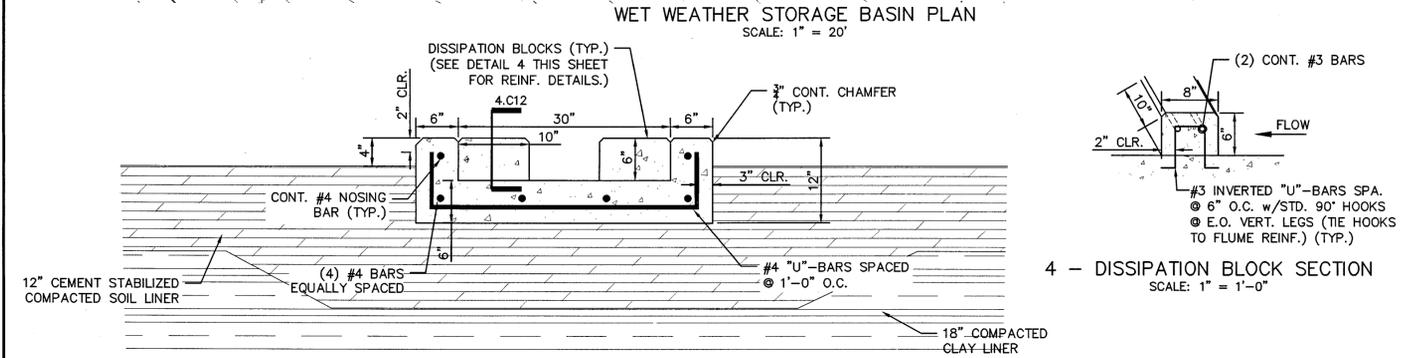


WET WEATHER STORAGE BASIN INLET FLUME DETAILED PLAN VIEW
SCALE: 1/8" = 1'-0"

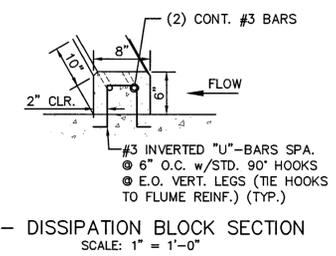


1 - WET WEATHER STORAGE BASIN INLET FLUME SECTION
SCALE: 1/8" = 1'-0"

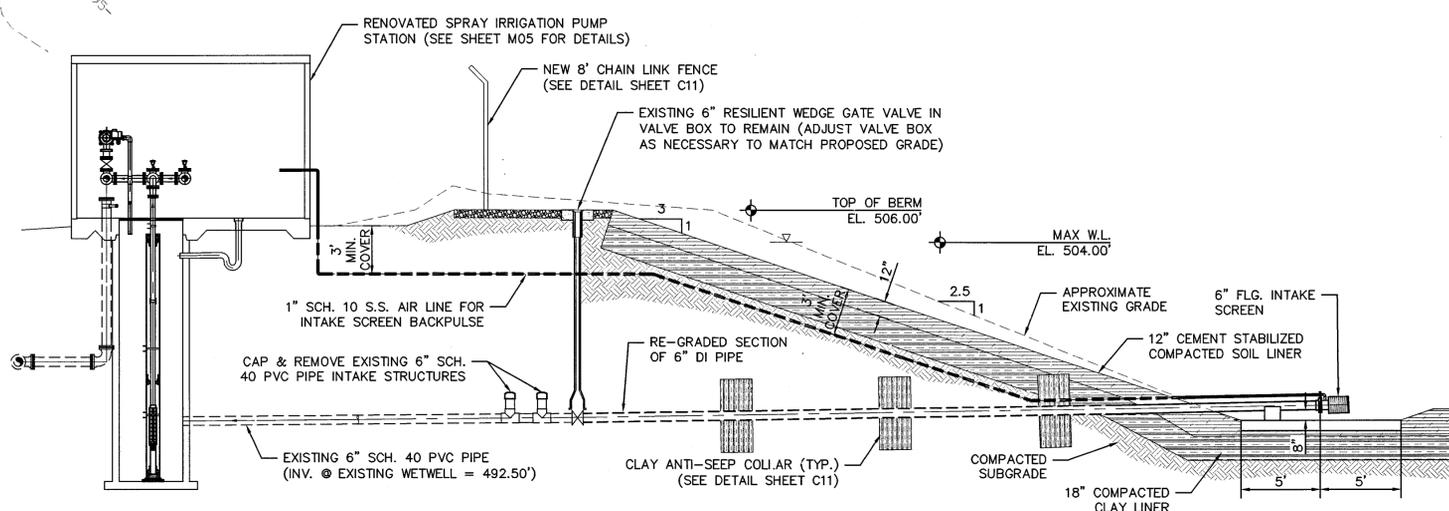
- NOTES**
- EXISTING UNDERGROUND UTILITIES ARE SHOWN BASED ON BEST AVAILABLE INFORMATION AT THE TIME OF DESIGN. IT IS THE CONTRACTOR'S RESPONSIBILITY TO LOCATE ALL EXISTING UTILITIES BEFORE PERFORMING WORK.
 - REFERENCE ELECTRICAL DRAWINGS FOR EXISTING UNDERGROUND ELECTRICAL UTILITIES.



2 - WET WEATHER STORAGE BASIN INLET FLUME SECTION
SCALE: 1" = 1'-0"

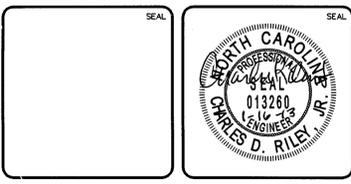


4 - DISSIPATION BLOCK SECTION
SCALE: 1" = 1'-0"



3 - IRRIGATION PUMP STATION INTAKE SECTION
SCALE: 1/8" = 1'-0"

REV.	DESCRIPTION	DATE
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B	90% DESIGN SUBMITTAL	4/26/11
A	60% DESIGN SUBMITTAL	3/21/11

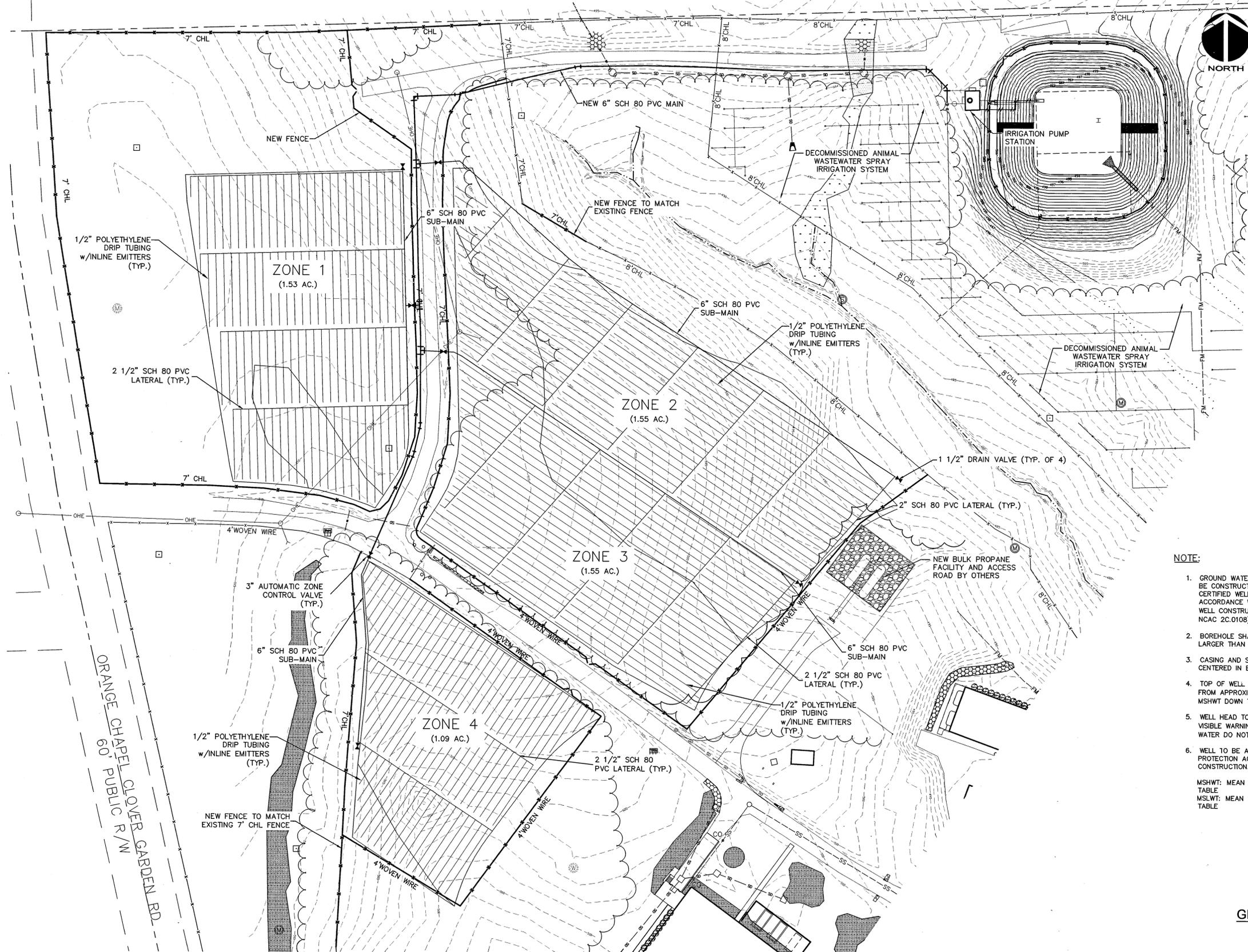


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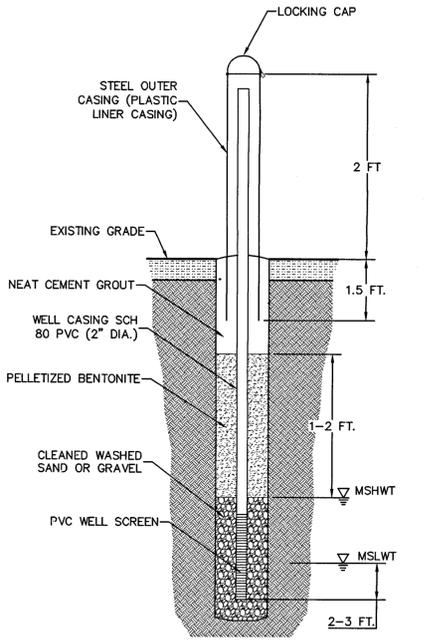
BINGHAM FACILITY WASTEWATER SYSTEM IMPROVEMENTS
WET WEATHER STORAGE BASIN IMPROVEMENTS
PLAN, SECTIONS, & DETAILS

DATE: FEBRUARY 2011	SCALE: AS SHOWN	MAC FILE NUMBER: C12
MCE PROJ. # 1488-0032	HORIZONTAL: AS SHOWN	DRAWING NUMBER: C12
DRAWN: SHK	VERTICAL: NA	REVISION: E
DESIGNED: CDR		
CHECKED: CDR		
PROJ. MGR: CDR		
STATUS: FINAL DESIGN - NOT FOR CONSTRUCTION		



- LEGEND**
- ⊙ — EXISTING POTABLE WATER WELL
 - ⊙ — EXISTING MONITORING WELL
 - ⊙ — PROPOSED MONITORING WELL
 - ⊙ — PROPOSED SURFACE WATER MONITORING POINT
 - — — — — EXISTING POTABLE WATER TREATMENT BACKWASH FORCEMAIN
 - — — — — EXISTING FORCEMAIN
 - — — — — EXISTING PUMP AND HAUL FORCEMAIN
 - — — — — EXISTING POTABLE WATER
 - — — — — EXISTING SANITARY SEWER
 - — — — — EXISTING FENCE
 - — — — — EXISTING STREAM
 - — — — — EXISTING PROPERTY LINE
 - — — — — EXISTING OVERHEAD ELECTRIC
 - SD — — — — — EXISTING STORM DRAIN
 - ⊕ — — — — — EXISTING BUSHES
 - ⊕ — — — — — EXISTING WOODSLINE
 - ▨ — — — — — EXISTING RIP RAP AREA
 - ▨ — — — — — EXISTING LANDSCAPED AREA
 - ▨ — — — — — EXISTING WETLAND AREA

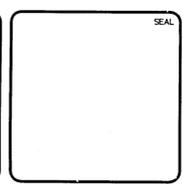
- NOTE:**
1. GROUND WATER MONITORING WELLS MUST BE CONSTRUCTED BY A NORTH CAROLINA CERTIFIED WELL CONTRACTOR IN ACCORDANCE WITH NORTH CAROLINA WELL CONSTRUCTION STANDARDS (15 A NCAC 2C.0108)
 2. BOREHOLE SHALL BE AT LEAST 4" LARGER THAN OUTSIDE Ø OF CASING.
 3. CASING AND SCREEN SHALL BE CENTERED IN BOREHOLE.
 4. TOP OF WELL SCREEN SHALL EXTEND FROM APPROXIMATELY 1'-2' ABOVE MSHWT DOWN TO 2'-3' BELOW MSLWT.
 5. WELL HEAD TO BE LABELED WITH HIGH VISIBLE WARNING READING "NON-POTABLE WATER DO NOT DRINK."
 6. WELL TO BE AFFORDED REASONABLE PROTECTION AGAINST DAMAGE AFTER CONSTRUCTION.
- MSHWT: MEAN SEASONABLE HIGH WATER TABLE
MSLWT: MEAN SEASONABLE LOW WATER TABLE



GROUND WATER MONITORING WELL DETAIL
NOT TO SCALE

PROPOSED WASTEWATER DRIP IRRIGATION SYSTEM PLAN
SCALE: 1" = 50'

REV. NO.	DESCRIPTION	DATE
E	FINAL DESIGN - NOT FOR CONSTRUCTION	1/21/13
D	FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION	8/21/11
C	FINAL DESIGN SUBMITTAL	7/08/11
B	95% DESIGN SUBMITTAL	4/18/11
A	80% DESIGN SUBMITTAL	3/21/11



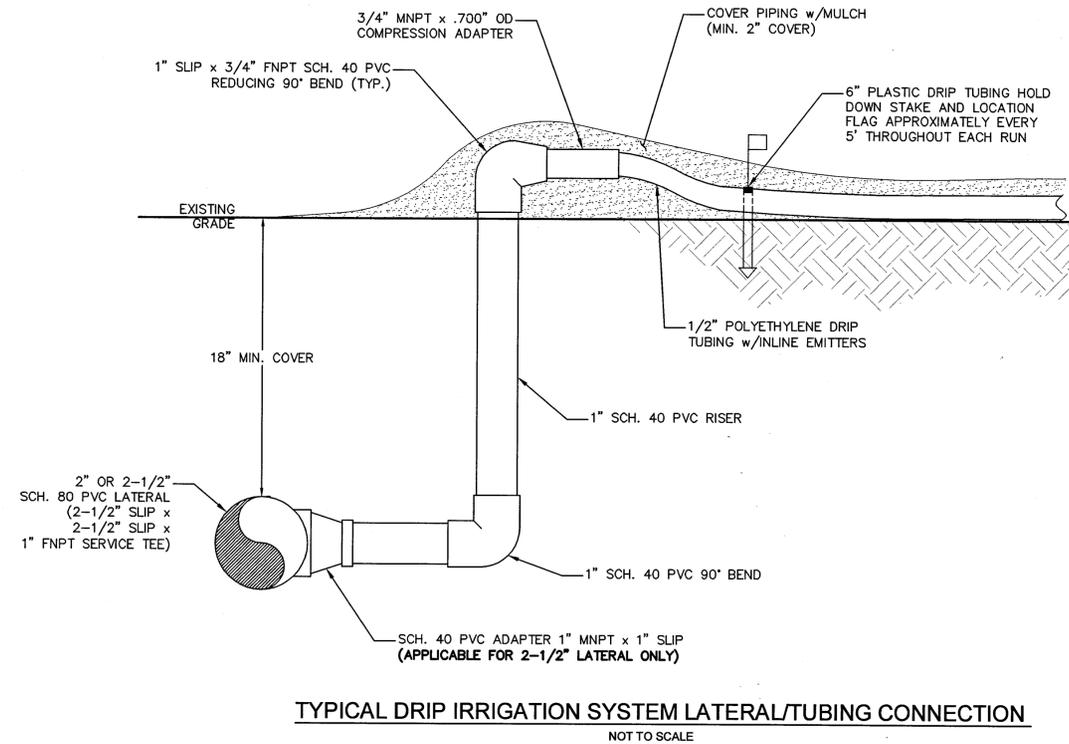
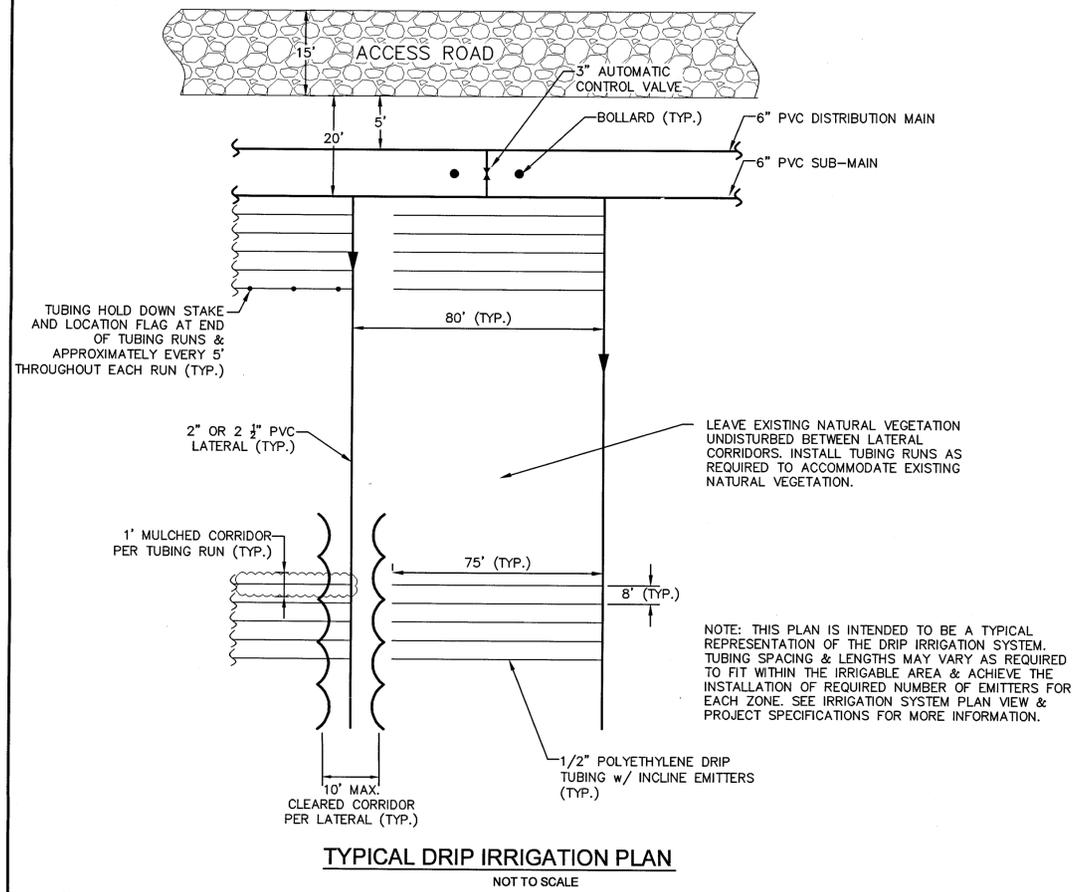
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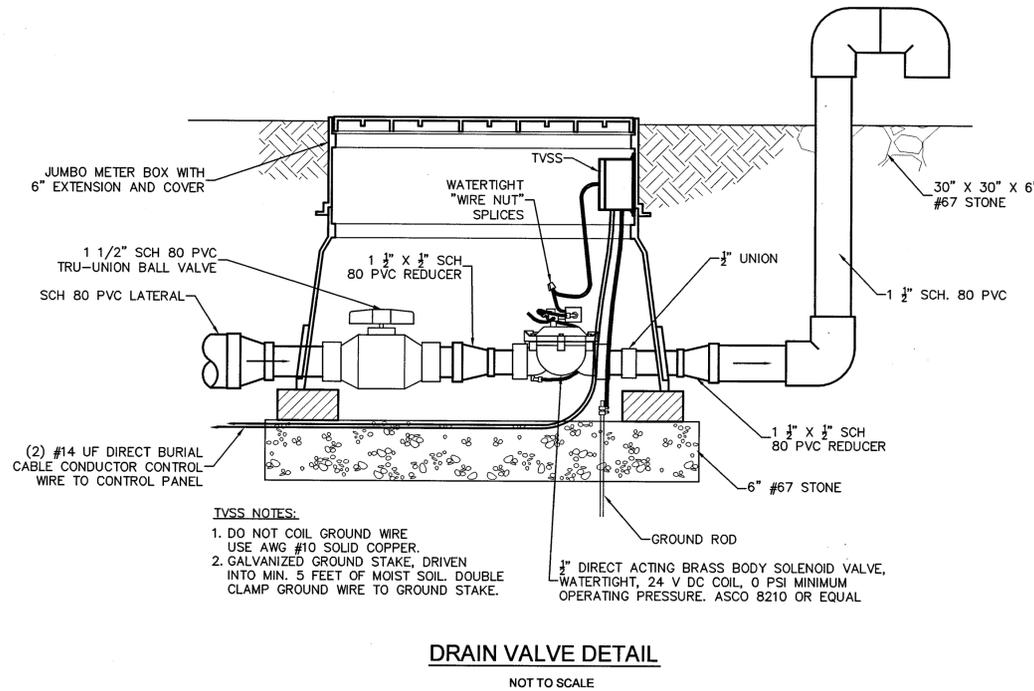
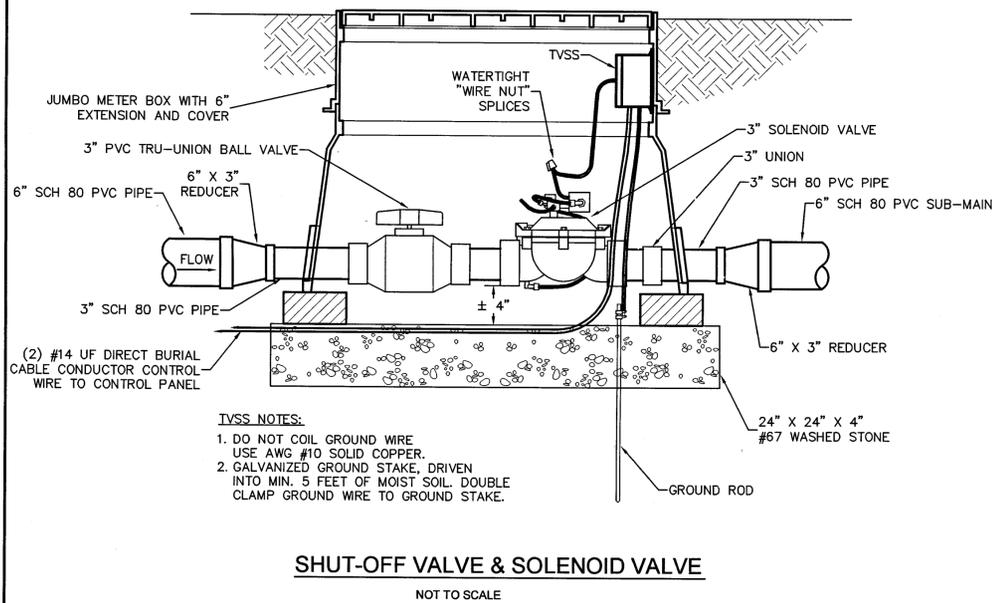
BINGHAM FACILITY WASTEWATER SYSTEM IMPROVEMENTS
NEW SECONDARY WASTEWATER DRIP IRRIGATION SYSTEM

DATE: FEBRUARY 2011	SCALE: HORIZONTAL: 1" = 50'	M&C FILE NUMBER: C13
M&C PROJ. # 1488-0032	DESIGNED: CDR	CHECKED: CDR
DRAWN: LEG	PROJ. MGR.: CDR	REVISION: E
STATUS: FINAL DESIGN - NOT FOR CONSTRUCTION		

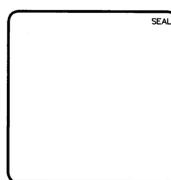
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NOTES:
1. CLEAR 10' CORRIDOR FOR LATERAL LINES INSTALLATION.
2. TRENCH AND INSTALL LATERAL LINES W/ 18" MIN. COVER



REVNO.	DESCRIPTIONS	DATE
E	FINAL DESIGN - NOT FOR CONSTRUCTION	1/31/13
D	FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION	6/21/11
C	FINAL DESIGN SUBMITTAL	7/26/11
B	90% DESIGN SUBMITTAL	4/18/11
A	80% DESIGN SUBMITTAL	3/21/11



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**BINGHAM FACILITY WASTEWATER SYSTEM IMPROVEMENTS
NEW SECONDARY WASTEWATER DRIP IRRIGATION SYSTEM
DETAILS**

DATE: FEBRUARY 2011	SCALE: 1" = 1'	MAC FILE NUMBER
MCE PROJ. # 1488-0032	HORIZONTAL: NA	DRAWING NUMBER
DRAWN: LEG	VERTICAL: NA	C14
DESIGNED: CDR		
CHECKED: CDR		
PROJ. MGR.: CDR		
STATUS: FINAL DESIGN - NOT FOR CONSTRUCTION	REVISION: E	



LEGEND

- - - - - EXISTING MINOR CONTOUR
- - - - - EXISTING MAJOR CONTOUR
- - - - - PROPOSED MINOR CONTOUR
- - - - - PROPOSED MAJOR CONTOUR
- - - - - EXISTING STREAM
- - - - - EXISTING PROPERTY LINE
- SD - - - - - EXISTING STORM DRAIN
- [Pattern] - - - - - EXISTING RIP RAP AREA
- [Pattern] - - - - - EXISTING LANDSCAPED AREA
- [Pattern] - - - - - EXISTING WETLAND AREA
- - - - - LIMITS OF DISTURBANCE
- - - - - TEMPORARY DIVERSION DITCH
- - - - - SILT FENCE
- - - - - COMBINATION SILT FENCE/TREE PROTECTION FENCE
- - - - - SILT FENCE OUTLET

GENERAL NOTES:

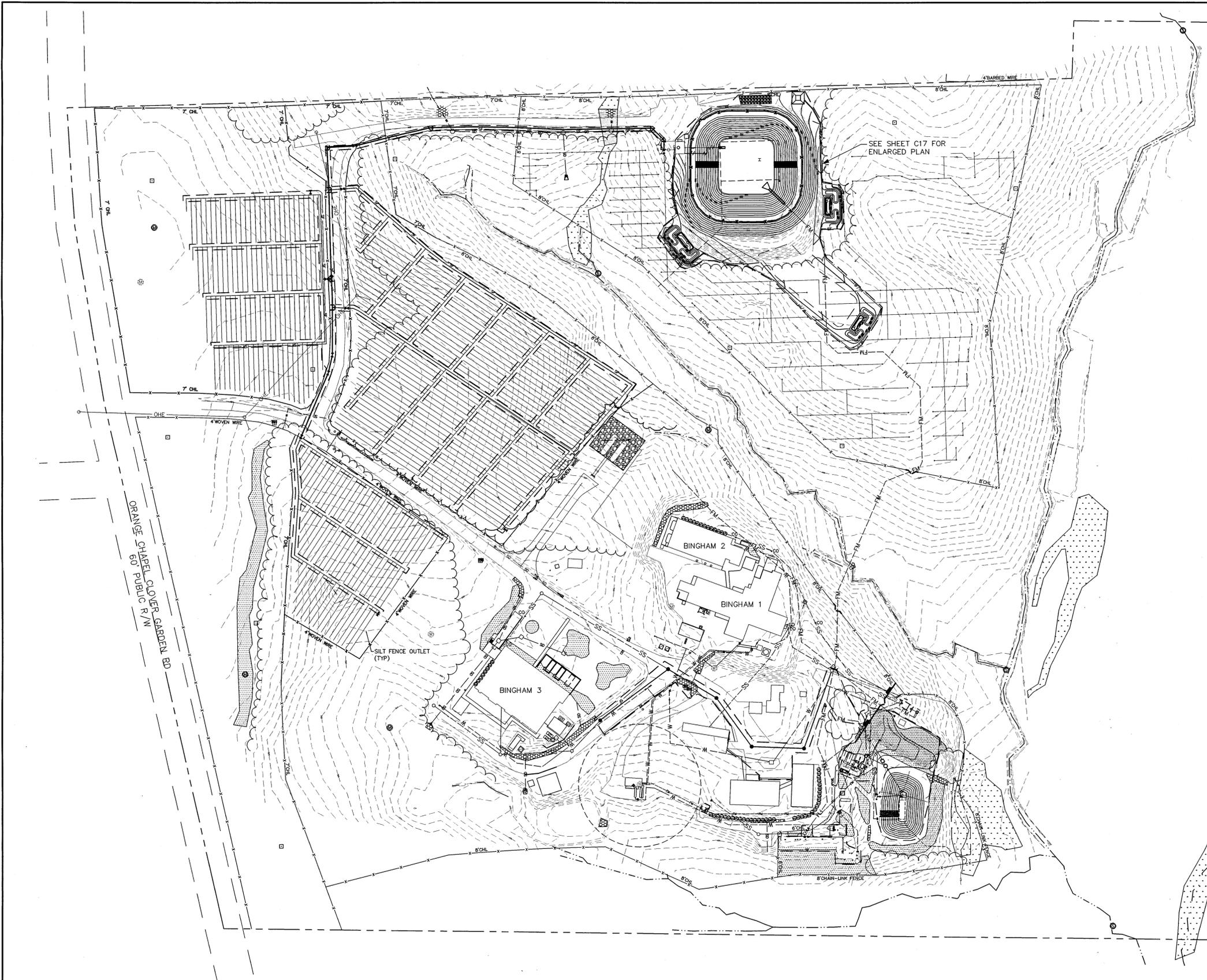
1. ALL DIMENSIONS AND GRADES SHOWN ON THE PLANS SHALL BE FIELD VERIFIED BY THE CONTRACTOR PRIOR TO CONSTRUCTION. CONTRACTOR SHALL NOTIFY OWNER IF ANY DISCREPANCIES EXIST PRIOR TO CONSTRUCTION. NO ADDITIONAL COMPENSATION WILL BE PAID TO CONTRACTOR FOR ANY WORK DONE DUE TO DIMENSIONS OR GRADES SHOWN INCORRECTLY ON THESE PLANS IF SUCH NOTIFICATION HAS NOT BEEN GIVEN.
2. CONTRACTOR SHALL NOTIFY "NORTH CAROLINA ONE CALL AT 1-800-632-4949 AT LEAST 48 HOURS PRIOR TO BEGINNING CONSTRUCTION OR EXCAVATION TO HAVE EXISTING UTILITIES LOCATED. CONTRACTOR TO CONTACT ANY LOCAL UTILITIES THAT PROVIDE THEIR OWN LOCATOR SERVICES INDEPENDENT OF "NORTH CAROLINA ONE CALL".
3. PRIOR TO CONSTRUCTION, CONTRACTOR SHALL ARRANGE AND ATTEND A PRECONSTRUCTION CONFERENCE WITH OWNER AND ENGINEER.
4. SOIL UNDER BUILDINGS, GRAVEL ROADS AND WITHIN SLOPES GREATER THAN 3:1 (H:V) SHALL BE APPROVED, PLACED AND COMPACTED AS RECOMMENDED BY THE GEOTECHNICAL ENGINEER. THESE SOILS SHALL BE COMPACTED TO THE STANDARD PROCTOR MAXIMUM DRY DENSITY UNLESS OTHERWISE RECOMMENDED BY THE GEOTECHNICAL ENGINEER.
5. ALL GRADED AREAS SHALL BE SLOPED SUCH THAT NO AREAS OF STANDING WATER OCCUR AND ALL AREAS POSITIVELY DRAIN TO DRAINAGE STRUCTURES, SWALES OR STORMWATER MANAGEMENT FACILITIES.
6. CONTRACTOR IS RESPONSIBLE FOR ALL DEWATERING AS NECESSARY THROUGHOUT CONSTRUCTION.
7. CONTRACTOR IS RESPONSIBLE FOR ADHERING TO ALL PERMIT CONDITIONS, MONITORING AND REPORTING REQUIREMENTS.
8. STREAM AND WETLAND LOCATIONS ARE BASED ON DELINEATIONS PROVIDED BY BIOHABITATS, INC. IN RICHMOND, VA - CONTACT LEE MALLONEE AT 804-750-1082.
9. PROJECT IS LOCATED IN THE HAW RIVER WATERSHED IN THE CAPE FEAR RIVER BASIN.

EROSION CONTROL NOTES:

1. ALL EROSION CONTROL MEASURES SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE NORTH CAROLINA EROSION AND SEDIMENTATION CONTROL PLANNING AND DESIGN MANUAL.
2. ALL EROSION CONTROL MEASURES SHALL BE INSPECTED WEEKLY AND AFTER RAINFALL EVENTS. NEEDED REPAIRS SHALL BE MADE IMMEDIATELY.
3. ADDITIONAL SEDIMENT AND EROSION CONTROL MEASURES MAY NEED TO BE INSTALLED IF DEEMED NECESSARY BY EITHER THE ENGINEER OR ENVIRONMENTAL INSPECTOR.
4. ESTABLISH GROUND COVER ON GRADED SLOPES AND FILLS WITHIN 15 CALENDAR DAYS AFTER COMPLETION OF ANY GRADING PHASE.
5. TEMPORARY SEDIMENT CONTROL MEASURES (SILT FENCE, CONSTRUCTION ENTRANCE, ETC.) SHALL BE MAINTAINED UNTIL ALL CONTRIBUTING AREAS ARE GRADED AND STABILIZED.
6. DUST CONTROL ON SITE SHALL BE MINIMIZED BY SPRAYING WATER ON DRY AREAS OF THE SITE. THE USE OF OILS AND OTHER PETROLEUM BASED OR TOXIC LIQUIDS FOR DUST SUPPRESSION IS STRICTLY PROHIBITED.
7. IF THE MAJORITY OF MUD OR DIRT IS NOT REMOVED FROM CONSTRUCTION TRAFFIC BY CONSTRUCTION ENTRANCES, CONTRACTOR SHALL CONSTRUCT VEHICLE WASH AREAS AT CONSTRUCTION TRAFFIC EXIT POINTS. MUD AND DIRT SHALL BE INTERCEPTED AND TRAPPED BEFORE WASH WATER IS ALLOWED TO BE DISCHARGED OFFSITE. RINSE-OFF WILL NOT BE ALLOWED OUTSIDE THE PROJECT CONSTRUCTION LIMITS.
8. SEDIMENT SHALL BE REMOVED FROM BEHIND THE SILT FENCE WHEN IT REACHES 4-INCHES DEEP.
9. MAXIMUM GRADED SLOPE SHALL NOT EXCEED 2:1.
10. REFER TO SHEET C-18 FOR CONSTRUCTION SEQUENCE AND EROSION CONTROL DETAILS.
11. TOTAL DISTURBED AREA = 4.26 ACRES.
12. CONTRACTOR SHALL SEEK PERMIT FOR ANY BORROW AND/OR SPOIL AREAS NOT SHOWN ON THESE PLANS.

GRADING NOTES:

1. INITIATE EROSION CONTROL SEQUENCE BEFORE BEGINNING CLEARING AND GRADING OPERATIONS.
2. CLEAR AREAS TO BE GRADED OF ALL VEGETATION. PROTECT VEGETATION BEYOND GRADING LIMITS.
3. STRIP TOPSOIL TO FULL DEPTH IN AREAS TO BE GRADED.
4. COMPACT ALL FILL AREAS TO 95% OF MAXIMUM DENSITY, OR PER GEOTECHNICAL RECOMMENDATIONS.
5. ALL AREAS ARE TO BE GRADED SO THAT NO AREAS OF STANDING WATER OCCUR.
6. OPERATOR SHALL FIELD VERIFY EXISTING TOPOGRAPHY IN RELATION TO THE PROPOSED GRADES TO ENSURE DRAINAGE IN THE DIRECTIONS INDICATED ON THE PLAN.



REV. NO.	DESCRIPTIONS	DATE
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C	FINAL DESIGN SUBMITTAL	7/26/11
B	90% DESIGN SUBMITTAL	4/15/11
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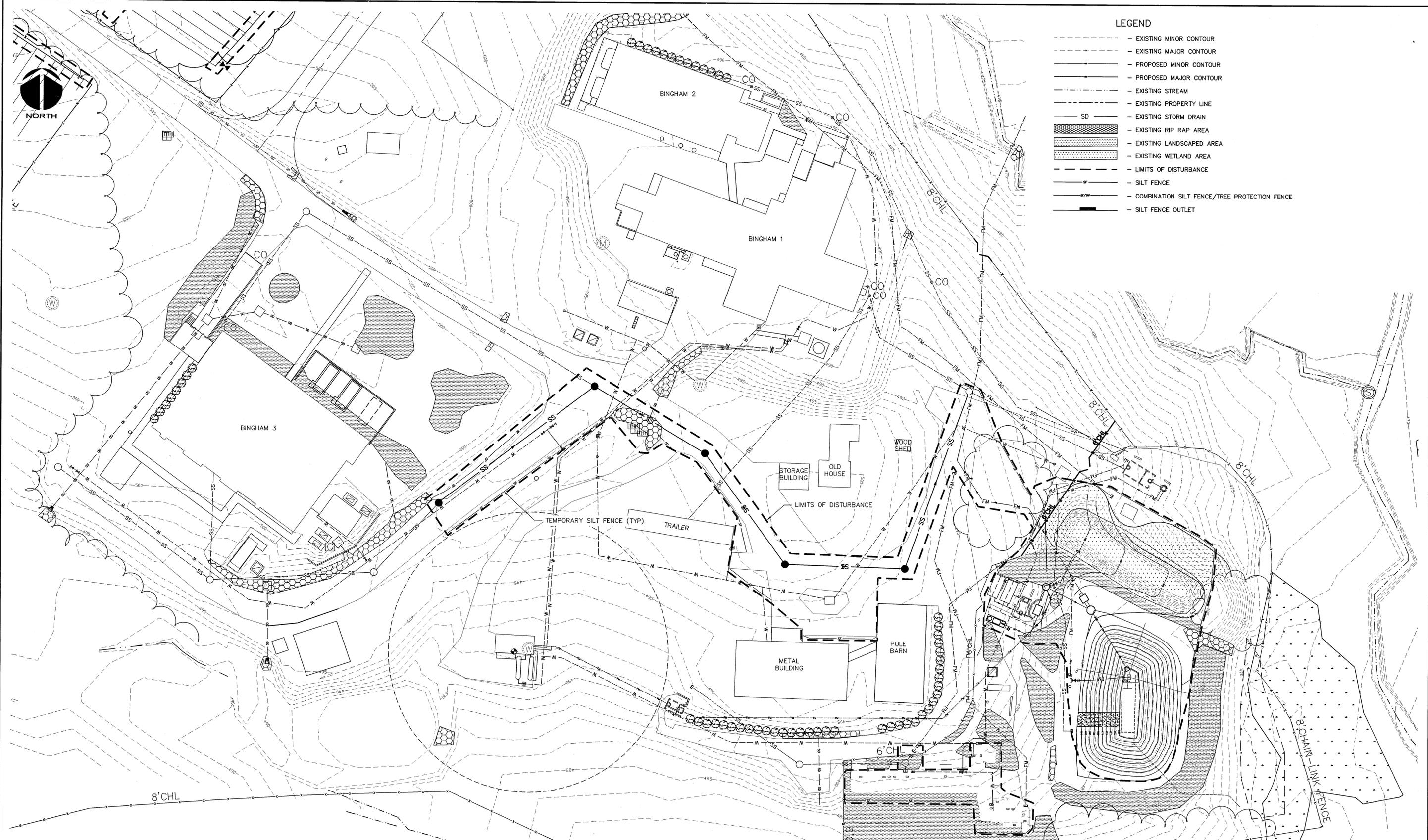
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BINGHAM FACILITY WASTEWATER SYSTEM IMPROVEMENTS
EROSION AND SEDIMENT CONTROL PLAN

DATE:	FEBRUARY 2011
MCE PROJ. #	1488-0032
DRAWN	CMB
DESIGNED	CMB
CHECKED	CDR
PROJ. MGR.	CDR

SCALE	MAC FILE NUMBER
HORIZONTAL: 1" = 80'	DRAWING NUMBER
VERTICAL: NA	C15
STATUS: FINAL DESIGN - NOT FOR CONSTRUCTION	REVISION: E

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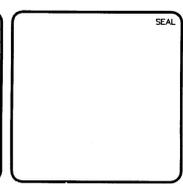


PROPOSED EROSION CONTROL PLAN
SCALE: 1" = 30'

LEGEND

- - - - - EXISTING MINOR CONTOUR
- - - - - EXISTING MAJOR CONTOUR
- - - - - PROPOSED MINOR CONTOUR
- - - - - PROPOSED MAJOR CONTOUR
- - - - - EXISTING STREAM
- - - - - EXISTING PROPERTY LINE
- SD - - - - - EXISTING STORM DRAIN
- [Pattern] - - - - - EXISTING RIP RAP AREA
- [Pattern] - - - - - EXISTING LANDSCAPED AREA
- [Pattern] - - - - - EXISTING WETLAND AREA
- - - - - LIMITS OF DISTURBANCE
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- - - - - COMBINATION SILT FENCE/TREE PROTECTION FENCE
- - - - - SILT FENCE OUTLET

REV. NO.	DESCRIPTIONS / REVISIONS	DATE
E	FINAL DESIGN - NOT FOR CONSTRUCTION	1/21/11
D	FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION	6/21/11
C	FINAL DESIGN SUBMITTAL	7/06/11
B	95% DESIGN SUBMITTAL	4/18/11
A	60% DESIGN SUBMITTAL	3/21/11



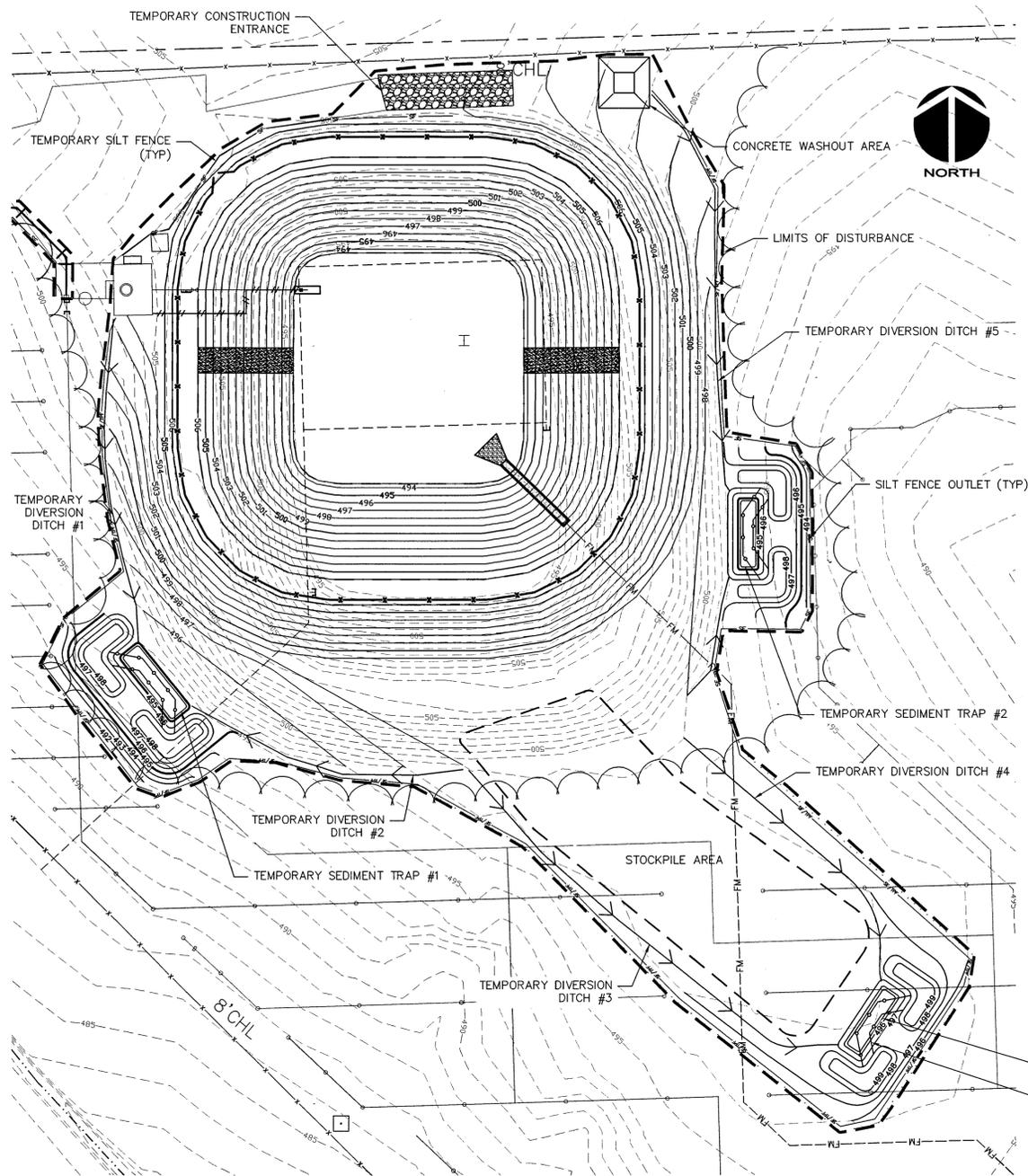
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THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

BINGHAM FACILITY WASTEWATER SYSTEM IMPROVEMENTS
EROSION AND SEDIMENT CONTROL PLAN

DATE: FEBRUARY 2011	SCALE: 1" = 30'	M&C FILE NUMBER
MCE PROJ. # 1488-0032	HORIZONTAL: NA	DRAWING NUMBER
DRAWN: CMB	VERTICAL: NA	C16
DESIGNED: CMB		
CHECKED: CDR		
PROJ. MGR.: CDR		
STATUS: FINAL DESIGN - NOT FOR CONSTRUCTION	REVISION: E	

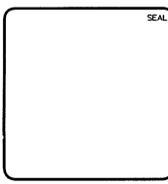
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- LEGEND**
- - - - - EXISTING MINOR CONTOUR
 - - - - - EXISTING MAJOR CONTOUR
 - - - - - PROPOSED MINOR CONTOUR
 - - - - - PROPOSED MAJOR CONTOUR
 - - - - - EXISTING STREAM
 - - - - - EXISTING PROPERTY LINE
 - - - - - SD
 - - - - - EXISTING STORM DRAIN
 - [Pattern] EXISTING RIP RAP AREA
 - [Pattern] EXISTING LANDSCAPED AREA
 - [Pattern] EXISTING WETLAND AREA
 - - - - - STOCKPILE LIMITS
 - - - - - LIMITS OF DISTURBANCE
 - - - - - TEMPORARY DIVERSION DITCH
 - - - - - SILT FENCE
 - - - - - COMBINATION SILT FENCE/TREE PROTECTION FENCE
 - - - - - SILT FENCE OUTLET

PROPOSED EROSION CONTROL PLAN
SCALE: 1" = 30'

REV. NO.	DESCRIPTIONS	DATE
E	FINAL DESIGN - NOT FOR CONSTRUCTION	1/31/13
D	FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION	8/11/11
C	FINAL DESIGN SUBMITTAL	7/28/11
B	60% DESIGN SUBMITTAL	4/7/11
A	60% DESIGN SUBMITTAL	3/21/11



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**THE UNIVERSITY
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at CHAPEL HILL**

**BINGHAM FACILITY
WASTEWATER SYSTEM IMPROVEMENTS**

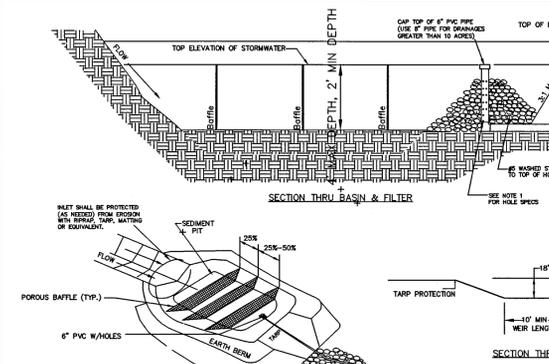
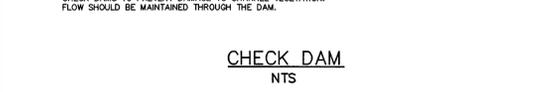
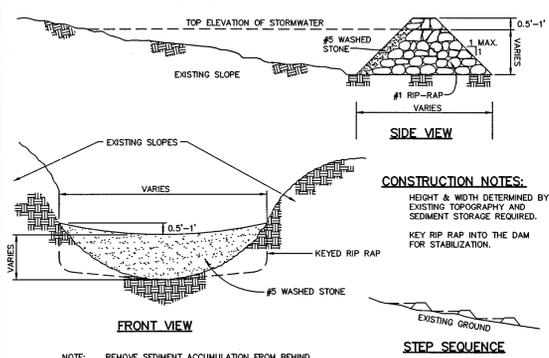
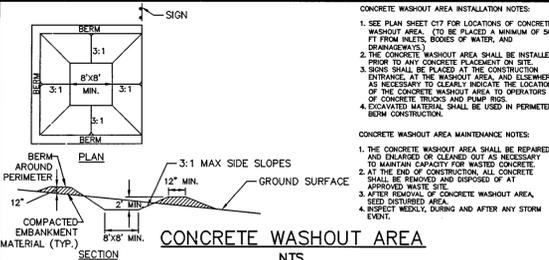
**EROSION AND SEDIMENT CONTROL
PLAN**

DATE: FEBRUARY 2011	SCALE	MAC FILE NUMBER
MCE PROJ. # 1488-0032	HORIZONTAL: 1" = 30'	DRAWING NUMBER C17
DRAWN: CMB	VERTICAL: NA	REVISION E
DESIGNED: CMB		
CHECKED: CDR		
PROJ. MGR: CDR		
STATUS: FINAL DESIGN - NOT FOR CONSTRUCTION		

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CONSTRUCTION SEQUENCE:

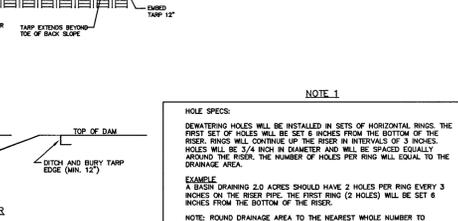
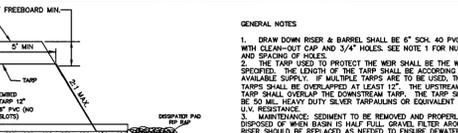
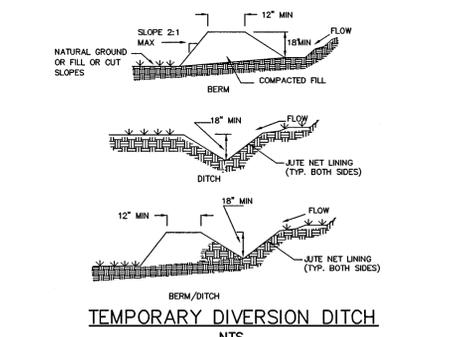
1. THE INTENT OF THE CONSTRUCTION SEQUENCE IS TO PROVIDE THE CONTRACTOR WITH A GENERAL GUIDE FOR CONSTRUCTION PURPOSES. THIS SEQUENCE IS NOT INTENDED TO OUTLINE ALL CONSTRUCTION ACTIVITIES ON THIS PROJECT.
2. ALL EROSION CONTROL MEASURES SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE NORTH CAROLINA EROSION AND SEDIMENTATION CONTROL PLANNING AND DESIGN MANUAL.
3. ALL EROSION CONTROL MEASURES SHALL BE INSPECTED AND A SELF-INSPECTION REPORT FOR LAND DISTURBING ACTIVITY IS TO BE FILLED OUT AFTER EACH OF THE FOLLOWING PHASES OF CONSTRUCTION: INSTALLATION OF PERIMETER EROSION AND SEDIMENT CONTROL MEASURES, CLEARING AND GRUBBING OF EXISTING GROUND COVER, COMPLETION OF ANY PHASE OF GRADING OF SLOPES OR FILLS, INSTALLATION OF STORM DRAINAGE FACILITIES, COMPLETION OF CONSTRUCTION OR DEVELOPMENT, AND ESTABLISHMENT OF PERMANENT GROUND COVER. ANY NEEDED REPAIRS ARE TO BE PERFORMED IMMEDIATELY.
4. IF IT IS DETERMINED DURING CONSTRUCTION THAT SIGNIFICANT SEDIMENT IS LEAVING THE SITE, DESPITE PROPER IMPLEMENTATION AND MAINTENANCE, THE CONTRACTOR IS OBLIGATED TO TAKE ADDITIONAL CORRECTIVE ACTION. CONTACT OWNER'S REPRESENTATIVE AND ENGINEER WITH ANY ADDITIONAL MEASURES NEEDED.
5. CONTRACTOR SHALL ESTABLISH GROUND COVER ON DISTURBED AREAS WITHIN TWENTY-ONE (21) CALENDAR DAYS AFTER COMPLETION OF ANY PHASE OF GRADING.
6. CONTRACTOR SHALL ABANDON PRE-CONSTRUCTION MEETING WITH THE OWNER'S REPRESENTATIVE, ENGINEER, AND THE NCDENR DIVISION OF LAND QUALITY EROSION CONTROL OFFICER.
7. OBTAIN LETTER OF PLAN APPROVAL FOR SEDIMENTATION AND EROSION CONTROL FROM NCDENR DIVISION OF LAND QUALITY.
8. CONTRACTOR IS TO POST GRADING PERMIT PROMINENTLY ON SITE AT ALL TIMES.
9. CONTRACTOR IS TO VERIFY LOCATION AND DEPTH OF EXISTING UTILITIES TO AVOID CONFLICT DURING INSTALLATION OF EROSION CONTROL MEASURES, STORM SEWER PIPES, AND UNDERGROUND UTILITY LINES. CONTRACTOR IS TO CALL 1-800-632-4949 FOR "NO ONE CALL" TO HAVE EXISTING UTILITIES LOCATED.
10. CONTRACTOR IS TO HAVE A PROFESSIONAL LAND SURVEYOR TREE PROTECTION AREAS AND LIMITS OF DISTURBANCE. CONTRACTOR TO VERIFY FLAGGING ON PROPERTY LINES AND STREAM BUFFERS.
11. INSTALL TEMPORARY CONSTRUCTION ENTRANCE AS SHOWN ON PLANS.
12. INSTALL TEMPORARY SILT FENCE, TEMPORARY SILT/TREE PROTECTION FENCE AND SILT FENCE OUTLETS, TEMPORARY DIVERSION DITCHES, AND CHECK DAMS AS SHOWN AND DETAILED ON PLAN OR AS INSTRUCTED BY NCDENR EROSION CONTROL OFFICER DURING PRECONSTRUCTION MEETING.
13. INSTALL TEMPORARY SEDIMENT TRAPS #1 AND #2.
14. IN THE STOCKPILE AREA SOUTH OF THE WET WEATHER STORAGE BASIN, CUT OFF RISERS FROM EXISTING ANIMAL WASTEWATER SPRAY IRRIGATION SYSTEM BELOW GRADE.
15. PERFORM CLEARING, GRUBBING AND TOPSOIL REMOVAL AS REQUIRED IN THE STOCKPILE AND SEDIMENT TRAP AREA.
16. INSTALL TEMPORARY SEDIMENT TRAP #3.
17. CUT EMBANKMENT OF EXISTING WET WEATHER STORAGE BASIN AND STOCKPILE SOIL IN DESIGNATED AREA.
18. PERFORM WET WEATHER STORAGE BASIN DEMOLITION AND INFRASTRUCTURE IMPROVEMENTS AS PER PLANS.
19. CONSTRUCT THE NEW EMBANKMENT OF THE WET WEATHER STORAGE BASIN. THE GEOTECHNICAL ENGINEER SHALL DETERMINE IF STOCKPILED FILL SOIL IS SUITABLE FOR RE-USE IN THE CONSTRUCTION OF THE BASIN. OFF-SITE FILL SOIL SHALL BE USED IF NECESSARY.
20. INSTALL CONCRETE WASHOUT AREA BEFORE THE INLET FLUME IS CONSTRUCTED INSIDE THE WET WEATHER STORAGE BASIN.
21. REMOVE EXISTING FENCE ON THE WESTERN PORTION OF THE SITE AS SHOWN ON PLAN.
22. CUT OFF RISERS OF REMAINDER OF EXISTING ANIMAL WASTEWATER SPRAY IRRIGATION SYSTEM AT GRADE. CUT OFF RISERS OF EXISTING DOMESTIC WASTEWATER SPRAY IRRIGATION SYSTEM BELOW GRADE.
23. ABANDON EXISTING POTABLE WATER WELLS AS SHOWN ON PLAN.
24. DEMOLISH EXISTING ANIMAL WASTEWATER TREATMENT SYSTEM AS SHOWN ON PLAN SHEET C04.
25. REMOVE EXISTING GRAVITY SEWER. INSTALL NEW GRAVITY SEWER AS SHOWN ON THE PLANS.
26. PERFORM CLEARING, GRUBBING AND TOPSOIL REMOVAL AS REQUIRED IN THE SMALL EFFLUENT STORAGE BASIN AREA.
27. REMOVE EXISTING PLASTIC LINER, FENCE, BRIDGE, HOIST, AND ALL ASSOCIATED APPURTENANCES FROM SMALL EFFLUENT STORAGE BASIN AS SHOWN ON PLAN SHEET C04. FILL IN BASIN WITH STOCKPILED OR OFF-SITE FILL SOIL. GRADE OUT AND SEED FILLED IN BASIN AREA.
28. REMOVE EXISTING PLASTIC LINER AND INFRASTRUCTURE IN MEDIUM EFFLUENT STORAGE BASIN AS SHOWN ON PLAN SHEET C04. CUT AND CAP EXISTING PIPES SERVING THE BASIN. RE-GRADE THE BASIN AND INSTALL NEW LINER.
29. INSTALL NEW DOMESTIC WASTEWATER SPRAY IRRIGATION SYSTEM.
30. INSTALL MULCH TO 2 TO 3 INCH DEPTH THROUGHOUT NEW DOMESTIC WASTEWATER IRRIGATION AREA.
31. CONTRACTOR IS TO MAINTAIN EROSION CONTROL MEASURES AT ALL TIMES.
32. REMOVE TEMPORARY CONSTRUCTION ENTRANCE AND PERFORM FINAL GRADING.
33. RESPREAD TOPSOIL IN NON-STRUCTURAL LOCATIONS. CONTRACTOR TO REFER TO GEOTECHNICAL RECOMMENDATIONS FOR DEPTH COMPACTION REQUIREMENTS FOR TOPSOIL SPREADING.
34. PERFORM SEEDING AND MULCHING AS REQUIRED IN ACCORDANCE WITH REQUIREMENTS SHOWN ON SHEET C17.
35. PERMANENT GROUND COVER IS TO BE ESTABLISHED FOR ALL DISTURBED AREAS WITHIN FIFTEEN (15) WORKING DAYS OR NINETY (90) CALENDAR DAYS (WHICHEVER IS SHORTER) FOLLOWING COMPLETION OF CONSTRUCTION OR DEVELOPMENT.
36. ONCE ALL GROUND COVER HAS BEEN ESTABLISHED, AND OTHER CONSTRUCTION IS COMPLETE, CONTACT NCDENR EROSION CONTROL OFFICER AND ENGINEER BEFORE REMOVING ANY TEMPORARY EROSION CONTROL MEASURES.
37. AFTER SITE IS COMPLETELY STABILIZED, REMOVE ALL TEMPORARY MEASURES AND INSTALL PERMANENT VEGETATION AS REQUIRED AND ON ANY RESULTING BARE AREAS.



Basin	Dist. Area	Drain. Area	Cc	Intensity (in/hr)	Q ₁₀ (cfs)	Required Storage	Required SA (sf)	Depth	Avg. Dims. Width	Bottom Dims. Length	Top Dims. Length	Width	Length	Provided Storage	Provided SA (sf)	Weir Width	Spillway Flow Depth	
1	0.45 ac	0.45 ac	0.45	7.37	1.49	1,620 cf	650	3.5'	15'	38'	8'	31'	22'	45'	1,995 cf	990	10.0'	0.13'
2	0.38 ac	0.38 ac	0.45	7.37	1.26	1,370 cf	550	3.5'	13'	33'	8'	26'	20'	40'	1,502 cf	800	10.0'	0.12'
3	0.39 ac	0.39 ac	0.45	7.37	1.29	1,400 cf	560	3.5'	13'	33'	8'	26'	20'	40'	1,502 cf	800	10.0'	0.12'

- NOTES:**
- a. POSITIVE GRADE MUST BE PROVIDED TO ASSURE DRAINAGE. IF SLOPE EXCEEDS 2%, SEED AND MULCH DIVERSION. TRY NOT TO EXCEED 5% MAXIMUM D.A.= 5 ACRES WITHOUT SUPPORTING CALCULATIONS. DIVERSIONS AT THE TOP OF SLOPES MUST EMPTY INTO AN APPROVED SLOPE DRAIN. BERM/DITCH IS MOST COMMONLY USED.
 - b. MACHINE COMPACTION OF ALL FILL IS REQUIRED. DIVERSIONS SUFFICIENT TO DIRECT ALL SEDIMENT-LADEN STORMWATER INTO A SEDIMENT CONTROL DEVICE MUST BE INSTALLED PRIOR TO CLEARING AND GRUBBING OF THE AREA (OR IN CONJUNCTION WITH THIS OPERATION) IF SEDIMENT CONTROLS AND DIVERSIONS ARE INSTALLED AS EACH CRITICAL POINT IS REACHED.
 - c. DIVERSIONS SHOULD BE SEEDING AND STRAWED ON THE SIDES, WITH JUTE NET LINING INSTALLED ON TOP OF THE SEED.
 - d. CHECK DEVICE AFTER EACH RAIN, BUT ONCE A WEEK REGARDLESS. REPAIR AS NECESSARY.
- MAINTENANCE**
1. INSPECT TEMPORARY DIVERSIONS ONCE A WEEK AND AFTER EVERY RAINFALL. IMMEDIATELY REMOVE SEDIMENT FROM THE FLOW AREA AND REPAIR THE DIVERSION RIDGE. CAREFULLY CHECK OUTLETS AND MAKE TIMELY REPAIRS AS NEEDED. WHEN THE AREA PROTECTED IS PERMANENTLY STABILIZED, REMOVE THE RIDGE AND THE CHANNEL TO BLEND WITH THE NATURAL GROUND LEVEL AND APPROPRIATELY STABILIZE IT.

TDD #	TOTAL LENGTH	SLOPE (%)	LINER
1	128'	5.3	STRAW W/NET
2	113'	2.6	STRAW W/NET
3	187'	0.6	STRAW W/NET
4	129'	0.8	STRAW W/NET
5	164'	2.4	STRAW W/NET

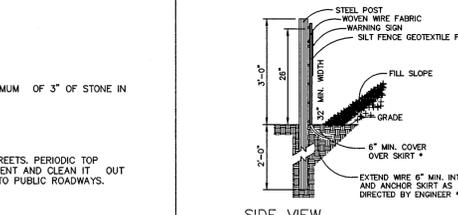
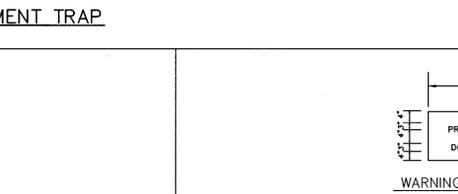


NOTE 1

HOLE SPACING: DEWATERING HOLES WILL BE INSTALLED IN SETS OF HORIZONTAL RINGS. THE FIRST SET OF HOLES SHALL BE SET 6 INCHES FROM THE BOTTOM OF THE RISER. RINGS WILL CONTINUE UP THE RISER IN INTERVALS OF 3 INCHES. HOLES WILL BE 3/4 INCH IN DIAMETER AND WILL BE SPACED EQUALLY AROUND THE RISER. THE NUMBER OF HOLES PER RING WILL EQUAL TO THE DRAINAGE AREA.

EXAMPLE: A BASIN DRAINING 2.0 ACRES SHOULD HAVE 2 HOLES PER RING EVERY 3 INCHES ON THE RISER. THE FIRST RING IS HOLES WILL BE SET 6 INCHES FROM THE BOTTOM OF THE RISER.

NOTE: ROUND DRAINAGE AREA TO THE NEAREST WHOLE NUMBER TO OBTAIN NUMBER OF HOLES.



TEMPORARY CONSTRUCTION ENTRANCE

- A. COARSE AGGREGATE (2"-3" STONE) SHALL BE USED. PAD TO BE 50' X 12' X 6" MIN. PLACE A MINIMUM OF 3" OF STONE IN A CUT SECTION TO HELP SECURE FILTER CLOTH.
- B. TURNING RADIUS SUFFICIENT TO ACCOMMODATE LARGE TRUCKS IS TO BE PROVIDED.
- C. ENTRANCES SHOULD BE LOCATED TO PROVIDE FOR MAXIMUM UTILITY BY ALL CONSTRUCTION VEHICLES.
- D. MUST BE MAINTAINED IN A CONDITION WHICH WILL PREVENT TRACKING OR DIRECT FLOW OF MUD ONTO STREETS. PERIODIC TOP DRESSING MAY BE NECESSARY. AFTER EACH RAINFALL, INSPECT ANY STRUCTURE USED TO TRAP SEDIMENT AND CLEAN IT UP AS NECESSARY. IMMEDIATELY REMOVE ALL OBJECTIONABLE MATERIALS SPILLED, WASHED, OR TRACKED ONTO PUBLIC ROADWAYS.
- E. TEMPORARY PADS MUST BE LOCATED ON EACH SIDE OF ADJOINING ROADWAY.

RECOMMENDATIONS FOR LATE WINTER AND EARLY SPRING

SEEDING MIXTURE SPECIES	RATE (lb./acre)
TALL FESCUE	100
KOREAN LESPEDEZA	10

NURSE PLANTS: BETWEEN MAY 15 AND AUG. 15, ADD 10 lb/acre GERMAN MILLET OR BROWNTOP MILLET. PRIOR TO MAY 1 OR AFTER AUG. 15, ADD 40 lb/ac RYE (GRAIN)

SEEDING DATES: BEST: AUG. 15 - SEPT. 15, POSSIBLE: AUG. 20 - OCT. 25
LATE WINTER: FEB. 15 - MAR. 21, FEB. 1 - APR. 15.

FALL IS BEST FOR TALL FESCUE AND LATER WINTER FOR LESPEDEZAS. OVERSEEDING OF KOBE LESPEDEZA OVER FALL-SEEDING TALL FESCUE IS VERY EFFECTIVE.

SOIL AMENDMENTS: FOLLOW RECOMMENDATIONS OF SOIL TESTS OR APPLY 3,000 lb/acre GROUND AGRICULTURAL LIMESTONE AND 1,750 lb/acre 5-10-10 FERTILIZER

MULCH: APPLY 4,000 lb/acre STRAW. ANCHOR STRAW BY TACKING WITH ASPHALT, NETTING OR A MULCH ANCHORING TOOL. A DISK WITH BLADES SET NEARLY STRAIGHT CAN BE USED AS A MULCH ANCHORING TOOL.

MAINTENANCE: REFERTILIZE IN THE SECOND YEAR UNLESS GROWTH IS FULLY ADEQUATE. MAY BE MOWED ONCE OR TWICE A YEAR, BUT MOWING IS NOT NECESSARY. RESEED, REFERTILIZE AND MULCH DAMAGED AREAS IMMEDIATELY.

RECOMMENDATIONS FOR GRASS-LINED CHANNELS

SEEDING MIXTURE SPECIES	RATE (lb./acre)
TALL FESCUE	200

NURSE PLANTS: BETWEEN MAY 1 AND AUG. 15, ADD 15 lb/acre SUDANGRASS OR 15 lb/acre GERMAN MILLET. PRIOR TO MAY 1 OR AFTER AUG. 15, ADD 40 lb/ac RYE (GRAIN)

SEEDING DATES: BEST: AUG. 25 - OCT. 15, POSSIBLE: FEB. - APR. 15

AVOID SEEDING FROM NOV. TO JAN. IF SEEDING MUST BE DONE AT THIS TIME, ADD 40 lb/acre RYE GRAIN AND USE A CHANNEL LINING THAT OFFERS MAXIMUM PROTECTION

SOIL AMENDMENTS: FOLLOW RECOMMENDATIONS OF SOIL TESTS OR APPLY 4,000 lb/acre GROUND AGRICULTURAL LIMESTONE AND 1,000 lb/acre 10-10-10 FERTILIZER

MULCH: USE ROLLED EROSION CONTROL PRODUCT TO COVER THE BOTTOM OF THE CHANNELS AND DITCHES, AND STAPLE SECURELY. THE LINING SHOULD EXTEND ABOVE THE HIGHEST CALCULATED DEPTH OF FLOW. ON CHANNEL SIDE SLOPES ABOVE THIS HEIGHT, AND IN DRAINAGES NOT REQUIRING TEMPORARY LININGS, APPLY 4,000 lb/acre GRAIN STRAW, AND ANCHOR STRAW BY STAPLING NETTING OVER THE TOP.

MULCH AND ANCHORING MATERIALS MUST NOT BE ALLOWED TO WASH DOWN SLOPES WHERE THEY CAN CLOG DRAINAGE DEVICES.

MAINTENANCE: INSPECT AND REPAIR MULCH FREQUENTLY. REFERTILIZE IN LATE WINTER OF THE FOLLOWING YEAR; USE SOIL TESTS OR APPLY 150 lb/acre 10-10-10. MOW REGULARLY TO A HEIGHT OF 2-4 INCHES.

NOTE: SEE NCDENR'S EROSION AND SEDIMENT CONTROL PLANNING DESIGN MANUAL SECTION 6.11 FOR ADDITIONAL PERMANENT SEEDING OPTIONS.

RECOMMENDATIONS FOR LATE WINTER AND EARLY SPRING

SEEDING MIXTURE SPECIES	RATE (lb./acre)
RYE (GRAIN)	120

IN THE PIEDMONT AND MOUNTAINS, A SMALL-STEMMED SUDANGRASS MAY BE SUBSTITUTED AT A RATE OF 50 lb/acre.

SEEDING DATES: MOUNTAINS: MAY 15 - AUG. 15, COASTAL PLAIN: APR. 15 - AUG. 15

SOIL AMENDMENTS: FOLLOW RECOMMENDATIONS OF SOIL TESTS OR APPLY 2,000 lb/acre GROUND AGRICULTURAL LIMESTONE AND 750 lb/acre 10-10-10 FERTILIZER

MULCH: APPLY 4,000 lb/acre STRAW. ANCHOR STRAW BY TACKING WITH ASPHALT, NETTING OR A MULCH ANCHORING TOOL. A DISK WITH BLADES SET NEARLY STRAIGHT CAN BE USED AS A MULCH ANCHORING TOOL.

MAINTENANCE: REFERTILIZE IF GROWTH IS NOT FULLY ADEQUATE. RESEED, REFERTILIZE AND MULCH IMMEDIATELY FOLLOWING EROSION OR OTHER DAMAGE.

RECOMMENDATIONS FOR FALL

SEEDING MIXTURE SPECIES	RATE (lb./acre)
RYE (GRAIN)	120

SEEDING DATES: MOUNTAINS: AUG. 15 - DEC. 15, COASTAL PLAIN AND PIEDMONT: AUG. 15 - DEC. 30

SOIL AMENDMENTS: FOLLOW RECOMMENDATIONS OF SOIL TESTS OR APPLY 2,000 lb/acre GROUND AGRICULTURAL LIMESTONE AND 750 lb/acre 10-10-10 FERTILIZER

MULCH: APPLY 4,000 lb/acre STRAW. ANCHOR STRAW BY TACKING WITH ASPHALT, NETTING OR A MULCH ANCHORING TOOL. A DISK WITH BLADES SET NEARLY STRAIGHT CAN BE USED AS A MULCH ANCHORING TOOL.

MAINTENANCE: REPAIR AND REFERTILIZE DAMAGED AREAS IMMEDIATELY. TOPDRESS WITH 50 lb/acre OF NITROGEN IN MARCH. IF IT IS NECESSARY TO EXTEND TEMPORARY COVER BEYOND JUNE 15, OVERSEED WITH 50 lb/acre KOBE (PIEDMONT AND COASTAL PLAIN) OR KOREAN (MOUNTAINS) LESPEDEZA IN LATE FEBRUARY OR EARLY MARCH.

RECOMMENDATIONS FOR LATE WINTER AND EARLY SPRING

SEEDING MIXTURE SPECIES	RATE (lb./acre)
RYE (GRAIN)	120

SEEDING DATES: MOUNTAINS: MAY 15 - AUG. 15, COASTAL PLAIN AND PIEDMONT: APR. 15 - AUG. 15

SOIL AMENDMENTS: FOLLOW RECOMMENDATIONS OF SOIL TESTS OR APPLY 2,000 lb/acre GROUND AGRICULTURAL LIMESTONE AND 750 lb/acre 10-10-10 FERTILIZER

MULCH: APPLY 4,000 lb/acre STRAW. ANCHOR STRAW BY TACKING WITH ASPHALT, NETTING OR A MULCH ANCHORING TOOL. A DISK WITH BLADES SET NEARLY STRAIGHT CAN BE USED AS A MULCH ANCHORING TOOL.

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RECOMMENDATIONS FOR LATE WINTER AND EARLY SPRING

SEEDING MIXTURE SPECIES	RATE (lb./acre)
RYE (GRAIN)	120

SEEDING DATES: MOUNTAINS: MAY 15 - AUG. 15, COASTAL PLAIN AND PIEDMONT: APR. 15 - AUG. 15

SOIL AMENDMENTS: FOLLOW RECOMMENDATIONS OF SOIL TESTS OR APPLY 2,000 lb/acre GROUND AGRICULTURAL LIMESTONE AND 750 lb/acre 10-10-10 FERTILIZER

MULCH: APPLY 4,000 lb/acre STRAW. ANCHOR STRAW BY TACKING WITH ASPHALT, NETTING OR A MULCH ANCHORING TOOL. A DISK WITH BLADES SET NEARLY STRAIGHT CAN BE USED AS A MULCH ANCHORING TOOL.

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RECOMMENDATIONS FOR LATE WINTER AND EARLY SPRING

SEEDING MIXTURE SPECIES	RATE (lb./acre)
RYE (GRAIN)	120

SEEDING DATES: MOUNTAINS: MAY 15 - AUG. 15, COASTAL PLAIN AND PIEDMONT: APR. 15 - AUG. 15

SOIL AMENDMENTS: FOLLOW RECOMMENDATIONS OF SOIL TESTS OR APPLY 2,000 lb/acre GROUND AGRICULTURAL LIMESTONE AND 750 lb/acre 10-10-10 FERTILIZER

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MAINTENANCE: REPAIR AND REFERTILIZE DAMAGED AREAS IMMEDIATELY. TOPDRESS WITH 50 lb/acre OF NITROGEN IN MARCH. IF IT IS NECESSARY TO EXTEND TEMPORARY COVER BEYOND JUNE 15, OVERSEED WITH 50 lb/acre KOBE (PIEDMONT AND COASTAL PLAIN) OR KOREAN (MOUNTAINS) LESPEDEZA IN LATE FEBRUARY OR EARLY MARCH.

RECOMMENDATIONS FOR LATE WINTER AND EARLY SPRING

SEEDING MIXTURE SPECIES	RATE (lb./acre)
RYE (GRAIN)	120

SEEDING DATES: MOUNTAINS: MAY 15 - AUG. 15, COASTAL PLAIN AND PIEDMONT: APR. 15 - AUG. 15

SOIL AMENDMENTS: FOLLOW RECOMMENDATIONS OF SOIL TESTS OR APPLY 2,000 lb/acre GROUND AGRICULTURAL LIMESTONE AND 750 lb/acre 10-10-10 FERTILIZER

MULCH: APPLY 4,000 lb/acre STRAW. ANCHOR STRAW BY TACKING WITH ASPHALT, NETTING OR A MULCH ANCHORING TOOL. A DISK WITH BLADES SET NEARLY STRAIGHT CAN BE USED AS A MULCH ANCHORING TOOL.

MAINTENANCE: REPAIR AND REFERTILIZE DAMAGED AREAS IMMEDIATELY. TOPDRESS WITH 50 lb/acre OF NITROGEN IN MARCH. IF IT IS NECESSARY TO EXTEND TEMPORARY COVER BEYOND JUNE 15, OVERSEED WITH 50 lb/acre KOBE (PIEDMONT AND COASTAL PLAIN) OR KOREAN (MOUNTAINS) LESPEDEZA IN LATE FEBRUARY OR EARLY MARCH.

RECOMMENDATIONS FOR LATE WINTER AND EARLY SPRING

SEEDING MIXTURE SPECIES	RATE (lb./acre)
RYE (GRAIN)	120

SEEDING DATES: MOUNTAINS: MAY 15 - AUG. 15, COASTAL PLAIN AND PIEDMONT: APR. 15 - AUG. 15

SOIL AMENDMENTS: FOLLOW RECOMMENDATIONS OF SOIL TESTS OR APPLY 2,000 lb/acre GROUND AGRICULTURAL LIMESTONE AND 750 lb/acre 10-10-10 FERTILIZER

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RECOMMENDATIONS FOR LATE WINTER AND EARLY SPRING

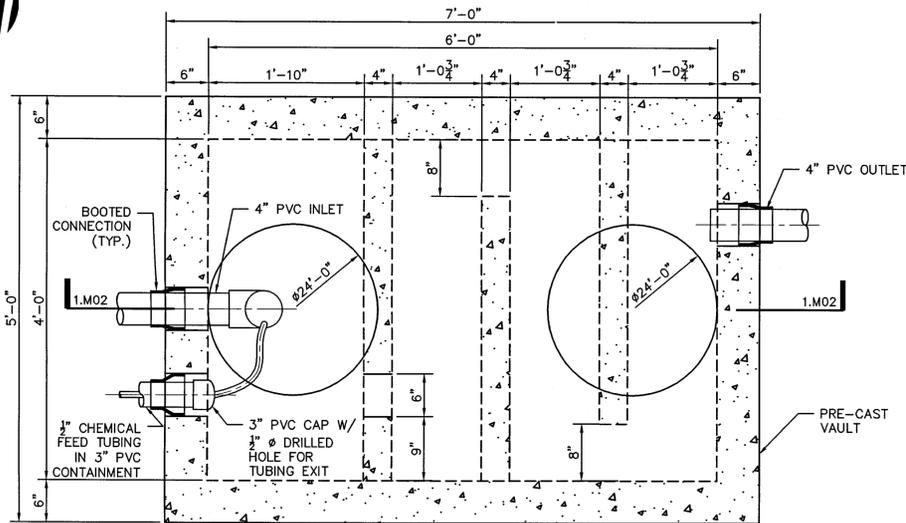
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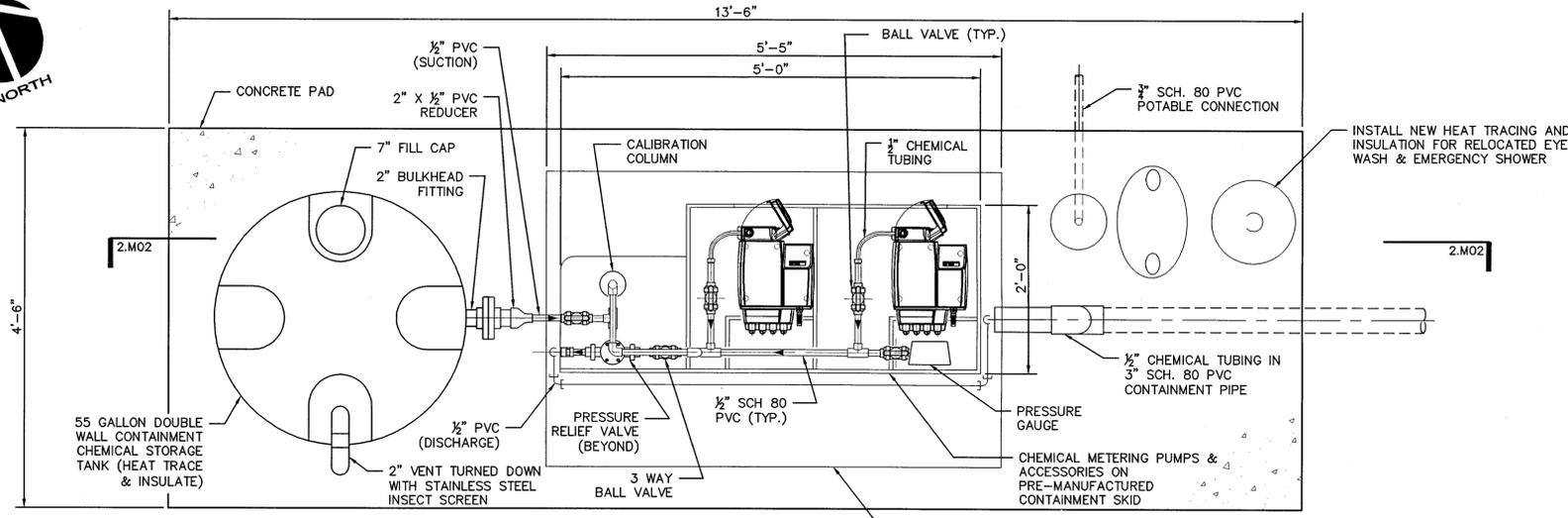
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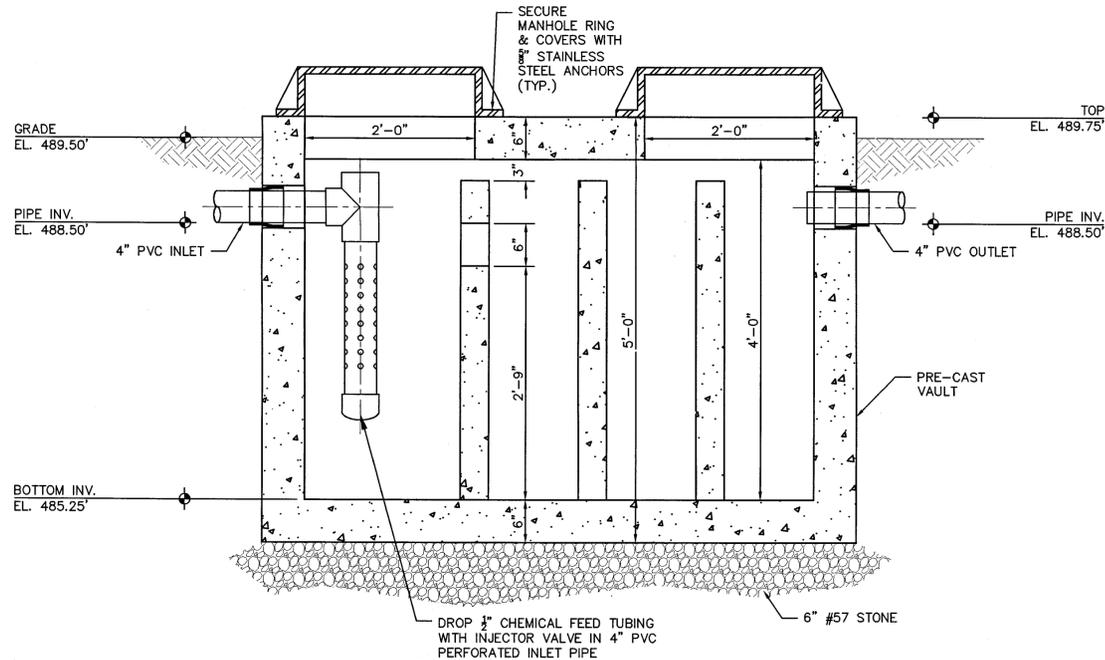
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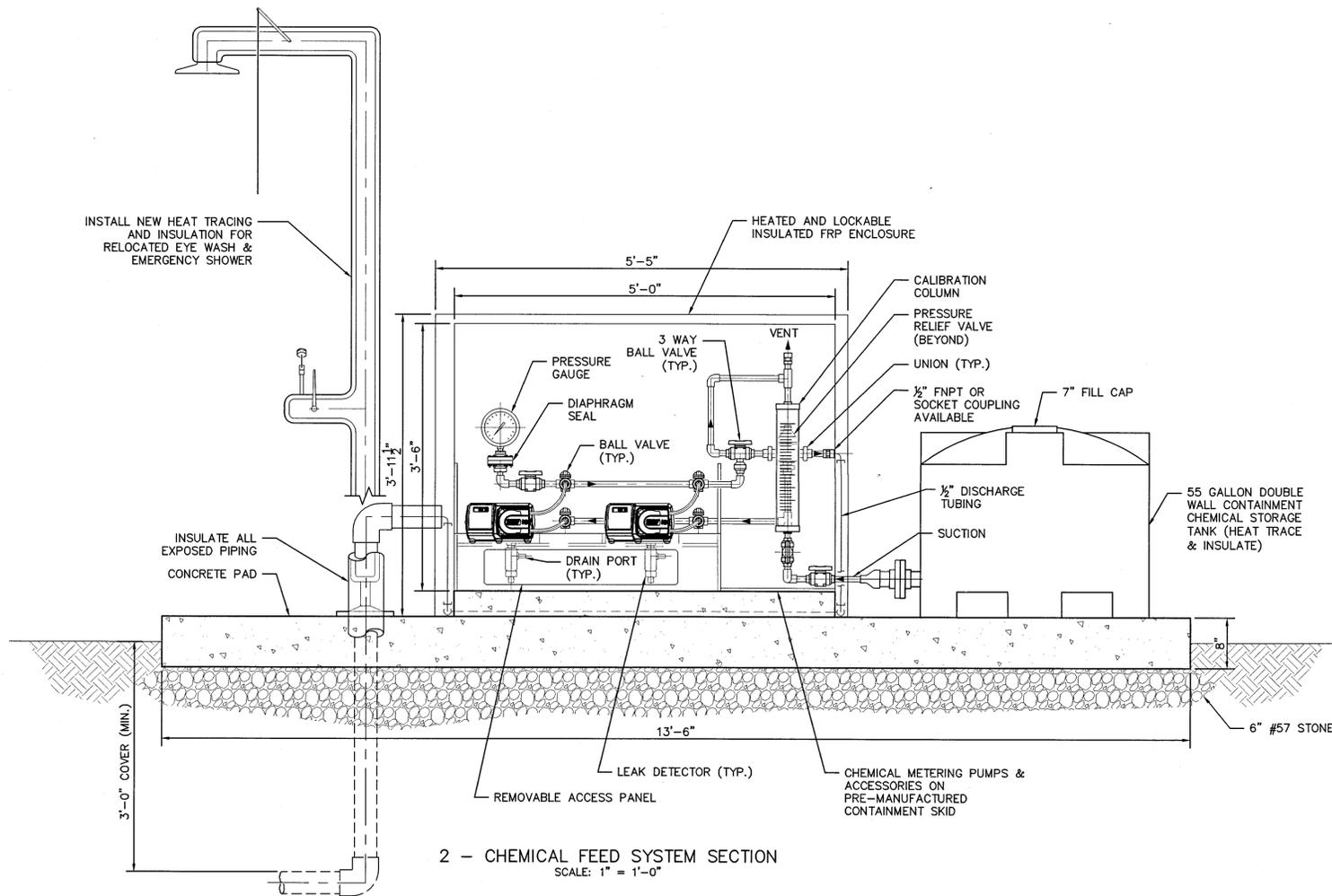
CHLORINE CONTACT TANK PLAN
SCALE: 1" = 1'-0"



CHEMICAL FEED SYSTEM PLAN
SCALE: 1" = 1'-0"

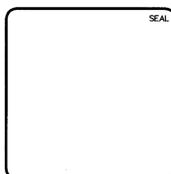


1 - CHLORINE CONTACT TANK SECTION
SCALE: 1" = 1'-0"



2 - CHEMICAL FEED SYSTEM SECTION
SCALE: 1" = 1'-0"

REV. NO.	DESCRIPTION	DATE
E	FINAL DESIGN - NOT FOR CONSTRUCTION	1/31/13
D	FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION	9/17/11
C	FINAL DESIGN SUBMITTAL	7/28/11
B	90% DESIGN SUBMITTAL	4/18/11
A	60% DESIGN SUBMITTAL	3/21/11



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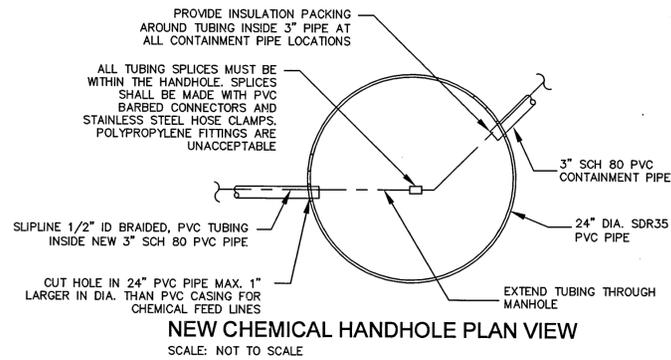
BINGHAM FACILITY
WASTEWATER SYSTEM IMPROVEMENTS
CHLORINE DISINFECTION SYSTEM
PLANS, SECTIONS, & DETAILS

DATE:	FEBRUARY 2011
MCE PROJ. #	1488-0032
DRAWN	SHK
DESIGNED	CDR
CHECKED	CDR
PROJ. MGR.	CDR

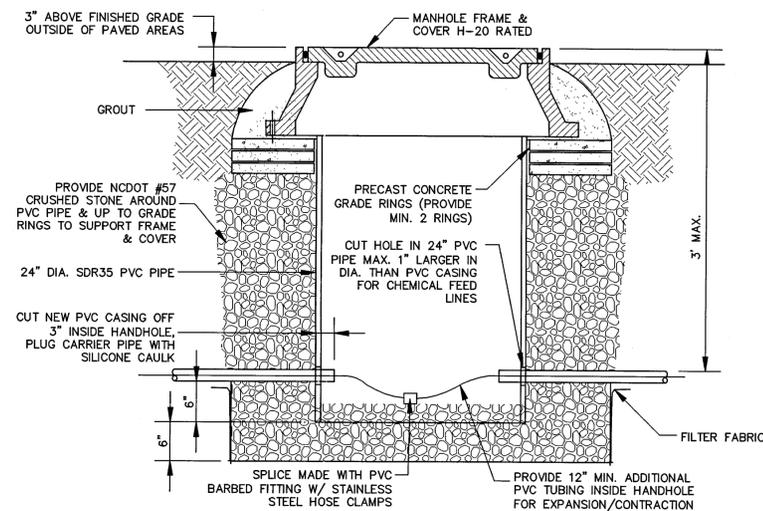
SCALE	REVISION
HORIZONTAL:	AS SHOWN
VERTICAL:	NA

M&C FILE NUMBER	REVISION
DRAWING NUMBER	E
M01	

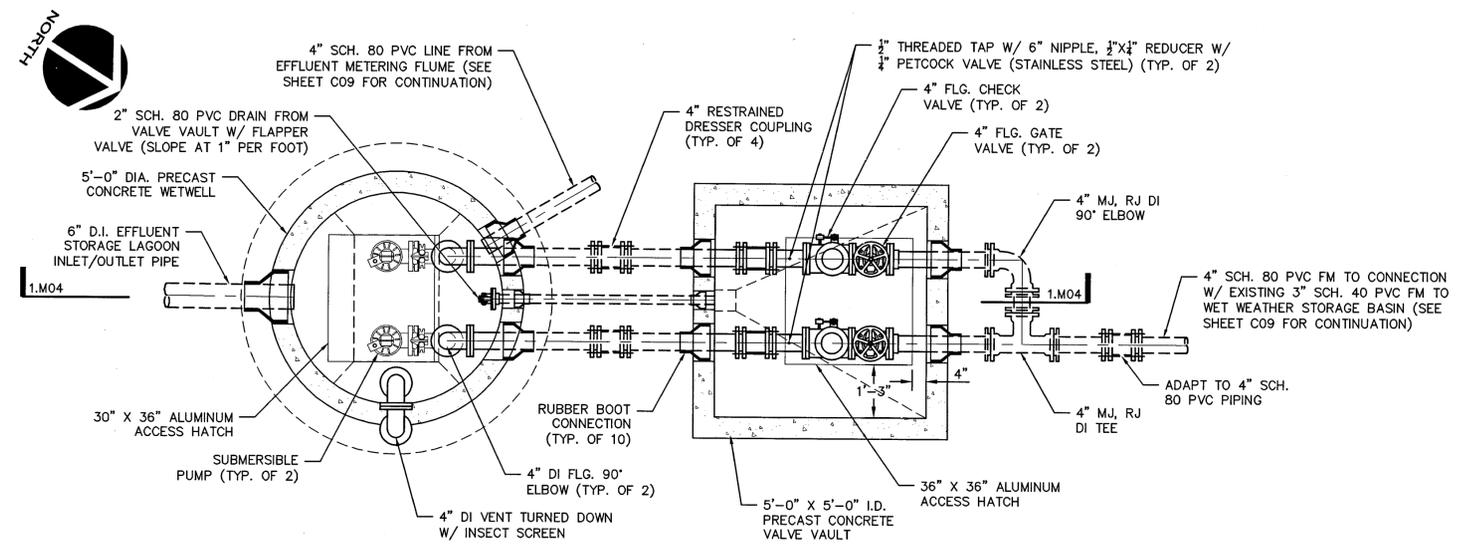
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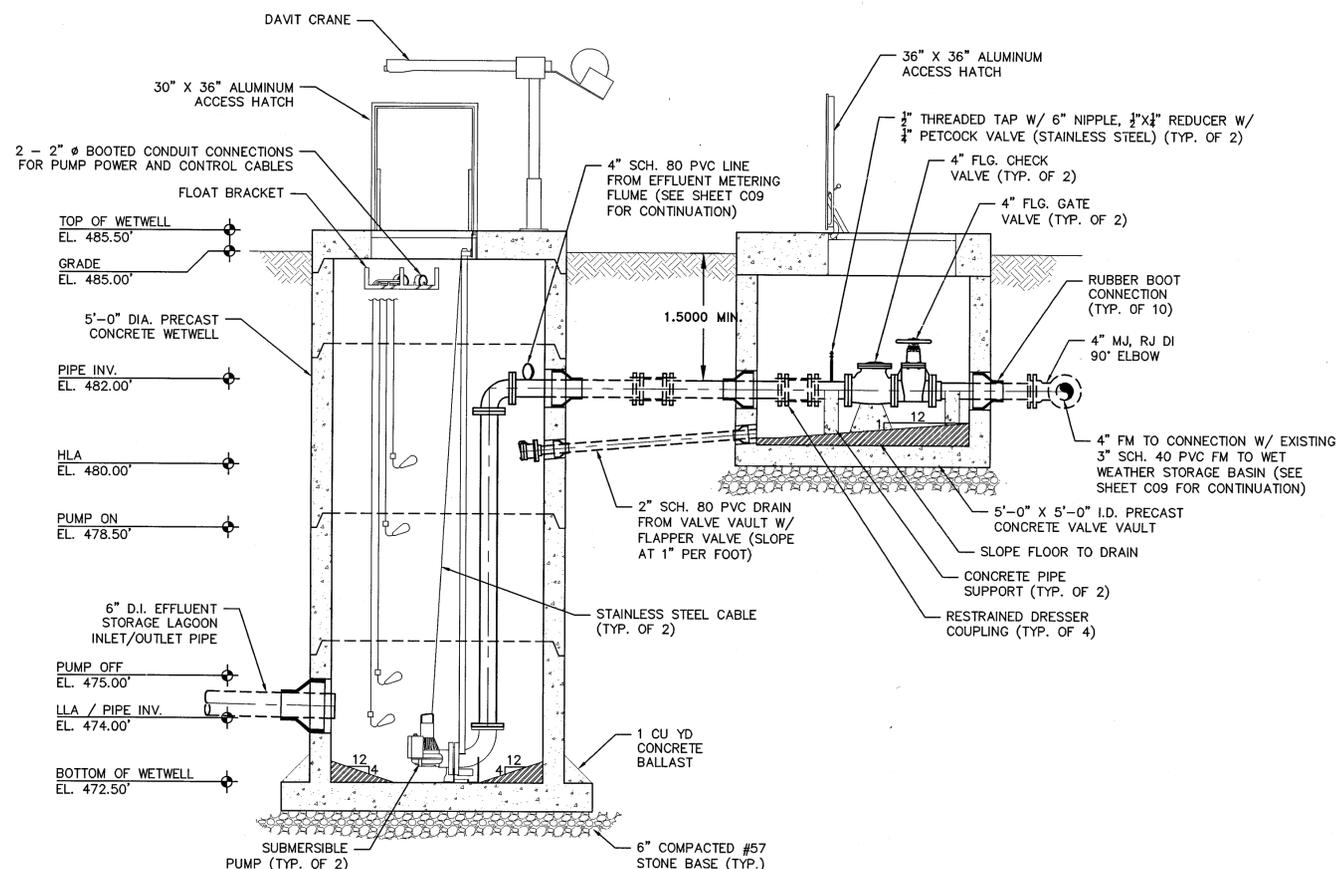
NEW CHEMICAL HANDHOLE PLAN VIEW
SCALE: NOT TO SCALE



CHEMICAL HANDHOLE DETAIL
SCALE: NOT TO SCALE

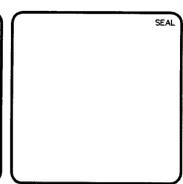


EFFLUENT PUMP STATION PLAN
SCALE: 1/2" = 1'-0"



1 - EFFLUENT PUMP STATION SECTION
SCALE: 1/2" = 1'-0"

REV. NO.	DESCRIPTIONS	DATE
E	FINAL DESIGN - NOT FOR CONSTRUCTION	1/31/11
D	FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION	4/21/11
C	FINAL DESIGN SUBMITTAL	7/06/11
B	90% DESIGN SUBMITTAL	4/15/11
A	80% DESIGN SUBMITTAL	3/21/11



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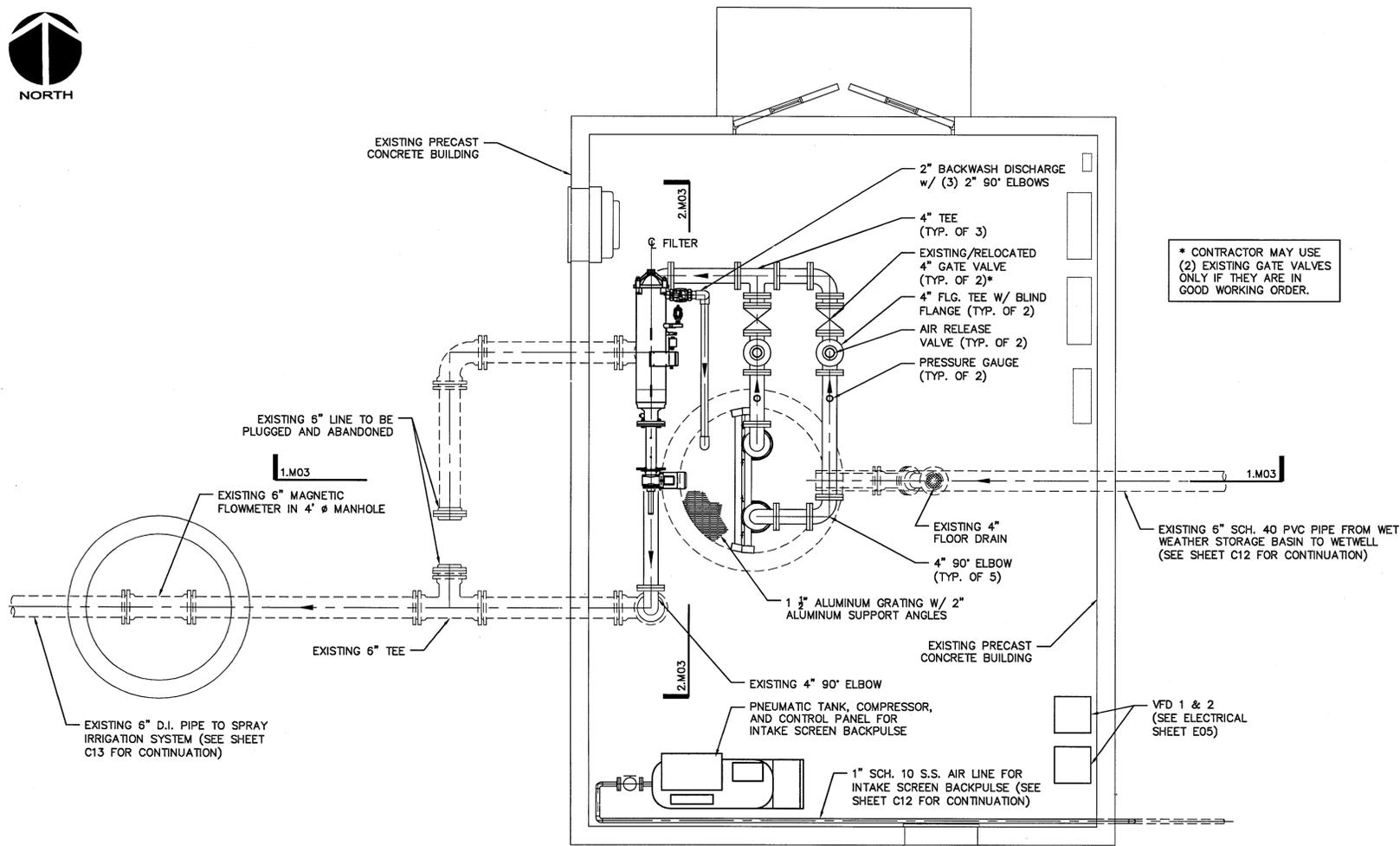
BINGHAM FACILITY WASTEWATER SYSTEM IMPROVEMENTS
EFFLUENT PUMP STATION PLAN, SECTIONS, & DETAILS

DATE: FEBRUARY 2011	SCALE: AS SHOWN	MAC FILE NUMBER: M02
MCE PROJ. # 1488-0032	HORIZONTAL: AS SHOWN	DRAWING NUMBER: M02
DRAWN: SHK	VERTICAL: NA	
DESIGNED: CDR		
CHECKED: CDR		
PROJ. MGR: CDR		

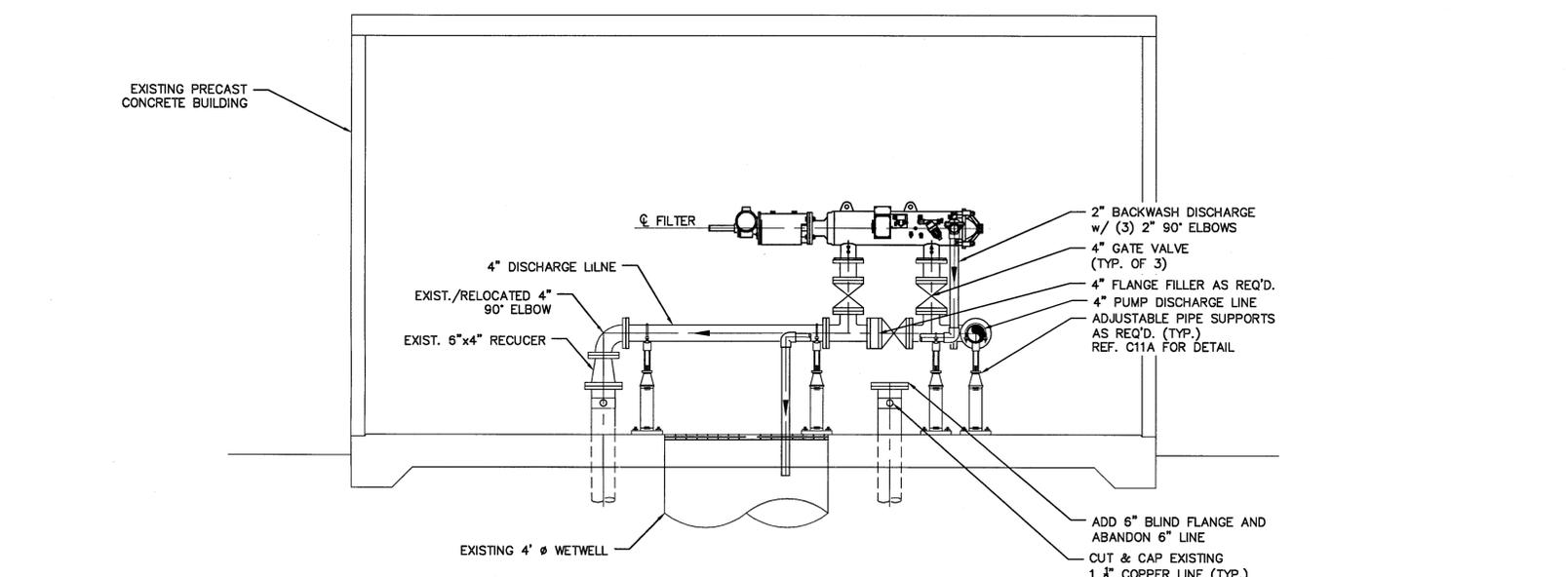
STATUS: FINAL DESIGN - NOT FOR CONSTRUCTION



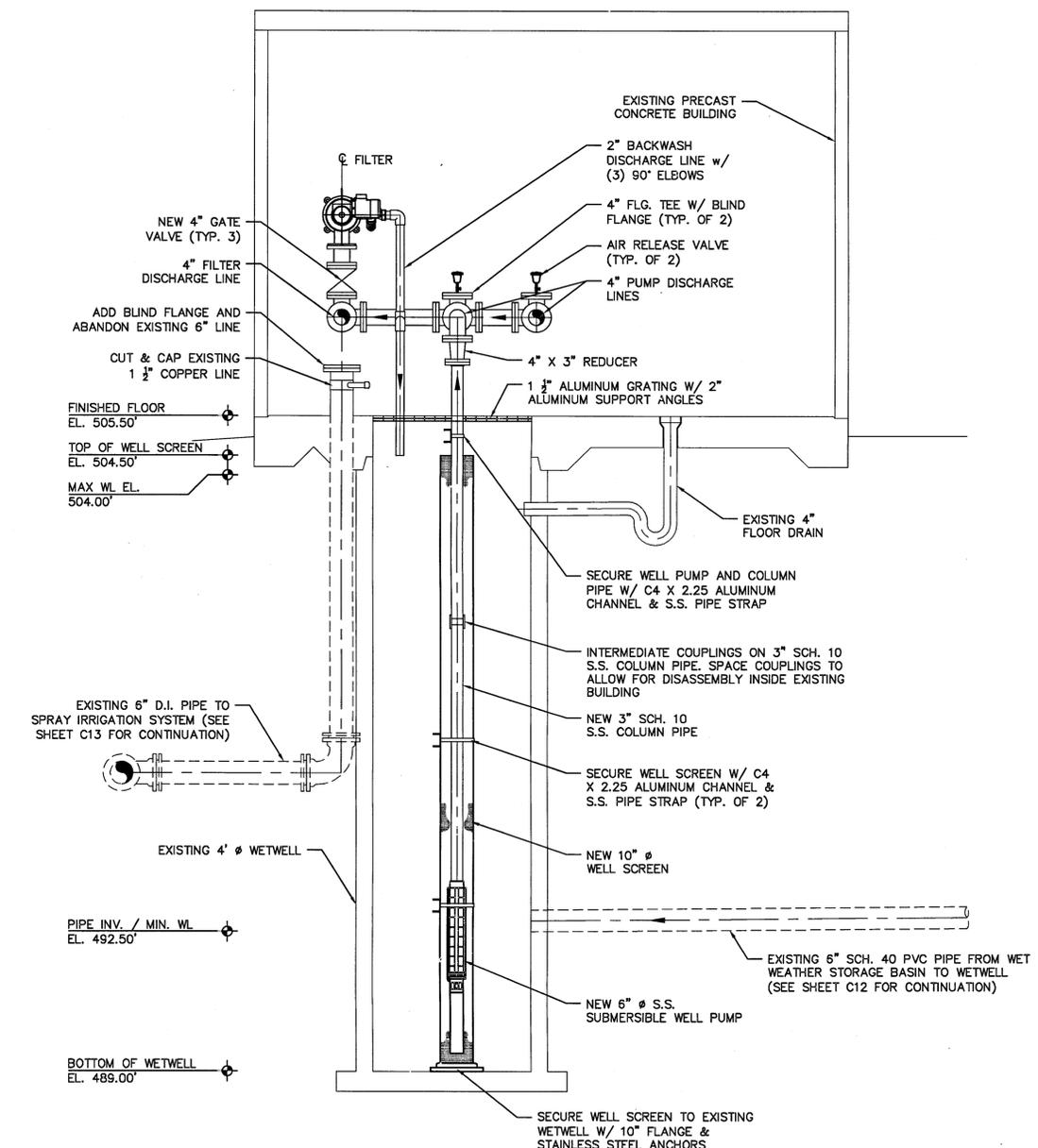
NORTH



IRRIGATION PUMP STATION PLAN
SCALE: 1/2" = 1'



2 - IRRIGATION PUMP STATION PLAN
SCALE: 1/2" = 1'



1 - IRRIGATION PUMP STATION SECTION
SCALE: 1/2" = 1'

REV. NO.	DESCRIPTIONS	DATE
E	FINAL DESIGN - NOT FOR CONSTRUCTION	1/20/11
D	FINAL DESIGN - NOT FOR CONSTRUCTION	8/11/11
C	FINAL DESIGN SUBMITTAL	7/26/11
B	SIX DESIGN SUBMITTAL	4/18/11
A	SIX DESIGN SUBMITTAL	3/21/11
REV. NO.	DESCRIPTIONS	DATE
	REVISIONS	



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BINGHAM FACILITY
 WASTEWATER SYSTEM IMPROVEMENTS

IRRIGATION PUMP STATION
 PLAN, SECTIONS, & DETAILS

DATE: FEBRUARY 2011	SCALE: AS SHOWN	M&C FILE NUMBER: M03
M&C PROJ. # 1488-0032	HORIZONTAL: AS SHOWN	DRAWING NUMBER: M03
DRAWN: SHK	VERTICAL: NA	
DESIGNED: CDR		
CHECKED: CDR		
PROJ. MGR: CDR		
STATUS: FINAL DESIGN - NOT FOR CONSTRUCTION	REVISION: E	

File: S:\1488\0032\00-Drawings\Mechanical\M03-14880032.dwg, Layout: M03, By: Johnson, Plotted: Fri Jun 11, 2011 at 4:41pm

GENERAL ELECTRICAL SYMBOLS

CONDUIT HOMERUN TO EQUIPMENT (PANEL BOARD) SHOWN. LINE TYPE DESIGNATES CONCEALED, EXPOSED, ETC. NUMBERS/TEXT DESIGNATE HOMERUN EQUIPMENT (I.E. PANEL BOARD CIRCUIT NUMBER).

GENERAL CONDUIT RUN CONCEALED IN FURRED WALLS AND CEILINGS, EXPOSED ELSEWHERE UNLESS OTHERWISE NOTED OR SPECIFIED.

CONCEALED CONDUIT IN FLOOR SLAB, UNDERGROUND, ETC.

EXISTING CABLE OR CONDUIT

CONDUIT TURNED DOWN

CONDUIT TURNED UP

E SITE ELECTRICAL
E EXISTING SITE ELECTRICAL
T SITE TELEPHONE
T EXISTING SITE TELEPHONE
OHE OVERHEAD ELECTRICAL UTILITY
OHT OVERHEAD TELEPHONE UTILITY
UGE UNDERGROUND ELECTRICAL UTILITY
UTG UNDERGROUND TELEPHONE UTILITY
G SITE GROUND
G EXISTING SITE GROUND

DS SECURITY - DOOR SWITCH
LS LIMIT SWITCH
LP LIGHTING PROTECTION
TR THERMOSTAT
Ⓟ PULL BOX, SIZE PER NEC UNLESS OTHERWISE NOTED
Ⓟ OR **Ⓟ** JUNCTION BOX, SIZE PER NEC UNLESS OTHERWISE NOTED
Ⓟ ELECTRICAL EQUIPMENT CONNECTION (HARDWIRED)
Ⓟ GROUND ROD
Ⓟ GROUND ROD TEST WELL
Ⓟ PANELBOARD
Ⓟ TRANSFORMER

20/30 DISCONNECT SWITCH. TOP NUMBER DENOTES FUSE SIZE (NF=NON-FUSED). BOTTOM NUMBER DENOTES FRAME SIZE. RIGHT NUMBER DENOTES NEMA ENCLOSURE RATING.
20/30 CIRCUIT BREAKER. TOP NUMBER DENOTES TRIP. BOTTOM NUMBER DENOTES FRAME SIZE. RIGHT NUMBER DENOTES NEMA ENCLOSURE RATING.
20/30 COMBINATION MAGNETIC MOTOR STARTER AND DISCONNECT SWITCH OR MOTOR CIRCUIT PROTECTOR. LEFT NUMBER DENOTES NEMA STARTER SIZE. TOP NUMBER DENOTES FUSE SIZE OR MCP. BOTTOM NUMBER DENOTES FRAME SIZE. RIGHT NUMBER DENOTES NEMA ENCLOSURE RATING.

Ⓟ OR **Ⓟ** CONTROL SWITCH:
 [LOWER CASE LETTER] - CONTROL SWITCHING
M - MANUAL STARTER
D - DIMMER CONTROL
3 - THREE-WAY SWITCHING
4 - FOUR-WAY SWITCHING
OS - OCCUPANCY SENSOR SWITCHING

OUTLETS - STANCHION, FLOOR BOX, OR WALL MOUNTED AS SHOWN. NUMBER DENOTES PANEL BOARD CIRCUIT FOR POWER OUTLETS. IF SHOWN, LOWER CASE LETTER DENOTES CONTROL SWITCHING FOR POWER OUTLETS.

STANCHION FLOOR WALL

Ⓟ SIMPLEX RECEPTACLE.
Ⓟ DUPLEX RECEPTACLE.
Ⓟ QUADRUPLEX RECEPTACLE.
Ⓟ VOICE (PHONE) OUTLET.
Ⓟ DATA OUTLET.
Ⓟ VOICE/DATA COMBINATION OUTLET.
30/240/2 SPECIAL PURPOSE RECEPTACLE (TYPE 1) - AMPERE RATING, VOLTAGE, AND PHASE AS INDICATED.
60/208/3 SPECIAL PURPOSE RECEPTACLE (TYPE 2) - AMPERE RATING, VOLTAGE, AND PHASE AS INDICATED.

LIGHTING SYMBOLS

AT LIGHT FIXTURES (VARIOUS TYPES) - UPPER CASE LETTER DENOTES FIXTURE TYPE, REFER TO LIGHTING SCHEDULE OR NOTES. NUMBER DENOTES LIGHTING PANEL CIRCUIT. LOWER CASE LETTER DENOTES CONTROL SWITCH. DUAL SWITCHING INDICATED BY PAIRS OF LOWER CASE LETTERS. "NL" DENOTES NIGHT LIGHT, CIRCUIT AHEAD OF CONTROL SWITCHES.

EMERGENCY/NIGHT LIGHT FIXTURES (VARIOUS TYPES) - DIAGONALLY SHADED SYMBOLS DENOTE BATTERY EQUIPPED EMERGENCY LIGHTING FIXTURES, CIRCUIT AHEAD OF CONTROL SWITCHES. UPPER CASE LETTER DENOTES FIXTURE TYPE, REFER TO LIGHTING SCHEDULE OR NOTES. NUMBER DENOTES LIGHTING PANEL CIRCUIT.

EXIT LIGHTS, CEILING MOUNTED. SHADING INDICATES FACE. MARK AS INDICATED WITH DIRECTION ARROWS. IF SHOWN, UPPER CASE LETTER DENOTES FIXTURE TYPE, REFER TO LIGHTING SCHEDULE OR NOTES. NUMBER DENOTES LIGHTING PANEL CIRCUIT.

EXIT LIGHTS, WALL MOUNTED. SHADING INDICATES FACE. MARK AS INDICATED WITH DIRECTION ARROWS. IF SHOWN, UPPER CASE LETTER DENOTES FIXTURE TYPE, REFER TO LIGHTING SCHEDULE OR NOTES. NUMBER DENOTES LIGHTING PANEL CIRCUIT.

EMERGENCY LIGHT - BATTERY EQUIPPED EMERGENCY LIGHT, CIRCUIT AHEAD OF CONTROL SWITCHES. ADDITIONAL FIXTURE HEADS MAY BE SHOWN CONNECTED TO UNIT. IF SHOWN, UPPER CASE LETTER DENOTES FIXTURE TYPE, REFER TO LIGHTING SCHEDULE OR NOTES. NUMBER DENOTES LIGHTING PANEL CIRCUIT.

PC PHOTOELECTRIC CONTROL DEVICE
Ⓟ LIGHTING CONTACTOR

TYPICAL ABBREVIATIONS

A, AMP	AMPERE
AFD	ADJUSTABLE FREQUENCY DRIVE
AFG	ABOVE FINISHED GRADE
AIT	ANALYTICAL INDICATION TRANSMITTER
AHU	AIR HANDLING UNIT
AIC	AMPERE INTERRUPTING CAPACITY
AL	ALUMINUM
ATS	AUTOMATIC TRANSFER SWITCH
AWG	AMERICAN WIRE GAUGE
BKR	BREAKER
C, CND	CONDUIT
CAB	CABINET
CAT	CATALOG
CL	CHLORINE
CB	CIRCUIT BREAKER
CCTV	CLOSED CIRCUIT TELEVISION
CKT	CIRCUIT
CLG	CEILING
CP	CONTROL PANEL
CR	CONTROL RELAY, CORROSION RESISTANT
CS	CONTROL SWITCH
CV	CONTROL VALVE
CT	CURRENT TRANSFORMER
CU	COPPER
EF	EXHAUST FAN
EMER	EMERGENCY
EMT	ELECTRICAL METALLIC TUBING
ENCL	ENCLOSURE
EQUIP	EQUIPMENT
EWC	ELECTRIC WATER COOLER
EW	ELECTRIC WATER HEATER
EPFR	EXPLOSION PROOF
FA	FIRE ALARM
FAAP	FIRE ALARM ANNUNCIATOR PANEL
FACP	FIRE ALARM CONTROL PANEL
FBO	FURNISHED BY OTHERS
FLA	FULL LOAD AMPS
FLUR	FLOUR
FLR	FLOOR
FMC	FLEXIBLE METAL CONDUIT
FWE	FURNISHED WITH EQUIPMENT
GEN	GENERATOR
G, GND	GROUND
GFI	GROUND FAULT INTERRUPTER
HH	HANDHOLE
HI	HIGH INTENSITY DISCHARGE
HOA	HAND-OFF-AUTO
HP	HORSE POWER
HFF	HIGH POWER FACTOR
HPS	HIGH PRESSURE SODIUM
HTR	HEATER
HV	HIGH VOLTAGE
HZ	HERTZ
IMC	INTERMEDIATE METALLIC CONDUIT (GALVANIZED)
INCAN	INCANDESCENT
JB	JUNCTION BOX
K	THOUSAND
KCMIL	THOUSAND CIRCULAR MILLS
KVA	KILOVOLT AMPERE
KW	KILOWATTS
KWH	KILOWATT-HOURS
LFTM	LIQUIDTIGHT FLEXIBLE METAL CONDUIT
LFLNC	LIQUIDTIGHT FLEXIBLE NONMETALLIC CONDUIT
LIT	LEVEL INDICATION TRANSMITTER
LP	LIGHTING PANEL, LIGHT POLE
LITG	LIGHTING
MCB	MAIN CIRCUIT BREAKER
MCC	MOTOR CONTROL CENTER
MCP	MOTOR CIRCUIT PROTECTOR
MDP	MAIN DISTRIBUTION PANEL
MFR	MANUFACTURER
MH	MANHOLE
MLO	MAIN LUGS ONLY
MSB	MAIN SWITCHBOARD
MTD	MOUNTED
MTG	MOUNTING
MTS	MANUAL TRANSFER SWITCH
MV	MEDIUM VOLTAGE
N, NEUT	NEUTRAL
NA	NOT APPLICABLE
NC	NORMALLY CLOSED
NEC	NATIONAL ELECTRIC CODE
NIC	NOT IN CONTRACT
NL	NIGHT LIGHT
NO	NORMALLY OPEN
NTS	NOT TO SCALE
P	POLE
PA	PUBLIC ADDRESS
PB	PULL BOX, PUSH-BUTTON
PCP	PUMP CONTROL PANEL
PF	POWER FACTOR
PH, Ⓟ	PHASE
PIT	PRESSURE INDICATION TRANSMITTER
PLC	PROGRAMMABLE LOGIC CONTROLLER
PNL	PANEL
PP	POWER PANEL, POWER POLE
PT	POTENTIAL TRANSFORMER
PR	POWER
RECPT	RECEPTACLE
REQ'D	REQUIRED
RM	ROOM
RMC	RIGID METAL CONDUIT (GALVANIZED)
RTU	REMOTE TELEMETRY UNIT
SCR	DC MOTOR DRIVE
SH	SHEET
SPEC	SPECIFICATION
SS	SELECTOR SWITCH
SST	STAINLESS STEEL
STP	SHIELDED TWISTED PAIR
SW	SWITCH
SWBD	SWITCHBOARD
SWGR	SWITCH GEAR
TEL	TELEPHONE
TVSS	TRANSIENT VOLTAGE SURGE SUPPRESSOR
TYP	TYPICAL
UG	UNDERGROUND
UH	UNIT HEATER
UON	UNLESS OTHERWISE NOTED
UTIL	UTILITY
UTP	UNSHIELDED TWISTED PAIR
V	VOLTS
VFD	VARIABLE FREQUENCY DRIVE
W	WIRE, WATT
WH	WATT-HOUR
WP	WEATHERPROOF
XFMR	TRANSFORMER

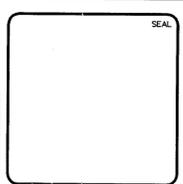
GENERAL NOTES

- THE GENERAL NOTES STATED ON THIS DRAWING ARE APPLICABLE TO ALL ELECTRICAL WORK UNLESS NOTED OTHERWISE. REFER TO THE SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS.
- ALL SYMBOLS AND ABBREVIATION MAY NOT BE UTILIZED FOR THIS PROJECT.
- ADDITIONAL SYMBOLS NOT SHOWN ON THIS DRAWING MAY BE SHOWN ELSEWHERE ON THE ELECTRICAL DRAWINGS.
- ELECTRICAL PLANS SHOW MAJOR CABLE AND CONDUIT REQUIREMENTS. REFER TO EQUIPMENT DETAILS FOR ADDITIONAL REQUIREMENTS.
- ALL ELECTRICAL EQUIPMENT SHALL BE INSTALLED SO THAT ALL CODE-REQUIRED AND MANUFACTURER-RECOMMENDED SERVICING CLEARANCES ARE MAINTAINED. INSTALLATIONS SHALL FULLY COMPLY WITH NEC 110-26 FOR CLEARANCE REQUIREMENTS.
- ROUGH-IN CONDUIT AS REQUIRED FOR DIRECT CONNECTION TO EQUIPMENT AS SHOWN. PROVIDE FLEXIBLE CONNECTIONS TO ALL EQUIPMENT AND MAKE ALL CONNECTIONS COMPLETE AND IN ACCORDANCE WITH THE SPECIFICATIONS.
- THE CONTRACTOR SHALL PROVIDE ALL REQUIRED PULL BOXES, TERMINAL BOXES AND JUNCTION BOXES FOR INSTALLATION OF THE WIRING IN ACCORDANCE WITH THE CONTRACT SPECIFICATIONS THOUGH THE BOXES MAY NOT BE INDICATED ON THE DRAWINGS.
- CONDUIT AND WIRING FOR LIGHTING, RECEPTACLES AND OTHER SINGLE PHASE POWERED DEVICES ARE GENERALLY NOT SHOWN BUT SHALL BE PROVIDED AS REQUIRED FOR PROPER SERVICE. CIRCUITS SHALL BE PROVIDED IN INDIVIDUAL CONDUITS.
- ALL AMPACITIES ARE BASED ON 75°C RATING. THE CONTRACTOR IS RESPONSIBLE FOR THE INCREASING OF CONDUCTOR SIZES AS NECESSARY TO MEET THE REQUIREMENTS OF NEC 110-14(C) WHERE TERMINATIONS ARE NOT LISTED AND LABELED FOR USE AT 75°C. THIS REQUIREMENT APPLIES TO TERMINATIONS IN BOTH NEW EQUIPMENT AND IN EXISTING EQUIPMENT TO WHICH TERMINATIONS ARE MADE AS PART OF THIS PROJECT.
- THE CONTRACTOR SHALL PROVIDE ALL NECESSARY COMPONENTS REQUIRED FOR MAKING FINAL CONNECTION OF ALL EQUIPMENT INSTALLED OR MODIFIED AS PART OF THIS CONTRACT.
- CONTRACTOR SHALL PROVIDE AUXILIARY SUPPORT FOR THE PANEL BOARDS, TRANSFORMER, CONTROL PANELS, ETC., AS REQUIRED.
- ALL CONDUIT SHALL RUN CONCEALED UNLESS OTHERWISE NOTED OR SHOWN. THE CONDUITS SHALL BE RUN PARALLEL TO LANDSCAPE AND STRUCTURAL FEATURES, AND THE BENDS AND TURNS SHALL BE MADE BY MEANS OF CONDUIT FITTINGS. MOST CONDUIT LAYOUTS ARE NOT AS SHOWN ON THE PLANS. THE CONTRACTOR SHALL PROPOSE LOGICAL GROUPINGS, MARSHALING AND ROUTING OF CONDUITS AND WIRING FOR APPROVAL BY ENGINEER PRIOR TO INSTALLATION.
- ALL SPARE CONDUITS SHALL BE CAPPED OR PLUGGED AND SHALL INCLUDE 1/8" POLYPROPYLENE PULL STRING.
- ALL NEW EQUIPMENT SHALL FIT INTO EXISTING AVAILABLE SPACE. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO PROVIDE EQUIPMENT WHICH MEETS THE SPACE REQUIREMENTS.
- THE WIRING DIAGRAMS, QUANTITY AND SIZE OF WIRES AND CONDUITS ARE BASED UPON SELECTED STANDARD COMPONENTS OF ELECTRICAL EQUIPMENT. MODIFICATIONS APPROVED BY THE ENGINEER MAY BE MADE BY THE CONTRACTOR AT HIS EXPENSE TO ACCOMMODATE EQUIPMENT ACTUALLY PURCHASED.
- CONTRACTORS SHALL PROVIDE A CIRCUIT IDENTIFICATION LABEL AT EACH END OF EACH BRANCH CIRCUIT WIRE.
- GROUND FAULT INTERRUPTING (GFI) RECEPTACLES FOR 120 VOLT SERVICE:
 - IN NON-PROCESS AREAS EXPOSED TO WATER SUCH AS TOILET ROOMS, SHOWER AREAS, KITCHENS, ETC., INDIVIDUAL GFI RECEPTACLES SHALL BE PROVIDED
 - OUTDOORS OR IN PROCESS AREAS, ALL RECEPTACLES SHALL BE WEATHER PROOF, CORROSION RESISTANT.
- NO SPLICES SHALL BE MADE WITHOUT ENGINEERS APPROVAL. NO JUNCTIONS SHALL BE MADE BELOW GRADE WITHOUT APPROVAL OF THE ENGINEER. PROVIDE NEMA 4X SST JUNCTION BOX MOUNTED 18" A.F.G. NEXT TO HANDHOLE. SUPPORTED BY SST UNISTRUT EMBEDDED IN THE CONCRETE SURROUNDING THE HANDHOLE TO MAKE JUNCTION ABOVE GRADE.
- ELECTRICAL DUCTBANKS SHALL CROSS PROCESS PIPING AT NEAR A 90° ANGLE WHERE POSSIBLE. REFER TO DUCTBANK DETAILS AND SPECIFICATIONS.
- NOT ALL MOISTURE AND HAZARDOUS AREA CONDUIT SEALS ARE SHOWN ON THE DRAWINGS. IT IS THE CONTRACTOR'S RESPONSIBILITY TO CONFIRM WITH THE CODE, SPECIFICATION, AND DRAWING REQUIREMENTS FOR THEIR LOCATION.
- ALL CONDUIT BELOW GRADE SHALL BE DIRECT BURIED SCH 80 PVC.
- ALL EXPOSED CPONDUIT ABOVE GRADE SHALL BE RIGID GALVANIZED STEEL.

DEMOLITION NOTES

- ALL EQUIPMENT LABELED AS "TO BE REMOVED" OR MARKED AS REMOVED BY THE FOLLOWING SYMBOL: 
- THE CONTRACTOR SHALL REMOVE ALL SUPPORTS, WIRE, CONDUIT, AND MATERIALS ASSOCIATED WITH EQUIPMENT BEING REMOVED UNLESS OTHERWISE STATED. CONDUIT STUBS THROUGH CONCRETE, FLOOR, WALLS, OR CEILING WILL REMAIN AND COVERED WITH A PVC CAP.

NO.	DESCRIPTION	DATE
E	FINAL DESIGN - NOT FOR CONSTRUCTION	1/31/11
D	FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION	7/28/11
C	FINAL DESIGN SUBMITTAL	4/18/11
B	95% DESIGN SUBMITTAL	3/21/11
A	60% DESIGN SUBMITTAL	



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BINGHAM FACILITY WASTEWATER SYSTEM IMPROVEMENTS
 LEGEND, ABBREVIATIONS, AND NOTES

DATE: FEBRUARY 2011	SCALE: HORIZONTAL: N/A	MAC FILE NUMBER: E01
MCE PROJ. # 1488-0032	VERTICAL: NA	
DRAWN: CDR		
DESIGNED: ALA		
CHECKED: ALA		
PROJ. MGR.: CDR		

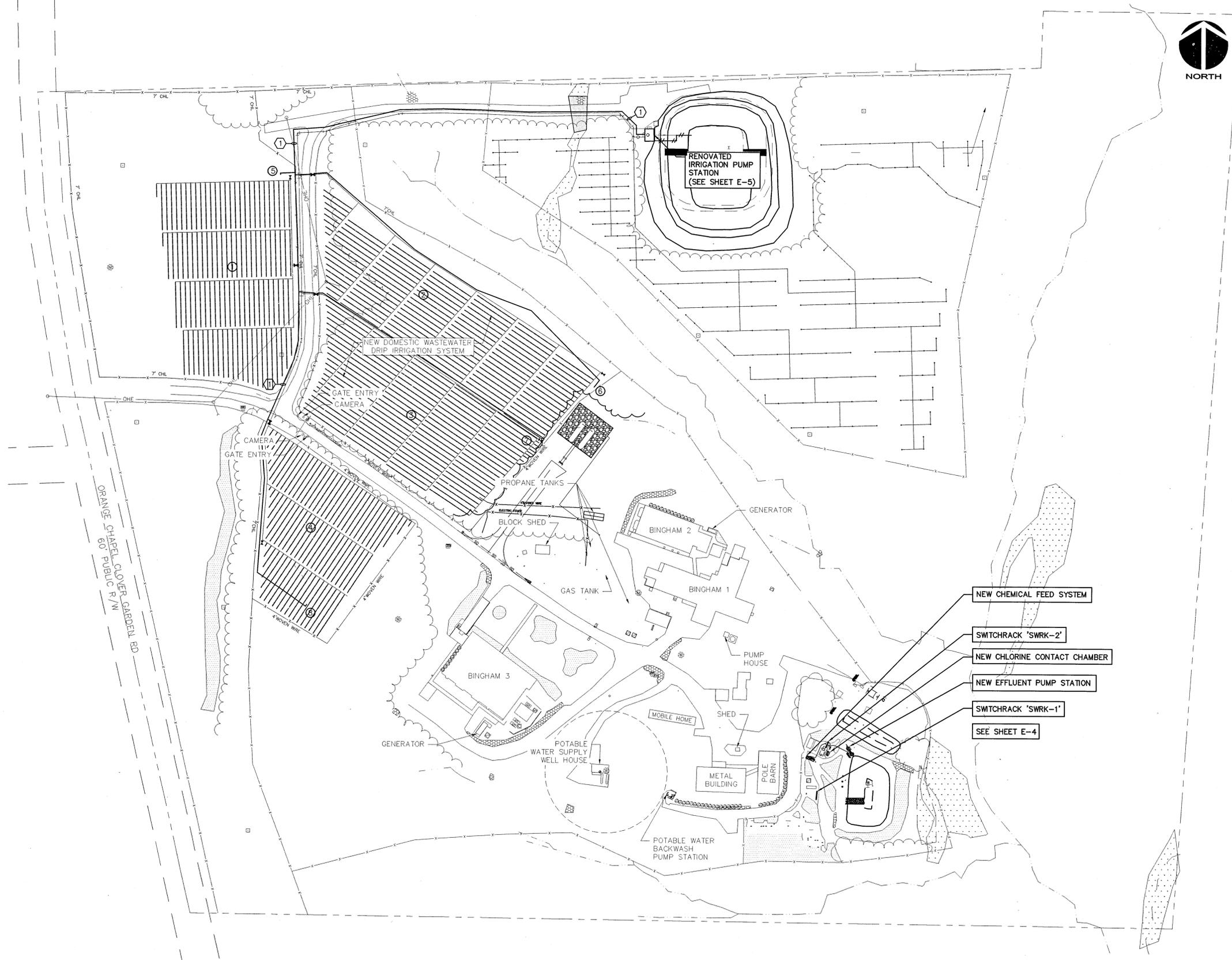
STATUS: FINAL DESIGN - NOT FOR CONSTRUCTION

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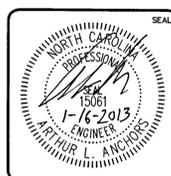
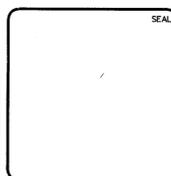
KEY NOTES

- ① CONTROL LINES FOR IRRIGATION VALVES TO BE DIRECT BURIED IN THE SAME TRENCH AS THE NEW IRRIGATION PIPING SYSTEM.
- ② IRRIGATION ZONE 1
- ③ IRRIGATION ZONE 2
- ④ IRRIGATION ZONE 3
- ⑤ IRRIGATION ZONE 1 DRAIN VALVE
- ⑥ IRRIGATION ZONE 2 DRAIN VALVE
- ⑦ IRRIGATION ZONE 3 DRAIN VALVE
- ⑧ IRRIGATION ZONE 4 DRAIN VALVE



PROPOSED OVERALL SITE PLAN
SCALE: 1" = 80'

REV. NO.	DESCRIPTIONS	DATE
E	FINAL DESIGN - NOT FOR CONSTRUCTION	1/31/13
D	FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION	8/21/11
C	FINAL DESIGN SUBMITTAL	7/26/11
B	90% DESIGN SUBMITTAL	4/18/11
A	60% DESIGN SUBMITTAL	3/21/11
REV. NO.	DESCRIPTIONS	DATE
	REVISIONS	



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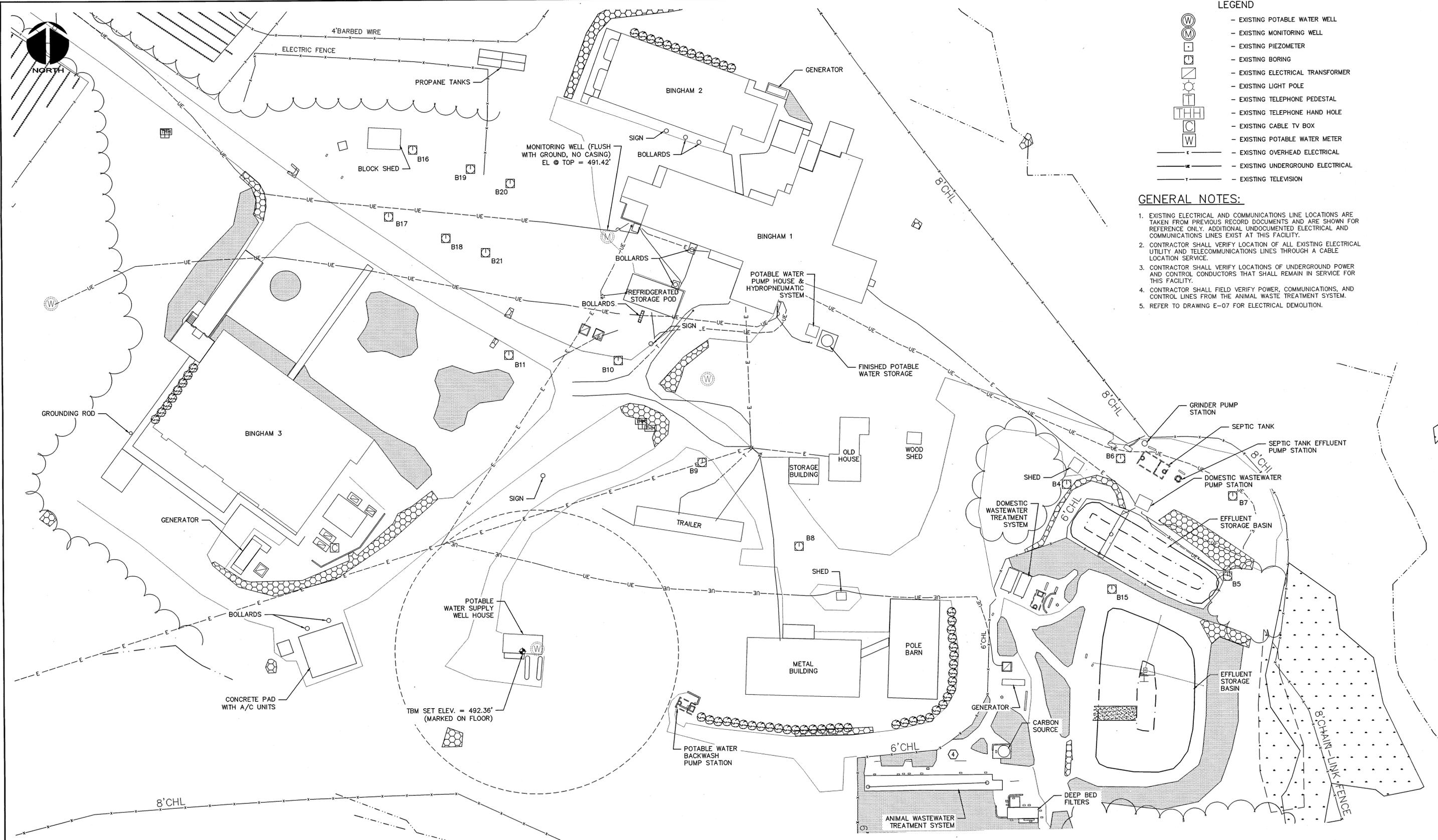


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BINGHAM FACILITY
WASTEWATER SYSTEM IMPROVEMENTS
PROPOSED OVERALL ELECTRICAL
SITE PLAN

DATE: FEBRUARY 2011	SCALE: 1" = 80'	MAC FILE NUMBER
MCE PROJ. # 1488-0032	HORIZONTAL: 1" = 80'	DRAWING NUMBER
DRAWN: CJR/SHK	VERTICAL: NA	E02
DESIGNED: ALA		
CHECKED: ALA		
PROJ. MGR.: CDR		
STATUS: FINAL DESIGN - NOT FOR CONSTRUCTION	REVISION: E	

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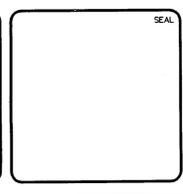
LEGEND

- (W) - EXISTING POTABLE WATER WELL
- (M) - EXISTING MONITORING WELL
- (P) - EXISTING PIEZOMETER
- (B) - EXISTING BORING
- (T) - EXISTING ELECTRICAL TRANSFORMER
- (L) - EXISTING LIGHT POLE
- (TP) - EXISTING TELEPHONE PEDESTAL
- (THH) - EXISTING TELEPHONE HAND HOLE
- (C) - EXISTING CABLE TV BOX
- (W) - EXISTING POTABLE WATER METER
- (E) - EXISTING OVERHEAD ELECTRICAL
- (UE) - EXISTING UNDERGROUND ELECTRICAL
- (TV) - EXISTING TELEVISION

- GENERAL NOTES:**
- EXISTING ELECTRICAL AND COMMUNICATIONS LINE LOCATIONS ARE TAKEN FROM PREVIOUS RECORD DOCUMENTS AND ARE SHOWN FOR REFERENCE ONLY. ADDITIONAL UNDOCUMENTED ELECTRICAL AND COMMUNICATIONS LINES EXIST AT THIS FACILITY.
 - CONTRACTOR SHALL VERIFY LOCATION OF ALL EXISTING ELECTRICAL UTILITY AND TELECOMMUNICATIONS LINES THROUGH A CABLE LOCATION SERVICE.
 - CONTRACTOR SHALL VERIFY LOCATIONS OF UNDERGROUND POWER AND CONTROL CONDUCTORS THAT SHALL REMAIN IN SERVICE FOR THIS FACILITY.
 - CONTRACTOR SHALL FIELD VERIFY POWER, COMMUNICATIONS, AND CONTROL LINES FROM THE ANIMAL WASTE TREATMENT SYSTEM.
 - REFER TO DRAWING E-07 FOR ELECTRICAL DEMOLITION.

EXISTING ENLARGED SITE PLAN
SCALE: 1" = 30'

REV. NO.	DESCRIPTIONS	DATE
E	FINAL DESIGN - NOT FOR CONSTRUCTION	1/21/13
D	FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION	6/11/11
C	FINAL DESIGN SUBMITTAL	7/28/11
B	95% DESIGN SUBMITTAL	4/18/11
A	80% DESIGN SUBMITTAL	3/21/11



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BINGHAM FACILITY WASTEWATER SYSTEM IMPROVEMENTS
EXISTING ELECTRICAL SITE PLAN

DATE: FEBRUARY 2011
MCE PROJ. # 1488-0032
DRAWN: SHK
DESIGNED: CDR
CHECKED: CDR
PROJ. MGR.: CDR

SCALE: HORIZONTAL: 1" = 30' VERTICAL: NA

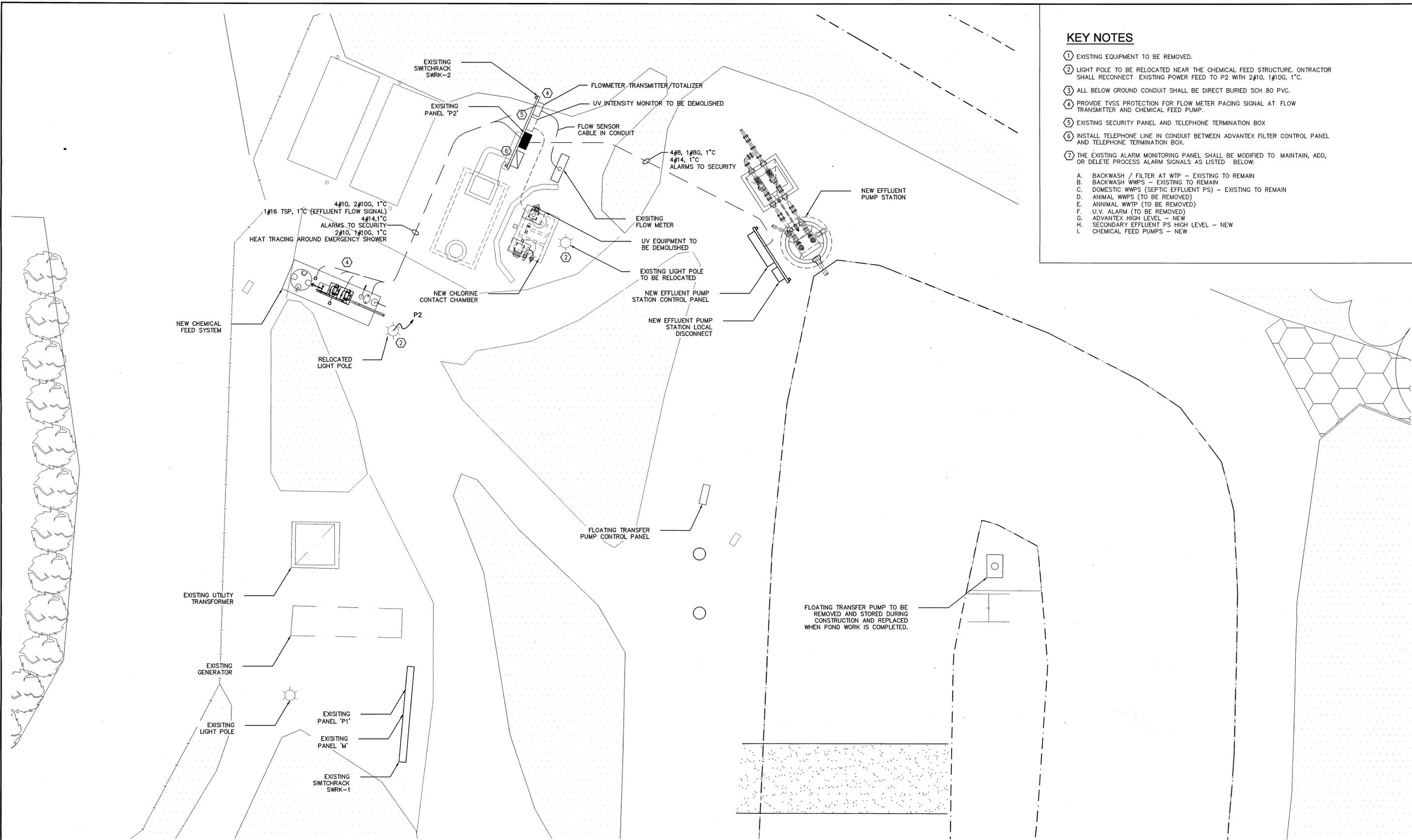
DRAWING NUMBER: E03

STATUS: FINAL DESIGN - NOT FOR CONSTRUCTION

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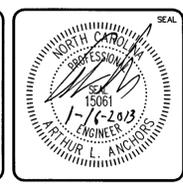
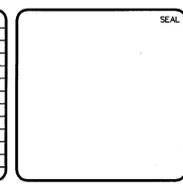
KEY NOTES

- ① EXISTING EQUIPMENT TO BE REMOVED.
- ② LIGHT POLE TO BE RELOCATED NEAR THE CHEMICAL FEED STRUCTURE. CONTRACTOR SHALL RECONNECT EXISTING POWER FEED TO P2 WITH 2#10, 1#10G, 1" C.
- ③ ALL BELOW GROUND CONDUIT SHALL BE DIRECT BURIED SCH 80 PVC.
- ④ PROVIDE TVSS PROTECTION FOR FLOW METER PACING SIGNAL AT FLOW TRANSMITTER AND CHEMICAL FEED PUMP.
- ⑤ EXISTING SECURITY PANEL AND TELEPHONE TERMINATION BOX
- ⑥ INSTALL TELEPHONE LINE IN CONDUIT BETWEEN ADVANTECH FILTER CONTROL PANEL AND TELEPHONE TERMINATION BOX.
- ⑦ THE EXISTING ALARM MONITORING PANEL SHALL BE MODIFIED TO MAINTAIN, ADD, OR DELETE PROCESS ALARM SIGNALS AS LISTED BELOW:
 - A. BACKWASH / FILTER AT WTP - EXISTING TO REMAIN
 - B. BACKWASH WFPS - EXISTING TO REMAIN
 - C. DOMESTIC WFPS (SEPTIC EFFLUENT PS) - EXISTING TO REMAIN
 - D. ANIMAL WFPS (TO BE REMOVED)
 - E. ANIMAL WWTP (TO BE REMOVED)
 - F. U.V. ALARM (TO BE REMOVED)
 - G. ADVANTECH HIGH LEVEL - NEW
 - H. SECONDARY EFFLUENT PS HIGH LEVEL - NEW
 - I. CHEMICAL FEED PUMPS - NEW



PROPOSED ENLARGED SITE PLAN
SCALE: 1" = 6'

REV. NO.	DESCRIPTIONS	DATE
E	FINAL DESIGN - NOT FOR CONSTRUCTION	1/31/13
D	FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION	8/11/11
C	FINAL DESIGN SUBMITTAL	7/28/11
B	50% DESIGN SUBMITTAL	4/16/11
A	50% DESIGN SUBMITTAL	3/21/11



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BINGHAM FACILITY
WASTEWATER SYSTEM IMPROVEMENTS
ENLARGED PROPOSED SITE PLAN

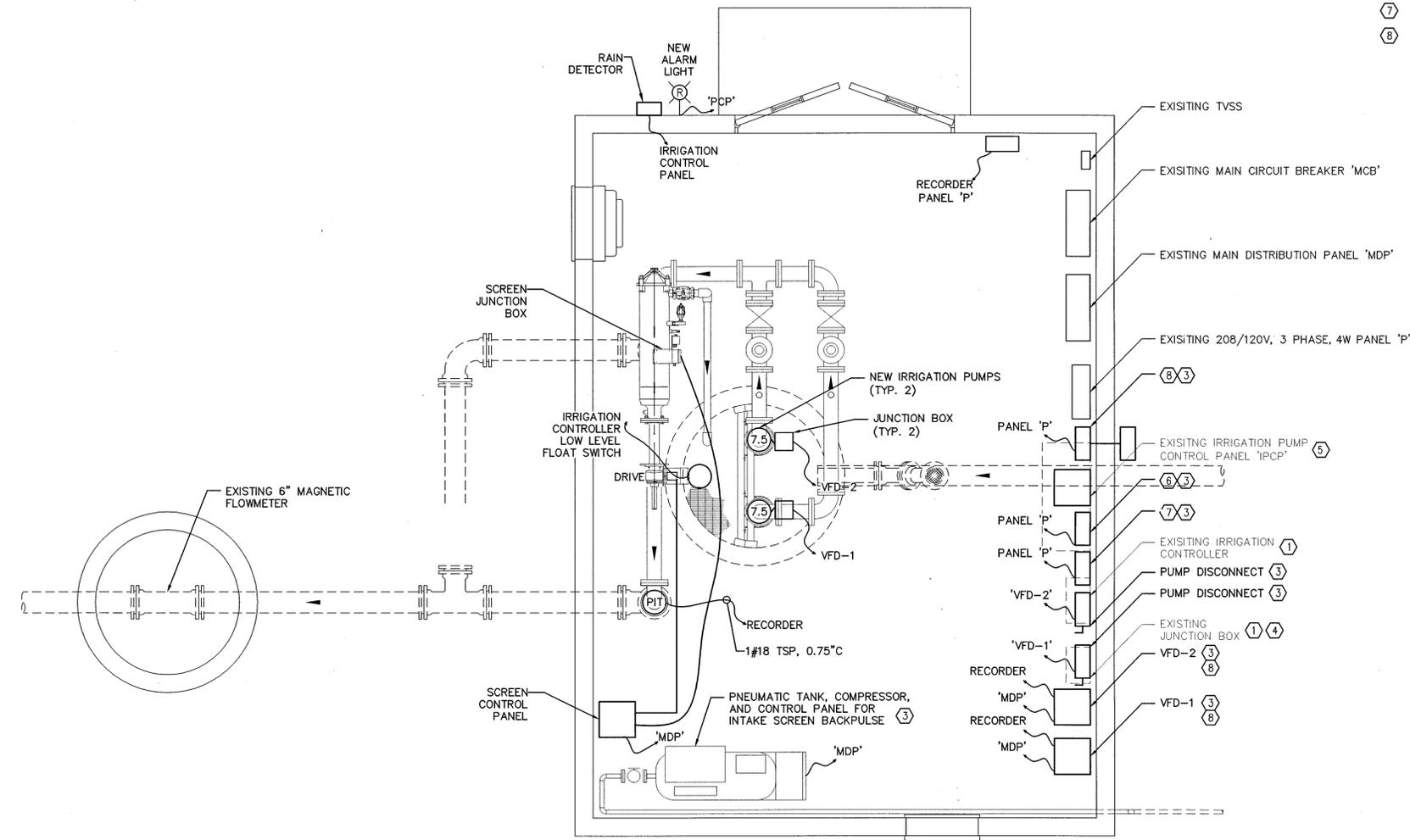
DATE: FEBRUARY 2011	SCALE: HORIZONTAL: 1" = 6' VERTICAL: NA	MAC FILE NUMBER: E04
MCE PROJ. # 1488-0032	DESIGNED: CDR	REVISION: E
DRAWN: SHK	CHECKED: CDR	
PROJ. MGR.		

STATUS: **FINAL DESIGN - NOT FOR CONSTRUCTION**

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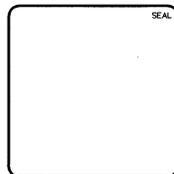
KEY NOTES

- ① EQUIPMENT TO BE REMOVED.
- ② NOT USED.
- ③ NEW EQUIPMENT.
- ④ REPLACE WITH NEW JUNCTION BOX FOR IRRIGATION FIELD CONTROL CABLES.
- ⑤ REPLACE WITH NEW IRRIGATION CONTROLLER.
- ⑥ NEW CIRCULAR CHART RECORDER / TOTALIZER CONTROLLER.
- ⑦ NEW IRRIGATION DRAIN VALVE / PUMP SELECTION CONTROL PANEL.
- ⑧ INSTALL NEW SECURITY PANEL AND TERMINATION BOX SUPPLIED BY UNC. INSTALL 3/4" CONDUIT THROUGH WALL BETWEEN INSIDE AND OUTSIDE BOX. CONNECT ALARMS TO VFD FAIL CONTACT AT EACH VFD.



IRRIGATION PUMP SITE PLAN
SCALE: 1/2"=1'

REV. NO.	DESCRIPTIONS	DATE
E	FINAL DESIGN - NOT FOR CONSTRUCTION	1/31/13
D	FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION	8/1/11
C	FINAL DESIGN SUBMITTAL	7/26/11
B	95% DESIGN SUBMITTAL	4/28/11
A	80% DESIGN SUBMITTAL	3/21/11



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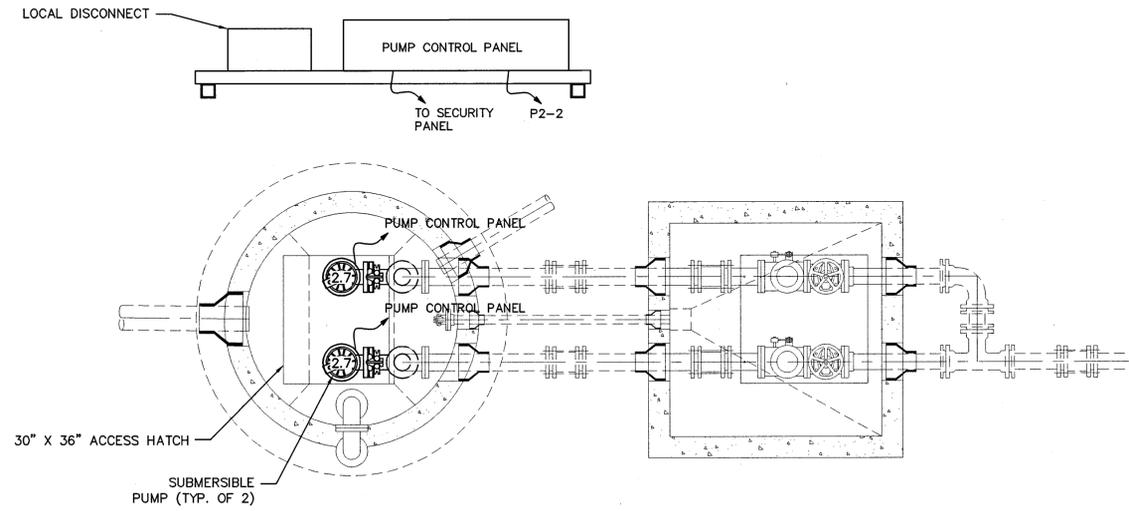
BINGHAM FACILITY WASTEWATER SYSTEM IMPROVEMENTS
IRRIGATION PUMP STATION ELECTRICAL

DATE: FEBRUARY 2011	SCALE: 1/2"=1'	MAC FILE NUMBER: E05
MCE PROJ. # 1488-0032	HORIZONTAL: 1/2"=1'	DRAWING NUMBER: E05
DRAWN: CJR	VERTICAL: 1/2"=1'	
DESIGNED: ALA		
CHECKED: ALA		
PROJ. MGR: CDR		
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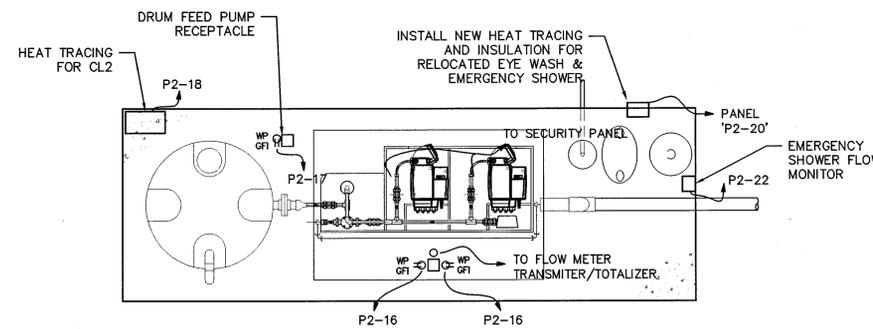
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KEY NOTES

1. ALL ELECTRICAL WORK AND MATERIALS SHALL COMPLY WITH THE NATIONAL ELECTRIC CODE AND LOCAL CODES.
2. ALL ABOVE GRADE CONDUIT SHALL BE RIGID GALVANIZED STEEL (RGS).
3. ALL BELOW GRADE CONDUIT SHALL BE DIRECT BURIED SCHEDULE.
4. REFER TO DETAILS FOR BELOW GRADE TO ABOVE GRADE CONDUIT INSTALLATION.
5. ALL AMPACITIES ARE BASED ON 75 DEG. C RATING. THE CONTRACTOR SHALL BE RESPONSIBLE TO INCREASE THE CONDUCTOR SIZE AS NECESSARY TO MEET THE REQUIREMENTS OF NEC 110-14 (C) WHERE DEVICE TERMINATIONS ARE NOT LABELED FOR USE AT 75 DEG. C.
6. CONTRACTOR SHALL COORDINATE LOCATION OF CONDUIT RUNS IN ORDER TO NOT CONFLICT WITH THE INSTALLED EQUIPMENT.
7. ALL WIRE RUNS IN CONDUIT SHALL BE THWN AND SHALL BE SPLICE FREE.
8. CONTRACTOR SHALL COORDINATE LOCATION OF CONDUIT RUNS IN ORDER NOT TO CONFLICT WITH THE INSTALLED EQUIPMENT.
9. HEAT TRACING CABLE SHALL BE SELF REGULATING, 5 WATTS PER FOOT WITH TINNED COPPER BRAID AND TPR OUTER JACKET. CHROMALOX SRL OR EQUAL.
10. HEAT TRACING CONTROLLER SHALL BE CHROMALOX SERIES HTLS OR EQUAL AND SHALL INCLUDE THE FOLLOWING:
 - A. NEMA 4X ENCLOSURE
 - B. CONTACTOR OUTPUT
 - C. TEMPERATURE CONTROL
 - D. TEMPERATURE SENSOR
 - E. GROUND FAULT BREAKER
 - F. 120 VAC OPERATION

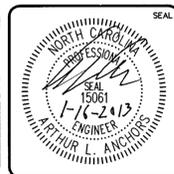
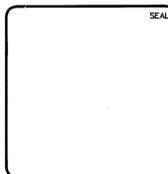


EFFLUENT PUMP STATION PLAN
SCALE: 1/2" = 1'-0"



CHEMICAL FEED SYSTEM
SCALE: 1/2" = 1'-0"

REV. NO.	DESCRIPTIONS	DATE
E	FINAL DESIGN - NOT FOR CONSTRUCTION	1/31/13
D	FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION	8/11/11
C	FINAL DESIGN SUBMITTAL	7/08/11
B	90% DESIGN SUBMITTAL	4/19/11
A	50% DESIGN SUBMITTAL	3/22/11



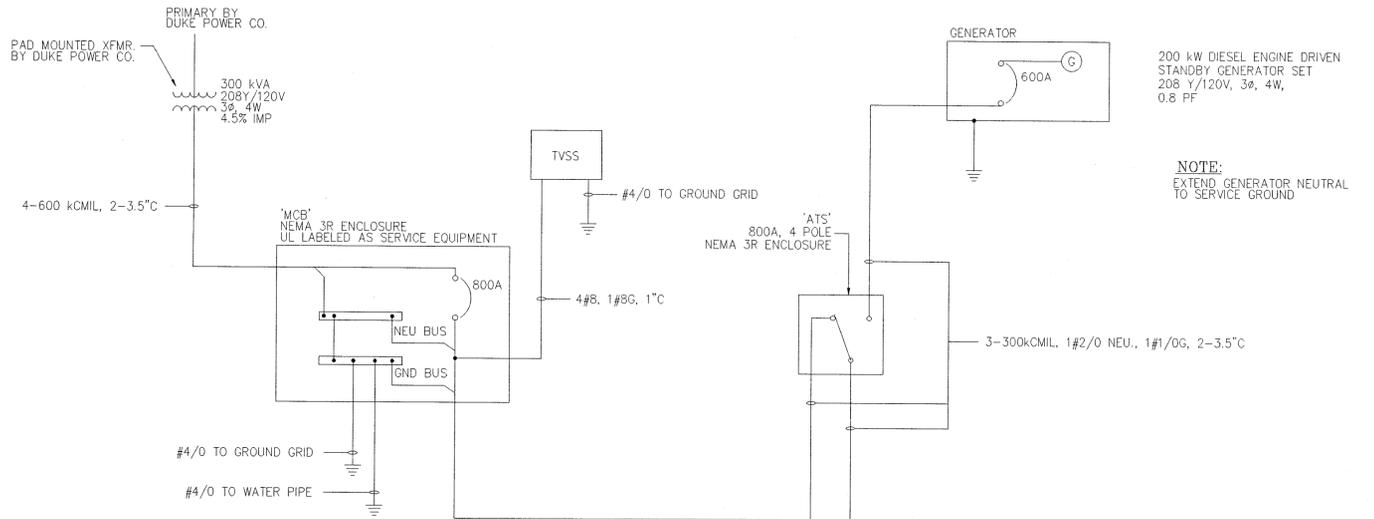
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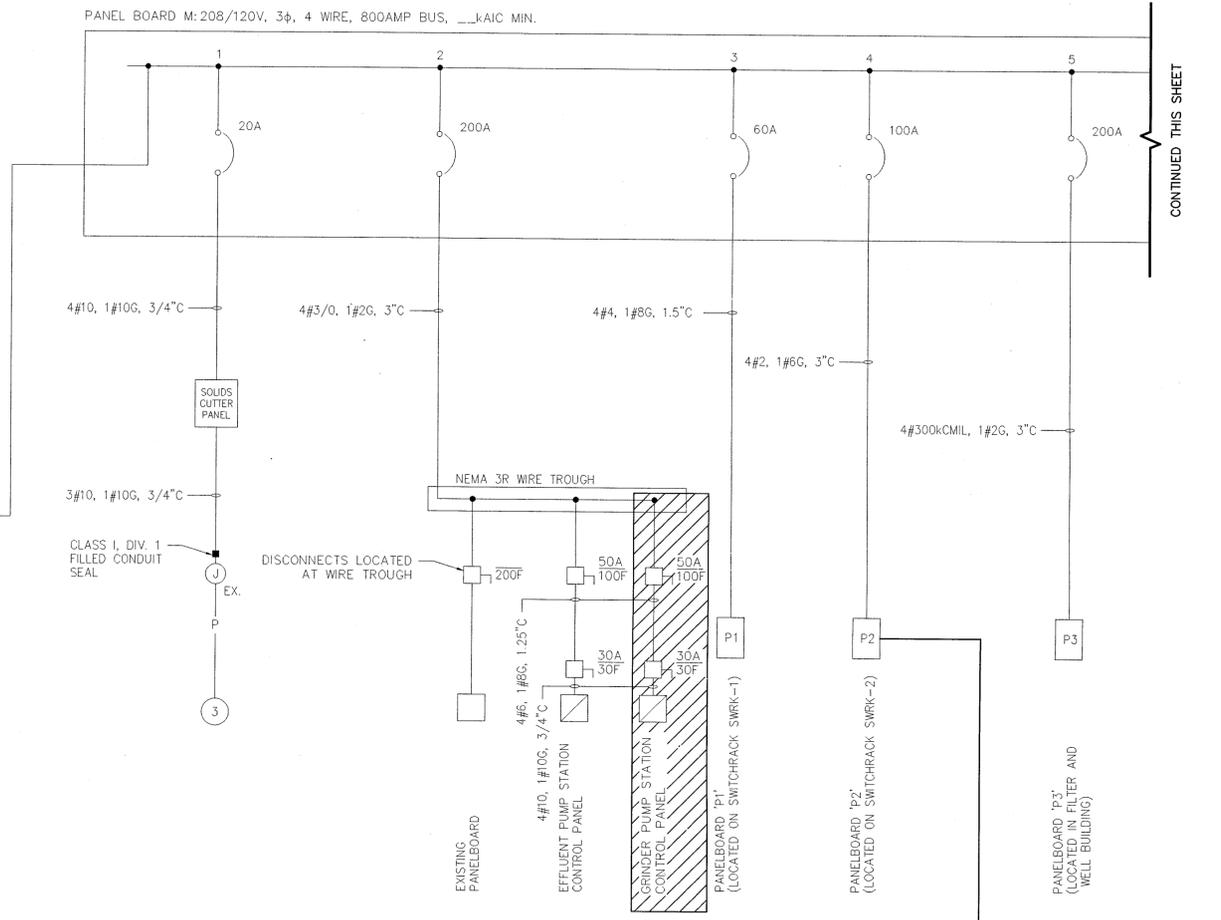
BINGHAM FACILITY WASTEWATER SYSTEM IMPROVEMENTS
EFFLUENT PUMP STATION AND CHEMICAL FEED SYSTEM ELECTRICAL PLAN

DATE: FEBRUARY 2011	SCALE:	MAC FILE NUMBER:
M&C PROJ. # 1488-0032	HORIZONTAL: AS SHOWN	DRAWING NUMBER: E06
DRAWN: CJR	VERTICAL: NA	
DESIGNED: ALA		
CHECKED: ALA		
PROJ. MGR.: CDR		
STATUS: FINAL DESIGN - NOT FOR CONSTRUCTION	REVISION: E	

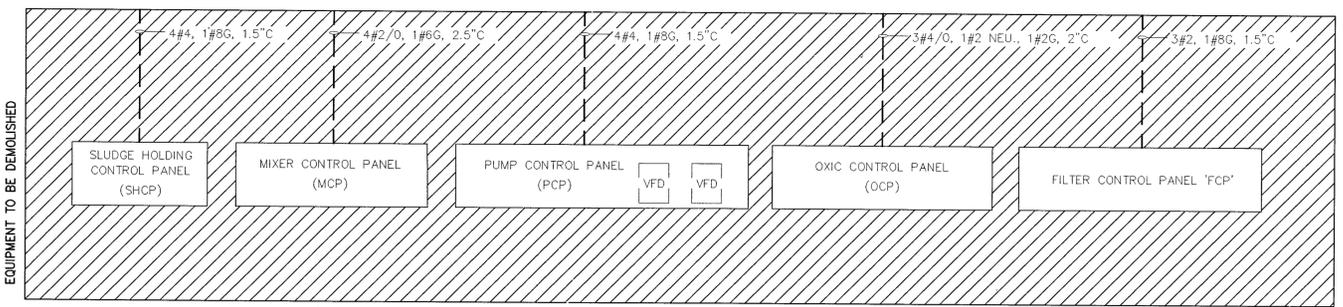
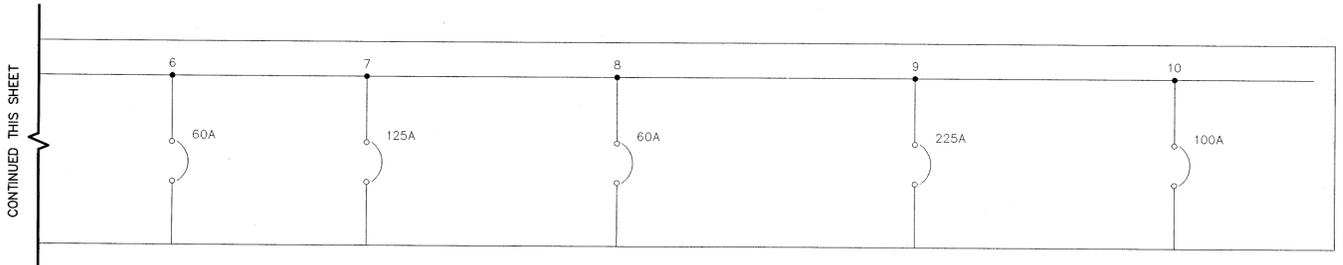
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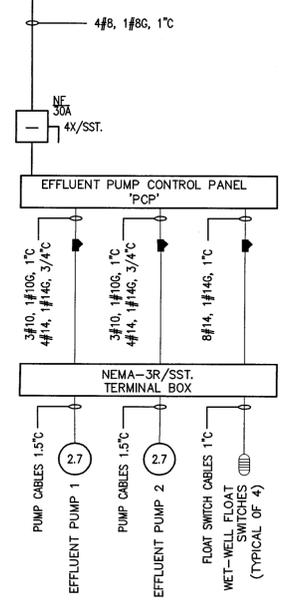
NOTE:
THE INTERRUPTING RATING OF MAIN SERVICE CIRCUIT BREAKER 'MCB' IS MINIMUM OF 30,000 AMPERES AT 240 VOLTS.



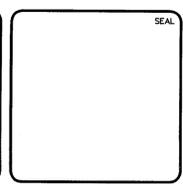
CONTINUED THIS SHEET



SINGLE LINE DIAGRAM
SCALE: N.T.S.



REV. NO.	DESCRIPTIONS	DATE
E	FINAL DESIGN - NOT FOR CONSTRUCTION	1/21/13
D	FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION	8/11/11
C	FINAL DESIGN SUBMITTAL	7/28/11
B	50% DESIGN SUBMITTAL	4/18/11
A	30% DESIGN SUBMITTAL	3/21/11



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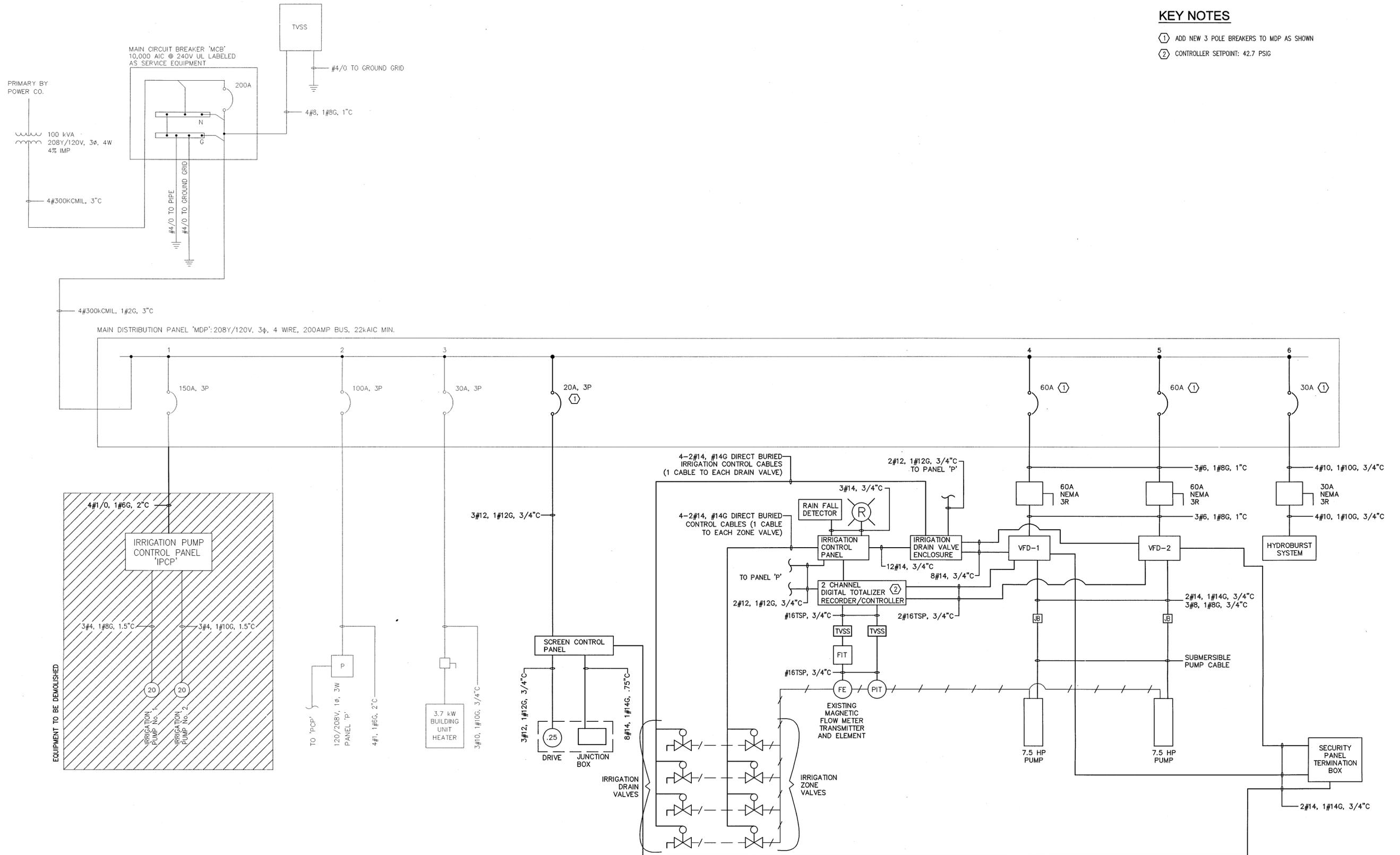
THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

BINGHAM FACILITY WASTEWATER SYSTEM IMPROVEMENTS
ELECTRICAL SINGLE LINE DIAGRAM

DATE: FEBRUARY 2011	SCALE: NA	MAC FILE NUMBER: E07
MCE PROJ. # 1488-0032	HORIZONTAL: NA	DRAWING NUMBER: E07
DRAWN: CJR	VERTICAL: NA	
DESIGNED: ALA		
CHECKED: ALA		
PROJ. MGR.: CDR		
STATUS: FINAL DESIGN - NOT FOR CONSTRUCTION	REVISION: E	

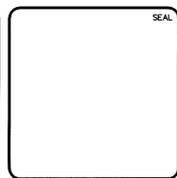
KEY NOTES

- ① ADD NEW 3 POLE BREAKERS TO MDP AS SHOWN
- ② CONTROLLER SETPOINT: 42.7 PSIG



IRRIGATION PUMP STATION SINGLE LINE DIAGRAM
SCALE: N.T.S.

REV. NO.	DESCRIPTIONS	DATE
E	FINAL DESIGN - NOT FOR CONSTRUCTION	1/31/13
D	FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION	8/11/11
C	FINAL DESIGN SUBMITTAL	7/26/11
B	95% DESIGN SUBMITTAL	4/18/11
A	60% DESIGN SUBMITTAL	3/21/11



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THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

BINGHAM FACILITY WASTEWATER SYSTEM IMPROVEMENTS
ELECTRICAL SINGLE LINE DIAGRAM

DATE: FEBRUARY 2011	SCALE:	MAC FILE NUMBER:
MCE PROJ. # 1488-0032	HORIZONTAL: AS SHOWN	DRAWING NUMBER: E08
DRAWN: CJR	VERTICAL: NA	
DESIGNED: ALA		
CHECKED: ALA		
PROJ. MGR.:		
STATUS: FINAL DESIGN - NOT FOR CONSTRUCTION	REVISION: E	

KEY NOTES

- ① EQUIPMENT TO BE REMOVED. BREAKER TO BE LABELED AS SPARE.
- ② DEDICATED RECEPTACLES FOR CHEMICAL FEED PUMPS AND CHEMICAL DRUM PUMP AT NEW CHLORINE CONTACT CHAMBER. SEE E06 FOR DETAILS.
- ③ CONNECT EXISTING SPARE BREAKER TO NEW EQUIPMENT AS SHOWN.

PANEL: M																	
ENCLOSURE: NEMA: 3R MOUNTING: SURFACE										MAIN: 800A							
VOLTS: 120/208V, 3 PHASE, 4 WIRE										NEUTRAL: 100% <input checked="" type="checkbox"/> 200% <input type="checkbox"/>							
LOCATION: SWITCHRACK SWRK-1										BRACING: 22,000A FULLY RATED							
FEED:																	
LOAD SERVED	LOAD (KVA)			BREAKER		BRANCH CIRCUIT CONDUIT & WIRING	CKT	PH	CKT	BRANCH CIRCUIT CONDUIT & WIRING	BREAKER		LOAD (KVA)			LOAD SERVED	
	A	B	C	AMP	POLE						AMP	POLE	A	B	C		
① SOLIDS CUTTER PANEL	0.00			20	3	EXISTING	1	A	2	EXISTING	20		12.00			EXISTING DOMESTIC WASTEWATER SYSTEM	
		0.00				EXISTING	3	B	4	EXISTING	20			12.00			
			0.00			EXISTING	5	C	6	EXISTING	20				12.00		
PANEL BOARD P1	2.80					EXISTING	7	A	8	EXISTING	20		3.70			PANEL BOARD P2	
		2.00		60	3	EXISTING	9	B	10	EXISTING	20		2.90				
			0.80			EXISTING	11	C	12	EXISTING	20				4.00		
	9.60					EXISTING	13	A	14	EXISTING	20		0.00				
PANEL BOARD P3		8.30		200	3	EXISTING	15	B	16	EXISTING	20		0.00			SLUDGE HOLDING CONTROL PANEL	
			0.90			EXISTING	17	C	18	EXISTING	20				0.00		
① MIXER CONTROL PANEL	0.00			125	3	EXISTING	19	A	20	EXISTING	20		0.00				
		0.00				EXISTING	21	B	22	EXISTING	20		0.00			PANEL BOARD P1	
			0.00			EXISTING	23	C	24	EXISTING	20				0.00		
① OXIC CONTROL PANEL	0.00			150	3	EXISTING	25	A	26	EXISTING	20		0.00				
		0.00				EXISTING	27	B	28	EXISTING	20		0.00			FILTER CONTROL PANEL	
			0.00			EXISTING	29	C	30	EXISTING	20				0.00		
TOTAL(S):			12.400	10.300	1.700							15.700	14.900	16.000			
TOTAL BUS A LOAD: 28.100 KVA																	
TOTAL BUS B LOAD: 25.200 KVA																	
TOTAL BUS C LOAD: 17.700 KVA																	
TOTAL CONNECTED KVA: 71.000																	

SCHEDULE NOTES:
 1. REFER TO SPECIFICATION SECTION 16470 PANELBOARDS FOR ADDITIONAL REQUIREMENTS.
 2. ALL BUSSES SHALL BE PLATED COPPER.
 3. ALL BREAKERS SHALL BE FULLY RATED.

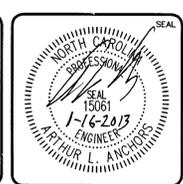
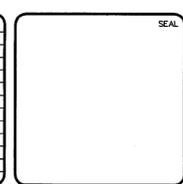
PANEL: P																	
ENCLOSURE: NEMA: 1 MOUNTING: SURFACE										MAIN: 100A							
VOLTS: 120/208V, 3 PHASE, 4 WIRE										NEUTRAL: 100% <input checked="" type="checkbox"/> 200% <input type="checkbox"/>							
LOCATION: IRRIGATION PUMP BUILDING										BRACING: 22,000A FULLY RATED							
FEED:																	
LOAD SERVED	LOAD (KVA)			BREAKER		BRANCH CIRCUIT CONDUIT & WIRING	CKT	PH	CKT	BRANCH CIRCUIT CONDUIT & WIRING	BREAKER		LOAD (KVA)			LOAD SERVED	
	A	B	C	AMP	POLE						AMP	POLE	A	B	C		
LIGHTING	0.50			20	1	EXISTING	1	A	2	EXISTING	20		0.40			RECEPTACLES	
LIGHTING		0.50				EXISTING	3	B	4	EXISTING	20		0.40			RECEPTACLES	
EXTERIOR LIGHTING			0.60			EXISTING	5	C	6	EXISTING	20				0.40	RECEPTACLES	
SPRAY IRRIGATION FLOW METER	0.10					EXISTING	7	A	8	EXISTING	20		0.10			IRRIGATION CONTROLLER	
NEW FLOW RECORDER		0.10				2#12, #12G, 3/4" C	9	B	10	EXISTING	20			0.20		EXHAUST FAN	
NEW SECURITY PANEL			0.10			2#12, #12G, 3/4" C	11	C	12	2#12, #12G, 3/4" C	20			0.40		(REPLACE) SPRAY FIELD DRAIN VALVE CONTROL PANEL	
	0.00					EXISTING	13	A	14	EXISTING	20		0.00			SPARE	
		0.00				EXISTING	15	B	16	EXISTING				0.00		SPACE	
			0.00			EXISTING	17	C	18	EXISTING				0.00		SPACE	
	0.00					EXISTING	19	A	20		20		0.00				
		0.00				EXISTING	21	B	22		20			0.00			
			0.00			EXISTING	23	C	24		20				0.00		
TOTAL(S):			0.600	0.600	0.700							0.500	0.600	0.800			
TOTAL BUS A LOAD: 1.100 KVA																	
TOTAL BUS B LOAD: 1.200 KVA																	
TOTAL BUS C LOAD: 1.500 KVA																	
TOTAL CONNECTED KVA: 3.800																	

SCHEDULE NOTES:
 1. REFER TO SPECIFICATION SECTION 16470 PANELBOARDS FOR ADDITIONAL REQUIREMENTS.
 2. ALL BUSSES SHALL BE PLATED COPPER.
 3. ALL BREAKERS SHALL BE FULLY RATED.

PANEL: P2																	
ENCLOSURE: NEMA: 3R MOUNTING: SURFACE										MAIN: 100A							
VOLTS: 120/208V, 3 PHASE, 4 WIRE										NEUTRAL: 100% <input checked="" type="checkbox"/> 200% <input type="checkbox"/>							
LOCATION: SWITCHRACK SWRK-2										BRACING: 22,000A FULLY RATED							
FEED:																	
LOAD SERVED	LOAD (KVA)			BREAKER		BRANCH CIRCUIT CONDUIT & WIRING	CKT	PH	CKT	BRANCH CIRCUIT CONDUIT & WIRING	BREAKER		LOAD (KVA)			LOAD SERVED	
	A	B	C	AMP	POLE						AMP	POLE	A	B	C		
FLOATING TRANSFER PUMP CONTROL PANEL	1.00			20	3	EXISTING	1	A	2				2.10			EFFLUENT PUMP CONTROL PANEL	
		1.00				EXISTING	3	B	4	4#8, 1#8G, 1" C	30	3		2.10			
			1.00			EXISTING	5	C	6						2.10		
① RECIRCULATION PUMPS CONTROL PANEL	1.50					EXISTING	7	A	8	EXISTING	20		0.10			RPZ ENCLOSURE	
① UV SYSTEM		0.00				EXISTING	9	B	10	EXISTING	20			0.30		AREA LUMINAIRE	
① FLOW METER			0.60			EXISTING	11	C	12	EXISTING	20				0.50	RECEPTACLE	
① SPARE	0.00					EXISTING	13	A	14	EXISTING	20		0.00			SPARE	
① UN MONITOR		0.00				EXISTING	15	B	16	4#10, 1#10G, 1" C	20			0.50		RECEPTACLES FOR CHEM FEED PUMPS	
② ③ RECEPTACLE FOR CHEM DRUM PUMP			0.50			2#10, 1#10G, 1" C	17	C	18	EXISTING	20			0.30		HEAT TRACING FOR CHLORINE TANK	
	0.00					EXISTING	19	A	20	2#10, 1#10G, 1" C	20			0.30		HEAT TRACING FOR EMERGENCY SHOWER	
		0.00				EXISTING	21	B	22	2#10, 1#10G, 1" C	20			0.00		EMERGENCY SHOWER FLOW MONITOR	
			0.00			EXISTING	23	C	24		20				0.00		
TOTAL(S):			2.500	1.000	2.100							2.500	2.900	2.900			
TOTAL BUS A LOAD: 5.000 KVA																	
TOTAL BUS B LOAD: 3.900 KVA																	
TOTAL BUS C LOAD: 5.000 KVA																	
TOTAL CONNECTED KVA: 13.900																	

SCHEDULE NOTES:
 1. REFER TO SPECIFICATION SECTION 16470 PANELBOARDS FOR ADDITIONAL REQUIREMENTS.
 2. ALL BUSSES SHALL BE PLATED COPPER.
 3. ALL BREAKERS SHALL BE FULLY RATED.

REV. NO.	DESCRIPTIONS	DATE
E	FINAL DESIGN - NOT FOR CONSTRUCTION	1/21/13
D	FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION	9/17/11
C	FINAL DESIGN SUBMITTAL	7/28/11
B	90% DESIGN SUBMITTAL	4/18/11
A	60% DESIGN SUBMITTAL	3/21/11



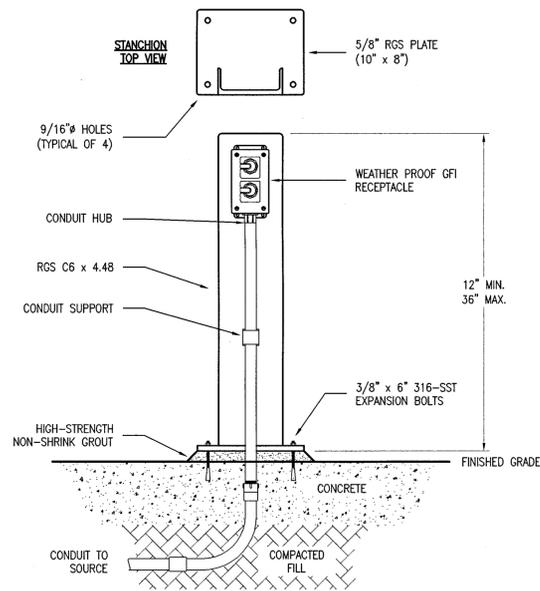
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BINGHAM FACILITY WASTEWATER SYSTEM IMPROVEMENTS
 ELECTRICAL PANEL BOARD SCHEDULE

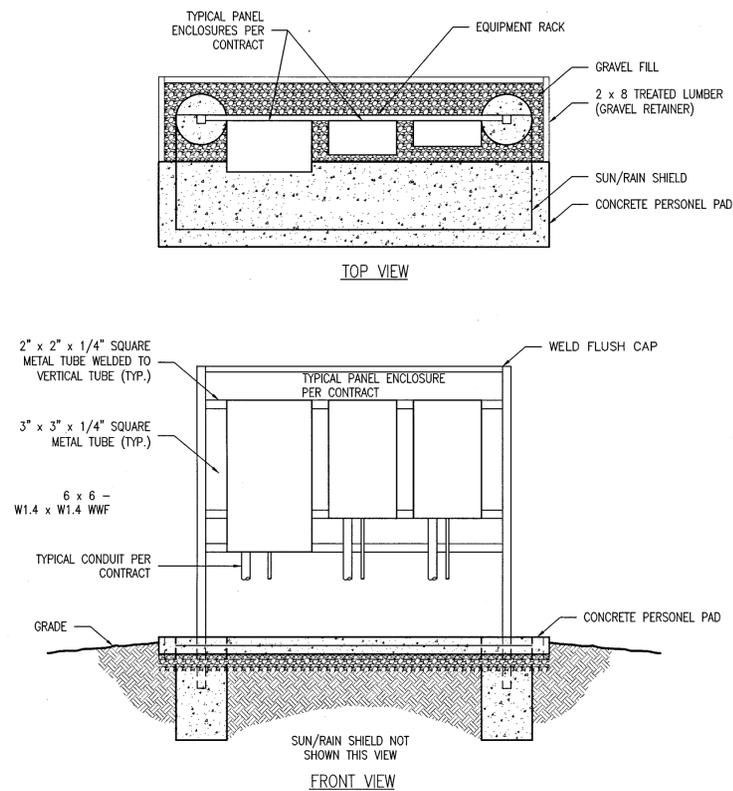
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DESIGNED: ALA	CHECKED: ALA	REVISION: E
PROJ. MGR: CDR	STATUS: FINAL DESIGN - NOT FOR CONSTRUCTION	

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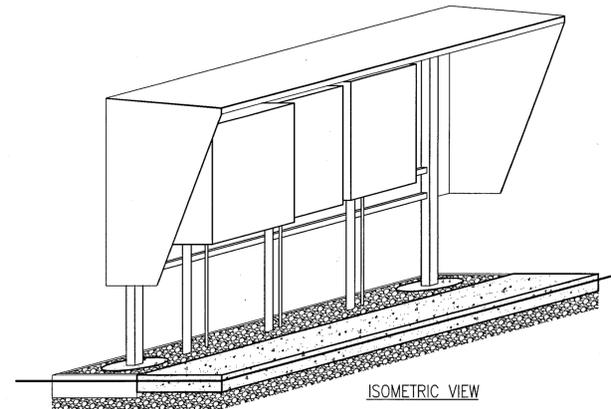


- NOTES:**
1. COAT ALL RGS SURFACES IN CONTACT WITH CONCRETE PER SPECIFICATIONS.
 2. FILE AND ROUND ALL CORNERS SMOOTH, REAM ALL HOLES AND REMOVE ALL SLAG
 3. USE 316-SST FASTENERS AND HARDWARE.
 4. PROVIDE AND INSTALL 18" x 30" DEEP CONCRETE FOUNDATION WHERE MOUNTING SURFACE IS NOT AVAILABLE.

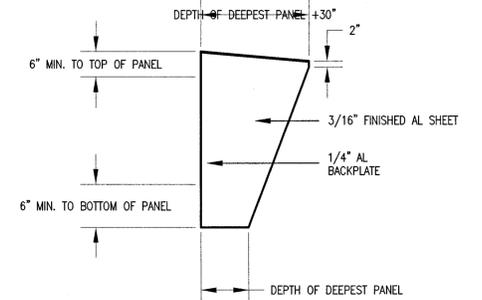
TYPICAL RECEPTACLE STANCHION DETAIL
SCALE: N.T.S.



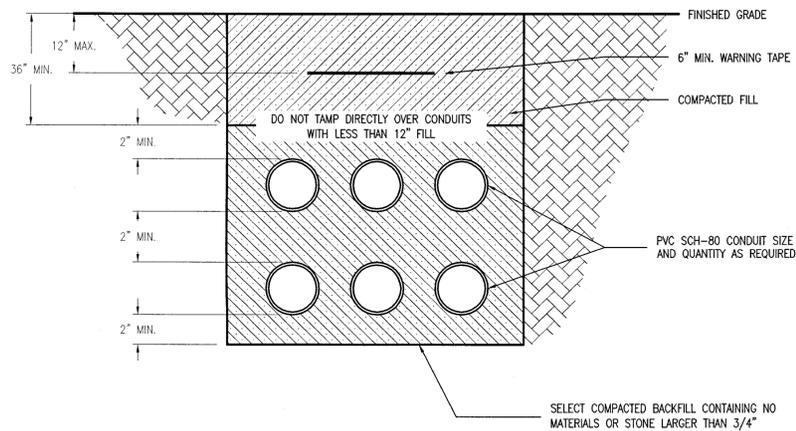
ELECTRICAL EQUIPMENT RACK WITH SUN/RAIN SHIELD
SCALE: NOT TO SCALE



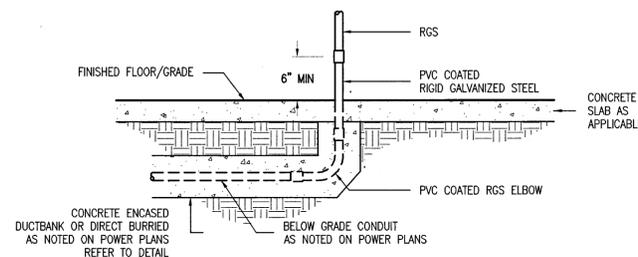
- Notes:**
1. RACK SHALL BE CONSTRUCTED OF GALVANIZED STEEL PAINTED WITH 2 COATS OF INDUSTRIAL GREY PAINT. GRIND SMOOTH ALL WELDS AND TREAT WITH COLD GALVANIZING COMPOUND PRIOR TO PAINTING.
 2. ALL MOUNTING HARDWARE TO BE 316 STAINLESS STEEL.
 3. PROVIDE ADDITIONAL 2"x2"x1/4" SQUARE TUBE SUPPORTS WELDED TO OTHER HORIZONTAL OR VERTICAL SUPPORTS TO MOUNT EACH PANEL. EACH PANEL ENCLOSURE SHALL BE SUPPORTED BY A MINIMUM OF TWO 2"x2"x1/4" SQUARE TUBE SUPPORTS ON THE BACK OF PANELS TOP/BOTTOM OR SIDES.
 4. CONCRETE SHALL BE 3000 PSI. PAD SHALL BE REINFORCED WITH 6x6-1.4Wx1.4W WWF.
 5. WOOD SHALL BE TREATED LUMBER WITH WATERPROOFING APPLIED.
 6. PROVIDE ADDITIONAL VERTICAL 3"x3"x1/4" SQUARE TUBE RACK SUPPORT AND BASES LIKE ENDS SHOWN TO SPAN GREATER THAN 108".
 7. SUBMIT LAYOUT OF EQUIPMENT RACKS PRIOR TO FABRICATION.
 8. WHERE THE EQUIPMENT RACK IS SHOWN ON THE PLANS NEXT TO AN EQUIPMENT PAD, THE EQUIPMENT PAD WILL TAKE THE PLACE OF THE PERSONEL PAD SHOWN ON THIS DETAIL. PROVIDE ADDITIONAL GRAVEL AND WOOD EDGING TO EQUAL THE HEIGHT OF THE EQUIPMENT PAD.
 9. WHERE SHOWN OR PROVIDED, ALARM STROBE AND HORN SHALL BE MOUNTED ON SUN/RAIN SHIELD.
 10. WHERE SCHEDULED OR SHOWN ON THE PLANS PROVIDE WEATHERPROOF CORROSION RESISTANT FLOURESCENT FIXTURE MOUNTED UNDERNEATH SUN/RAIN SHIELD, LIGHT SWITCH, AND GFI RECEPTACLE.
 11. WHERE SHOWN ON PLANS PROVIDE BACK-BACK RACK EQUIPMENT MOUNTING.



SUN/RAIN HOOD DETAIL (SIDE-VIEW)
SCALE: NOT TO SCALE



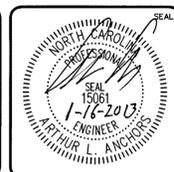
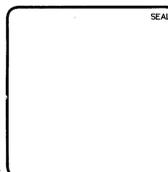
DIRECT BURIED DUCTBANK
SCALE: N.T.S.



NOTE: PVC COATED RGS CONDUIT MAY NEED TO EXTEND FARTHER THAN 6" SHOWN TO PASS THROUGH HAZARDOUS AREAS WITHOUT CREATING A BREAK. REFER TO SEAL-OFF WIRING DETAIL FOR ADDITIONAL REQUIREMENTS.

TYP. CONDUIT TRANSITION DETAIL
SCALE: N.T.S.

REV. NO.	DESCRIPTIONS	DATE
E	FINAL DESIGN - NOT FOR CONSTRUCTION	1/31/13
D	FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION	8/11/11
C	FINAL DESIGN SUBMITTAL	7/26/11
B	95% DESIGN SUBMITTAL	4/26/11
A	60% DESIGN SUBMITTAL	3/21/11

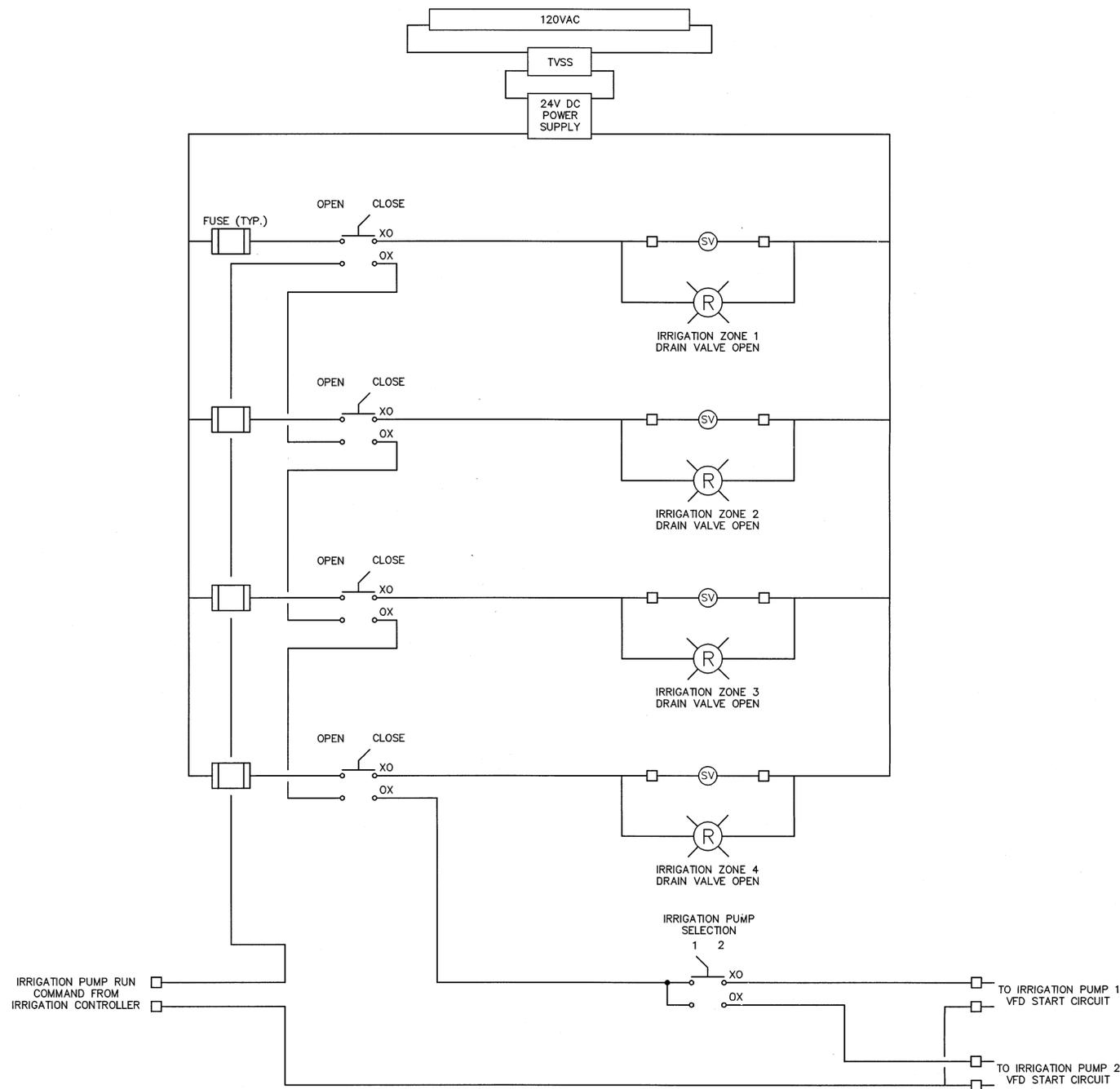


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BINGHAM FACILITY WASTEWATER SYSTEM IMPROVEMENTS
ELECTRICAL DETAILS

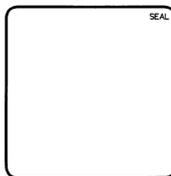
DATE: FEBRUARY 2011	SCALE:	MAC FILE NUMBER:
MCE PROJ. # 1488-0032	HORIZONTAL: AS SHOWN	DRAWING NUMBER: E10
DRAWN: CJR	VERTICAL: NA	
DESIGNED: ALA		
CHECKED: ALA		
PROJ. MGR: CDR		
STATUS: FINAL DESIGN - NOT FOR CONSTRUCTION	REVISION: E	



DRAIN VALVE CONTROL / PUMP SELECT CONTROL PANEL
SCALE: N.T.S.

- NOTES:
 1. REFER TO SPECIFICATION 11650 FOR ADDITIONAL REQUIREMENTS.
 2. CONTROL DIAGRAM MAY NOT SHOW ALL COMPONENTS REQUIRED FOR A COMPLETE THIRD PARTY-LABELED ASSEMBLY.
 3. REFER TO DRAWING E02 FOR DRAIN VALVE LOCATIONS.

REV. NO.	DESCRIPTIONS	DATE
E	FINAL DESIGN - NOT FOR CONSTRUCTION	1/31/13
D	FINAL DESIGN - NOT RELEASED FOR CONSTRUCTION	8/1/11
C	FINAL DESIGN SUBMITTAL	7/26/11
B	90% DESIGN SUBMITTAL	4/26/11
A	60% DESIGN SUBMITTAL	3/21/11



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THE UNIVERSITY
of **NORTH CAROLINA**
 at **CHAPEL HILL**

BINGHAM FACILITY
WASTEWATER SYSTEM IMPROVEMENTS

ELECTRICAL
WIRING DIAGRAM

DATE:	FEBRUARY 2011
MCE PROJ. #	1488-0032
DRAWN:	CJR
DESIGNED:	ALA
CHECKED:	ALA
PROJ. MGR.	CDR

SCALE	MAC FILE NUMBER
HORIZONTAL: AS SHOWN	DRAWING NUMBER E11
VERTICAL: NA	REVISION E

STATUS: **FINAL DESIGN - NOT FOR CONSTRUCTION**

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THE UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL

UNC-BINGHAM FACILITY
WASTEWATER SYSTEM IMPROVEMENTS

DESIGN MANUAL
AMENDMENT NO. 1

JANUARY 2013



Prepared By:

McKim & Creed, Inc.
1730 Varsity Drive, Suite 500
Raleigh, NC 27606

**BINGHAM FACILITY
WASTEWATER SYSTEM IMPROVEMENTS**

**DESIGN MANUAL AMENDMENT NO. 1
TABLE OF CONTENTS**

~~BASIS OF DESIGN REPORT..... TAB 1~~
~~EXISTING SYSTEM REFURBISHMENT..... TAB 2~~
~~SODIUM HYPOCHLORITE DISINFECTION SYSTEM..... TAB 3~~
~~EFFLUENT PUMP STATION..... TAB 4~~
~~WET WEATHER STORAGE BASIN..... TAB 5~~
~~DRIP IRRIGATION SYSTEM..... TAB 6~~

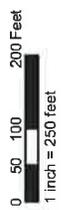
NOTE: Replace contents of previously submitted Tab 6 with contents of Design Manual Amendment No. 1.

Existing Bingham Site Layout With Available Secondary Irrigable Area

- Streams*
 - Surface Water Diversions #
 - Streets
 - Secondary Effluent Irrigable Area
 - Soil Area 1
 - Soil Area 2
 - Soil Area 3
 - Wetlands (Biohabitats)
 - Proposed Wastewater Facilities
 - Proposed Chiller Building
 - Existing Wastewater Facilities
 - Existing Building Footprints
 - Existing Paved Area
 - Bingham Property Boundary
 - Orange County Parcels
- * Stream locations from McKim & Creed Survey
 # Surface water diversions from Biohabitats



Secondary Effluent	Acres
Soil Type 1	7.655
Soil Type 2	3.622
Soil Type 3	0.503
Total	11.78



4.2 RECOMMENDATIONS:

The recommendations resulting from this analysis are summarized as follows:

- The loading rates were established at one value to simplify operation;
- Use an annual average loading rate 0.158 inch per week for the Group 1 soil; and, 0.158 inch per week for the Group 2 Soil;
- Use the good agronomic practices recommended in the Soil, Water & Environment, Group report, December 2010;
- Irrigate at doses less than 0.1 inch;
- Plan for summer drawdown irrigation rate up to 0.62 inch per week
- Provide storage for 964,849 gallons;
- Provide nitrification (verbal communication with Mr. Kevin Eberle, PE) to reduce the land requirement to less than 5.72 acres for spray irrigation site.
- The MT3D simulation indicated that the potential for migration into the deeper fracture system is not direct.

In summary, the site can be used safely for a discharge using spray irrigation as follows: 2,183 gallons per day at a loading rate up to 0.158 inch per week on the Group 1 on 3.56435 acres; and, 1,318 gallons per day at a loading rate of 0.158 in/wk on the Group 2 on 2.152748 acres for a total of 3,500 gallons per day.



- MEMO
- TELEPHONE
- FIELD REPORT
- CONFERENCE

DATE: 12-11-12 TIME: _____

AUTHOR: Stephanie Kellogg

PROJECT: Bingham Facility WW System CLIENT: UNX

SUBJECT: Irrigation System PROJ. NO. 01488-0032

1. Application Rates (From Hydrogeologic Report)

Soil Type	Name	Agronomy	Rate
SA-1	Georgeville	Grass/Mixed Pines	0.158 in/wk
SA-2	Hendon	Grass	0.153 in/wk

Max. App. Rate (Summer Drawdown) : 0.162 in/wk

2. Total Site Capacity

Soil Type	Acres
SA-1	3.5104
SA-2	2.153
Total: 5.72 acres	

$$\frac{0.158 \text{ in/wk}}{(12 \text{ in/ft})(7 \text{ day/wk})} \times 43,510 \frac{\text{ft}^3}{\text{ac}} \times 5.72 \text{ ac} \times 7.48 \frac{\text{gal}}{\text{ft}^3} = 3,500 \frac{\text{gal}}{\text{day}}$$

3. Application Rate per Acre

Assume Design Application Rate = 0.22 in/hr

$$\frac{0.22 \text{ in/hr}}{12 \text{ in/ft}} \times 43,510 \frac{\text{ft}^3}{\text{ac}} \times 7.48 \frac{\text{gal}}{\text{ft}^3} = 5,970 \frac{\text{gal}}{\text{ac}} \approx 100 \frac{\text{gpm}}{\text{ac}}$$

4. Operation

Max dose (from Hydrogeologic Report) : 0.1 in/hr

ACTION

COPY:



- MEMO
- TELEPHONE
- FIELD REPORT
- CONFERENCE

DATE: _____ TIME: _____

AUTHOR: _____

PROJECT: _____ CLIENT: _____

SUBJECT: _____ PROJ. NO. _____

$$\frac{0.1 \text{ in/hr}}{12 \text{ in/ft}} \times 43,560 \text{ ft}^2/\text{ac} \times 7.48 \text{ gal/ft}^3 = 2,715 \text{ gal/ac / max dose}$$

Irrigation time for max. dose: $\frac{2,715 \text{ gal/ac}}{5,970 \text{ gph/ac}} \times 60 \text{ min/hr} \approx 30 \text{ min}$

$$\frac{0.60 \text{ in/wk}}{12 \text{ in/ft}} \times 43,560 \text{ ft}^2/\text{ac} \times 7.48 \text{ gal/ft}^3 = 116,835 \text{ gal/wk / acre}$$

Max. Doses per week: $\frac{116,835 \text{ gal/wk}}{2,715 \text{ gal/max dose}} \approx 6 - 30 \text{ min doses/wk}$

⇒ use 12 - 15 min doses/wk

$$\frac{0.158 \text{ in/wk}}{12 \text{ in/ft}} \times 43,560 \text{ ft}^2/\text{ac} \times 7.48 \text{ gal/ft}^3 = 4,290 \text{ gal/wk / acre}$$

Min. Doses per week: $\frac{4,290 \text{ gal/wk}}{2,715 \text{ gal/max dose}} \approx 2 - 30 \text{ min doses/wk}$

⇒ use 4 - 15 min doses/wk

5. System Design

Use Dura-Flo PC Dripperline as basis of design
 - pressure compensating inline emitters pre-inserted into
 1/2" tubing at constant intervals
 SFPC - BR - 7818 - 05 (1.8 gph @ 40 psi)

ACTION

COPY:



- MEMO
- TELEPHONE
- FIELD REPORT
- CONFERENCE

DATE: _____ TIME: _____

AUTHOR: _____

PROJECT: _____ CLIENT: _____

SUBJECT: _____ PROJ. NO. _____

Zone	Acres	Flow	Emitters
1	1.53	$100 \text{ gpm/ac} \times 1.53 = 153 \text{ gpm}$	$153 \text{ gpm} / 0.8 \text{ gph} = 5,100$
2	1.55	155 gpm	5,167
3	1.55	155 gpm	5,167
4	1.09	109 gpm	3,634

Use emitters spaced 18" apart
 tubing spaced @ 8'
 laterals spaced @ 80'

ACTION _____

COPY: _____



ESP Modular Series Controller

4, 7, 10 or 13 Station Indoor or Outdoor Controller

Rain Bird® ESP-Modular Irrigation Controllers are indoor or outdoor controllers that can easily expand from 4 to 13 stations to meet your landscape needs. They have three independent programs and an array of features for maximum flexibility. They also incorporate Rain Bird's ESP Extra Simple Programming, making it easy to monitor and adjust watering schedules.



[Buy Now](#)

[Features](#)

[Models](#)

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Operating Specs

- Number of programs: 3 independent
- Automatic Starts: 4 per program, 12 total
- Station timing: 0 to 6 hours for all stations
- Independent programming schedules:
 - Custom (user selects the day of the week to water)
 - Odd (watering occurs on only odd days of the month except the 31st and February 29th on a leap year)
 - Even (watering occurs on only even days of the month)
 - Cyclical (watering occurs between from once a day to once every 31 days)

Electrical Specifications

- Input required: 120 VAC \pm 10%, 60Hz
- Output: 25.5 VAC 1A
- Surge Protection: Primary input side has built in MOV (metal oxide varistor) to protect microcircuitry. Output side has 1 built in MOV for each valve station
- Power back-up: Lithium coin-cell battery maintains time and date while non-volatile memory maintains the schedule
- Multi-valve station capacity: Up to two 24 VAC, 7VA solenoid valves per station plus a master valve

Dimensions

- Width: 10.7 in. (27,2 cm)
- Height: 7.7 in. (19,5 cm)
- Depth: 4.4 in. (11,2 cm)

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[Video Tutorial](#)



[ESP Modular Interactive Tour](#)

[Remote Control](#)

Learn about the remote designed for this controller!

Introducing the Rain Bird Landscape Irrigation & Maintenance Remote.



[CLICK TO LEARN MORE >](#)

The ESP-Modular Controller Maximize Your Productivity

A member of the popular ESP family of controllers, the ESP-Modular is designed to maximize your productivity by saving you time and money. The large, easy to read display and intuitive programming sequence make this the most user-friendly controller in its class. The spacious cabinet and terminal locations make installation and wire-up a snap. And features like the Contractor Default™ program make service calls more efficient and earn you more money by taking less time! The ESP-Modular: Maximizing your Productivity.

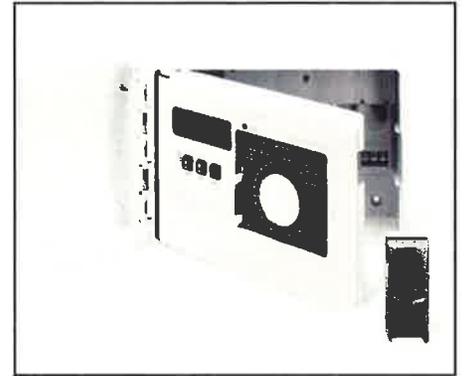
Features

- ESP Programming: Extra-Simple Programming with large numbers and text in the LCD to aid user programming
- Three independent programs with 4 start times each for a total of 12 start times
- Four station base model with the capacity to receive plug-in station modules of three stations each allows the controller to expand from 4 to 13 stations
- Hot swappable modules can be installed while in operation and in any position
- Station 13, called an "Auxiliary Station™" can bypass an active sensor to allow watering even if the other stations are disabled or can operate as a normal station
- Contractor Default™ setting allows the contractor to set his own default program and can be accessed with the push of a button. Useful in easily restoring a schedule that has been altered by a homeowner or to replace a temporary schedule for new seed or sod
- 5-year lithium battery maintains time and date during a power outage.
- 365-day calendar with leap year intelligence means that you can set an "Odd" or "Even" day watering schedule and not worry about changing the date on leap years
- Four irrigation cycle modes for maximum flexibility and compliance to all major watering restrictions (Custom 7-day calendar, 1-31 day cycle and odd/even cycles)
- Non-volatile memory maintains the irrigation schedule indefinitely during a power outage

- Permanent day off feature prevents watering on any day of the week in any cycle mode
- Global Season Adjust (0-200%) allows the user to alter the run time of all the valves in every program with the push of a button
- Dedicated sensor terminals allow the user to easily connect a sensor to the controller for maximum water efficiency. A light (LED) and a message on the LCD indicates when a sensor is active
- Sensor bypass switch allows the user to override an active sensor
- Diagnostic self-setting circuit breaker identifies a valve or wire fault and continues to water operable stations
- Enhanced Diagnostic Feedback™ alerts the user to programming errors and other conditions that may render a schedule inoperable
- "Valve Test Terminal" allows the installer to test the valve wires during installation to determine the valve that each wire is connected to
- Master valve/pump start circuit programmable by station allows operation of connected pump as needed.
- Programmable Delay between station feature allows additional time between zones for water well recovery or slow closing valves
- Spacious heavy-duty cabinet with internal junction box provides lots of room for wiring and eliminates the need to purchase an external j-box for a clean and professional looking installation. Outdoor model comes with key-locking cabinet
- Remote ready connector enables the controller to be used with RM1 and RMX1 remote control systems where available.

Operating Specs

- Station timing: 0 to 6 hours for all stations
- Automatic Starts: 4 start times per program on the quarter hour for up to a total of 12 start times per day if using all three programs
- Independent programming schedules:
 - ◆ Custom (water by day of the week)
 - ◆ Odd (water on odd days of the month except 31st or 29th if leap year)
 - ◆ Even (water on even days of the month)
 - ◆ Cyclic (1-31 days: Water from every other day to once every 31 days)



Electrical Specifications

- Input required: 120 VAC ±10%, 60Hz or 230VAC/240VAC ±10%, 50Hz.
- Output: 25.5 VAC 1A
- Surge Protection: Primary input side has 2 built in MOVs (metal oxide varistors) to protect microcircuitry. Output side has 2 built in MOVs for each valve station.
- Power back-up: Lithium coin-cell battery maintains time and date while non-volatile memory maintains the schedule
- Multi-valve station capacity: Up to two 24 VAC, 7VA solenoid valves per station plus a master valve

Dimensions

- Width: 10.7 in. (27,2 cm)
- Height: 7.7 in. (19,5 cm)
- Depth: 4.4 in. (11,2 cm)

Models

- ESP-4Mi: 4 station indoor model
- ESP-4M: 4 station outdoor model*
- ESP-SM3: 3-station module

*Available in 120VAC, 230VAC and 240VAC models.

How to Specify

ESP-4Mi **ESP-SM3**

**Controller
Base Model**

ESP-4Mi: Indoor
ESP-4M: Outdoor

Modules

3-Station Module



Specifications

The controller shall be of a hybrid type that combines electro-mechanical and microelectronic circuitry capable of fully automatic or manual operation. The controller shall be housed in a wall-mountable, weather-resistant plastic cabinet with a key-locking cabinet door (outdoor models only) suitable for either indoor or outdoor installation.

The controller shall have a base unit with 4 stations as well as three expansion slots capable of receiving station modules of three stations each to create a controller of up to 13 stations. Station 13 shall be called an "auxiliary station" and shall have the capability of bypassing an active rain sensor or of functioning as a normal station output. Station timing shall be from 0 minutes to 6 hours. Run time resolution shall be in 1-minute increments from 0 to 59 minutes and 10 minutes from 1 to 6 hours. The LCD shall display "No Run Times" or equivalent icon for 230 VAC models if no run time has been entered for any station in any program.

The controller shall have three separate and independent programs which can have different start times, station timing and watering days. Each program shall have up to 4 start times available. The controller shall track multiple start times in sequence to prevent hydraulic overload. The LCD shall display "No Start Times" or the equivalent icon for 230VAC models if no start time has been entered for any program. The controller shall be capable of operating two 24 VAC solenoid valves per station plus a master valve or remote pump start relay. The controller shall operate on 120 VAC ± 20% at 60Hz (230VAC ± 20% at 50Hz for international models). The controller shall have an electronic, diagnostic circuit breaker that shall sense a station with an electrical overload or short circuit and shall bypass that station and continue operating all other stations.

The controller shall have a 365-day calendar with a permanent day off feature that allows a

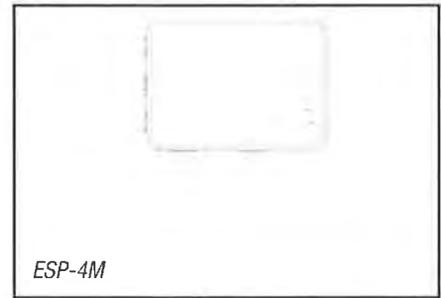
day(s) of the week to be turned OFF on any cycle (odd/even/1-31 day cycle). A day set to "Permanent Off" shall override the normal repeating schedule and shall display the words "Day Always Off/Day Off" in the LCD screen. The controller shall have a seasonal adjust feature adjustable from 0% to 200% in increments of 10%. Seasonal adjust shall effect all programs simultaneously. If seasonal adjust is set to 0% the LCD shall display "SEASONAL ADJ" (equivalent icon for 230 VAC models).

The controller shall have a 12-hour AM/PM or 24 hour military (for 230VAC models) clock with a midnight day change over. The controller shall have a sensor circuit for connection to a rain sensor or to an underground moisture sensor system that will interrupt a scheduled watering under "wet" or "moist" conditions. The controller shall have an indicator on the LCD screen and one LED light to indicate that a sensor is connected and active and that watering has been temporarily disabled.

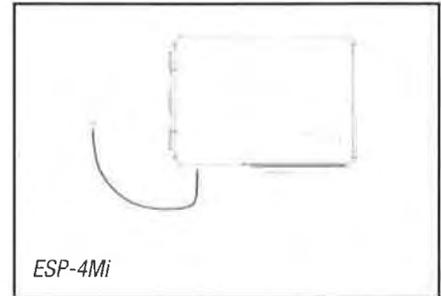
The controller shall have access to a variety of "hidden features" by turning the dial to a specific location on the dial and pushing the ON OFF buttons simultaneously. These features shall include: 1) save a custom default program 2) retrieve a custom default program 3) bypass an active rain sensor on the Auxiliary Station 4) allow the Auxiliary Station to be interrupted by an active rain sensor 5) Clear memory 6) Set a day as "Permanently Off" 7) Set master valve/pump start circuit by station 8) Set programmable delay between station.

The controller shall have the following manual operations and manual advances for semi-automatic control:

- Run a single valve
- Run multiple manually stacked valves
- Run a semi-automatic program
- Run a test on all valves (all stations with any time assigned regardless of the program) from 1 to 10 minutes



ESP-4M



ESP-4Mi

The controller shall have a removable, battery programmable front panel (uses a 9 volt battery [not included]) for conveniently programming the controller away from the installation site or for teaching irrigation scheduling.

The controller shall have the capacity for the program to be erased allowing the user to start programming with a blank controller. The controller shall have multiple knockouts, sizes and locations, including the back of the cabinet, to facilitate installation and provide a clean professional look. The controller shall have a factory default program that runs 10 minutes every day beginning 8 hours after power resumption.

The controller shall have a reset button to reset the controller in the case of micro-controller "lock-up" due to power surges or frequent interruption to the power supply.

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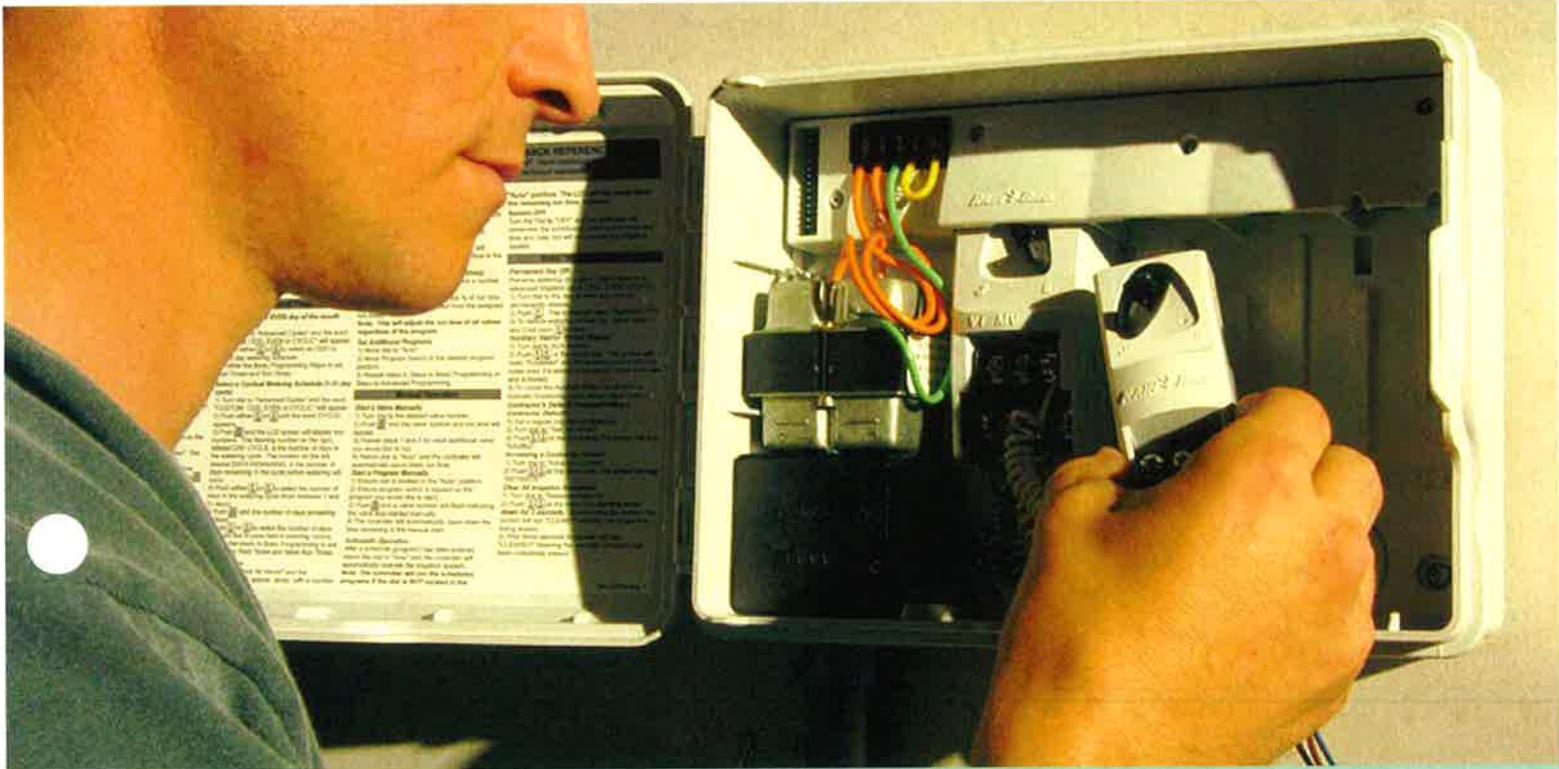
ESP Modular Controllers

Installing another controller would be a waste of time.





Never again will you have to replace a controller just to add more stations.



Rain Bird® ESP Modular Controllers make time work to your advantage:



Easily upgrades from 4 to 13 stations with the addition of 3-station modules at installation or in the future



Installation is a snap with the roomy cabinet and horizontal terminal strips



Improves upon Rain Bird's already easy-to-use ESP style of programming



Reinforces Rain Bird's proven track record for quality, reliability and homeowner peace of mind

Take a few moments right now to review the Inside Story, then see your Rain Bird distributor for all the details about ESP Modular Controllers.

NEW

5-Year Lithium Battery

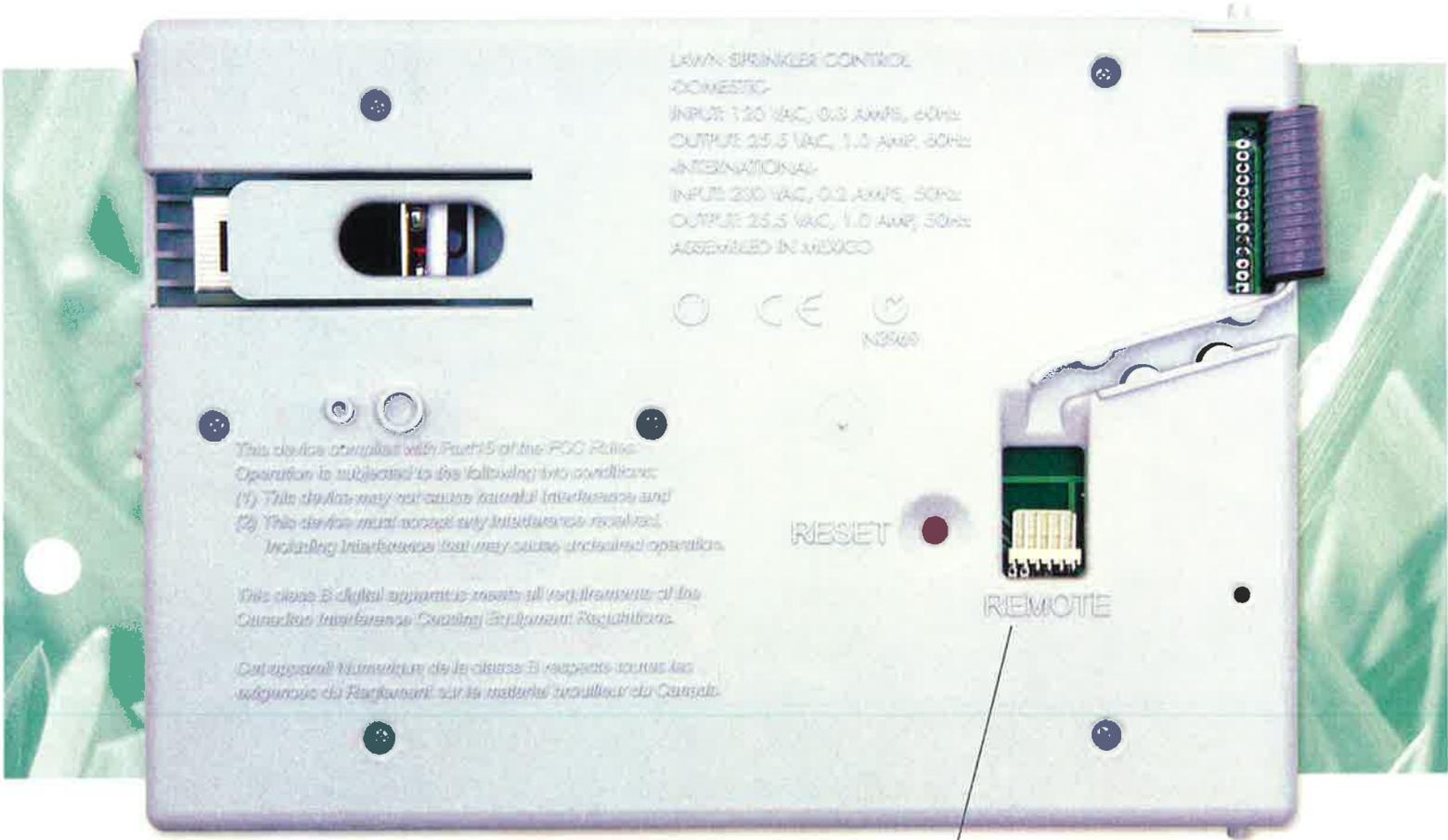
Maintains the time and date for a cumulative life of 5 years without AC power.

Non-volatile Memory

Maintains the irrigation schedule during a power outage

Remote Panel Programming

Allows you to program the front panel by installing an optional 9V battery



NEW

Programmable Master Valve/ Pump Start Circuit

Allows the user to set the pump to operate with specific stations as needed.

NEW

Programmable Delay Between Stations

Allows additional time between zones for water well recovery or slow closing valves.

Remote-ready Connector

Enables the controller to be used with Rain Bird's *Remote Control Systems* where available

Fuseless, Diagnostic Circuit Breaker

Identifies a station with valve or wiring problems, and continues to water operable stations

Valve Test Terminal

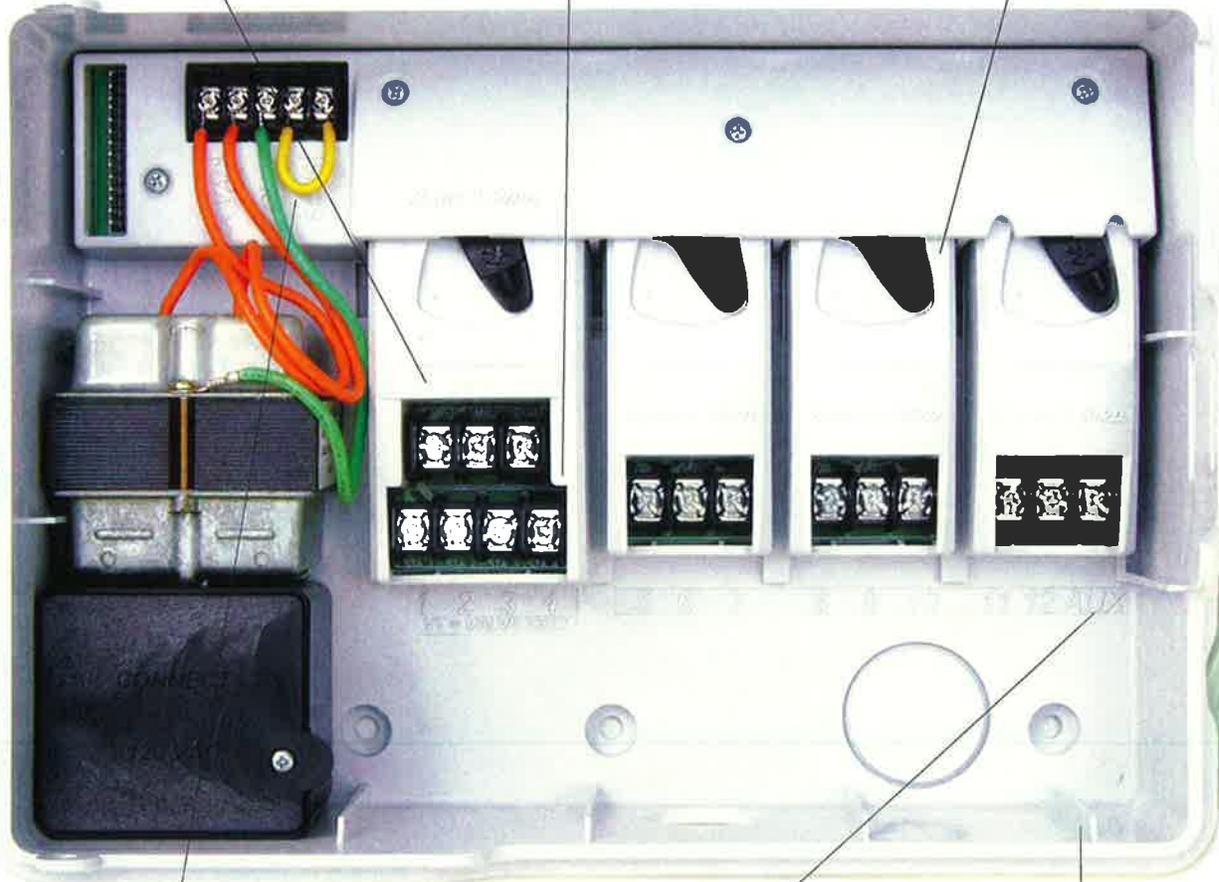
Allows you to quickly match field wires with valves during installation

Four Station Base Model

Capacity to receive plug-in modules of three stations each to allow expansion from 4 to 13 stations

Hot-swappable Modules

Make installations quick and easy, because they can be installed while in operation and in any position



Dedicated Sensor Terminals

Allows the user to easily connect a sensor to the controller for maximum water efficiency—the red LED warning light comes on and stays on when the sensor is active

Auxiliary Station™

Station 13 can be set to bypass an active sensor to allow watering even if other stations are disabled, or can operate as a normal station. Ideal for covered patio irrigation, landscape lighting, or other non-irrigation systems

Large, Spacious Cabinet w/ Internal Junction Box

Affords easy access, quick wire-up and eliminates the need to purchase an external j-box for a clean, professional installation

Large LCD Screen and Simple Dial

Bigger numbers and text messages make this controller very easy to use

365-day Calendar

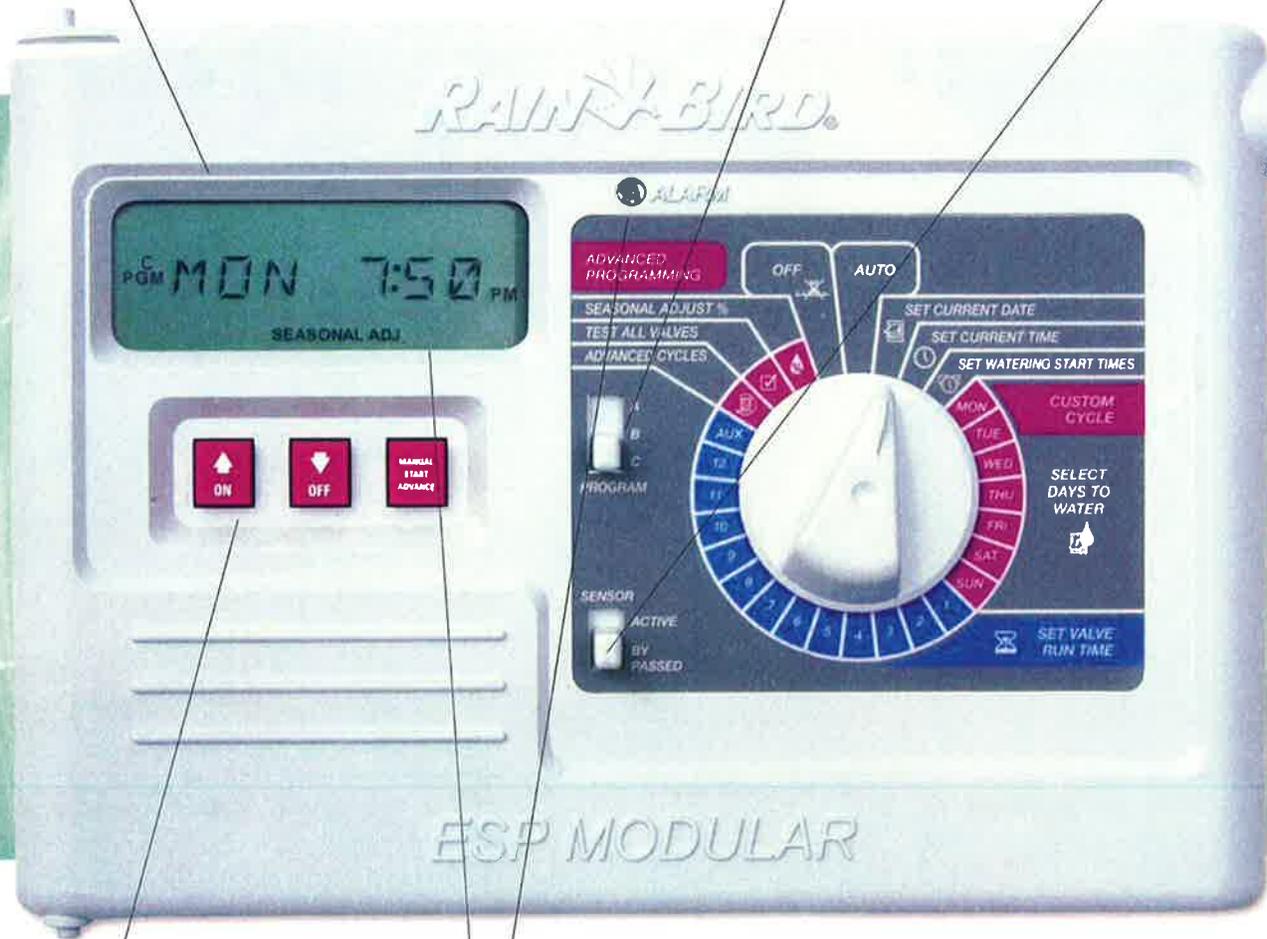
Includes leap year intelligence, provides accurate odd/even calendar day watering

3 Programs Feature

A slide switch makes for easy program selection and reduces programming errors

Sensor Bypass Switch

Allows the user to override an active sensor for maintenance or run a station or program manually



Contractor Default™ Program

Allows you to set up a program, save it to memory, then recall it without having to reprogram the controller zone by zone. The benefit: easily reloads a schedule that has been accidentally altered by the homeowner, or replace a temporary schedule for new seed or sod

Enhanced Diagnostic Feedback™

Alerts the user to programming errors and other conditions that may prevent an irrigation schedule from running. The benefit: the homeowner can fix the problem so you don't have to make a service call

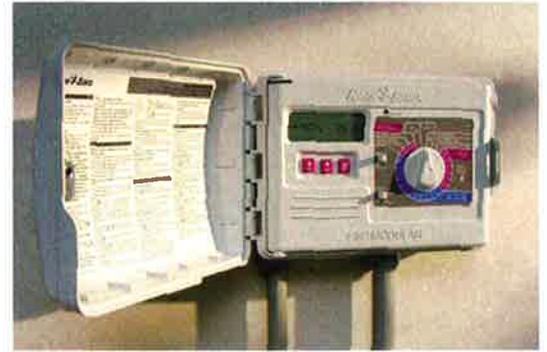


Permanent-Day-Off

Allows the user to set any day of the week as a non-watering day in any program or schedule, making it easy to comply with watering restrictions or other requirements, such as weekly lawn care or maintenance

From the company contractors rate #1 in controller reliability, performance, long life and overall quality,* the tradition continues. Install Confidence.® Install Rain Bird® ESP Modular Controllers.

** Scores obtained from the independent survey commissioned by Rain Bird, "Residential and Commercial Installer Customer Satisfaction Research" by Market Research Associates, May 2001.*



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WR2 Series Wireless Rain/Freeze Sensors

Superior Signal Reliability and Ease of Use

The **Rain Bird Wireless Rain Sensor** is designed for 24 VAC residential and commercial irrigation systems. This high-quality product saves water and extends irrigation system life by automatically sensing precipitation and interrupting irrigation during rain and low temperature events.

Programming logic can suspend irrigation using the "Quick Shut Off" feature or when the amount of rainfall exceeds the rainfall set point. Likewise, the **Wireless Rain / Freeze Sensor** will suspend irrigation when the system reaches a programmed low temperature set point.

Features & Benefits

- Enhanced antenna array provides superior signal reliability that overcomes most line-of-sight obstructions
- Sensor signal strength indicator enables one person set up, reducing installation time
- Convenient adjustment and monitoring of rain or freeze settings at the controller interface
- Simple battery replacement requiring no tools or need to disassemble sensor
- Highly intuitive icon-driven controller interface simplifies programming
- Easy to install, self-leveling sensor bracket mounts to flat surfaces or rain gutters
- Antennas concealed within the units for greater visual appeal and product robustness
- "Quick Shut Off" interrupts active irrigation cycle during a rain event

Models

Product Models	Description
WR2-RC	Rain Combo
WR2-RFC	Rain/Freeze Combo
WR2-RS	Rain Sensor Only
WR2-RFS	Rain/Freeze Sensor Only
WR2-RFI	Rain/Freeze Controller Interface Only

Electrical Specifications

- Application: suitable for use with 24 VAC controllers (with or without pump start / master valve)
- Electrical rating suitable for use with up to six 24VAC 7VA solenoids plus an additional master valve or pump start that does not exceed 53VA
- Controller Interface Wire: 30" (76 cm) length of #22 gauge (0.64 mm) UV resistant extension wire
- UL, cUL, CE, C-Tick, and WEEE certifications
- FCC approved spread spectrum 2 way radio transceivers with FCC Class B approvals
- Signal transmission distance of 700' Line of Sight
- Battery life: four or more years under normal operating conditions
- 6 KV surge / lighting protection

Mechanical Properties

- Adjustable rainfall settings from 1/8" – 1/2" (3 – 13 mm)
- Adjustable low temperature settings from 33°F – 41°F (0.5° – 5°C)
- Three irrigation modes to select: Programmed, Suspend Irrigation for 72 hours, Override sensor for 72 hours
- "Quick Shut Off" suspends active irrigation cycle within approximately two minutes
- High-grade, UV resistant polymer units resist harmful environmental affects

Dimensions

WR2 Controller Interface

- Width: 3.1" (7.9 cm)
- Length: 6.8" (17.2 cm)
- Depth: 1.7" (4.3 cm)
- Distance between Mounting Holes: 6.25" (15.9 cm)



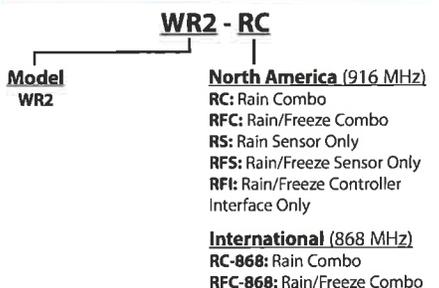
WR2 Sensor Assembly

- Sensor Length: 5.8" (14.7 cm)
- Attachment Bracket Length: 4.6" (11.7 cm)
- Distance between Mounting Holes: 4.25" (10.8 cm)
- Horizontal displacement (bracket + fixed ball arm): 5.5" (14.0 cm)

Replacement or Spare Parts

- WR2 Battery - #651009S
- WR2 Disk Assembly - #637810S

How to Specify/Order



Specifications

The wireless rain or rain / freeze sensor shall employ an electro-mechanical actuating mechanism designed to cause a circuit interrupt if programmable low temperature or rainfall set points are satisfied. Satisfied set points cause the device to temporarily suspend the irrigation controller schedule. As environmental conditions return to a state that no longer satisfy the low temperature or rainfall set points, the controllers normal irrigation schedule is resumed. The sensor shall be wired to normally closed (N.C.) controllers – in series with the valve common, or alternately, wires shall be inserted into the appropriate controller sensor terminal ports.

The device shall be of rugged construction to withstand the elements, including exposure to sunlight and precipitation. Antennas shall be concealed within the sensor and controller interface to improve aesthetics and product robustness.

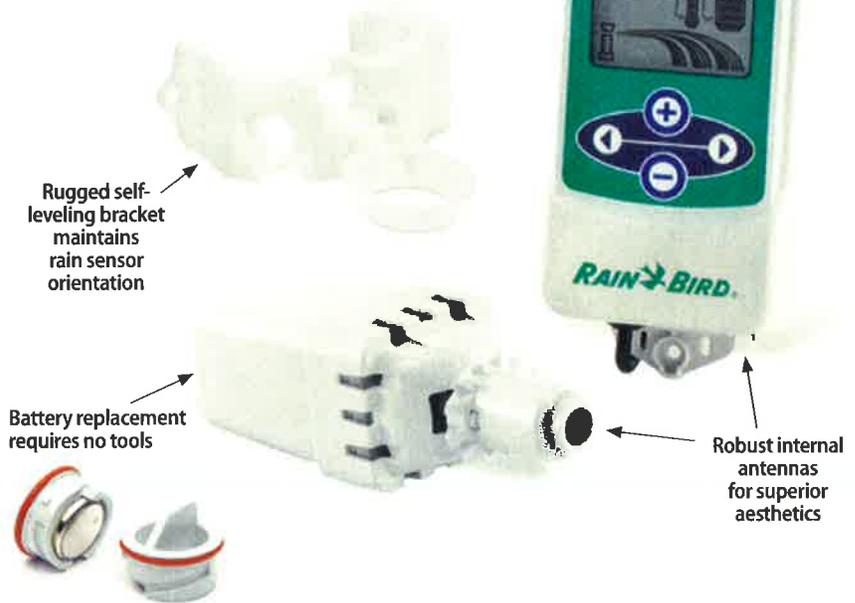
The device shall be used with 24VAC controllers and shall be of sufficient capacity to be used with a maximum of six 24VAC 7VA solenoids plus an additional master valve or pump start that does not exceed 53VA.

The wireless rain sensor shall incorporate a provision that allows the installer to select from several rainfall or low temperature settings that can be programmed through the use of icons on a controller interface. A sensor LED shall communicate signal strength during the installation process.

The Rain Bird Rain or Rain / Freeze Sensor shall be manufactured by Rain Bird Corporation, Glendora, California.



Versatile Mounting Bracket



RAIN BIRD®

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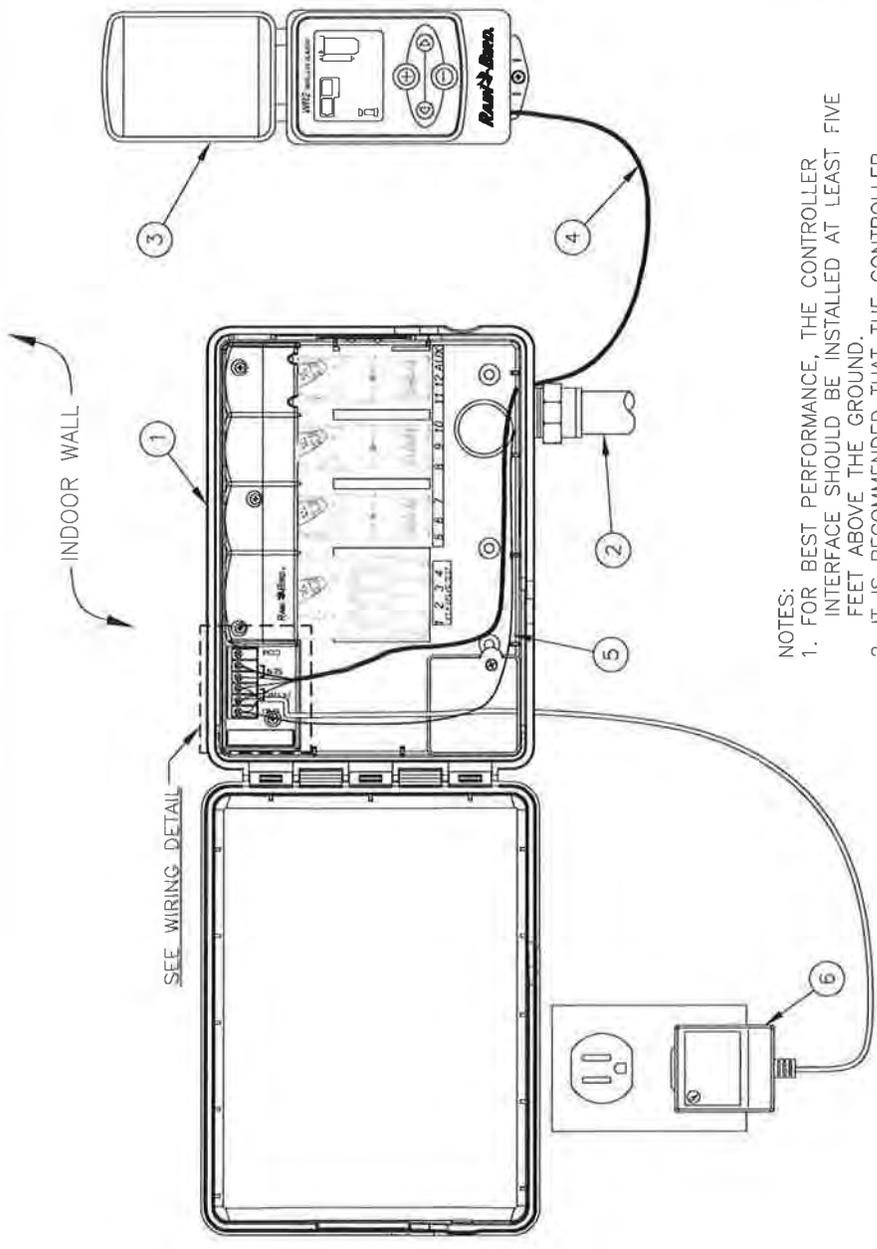
Specification Hotline

800-458-3005 (U.S. and Canada)

Rain Bird International, Inc.

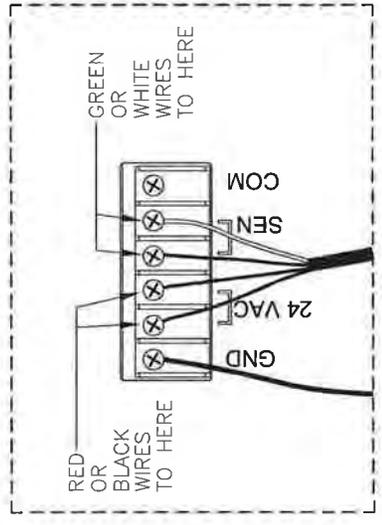
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- 1 RAIN BIRD CONTROLLER:
RAIN BIRD ESP-4M:
INDOOR WALL MOUNT
- 2 1-INCH PVC SCH 40 CONDUIT
AND FITTINGS FOR VALVE WIRES
- 3 RAIN BIRD WR2 WIRELESS SENSOR
CONTROLLER INTERFACE
- 4 CABLE HARNESS FOR CONTROLLER
INTERFACE (30" MAXIMUM)
- 5 GROUND WIRE TO
GROUNDING GRID
- 6 120 VAC, 60 HZ EXTERNAL
PLUG-IN TRANSFORMER

NOTES:
 1. FOR BEST PERFORMANCE, THE CONTROLLER INTERFACE SHOULD BE INSTALLED AT LEAST FIVE FEET ABOVE THE GROUND.
 2. IT IS RECOMMENDED THAT THE CONTROLLER INTERFACE BE INSTALLED AWAY FROM SOURCES OF ELECTRICAL INTERFERENCE (SUCH AS TRANSFORMERS, GENERATORS, PUMPS, FANS, ELECTRICAL METER BOXES) AND METAL OBJECTS TO MAXIMIZE COMMUNICATION RANGE.



D WIRELESS RAIN SENSOR (INDOOR)
 N.I.S. WR2 SERIES CONTROLLER INTERFACE

11-04-09



Watch how easy it is to use the WR2!
 Visit www.rainbird.com/WR2 to see a video demo of the new Rain Bird® WR2 in action. You'll see just how easy it is to install and program this revolutionary wireless rain/freeze sensor.



WR2 Series Wireless Rain and Rain/Freeze Sensors



Installs fast, easy to use, superior reliability

Other smart technology products from Rain Bird:



ESP-SMT Smart Irrigation Control System



ET Manager™ Cartridge



SMRT-Y Soil Moisture Sensor Kit



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The NEW Rain Bird® Wireless Rain and Rain/Freeze Sensors: saving water and so much more.

Rain and rain/freeze sensors are becoming "must have" components for irrigation systems these days. Rain Bird designed the new WR2 wireless sensor to exceed the standard. With revolutionary features, this sensor saves time, improves system performance and enhances your reputation as a water management expert.

Reliable signal transmission and other innovations deliver superior responsiveness to rainfall and cold temperatures, while user-friendly features cut installation and programming time in half. Choose your own rainfall set points and save up to 35% on water usage while promoting lush, beautiful landscapes.

Product comparison chart

Multiple features make choosing the Rain Bird WR2 an easy decision.

Feature	Benefit	Rain Bird	Hunter	Introl
 LCD Screen	See signal strength, set points, etc. at a glance.	✓		
 Signal strength sensor location is a quick, one-person job.	Determining good sensor location is a quick, one-person job.	✓		
 Versatile mounting bracket	Easily attaches to walls, fences or gutters.	✓		Inconvenient thumb-screw
 Par one sensor controller interface	Cost effective water management for commercial properties.	✓		
 Six rain fall set points on controller interface	More convenient than adjusting set points on a sensor.	✓		
 Quick Shut-Off	Suspends irrigation immediately during rain events without need for rainfall accumulation.	✓	✓	
 Three adjustable low temperature points	Lets you adapt to environmental and soil conditions.	✓		
 Dual built-in antenna	More durable design; neater appearance.	✓		
 Tool-free battery replacement	Saves time; eliminates risk of damaging sensor.	✓		
 Clearly shows level of signal strength	Confirms signal reliability.	✓		General signal quality only
 Weather data updated every 45 seconds	Assures reliable performance; responsive to changing weather conditions.	✓		
 Overcomes most line-of-sight restrictions	Makes it easier to choose a sensor location; improves overall reliability.	✓	✓	✓



Very important! Don't connect the sensor to the controller until you have programmed the sensor. Follow the instructions in the manual.

Installs faster with a one-person crew

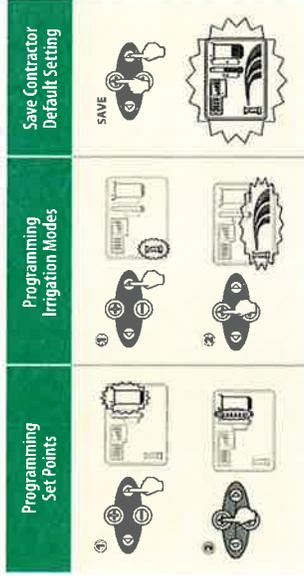
Rain Bird designed the WR2 so that one person can install it quickly and easily. Signal strength is displayed on both the sensor unit and the controller interface. The sensor's innovative versatile mounting bracket quickly attaches securely to a gutter or any vertical surface, such as a fence or wall. Three quick steps, and you're on to your next job.



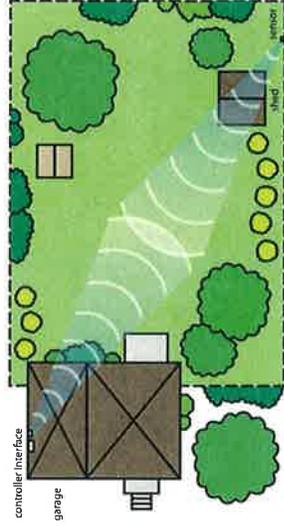
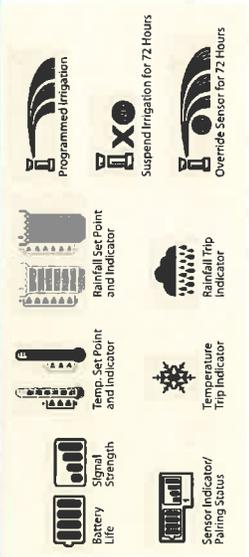
Easier to use and program

Programming overview

Programming the WR2 is simplified for fast set-up. In just a few seconds, you can select set points, program the irrigation modes and save your contractor default. On the controller interface, all settings are displayed on the easy-to-read LCD screen, so you can see signal strength, rain and temperature set points, battery life and more at a glance. Unlike other rain sensors, the WR2 has a long-lasting battery that's quick and easy to replace.



LCD Icons



Superior signal reliability

Signal strength is displayed on the controller interface using familiar cell phone icons. Dual antennas safeguard the system from signal interference by radios, mobile phones, power lines, etc. The WR2 system overcomes most line-of-sight obstructions so you have freedom in locating the sensor. Weather data is updated every 45 seconds to ensure the most reliable communication between sensor and controller.



BPE / BPES Series

Brass Irrigation Valves

Rain Bird's 3" BPE and BPES irrigation valves are built tough to offer long life and efficient, trouble-free performance under harsh conditions.

Featuring a unique combination construction of brass body and glass-filled nylon bonnet, these valves are designed to withstand extreme pressure surges, effluent water and clogging debris.

For additional protection, the BPES model is equipped with a patented scrubber mechanism to actively fight dirt and particles.



Features

Models

Specifications

Manuals & Literature

- Pressure: 20 to 200 psi (1,4 to 13,8 bar)
- Flow with/without PRS-D option: 60 to 300 gpm (13,6 to 68,1 m³/h; 3,78 to 18,90 l/s)
- Temperature: up to 140° F (60° C)
- Power: 24 VAC 50/60 Hz (cycles per second) solenoid
- Inrush current: 0,41 A (9,8 VA) at 60Hz
- Holding current: 0,28 A (6,7 VA) at 60Hz
- Coil resistance: 28 Ohms, nominal

Dimensions:

- 300-BPE(s): H x L x W
- 13 5/8" x 8" x 7"
- 34,6 cm x 20,3 cm x 17,8 cm

Note: PRS-D option adds 2": (5,1 cm) to the valve height.

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Purchase genuine Rain Bird replacement parts, including solenoids, diaphragms, cap/covers, bleed screws, and more.

BPE and BPES 3" Valve Pressure Loss (psi)		
Flow gpm	Globe	Angle
60	6.6	6.8
80	5.1	5.9
100	3.2	3.5
120	1.8	1.8
140	1.8	2.1
160	2.0	2.1
180	2.2	2.0
200	2.7	2.5
250	4.0	3.4
300	4.9	4.5

BPE and BPES 3" Valve Pressure Loss (bar)			METRIC
Flow m ³ /h	Flow l/m	Globe	Angle
13.6	227	0.46	0.47
24	400	0.19	0.21
36	600	0.14	0.14
48	800	0.21	0.19
60	1000	0.29	0.26
68	1136	0.34	0.31

Notes

1. Loss values are with flow control fully open
2. PRS-Dial module recommended for all flow rates

Interpolate to get Pressure Loss for each zone's operating flow:

Zone 1	154.8 gpm	1.948 psi
Zone 2	158.4 gpm	1.984 psi
Zone 3	154.8 gpm	1.948 psi
Zone 4	108 gpm	2.640 psi

300-BPE and 300-BPES Valves Hybrid Performance and Value

Rain Bird's 3" BPE and BPES valves are built tough to offer long life and efficient, trouble-free performance - even under harsh conditions. Featuring a unique combination construction of brass body and glass-filled nylon bonnet, these valves are designed to withstand extreme pressure surges, effluent water and clogging debris. For additional protection, the BPES model is equipped with a patented scrubber mechanism to actively fight dirt and particles.

Features

- Unique hybrid construction featuring durable brass body and glass-filled nylon bonnet for long life and heavy-duty performance at 200 psi (13,80 bar).
- Globe and angle configuration for flexibility in design and installation.
- Manual internal and external bleed. External bleed does not allow debris to go through the solenoid ports when system is flushed. Internal bleed operates the valve without allowing water into the valve box; allows pressure regulator to be adjusted without turning the valve on at the controller first.
- Slow closing to prevent water hammer and subsequent system damage.
- Highly efficient operation with extremely low pressure loss.
- Flow control handle adjusts water flows as needed.
- **BPES only:** Nylon scrubber scrapes its stainless steel screen clean to break down grit and plant material. Prevents debris build-up and clogging.

Options (order separately)

- Accommodates optional, field-installed PRS-D pressure regulating module to ensure optimum sprinkler performance.
- Optional purple flow control handle for non-potable water applications. (BPE-NP-HAN)
- Accepts latching solenoid for use with Rain Bird battery-operated controllers up to 150 psi (10,35 bar).

Operating Range

- Pressure: 20 to 200 psi (1,38 to 13,80 bar)
- Flow with/without PRS-D: 60 to 300 gpm (13,62 to 68,10 m³/h; 227 to 1136 l/m)
- Temperature: up to 150°F (66°C)

Electrical Specifications

- Power: 24 VAC 50/60 Hz (cycle/sec) solenoid
- Inrush current: 0.41 A (9.84VA) at 60 Hz
- Holding current: 0.28 A (6.72VA) at 60 Hz

Dimensions

Size	Height	Length	Width
300	13 3/4" (34,61 cm)	8" (20,32 cm)	7" (17,78 cm)

Models

- 300BPE 3" (80/90)
- 300BPES 3" (80/90)

BSP threads available; specify when ordering.

BPE & BPES 3" Valve Pressure Loss (psi)

Flow GPM	Globe	Angle
60	6.6	6.8
80	5.1	5.9
100	3.2	3.5
120	1.8	1.8
140	1.8	2.1
160	2.0	2.1
180	2.2	2.0
200	2.7	2.5
250	4.0	3.4
300	4.9	4.5

BPE & BPES 3" Valve Pressure Loss (bar)

Flow m ³ /h	Flow l/m	Globe	Angle
13,6	227	0,46	0,47
24	400	0,19	0,21
36	600	0,14	0,14
48	800	0,21	0,19
60	1000	0,29	0,26
68	1136	0,34	0,31

Notes

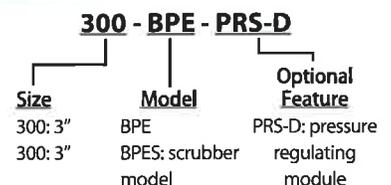
1. Loss values are with flow control fully open
2. PRS-D module recommended for all flow rates.

Recommendations

1. Rain Bird recommends flow rates in the supply line not to exceed 7.5 ft./sec. (2,29 m/s) in order to reduce the effects of water hammer
2. For flows below 5 gpm (1,14 m³/h; 19,21 l/m), Rain Bird recommends use of upstream filtration to prevent debris from collecting below the diaphragm.
3. For flows below 10 gpm (2,27 m³/h; 37,8 l/m) Rain Bird recommends the flow control stem be turned down two full turns from the fully open position.



How to Specify/Order



Note: Valve and PRS-D must be ordered separately.



Specifications

The electric remote control valve shall be a normally closed 24 VAC 50/60 Hz (cycle/sec) solenoid actuated globe/angle pattern design. The valve pressure rating shall not be less than 200 psi (13,80 bar). The valve shall have the following characteristics (circle one):

Flow rate: _____ gpm m³/h l/m

Pressure loss not to exceed: _____ psi bar

The valve body and bonnet shall be a combination of heavy cast red brass body and heavy-duty glass-filled UV-resistant nylon bonnet and have stainless steel bolts. The diaphragm shall be of nylon reinforced nitrile rubber.

The valve shall have both internal and external manual open/close control (internal and external bleed) to manually open and close the valve without electrically energizing the solenoid. The valves internal bleed shall prevent flooding of the valve box.

The solenoid shall require 24 VAC 50/60 Hz power and open with 19.6 VAC minimum at 200 psi (13,80 bar). At 24VAC, average inrush current shall not exceed 0.41 amps. Average holding current shall not exceed 0.28 amps.

The valve shall have a brass flow control stem for accurate manual regulation and/or shut-off of outlet flow. The valve must open or close in less than 1 minute at 200 psi (13,80 bar) and less than 30 seconds at 20 psi (1,38 bar).

The BPES valve shall have a self-cleaning stainless steel screen designed for use in dirty water applications.

The valve construction shall be such as to provide for all internal parts to be removable from the top of the valve without disturbing the valve installation.

Optional Feature Specification

PRS-D Pressure Regulating Module 300BPE-PRS-D, 300BPES-PRS-D

When so indicated on the design, the 3" electric remote control valve shall have a pressure regulating module (PRS-D) capable of regulating outlet pressure between 15 and 100 psi (± 3 psi) (1,04 and 6,90 bar ($\pm 0,21$ bar)).

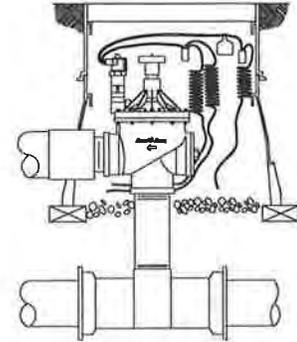
The PRS-D module shall have an adjusting knob for setting pressure and Schrader valve connection for monitoring pressure. The pressure shall be adjustable from the PRS-D when the valve is internally manually bled or electrically activated.

Non-Potable Flow Control Handle BPE-NP-HAN

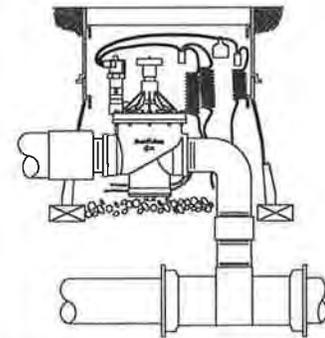
When so indicated on the design, the valve shall have a purple flow control handle to indicate to the user that non-potable water is being used. There shall be no difference between the black and purple handles except for the color.

The valve shall be as manufactured by Rain Bird Corporation, Glendora, California.

Heavy Duty 3" Remote Control Valve
Angle Installation



Heavy Duty 3" Remote Control Valve
Globe Installation



Rain Bird Corporation

6991 E. Southpoint Road, Tucson, AZ, 85706, U.S.A.
Phone: (520) 741-6100 Fax: (520) 741-6522

Rain Bird Corporation

970 W. Sierra Madre Avenue, Azusa, CA, 91702, U.S.A.
Phone: (626) 812-3400 Fax: (626) 812-3411

Rain Bird International, Inc.

P.O. Box 37, Glendora, CA, 91740-0037, U.S.A.
Phone: (626) 963-9311 Fax: (626) 852-7343

Technical Service and Support

(800) RAINBIRD (U.S. and Canada only)

Specification Hotline

(800) 458-3005 (U.S. and Canada only)

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Features

- Wide range of pressure ratings, sizes, and resilient materials provide long service life and low internal leakage
- High Flow Valves for liquid, corrosive, and air/inert gas service
- Industrial applications include:
 - Car wash
 - Laundry equipment
 - Air compressors
 - Industrial water control
 - Pumps

Construction

Valve Parts in Contact with Fluids		
Body	Brass	304 Stainless Steel
Seals and Discs	NBR or PTFE	
Disc-Holder	PA	
Core Tube	305 Stainless Steel	
Core and Plugnut	430F Stainless Steel	
Springs	302 Stainless Steel	
Shading Coil	Copper	Silver

Electrical

Standard Coil and Class of Insulation	Watt Rating and Power Consumption				Spare Coil Part Number			
	DC Watts	AC			General Purpose		Explosionproof	
		Watts	VA Holding	VA Inrush	AC	DC	AC	DC
F	-	6.1	16	40	238210	-	238214	-
F	11.6	10.1	25	70	238610	238710	238614	238714
F	16.8	16.1	35	180	272610	97617	272614	97617
F	-	17.1	40	93	238610	-	238614	-
F	-	20	43	240	99257	-	99257	-
F	-	20.1	48	240	272610	-	272614	-
H	30.6	-	-	-	-	74073	-	74073
H	40.6	-	-	-	-	238910	-	238914

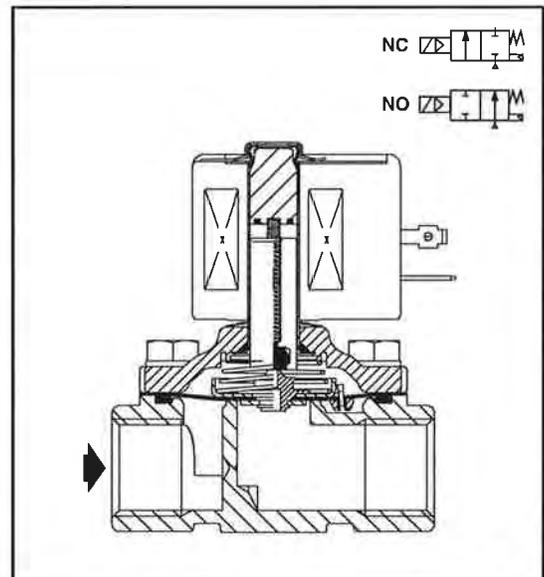
Standard Voltages: 24, 120, 240, 480 volts AC, 60 Hz (or 110, 220 volts AC, 50 Hz). 6, 12, 24, 120, 240 volts DC. Must be specified when ordering.
Other voltages available when required.

Solenoid Enclosures

Standard: RedHat II - Watertight, Types 1, 2, 3, 3S, 4, and 4X; RedHat - Type I.

Optional: RedHat II - Explosionproof and Watertight, Types 3, 3S, 4, 4X, 6, 6P, 7, and 9; Red-Hat - Explosionproof and Watertight, Types 3, 4, 4X, 7, and 9.

(To order, add prefix "EF" to catalog number, except Catalog Numbers 8210B057, 8210B058, and 8210B059, which are not available with Explosionproof enclosures.)
See *Optional Features Section* for other available options.



Nominal Ambient Temp. Ranges

RedHat II/
RedHat AC: 32°F to 125°F (0°C to 52°C)

RedHat II DC: 32°F to 104°F (0°C to 40°C)
RedHat DC: 32°F to 77°F (0°C to 25°C)
(104°F/40°C occasionally)

Refer to *Engineering Section* for details.

Approvals

UL listed as indicated. CSA certified.
RedHat II meets applicable CE directives.
Refer to *Engineering Section* for details.

Specifications (English units)

Pipe Size (ins.)	Orifice Size (ins.)	Cv Flow Factor	Operating Pressure Differential (psi)							Max. Fluid Temp. °F		Brass Body			Stainless Steel Body			Watt Rating/ Class of Coil Insulation ⑦		
			Max. AC			Max. DC						Catalog Number	Const. Ref. ④	UL ⑤ Listing	Catalog Number	Const. Ref. ④	UL ⑤ Listing			
			Min.	Air-Inert Gas	Water	Light Oil @ 300 SSU	Air-Inert Gas	Water	Light Oil @ 300 SSU	AC	DC							AC	DC	
NORMALLY CLOSED (Closed when de-energized), NBR or PTFE Sealing																				
3/8	3/8	1.5	④	150	125	-	40	40	-	180	150	8210G073 ③	1P	●	8210G036 ③	1P	●	6.1/F	11.6/F	
3/8	5/8	3	0	150	150	-	40	40	-	180	150	8210G093	5D	○	-	-	-	10.1/F	11.6/F	
3/8	5/8	3	5	200	150	135	125	100	100	180	150	8210G001	6D	○	-	-	-	6.1/F	11.6/F	
3/8	5/8	3	5	300	300	300	-	-	-	175	-	8210G006	5D	○	-	-	-	17.1/F	-	
1/2	7/16	2.2	④	150	125	-	40	40	-	180	150	8210G015 ③	2P	●	8210G037 ③	2P	●	6.1/F	11.6/F	
1/2	5/8	4	0	150	150	-	40	40	-	180	150	8210G094	5D	○	-	-	-	10.1/F	11.6/F	
1/2	5/8	4	0	150	150	125	40	40	-	175	150	-	-	-	8210G087	7D	●	17.1/F	11.6/F	
1/2	5/8	4	5	200	150	135	125	100	100	180	150	8210G002	6D	○	-	-	-	6.1/F	11.6/F	
1/2	5/8	4	5	300	300	300	-	-	-	175	-	8210G007	5D	○	-	-	-	17.1/F	-	
1/2	3/4	4	5	-	300	-	-	300	-	180	125	8210G227	5D	○	-	-	-	17.1/F	40.6/H	
3/4	5/8	4.5	0	150	150	125	40	40	-	175	150	-	-	-	8210G088	7D	●	17.1/F	11.6/F	
3/4	3/4	5	5	125	125	125	100	90	75	180	150	8210G009	9D	○	-	-	-	6.1/F	11.6/F	
3/4	3/4	5	0	150	150	-	40	40	-	180	150	8210G095	8D	○	-	-	-	10.1/F	11.6/F	
3/4	3/4	6.5	5	250	150	100	125	125	125	180	150	8210G003	11D	○	-	-	-	6.1/F	11.6/F	
3/4	3/4	6	0	-	-	-	200	180	180	-	77	8210B026 ② ‡	10P	-	-	-	-	-	30.6/H	
3/4	3/4	6	0	350	300	200	-	-	-	200	-	8210G026 ② ‡	40P	●	-	-	-	-	16.1/F	-
1	1	13	0	-	-	-	100	100	80	-	77	8210B054 ‡	31D	-	8210D089	15D	-	-	30.6/H	
1	1	13	0	150	125	125	-	-	-	180	-	8210G054	41D	●	8210G089	45D	●	16.1/F	-	
1	1	13	5	150	150	100	125	125	125	180	150	8210G004	12D	○	-	-	-	6.1/F	11.6/F	
1	1	13.5	0	300	225	115	-	-	-	200	-	8210G027 ‡	42P	●	-	-	-	20.1/F	-	
1	1	13.5	10	300	300	300	-	-	-	175	-	8210G078 ②	13P	-	-	-	-	17.1/F	-	
1 1/4	1 1/8	15	0	-	-	-	100	100	80	-	77	8210B055 ‡	32D	-	-	-	-	-	30.6/H	
1 1/4	1 1/8	15	0	150	125	125	-	-	-	180	-	8210G055	43D	●	-	-	-	16.1/F	-	
1 1/4	1 1/8	15	5	150	150	100	125	125	125	180	150	8210G008	16D	○	-	-	-	6.1/F	11.6/F	
1 1/2	1 1/4	22.5	0	-	-	-	100	100	80	-	77	8210B056 ‡	33D	-	-	-	-	-	30.6/H	
1 1/2	1 1/4	22.5	0	150	125	125	-	-	-	180	-	8210G056	44D	●	-	-	-	16.1/F	-	
1 1/2	1 1/4	22.5	5	150	150	100	125	125	125	180	150	8210G022	18D	●	-	-	-	6.1/F	11.6/F	
2	1 3/4	43	5	150	125	90	50	50	50	180	150	8210G100	20P	●	-	-	-	6.1/F	11.6/F	
2 1/2	1 3/4	45	5	150	125	90	50	50	50	180	150	8210G101	21P	●	-	-	-	6.1/F	11.6/F	
NORMALLY OPEN (Open when de-energized), NBR Sealing (PA Disc-Holder, except as noted)																				
3/8	5/8	3	0	150	150	125	125	125	80	180	150	8210G033	23D	●	-	-	-	10.1/F	11.6/F	
3/8	5/8	3	5	250	200	200	250	200	200	180	180	8210G011 ② ⑧	39D	●	-	-	-	10.1/F	11.6/F	
1/2	5/8	4	0	150	150	125	125	125	80	180	150	8210G034	23D	●	-	-	-	10.1/F	11.6/F	
1/2	5/8	3	0	150	150	100	125	125	80	180	150	-	-	-	8210G030	37D	●	10.1/F	11.6/F	
1/2	5/8	4	5	250	200	200	250	200	200	180	180	8210G012 ② ⑧	39D	●	-	-	-	10.1/F	11.6/F	
3/4	3/4	5.5	0	150	150	125	125	125	80	180	150	8210G035	25D	●	-	-	-	10.1/F	11.6/F	
3/4	5/8	3	0	150	150	100	125	125	80	180	150	-	-	-	8210G038	38D	●	10.1/F	11.6/F	
3/4	3/4	6.5	5	-	-	-	250	200	200	-	180	8210C013	24D	●	-	-	-	-	16.8/F	
3/4	3/4	6.5	5	250	200	200	-	-	-	180	-	8210G013	46D	●	-	-	-	16.1/F	-	
1	1	13	0	125	125	125	-	-	-	180	-	8210B057 ② ⑩	34D	●	-	-	-	20/F	-	
1	1	13	5	-	-	-	125	125	125	-	180	8210D014	26D	●	-	-	-	-	16.8/F	
1	1	13	5	150	150	125	-	-	-	180	-	8210G014	47D	●	-	-	-	16.1/F	-	
1 1/4	1 1/8	15	0	125	125	125	-	-	-	180	-	8210B058 ② ⑩	35D	●	-	-	-	20/F	-	
1 1/4	1 1/8	15	5	-	-	-	125	125	125	-	180	8210D018	28D	●	-	-	-	-	16.8/F	
1 1/4	1 1/8	15	5	150	150	125	-	-	-	180	-	8210G018	48D	●	-	-	-	16.1/F	-	
1 1/2	1 1/4	22.5	0	125	125	125	-	-	-	180	-	8210B059 ② ⑩	36D	●	-	-	-	20/F	-	
1 1/2	1 1/4	22.5	5	-	-	-	125	125	125	-	180	8210D032	29D	●	-	-	-	-	16.8/F	
1 1/2	1 1/4	22.5	5	150	150	125	-	-	-	180	-	8210G032	49D	●	-	-	-	16.1/F	-	
2	1 3/4	43	5	-	-	-	125	125	125	-	150	8210 103	30P	●	-	-	-	-	16.8/F	
2	1 3/4	43	5	125	125	125	-	-	-	180	-	8210G103	50P	●	-	-	-	16.1/F	-	
2 1/2	1 3/4	45	5	-	-	-	125	125	125	-	150	8210 104	27P	●	-	-	-	-	16.8/F	
2 1/2	1 3/4	45	5	125	125	125	-	-	-	180	-	8210G104	51P	●	-	-	-	16.1/F	-	

11.66

① 5 psi on Air; 1 psi on Water.

② Valve provided with PTFE main disc.

③ Valve includes Ultem (G.E. trademark) piston.

④ Letter "D" denotes diaphragm construction; "P" denotes piston construction.

⑤ ○ Safety Shutoff Valve; ● General Purpose Valve.

Refer to Engineering Section (Approvals) for details.

⑥ Valves not available with Explosionproof enclosures.

⑦ On 50 hertz service, the watt rating for the 6.1/F solenoid is 8.1 watts.

⑧ AC construction also has PA seating.

⑨ No disc-holder.

⑩ Stainless steel disc-holder.

‡ Must have solenoid mounted vertical and upright.

Specifications (Metric units)

Pipe Size (ins.)	Orifice Size (mm)	Kv Flow Factor (m3/h)	Operating Pressure Differential (bar)							Max. Fluid Temp. °C		Brass Body			Stainless Steel Body			Watt Rating/ Class of Coil Insulation ⑦	
			Max. AC			Max. DC				AC	DC	Catalog Number	Const. Ref. ④	UL ⑤ Listing	Catalog Number	Const. Ref. ④	UL ⑤ Listing	AC	DC
			Min.	Air-Inert Gas	Water	Light Oil @ 300 SSU	Air-Inert Gas	Water	Light Oil @ 300 SSU										
NORMALLY CLOSED (Closed when de-energized), NBR or PTFE ② Sealing																			
3/8	10	1.3	①	10	9	-	3	3	-	82	65	8210G073 ③	1P	●	8210G036 ③	1P	●	6.1/F	11.6/F
3/8	16	2.6	0	10	10	-	3	3	-	82	65	8210G093	5D	○	-	-	-	10.1/F	11.6/F
3/8	16	2.6	0.3	14	10	9	9	7	7	82	65	8210G001	6D	○	-	-	-	6.1/F	11.6/F
3/8	16	2.6	0.3	21	21	21	-	-	-	79	-	8210G006	5D	○	-	-	-	17.1/F	-
1/2	11	1.9	①	10	9	-	3	3	-	82	65	8210G015 ③	2P	●	8210G037 ③	2P	●	6.1/F	11.6/F
1/2	16	3.4	0	10	10	-	3	3	-	82	65	8210G094	5D	○	-	-	-	10.1/F	11.6/F
1/2	16	3.4	0	10	10	9	3	3	-	79	65	-	-	-	8210G087	7D	●	17.1/F	11.6/F
1/2	16	3.4	0.3	14	10	9	9	7	7	82	65	8210G002	6D	○	-	-	-	6.1/F	11.6/F
1/2	16	3.4	0.3	21	21	21	-	-	-	79	-	8210G007	5D	○	-	-	-	17.1/F	-
1/2	19	3.4	0.3	-	21	-	-	21	-	82	52	8210G227	5D	○	-	-	-	17.1/F	40.6/H
3/4	16	3.9	0	10	10	9	3	3	-	79	65	-	-	-	8210G088	7D	●	17.1/F	11.6/F
3/4	19	4.3	0.3	9	9	9	7	6	5	82	65	8210G009	9D	○	-	-	-	6.1/F	11.6/F
3/4	19	4.3	0	10	10	-	3	3	-	82	65	8210G095	8D	○	-	-	-	10.1/F	11.6/F
3/4	19	5.6	0.3	17	10	7	9	9	9	82	65	8210G003	11D	○	-	-	-	6.1/F	11.6/F
3/4	19	5.1	0	-	-	-	14	12	12	-	25	8210B026 ② ‡	10P	-	-	-	-	-	30.6/H
3/4	19	5.1	0	24	21	14	-	-	-	93	-	8210G026 ② ‡	40P	●	-	-	-	16.1/F	-
1	25	11	0	-	-	-	7	7	6	-	25	8210B054 ‡	31D	-	8210D089	15D	-	-	30.6/H
1	25	11	0	10	9	9	-	-	-	82	-	8210G054	41D	●	8210G089	45D	●	16.1/F	-
1	25	11	0.3	10	10	7	9	9	9	82	65	8210G004	12D	○	-	-	-	6.1/F	11.6/F
1	25	11.5	0	21	16	8	-	-	-	93	-	8210G027 ‡	42P	●	-	-	-	20.1/F	-
1	25	11.5	0.7	21	21	21	-	-	-	79	-	8210G078 ②	13P	-	-	-	-	17.1/F	-
1 1/4	29	13	0	-	-	-	7	7	6	-	25	8210B055 ‡	32D	-	-	-	-	-	30.6/H
1 1/4	29	13	0	10	9	9	-	-	-	82	-	8210G055	43D	●	-	-	-	16.1/F	-
1 1/4	29	13	0.3	10	10	7	9	9	9	82	65	8210G008	16D	○	-	-	-	6.1/F	11.6/F
1 1/2	32	19.5	0	-	-	-	7	7	6	-	25	8210B056 ‡	33D	-	-	-	-	-	30.6/H
1 1/2	32	19.5	0	10	9	9	-	-	-	82	-	8210G056	44D	●	-	-	-	16.1/F	-
1 1/2	32	19.5	0.3	10	10	7	9	9	9	82	65	8210G022	18D	●	-	-	-	6.1/F	11.6/F
2	44	37	0.3	10	9	6	3	3	3	82	65	8210G100	20P	●	-	-	-	6.1/F	11.6/F
2 1/2	44	39	0.3	10	9	6	3	3	3	82	65	8210G101	21P	●	-	-	-	6.1/F	11.6/F
NORMALLY OPEN (Open when de-energized), NBR Sealing (PA Disc-Holder, except as noted)																			
3/8	16	2.6	0.0	10	10	9	9	9	6	82	65	8210G033	23D	●	-	-	-	10.1/F	11.6/F
3/8	16	2.6	0.3	17	14	14	17	14	14	82	82	8210G011 ⑧ ⑨	39D	●	-	-	-	10.1/F	11.6/F
1/2	16	3.4	0	10	10	9	9	9	6	82	65	8210G034	23D	●	-	-	-	10.1/F	11.6/F
1/2	16	2.6	0	10	10	7	9	9	6	82	65	-	-	-	8210G030	37D	●	10.1/F	11.6/F
1/2	16	3.4	0.3	17	14	14	17	14	14	82	82	8210G012 ⑧ ⑨	39D	●	-	-	-	10.1/F	11.6/F
3/4	19	4.7	0	10	10	9	9	9	6	82	65	8210G035	25D	●	-	-	-	10.1/F	11.6/F
3/4	16	2.6	0	10	10	7	9	9	6	82	65	-	-	-	8210G038	38D	●	10.1/F	11.6/F
3/4	19	5.6	0.3	-	-	-	17	14	14	-	82	8210C013	24D	●	-	-	-	-	16.8/F
3/4	19	5.6	0.3	17	14	14	-	-	-	82	-	8210G013	46D	●	-	-	-	16.1/F	-
1	25	11	0	9	9	9	-	-	-	82	-	8210B057 ⑧ ⑨	34D	●	-	-	-	20/F	-
1	25	11	0.3	-	-	-	9	9	9	-	82	8210D014	26D	●	-	-	-	-	16.8/F
1	25	11	0.3	10	10	9	-	-	-	82	-	8210G014	47D	●	-	-	-	16.1/F	-
1 1/4	29	13	0	9	9	9	-	-	-	82	-	8210B058 ⑧ ⑨	35D	●	-	-	-	20/F	-
1 1/4	29	13	0.3	-	-	-	9	9	9	-	82	8210D018	28D	●	-	-	-	-	16.8/F
1 1/4	29	13	0.3	10	10	9	-	-	-	82	-	8210G018	48D	●	-	-	-	16.1/F	-
1 1/2	32	19.5	0	9	9	9	-	-	-	82	-	8210B059 ⑧ ⑨	36D	●	-	-	-	20/F	-
1 1/2	32	19.5	0.3	-	-	-	9	9	9	-	82	8210D032	29D	●	-	-	-	-	16.8/F
1 1/2	32	19.5	0.3	10	10	9	-	-	-	82	-	8210G032	49D	●	-	-	-	16.1/F	-
2	44	37	0.3	-	-	-	9	9	9	-	65	8210 103	30P	●	-	-	-	-	16.8/F
2	44	37	0.3	9	9	9	-	-	-	82	-	8210G103	50P	●	-	-	-	16.1/F	-
2 1/2	44	39	0.3	-	-	-	9	9	9	-	65	8210 104	27P	●	-	-	-	-	16.8/F
2 1/2	44	39	0.3	9	9	9	-	-	-	82	-	8210G104	51P	●	-	-	-	16.1/F	-

① 0.3 bar on Air; 0.0 bar on Water.
 ② Valve provided with PTFE main disc.
 ③ Valve includes Ultem (G.E. trademark) piston.
 ④ Letter "D" denotes diaphragm construction; "P" denotes piston construction.
 ⑤ ○ Safety Shutoff Valve; ● General Purpose Valve.
 Refer to Engineering Section (Approvals) for details.

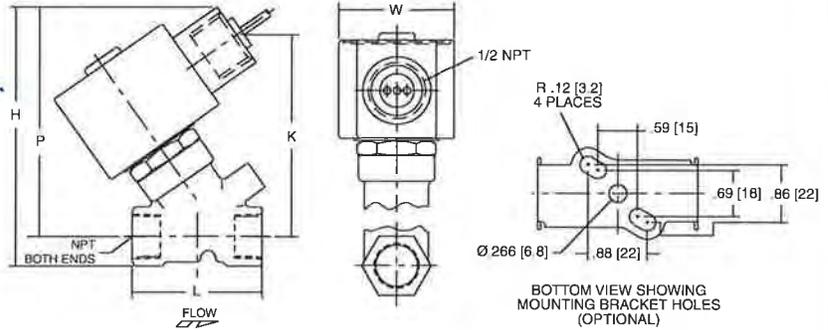
⑥ Valves not available with Explosionproof enclosures.
 ⑦ On 50 hertz service, the watt rating for the 6.1/F solenoid is 8.1 watts.
 ⑧ AC construction also has PA seating.
 ⑨ No disc-holder.
 ⑩ Stainless steel disc-holder.
 ‡ Must have solenoid mounted vertical and upright.

Dimensions: inches (mm)

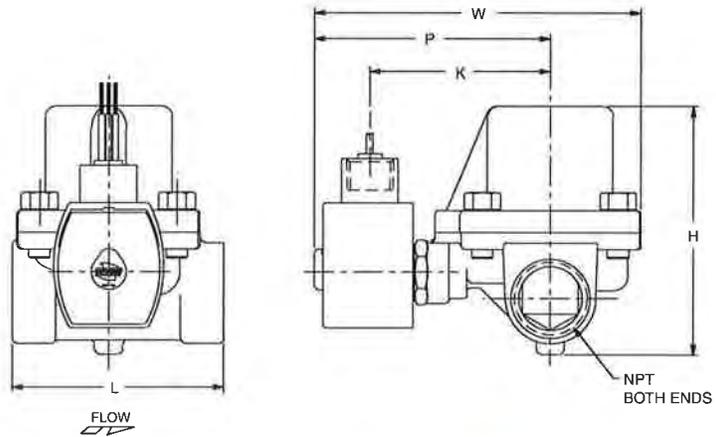
Const. Ref.		H	K	L	P	W
1*	ins.	3.85	3.00	1.91	3.41	1.69
	mm	98	76	49	87	43
2*	ins.	4.17	3.25	2.28	3.63	1.69
	mm	106	83	58	92	43
5	ins.	3.84	2.31	2.75	3.28	2.28
	mm	98	59	70	83	58
6*	ins.	3.38	1.94	2.75	2.80	2.28
	mm	86	49	70	71	58
7	ins.	4.19	2.50	2.81	3.47	2.39
	mm	106	64	71	88	61
8	ins.	4.13	2.47	2.81	3.44	2.29
	mm	105	63	71	87	58
9*	ins.	3.66	2.10	2.81	2.96	2.28
	mm	93	53	71	75	58
10*	ins.	5.25	X	2.81	4.59	2.31
	mm	133	X	71	117	59
11*	ins.	4.16	2.66	3.84	3.52	2.75
	mm	106	68	98	89	70
12	ins.	5.64	3.15	3.75	4.01	3.36
	mm	143	80	95	102	85
13	ins.	4.44	3.22	3.75	4.19	5.81
	mm	113	82	95	106	147
15*	ins.	5.34	X	3.75	4.47	3.84
	mm	136	X	95	114	98
16	ins.	5.64	3.15	3.66	4.01	3.56
	mm	143	80	93	102	90
18	ins.	6.11	3.30	4.38	4.16	3.92
	mm	155	84	111	106	100
20*	ins.	7.33	3.71	5.06	4.57	4.87
	mm	186	94	129	116	124
21*	ins.	7.33	3.71	5.50	4.57	4.87
	mm	186	94	140	116	124
23	ins.	4.35	2.65	2.75	3.79	2.28
	mm	110	67	70	96	58
24	ins.	5.06	X	3.78	4.44	2.75
	mm	129	X	96	113	70
25	ins.	4.64	2.81	2.81	3.94	2.28
	mm	118	71	71	100	58
26	ins.	6.53	X	3.75	4.91	3.19
	mm	166	X	95	125	81
27	ins.	8.22	X	5.50	5.47	4.87
	mm	209	X	140	139	124
28	ins.	6.53	X	3.66	4.91	3.19
	mm	166	X	93	125	81
29	ins.	7.03	X	4.38	5.06	4.40
	mm	179	X	111	129	112

* DC dimensions slightly larger.
IMPORTANT: Valves may be mounted in any position, except as noted in specifications table.

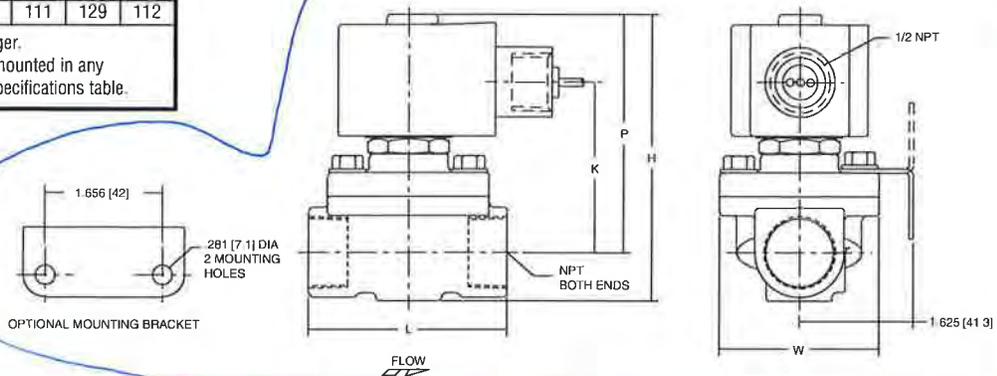
Const. Ref. 1, 2



Const. Ref. 13



Const. Ref. 5-9, 11, 20, 21, 23, 25, 37, 38

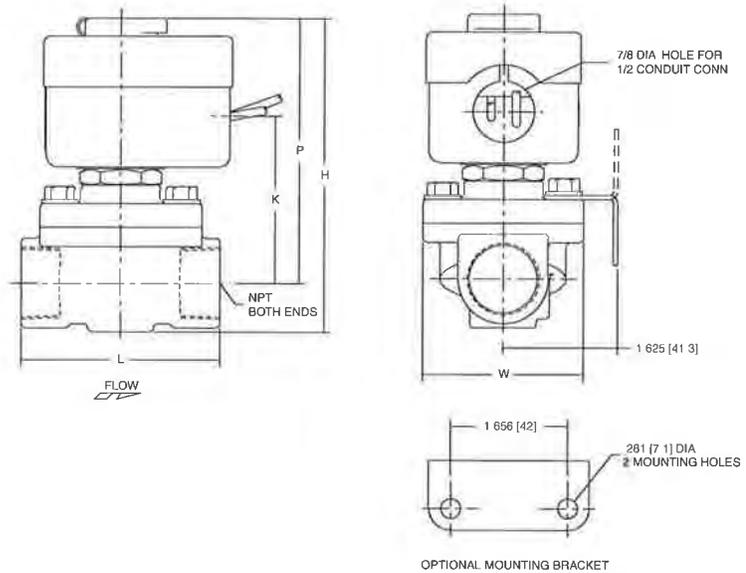


Dimensions: inches (mm)

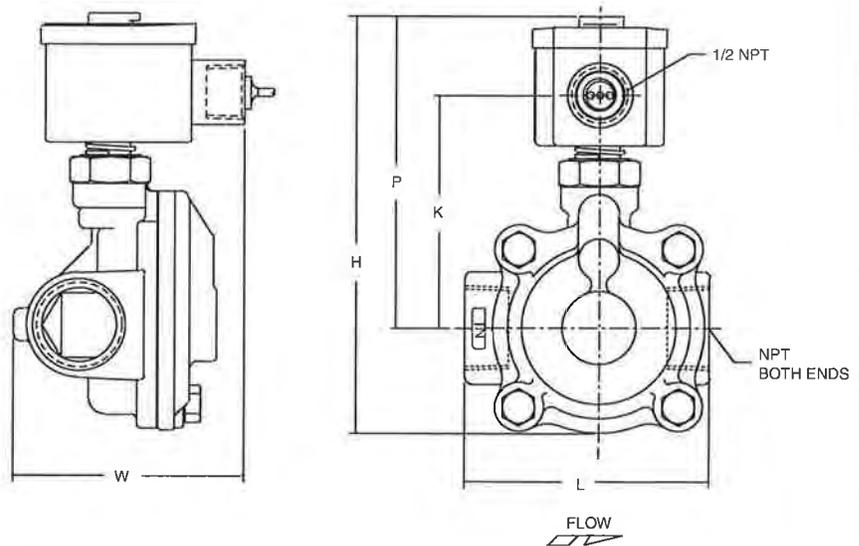
Const. Ref.		H	K	L	P	W
30	ins.	8.22	X	5.06	5.47	4.87
	mm	209	X	129	139	124
31	ins.	5.25	X	3.75	4.44	3.25
	mm	133	X	95	113	83
32	ins.	5.69	X	3.66	4.69	3.25
	mm	145	X	93	119	83
33	ins.	6.06	X	4.38	4.94	3.91
	mm	154	X	111	125	99
34	ins.	6.91	X	3.75	6.09	3.25
	mm	176	X	95	155	83
35	ins.	7.34	X	3.66	6.34	3.25
	mm	186	X	93	161	83
36	ins.	7.66	X	4.38	6.56	3.91
	mm	195	X	111	167	99
37	ins.	4.61	2.75	2.81	3.89	2.39
	mm	117	70	71	99	61
38	ins.	4.61	2.75	2.81	3.89	2.39
	mm	117	70	71	99	61
39	ins.	5.42	2.31	2.75	4.86	3.80
	mm	138	59	70	123	97
40	ins.	5.20	3.29	2.81	4.50	2.28
	mm	132	83	71	114	58
41	ins.	5.13	3.10	3.75	4.32	3.25
	mm	130	79	95	110	83
42	ins.	6.43	4.40	3.93	5.62	3.25
	mm	163	112	100	143	83
43	ins.	5.57	3.35	3.66	4.57	3.25
	mm	142	85	93	116	83
44	ins.	5.90	3.57	4.38	4.79	3.91
	mm	150	91	111	122	99
45	ins.	5.26	3.17	3.75	4.38	3.84
	mm	134	81	95	111	98
46	ins.	4.95	3.10	3.84	4.31	2.75
	mm	126	79	98	110	70
47	ins.	6.43	3.59	3.75	4.81	3.52
	mm	163	91	95	122	90
48	ins.	6.43	3.59	3.66	4.81	3.73
	mm	163	91	93	122	95
49	ins.	6.91	3.75	4.38	4.96	4.40
	mm	176	95	111	126	112
50	ins.	8.13	4.15	5.06	5.37	4.87
	mm	207	105	129	136	124
51	ins.	8.13	4.15	5.50	5.37	5.18
	mm	207	105	140	136	132

IMPORTANT: Valves may be mounted in any position, except as noted in specifications table.

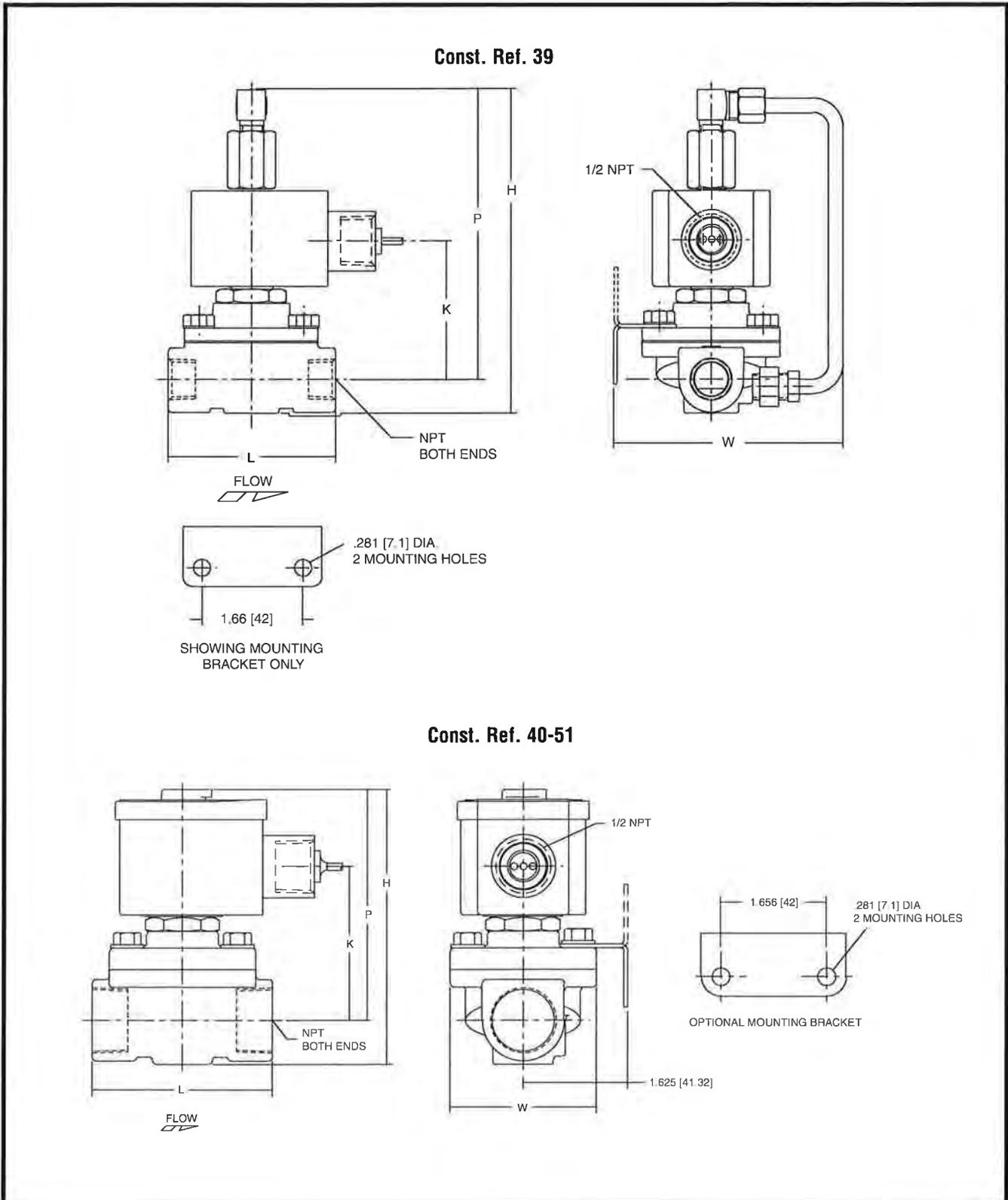
Const. Ref. 10, 15, 24, 26-36



Const. Ref. 12, 16, 18



Dimensions: inches (mm)





DURA-FLO™ PC DRIPPERLINE

SFPC-XX-6XXX-XX / SFPC-XX-7XXX-XX / SFPC-XX-20XXX-XX

Description

A pressure compensating inline emitter pre-inserted into ½" tubing at pre-determined constant intervals. Available in 0.5, 1, and 2 gph per emitter discharge rates.

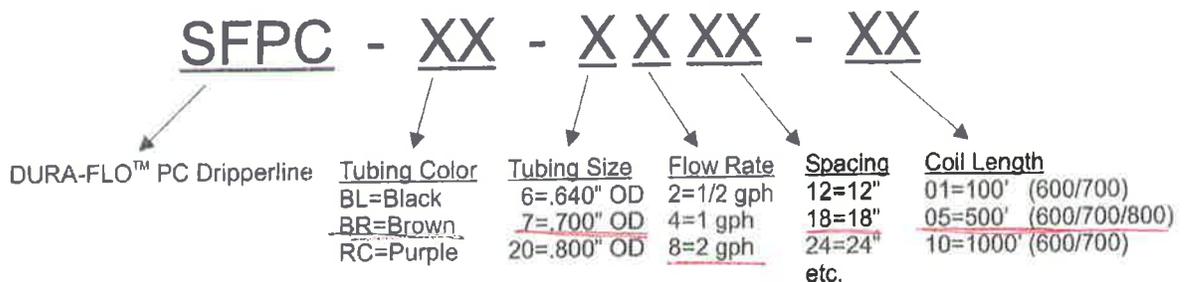
Features

- Self-cleaning
- Built-in filter slits and raised inlet to minimize clogging
- Silicone diaphragm
- Outstanding emission uniformity
- Dual 180° apart, water outlet holes
- Emitters color coded for easy flow rate identification
- Wide variety of spacings available
- UV stabilized
- Available in black, brown, or purple

Specifications

- Pressure compensating from 10 to 60 psi
- ½, 1 or 2 gph flow rates available
- Tubing size of .550" ID x .640" OD, wall = .045"
and .600" ID x .700" OD, wall = .050"
and .720" ID x .830" OD, wall = .055"
- Coil lengths available: 100' - Series 600 / 700
500' - Series 600 / 700 / 800
1000' - Series 600 & 700
- Bending radius of 7"
- Recommended filtration (140 mesh for ½ gph, 120 mesh for 1 gph, and 80 mesh for 2 gph emitter)
- Emitters are color coded, ½ gph (red), 1 gph (yellow), 2 gph (purple) *↳ 300 micron*

How To Specify



TECHNICAL INFORMATION — DRIP EMITTERS AND BUBBLERS

DISCHARGE RATES (GPH)

Model	Part No.	10 psi	15 psi	20 psi	25 psi	30 psi	40 psi	60 psi	80 psi
MAXI-FLO™ bubbler	MFBL 2			2.2 gph	2.3 gph	2.4 gph	2.5 gph	2.6 gph	2.6 gph
	MFBL 6			5.7 gph	6.3 gph	6.9 gph	7.7 gph	9.1 gph	9.5 gph
	MFBL 10			9.0 gph	9.7 gph	10.4 gph	11.6 gph	14.1 gph	15.3 gph
	MFBL 20			16.4 gph	17.7 gph	19.0 gph	22.1 gph	26.7 gph	28.2 gph
	MFBA			16.4 gph ^(max)	17.7 gph ^(max)	19.0 gph ^(max)	22.1 gph ^(max)		
HYDROPORT™	HPAM 4	7.0 gph ^(max)	10.0 gph ^(max)	12.0 gph ^(max)	13.0 gph ^(max)	14.0 gph ^(max)	16.0 gph ^(max)	20.0 gph ^(max)	
	HPAM 8	7.0 gph ^(max)	10.0 gph ^(max)	12.0 gph ^(max)	13.0 gph ^(max)	14.0 gph ^(max)	16.0 gph ^(max)	20.0 gph ^(max)	
CUATRO-FLO™ bubbler	CF 2 / CFL 2			1.8 gph	1.9 gph	2.0 gph	2.2 gph	2.5 gph	2.5 gph
	CF 6 / CFL 6			5.7 gph	6.9 gph	7.0 gph	7.8 gph	8.9 gph	10.0 gph
	CF 10 / CFL 10			7.6 gph	8.6 gph	9.7 gph	11.0 gph	13.3 gph	15.0 gph
	CF 20 / CFL 20			13.7 gph	15.0 gph	16.5 gph	18.8 gph	22.2 gph	25.3 gph
				2.2 gph	2.3 gph	2.4 gph	2.5 gph	2.6 gph	2.6 gph
POWER-FLO™ bubbler	PF 2			5.7 gph	6.3 gph	6.9 gph	7.7 gph	9.1 gph	9.5 gph
	PF 6			9.0 gph	9.7 gph	10.4 gph	11.6 gph	14.1 gph	15.3 gph
	PF 10			16.4 gph	17.7 gph	19.0 gph	22.1 gph	26.7 gph	28.2 gph
	PF 20								
*MONO-FLO™ emitter	APC 10	1.10 gph	1.15 gph	1.20 gph	1.22 gph	1.22 gph	1.23 gph		
	APC 20	2.10 gph	2.15 gph	2.20 gph	2.22 gph	2.23 gph	2.25 gph		
PC PLUS™ emitter	PCP 5	0.55 gph	0.57 gph	0.59 gph	0.59 gph	0.61 gph	0.62 gph		
	PCP 10	1.10 gph	1.13 gph	1.14 gph	1.17 gph	1.20 gph	1.21 gph		
	PCP 20	1.95 gph	2.01 gph	2.06 gph	2.12 gph	2.17 gph	2.22 gph		
UNI-FLO™ emitter	UF 5	0.55 gph	0.57 gph	0.59 gph	0.59 gph	0.61 gph	0.62 gph		
	UF 10	1.10 gph	1.13 gph	1.14 gph	1.17 gph	1.20 gph	1.21 gph		
	UF 20	1.95 gph	2.01 gph	2.06 gph	2.12 gph	2.17 gph	2.22 gph		
*UNI-FLO™ CLASSIC emitter	UFC 10	1.10 gph	1.15 gph	1.20 gph	1.22 gph	1.22 gph	1.23 gph		
	UFC 20	2.10 gph	2.15 gph	2.20 gph	2.22 gph	2.23 gph	2.25 gph		
SUPER-FLO™ emitter	TAE 10	0.56 gph	0.70 gph	0.80 gph	0.89 gph	0.97 gph			
	TAE 20	1.35 gph	1.62 gph	1.83 gph	2.12 gph	2.38 gph			
	TAE 40	2.38 gph	2.91 gph	3.33 gph	3.70 gph	3.97 gph			
DRIP STAR™	DS 10			1.0 gph	1.1 gph	1.2 gph	1.2 gph	1.4 gph	1.2 gph
	DS 20			1.7 gph	1.9 gph	2.0 gph	2.2 gph	2.5 gph	2.1 gph
	DS 30			3.0 gph	3.3 gph	3.6 gph	3.8 gph	3.6 gph	3.0 gph
DURA-FLO™ JR mini dripperline	SFJR-XX-XX-XX	0.39 gph	0.47 gph	0.56 gph	0.63 gph	0.69 gph			
DURA-FLO™ PC dripperline	SFPC-XX-62XX-XX	0.45 gph	0.50 gph	0.50 gph	0.50 gph	0.50 gph	0.50 gph	0.45 gph	
	SFPC-XX-64XX-XX	0.75 gph	0.90 gph	0.90 gph	0.90 gph	0.90 gph	0.85 gph	0.80 gph	
	SFPC-XX-68XX-XX	1.40 gph	1.60 gph	1.65 gph					
	SFPC-XX-72XX-XX	0.50 gph	0.55 gph	0.55 gph	0.55 gph	0.55 gph	0.55 gph	0.50 gph	
	SFPC-XX-74XX-XX	0.80 gph	0.95 gph	0.95 gph	0.95 gph	0.95 gph	0.95 gph	0.85 gph	
	SFPC-XX-78XX-XX	1.50 gph	1.75 gph	1.80 gph					
	SFPC-XX-202XX-XX	0.43 gph	0.45 gph	0.48 gph	0.48 gph	0.49 gph	0.49 gph	0.45 gph	
	SFPC-XX-204XX-XX	0.80 gph	0.83 gph	0.83 gph	0.86 gph	0.88 gph	0.93 gph	0.94 gph	
SFPC-XX-208XX-XX	1.55 gph	1.62 gph	1.62 gph	1.65 gph	1.65 gph	1.62 gph	1.77 gph		
DURA-FLO™ dripperline	SF-XX-62XX-XX	0.36 gph	0.40 gph	0.51 gph	0.60 gph	0.68 gph	0.78 gph		
	SF-XX-64XX-XX	0.63 gph	0.78 gph	0.92 gph	1.08 gph	1.21 gph	1.41 gph		
	SF-XX-68XX-XX	1.26 gph	1.58 gph	1.79 gph	2.00 gph	2.20 gph	2.54 gph		
	SF-XX-72XX-XX	0.40 gph	0.48 gph	0.56 gph	0.66 gph	0.75 gph	0.86 gph		
	SF-XX-74XX-XX	0.71 gph	0.86 gph	1.01 gph	1.19 gph	1.35 gph	1.56 gph		
	SF-XX-78XX-XX	1.40 gph	1.75 gph	1.98 gph	2.22 gph	2.44 gph	2.82 gph		
MINI-FLO™ emitter	MIL 5	0.51 gph	0.63 gph	0.73 gph	0.81 gph				
	MIL 10	0.86 gph	1.06 gph	1.22 gph	1.36 gph				
Laser Drilled Soaker Hose	ALT 6/12	1.0 gph	1.3 gph	1.6 gph					

Recommended operating range

FLUSHING CHARACTERISTICS OF COMPENSATING EMITTERS*

Nominal Flow	Peak Flush Flow	Peak Flush Pressure
1 gph	1.6 gph	3 psi
2 gph	3.0 gph	3 psi

*includes MONO-FLO™, and UNI-FLO™ CLASSIC emitters



DURA-FLO™ PC DRIPPERLINE

SFPC-XX-6XXX-XX / SFPC-XX-7XXX-XX / SFPC-XX-20XXX-XX

Pressure - Discharge Relationship Chart

Part No	10 psi	15 psi	20 psi	25 psi	30 psi	40 psi	60 psi
SFPC-XX-62XX-XX	0.45 gph	0.50 gph	0.45 gph				
SFPC-XX-64XX-XX	0.75 gph	0.90 gph	0.80 gph				
SFPC-XX-68XX-XX	1.40 gph	1.60 gph	1.65 gph				
SFPC-XX-72XX-XX	0.50 gph	0.55 gph	0.50 gph				
SFPC-XX-74XX-XX	0.80 gph	0.95 gph	0.85 gph				
SFPC-XX-78XX-XX	1.50 gph	1.75 gph	1.80 gph				
SFPC-XX-202XX-XX	0.43 gph	0.45 gph	0.48 gph	0.48 gph	0.49 gph	0.49 gph	0.45 gph
SFPC-XX-204XX-XX	0.80 gph	0.83 gph	0.83 gph	0.86 gph	0.88 gph	0.93 gph	0.94 gph
SFPC-XX-208XX-XX	1.55 gph	1.62 gph	1.62 gph	1.65 gph	1.65 gph	1.62 gph	1.77 gph

Tubing Dimension

Part #	Series	ID	OD	Wall
SFPC-XX-6XXX-XX	600	0.550"	0.640"	0.045"
SFPC-XX-7XXX-XX	700	0.600"	0.700"	0.050"
SFPC-XX-20XXX-XX	800	0.720"	0.830"	0.055"

Maximum Recommended Length of Run (feet)

Initial Pressure	12" spacing			18" spacing			24" spacing			36" spacing			48" spacing		
	½ gph	1 gph	2 gph	½ gph	1 gph	2 gph	½ gph	1 gph	2 gph	½ gph	1 gph	2 gph	½ gph	1 gph	2 gph
SERIES 600 - .550" I.D. X .640" O.D.															
15 psi	180'	130'	85'	255'	185'	125'	325'	240'	155'	455'	330'	215'	560'	410'	260'
20 psi	220'	165'	105'	320'	235'	155'	405'	300'	190'	515'	410'	240'	710'	515'	335'
25 psi	265'	195'	125'	380'	280'	180'	485'	355'	230'	675'	485'	315'	850'	615'	400'
30 psi	295'	215'	140'	420'	305'	200'	530'	390'	250'	740'	535'	350'	935'	680'	440'
35 psi	325'	240'	150'	460'	335'	215'	580'	430'	270'	810'	585'	380'	1020'	740'	480'
40 psi	345'	255'	160'	490'	355'	235'	620'	455'	290'	855'	625'	405'	1085'	790'	510'
45 psi	365'	265'	170'	520'	380'	250'	660'	485'	305'	920'	660'	430'	1150'	835'	540'
SERIES 700 - .600" I.D. X .700" O.D.															
15 psi	210'	155'	100'	300'	220'	145'	380'	280'	180'	525'	380'	245'	650'	475'	305'
20 psi	260'	195'	125'	375'	275'	180'	475'	350'	225'	655'	475'	305'	815'	600'	380'
25 psi	315'	230'	150'	450'	330'	215'	570'	420'	270'	780'	570'	365'	975'	715'	455'
30 psi	345'	255'	165'	495'	360'	235'	625'	460'	295'	860'	630'	405'	1075'	790'	505'
35 psi	380'	280'	180'	540'	395'	255'	685'	505'	320'	940'	690'	440'	1175'	860'	550'
40 psi	405'	300'	190'	575'	420'	275'	730'	535'	340'	1000'	735'	470'	1255'	920'	590'
45 psi	430'	315'	200'	610'	450'	290'	775'	570'	360'	1065'	780'	500'	1330'	975'	625'
SERIES 800 - .720" I.D. X .830" O.D.															
15 psi	315'	215'	150'	495'	315'	200'	560'	380'	250'	780'	540'	350'	950'	660'	430'
25 psi	460'	330'	215'	660'	460'	300'	825'	575'	380'	1160'	840'	520'	1420'	970'	640'
35 psi	565'	345'	265'	790'	560'	330'	990'	690'	460'	1400'	970'	635'	1700'	1190'	775'
45 psi	625'	445'	295'	890'	625'	410'	1120'	775'	510'	1580'	1100'	715'	1930'	1335'	875'

Bingham Facility Wastewater System Improvements
Irrigation Pump Station - Pump Selection

Pump Operating Points @ Maximum Static Head

Zone	Flow (GPM)	Max. Static Head (FT)	Segment Total Headloss (FT)										Head (ft.)	Pressure (psi)				
			A	B	Filters (Dirty)	3	4	5	6	7	8	9			10			
1	153	108.9	0.999	0.331	16.170	0.123	1.620	-	0.369	4.546	-	-	-	-	-	7.393	140.451	60.801
2	155	86.9	1.792	2.180	16.170	0.230	1.710	4.702	-	-	-	-	-	-	-	4.792	118.476	51.288
3	155	97.9	1.792	2.180	16.170	0.230	1.710	-	0.397	-	0.101	4.601	-	-	-	6.071	131.152	56.776
4	109	98.9	0.914	1.087	16.170	0.117	0.890	-	0.206	-	0.062	-	6.434	-	-	5.779	130.559	56.519

Pump Operating Points @ Minimum Static Head

Zone	Flow (GPM)	Min. Static Head (FT)	Segment Total Headloss (FT)										Head (ft.)	Pressure (psi)				
			A	B	Filters (Clean)	3	4	5	6	7	8	9			10			
1	153	97.4	0.049	0.101	1.155	0.123	1.620	-	0.369	4.546	-	-	-	-	-	7.393	112.756	48.812
2	155	75.4	0.769	1.841	1.155	0.230	1.710	4.702	-	-	-	-	-	-	-	4.792	90.599	39.220
3	155	86.4	0.380	0.911	1.155	0.230	1.710	-	0.397	-	0.101	4.601	-	-	-	6.071	101.956	44.137
4	109	87.4	0.000	0.000	1.155	0.117	0.890	-	0.206	-	0.062	-	6.434	-	-	5.779	102.043	44.174

Control Points @ Pressure Transducer

Zone	Flow (GPM)	Static Head (FT)	Segment Total Headloss (FT)										Head (ft.)	Pressure (psi)
			3	4	5	6	7	8	9	10				
1	153	92.9	0.123	1.620	-	0.369	4.546	-	-	7.393	106.951	46.299		
2	155	70.9	0.230	1.710	4.702	-	-	-	4.792	82.334	35.642			
3	155	81.9	0.230	1.710	-	0.397	-	0.101	4.601	95.010	41.130			
4	109	82.9	0.117	0.890	-	0.206	-	0.062	-	96.388	41.726			

Bingham Facility Wastewater System Improvements
Irrigation Pump Station - Pump Selection

Elevation of Pressure Transducer (FT MSL)	508.5
Min. Water Level Elevation in PS Wetwell (FT MSL)	492.5
Max. Water Level Elevation in PS Wetwell (FT MSL)	504
Required head at lowest nozzle in Zone 1 (FT MSL)*	601.4
*Lowest nozzle in Zone 1 grade elevation (lowest nozzle chosen to ensure application rate is < or = to 0.22 in/hr) (509 ft MSL) + 40 psi (92.4 ft) (required for the proper operation of the sprinkler)	
Required head at lowest nozzle in Zone 2 (FT MSL)*	579.4
*Lowest nozzle in Zone 2 grade elevation (lowest nozzle chosen to ensure application rate is < or = to 0.22 in/hr) (487 ft MSL) + 40 psi (92.4 ft) (required for the proper operation of the sprinkler)	
Required head at lowest nozzle in Zone 3 (FT MSL)*	590.4
*Lowest nozzle in Zone 3 grade elevation (lowest nozzle chosen to ensure application rate is < or = to 0.22 in/hr) (498 ft MSL) + 40 psi (92.4 ft) (required for the proper operation of the sprinkler)	
Required head at lowest nozzle in Zone 4 (FT MSL)*	591.4
*Lowest nozzle in Zone 4 grade elevation (lowest nozzle chosen to ensure application rate is < or = to 0.22 in/hr) (499 ft MSL) + 40 psi (92.4 ft) (required for the proper operation of the sprinkler)	
<hr/>	
Zone 1 Pump Maximum Static Head (FT)	108.9
** Vertical distance from minimum water level in the irrigation pump station to the required head at lowest nozzle in Zone 1	
Zone 1 Pump Minimum Static Head (FT)	97.4
** Vertical distance from maximum water level in the irrigation pump station to the required head at lowest nozzle in Zone 1	
Zone 1 Control Static Head (FT)	92.9
** Vertical distance from pressure transducer in the irrigation pump station to the required head at lowest nozzle in Zone 1	
Zone 2 Pump Maximum Static Head (FT)	86.9
** Vertical distance from minimum water level in the irrigation pump station to the required head at lowest nozzle in Zone 2	
Zone 2 Pump Minimum Static Head (FT)	75.4
** Vertical distance from maximum water level in the irrigation pump station to the required head at lowest nozzle in Zone 2	
Zone 2 Control Static Head (FT)	70.9
** Vertical distance from pressure transducer in the irrigation pump station to the required head at lowest nozzle in Zone 2	
Zone 3 Pump Maximum Static Head (FT)	97.9
** Vertical distance from minimum water level in the irrigation pump station to the required head at lowest nozzle in Zone 3	
Zone 3 Pump Minimum Static Head (FT)	86.4
** Vertical distance from maximum water level in the irrigation pump station to the required head at lowest nozzle in Zone 3	
Zone 3 Control Static Head (FT)	81.9
** Vertical distance from pressure transducer in the irrigation pump station to the required head at lowest nozzle in Zone 3	
Zone 4 Maximum Static Head (FT)	98.9
** Vertical distance from minimum water level in the irrigation pump station to the required head at lowest nozzle in Zone 4	
Zone 4 Minimum Static Head (FT)	87.4
** Vertical distance from maximum water level in the irrigation pump station to the required head at lowest nozzle in Zone 4	
Zone 4 Control Static Head (FT)	82.9
** Vertical distance from pressure transducer in the irrigation pump station to the required head at lowest nozzle in Zone 4	

Bingham Facility Wastewater System Improvements
Irrigation Pump Station - Pump Selection

Manufacturer's Pump Curve (Approximate)

Manufacturer	Grundfos	Model Number	150S74-4	Hp	7.5																																																																														
<table border="1"> <thead> <tr> <th colspan="2">FULL SPEED</th> <th colspan="2">97.39 % of Full Speed</th> <th colspan="2">94.49 % of Full Speed</th> </tr> <tr> <th colspan="2">3450 RPM</th> <th colspan="2">3360 RPM</th> <th colspan="2">3260 RPM</th> </tr> <tr> <th>Flow (GPM)</th> <th>Total Head (FT)</th> <th>Flow (GPM)</th> <th>Total Head (FT)</th> <th>Flow (GPM)</th> <th>Total Head (FT)</th> </tr> </thead> <tbody> <tr><td>0</td><td>222</td><td>0</td><td>211</td><td>0</td><td>198</td></tr> <tr><td>25</td><td>218</td><td>24</td><td>207</td><td>24</td><td>195</td></tr> <tr><td>50</td><td>208</td><td>49</td><td>197</td><td>47</td><td>186</td></tr> <tr><td>75</td><td>199</td><td>73</td><td>189</td><td>71</td><td>178</td></tr> <tr><td>100</td><td>185</td><td>97</td><td>175</td><td>94</td><td>165</td></tr> <tr><td>125</td><td>170</td><td>122</td><td>161</td><td>118</td><td>152</td></tr> <tr><td>150</td><td>148</td><td>146</td><td>140</td><td>142</td><td>132</td></tr> <tr><td>175</td><td>120</td><td>170</td><td>114</td><td>165</td><td>107</td></tr> <tr><td>200</td><td>90</td><td>195</td><td>85</td><td>189</td><td>80</td></tr> <tr><td>220</td><td>75</td><td>214</td><td>71</td><td>208</td><td>67</td></tr> </tbody> </table>						FULL SPEED		97.39 % of Full Speed		94.49 % of Full Speed		3450 RPM		3360 RPM		3260 RPM		Flow (GPM)	Total Head (FT)	Flow (GPM)	Total Head (FT)	Flow (GPM)	Total Head (FT)	0	222	0	211	0	198	25	218	24	207	24	195	50	208	49	197	47	186	75	199	73	189	71	178	100	185	97	175	94	165	125	170	122	161	118	152	150	148	146	140	142	132	175	120	170	114	165	107	200	90	195	85	189	80	220	75	214	71	208	67
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Bingham Facility Wastewater System Improvements
Irrigation Pump Station - Pump Selection

90.43 % of Full Speed
3120 RPM

Flow (GPM)	Total Head (FT)
0	182
23	178
45	170
68	163
90	151
113	139
136	121
158	98
181	74
199	61

87.83 % of Full Speed
3030 RPM

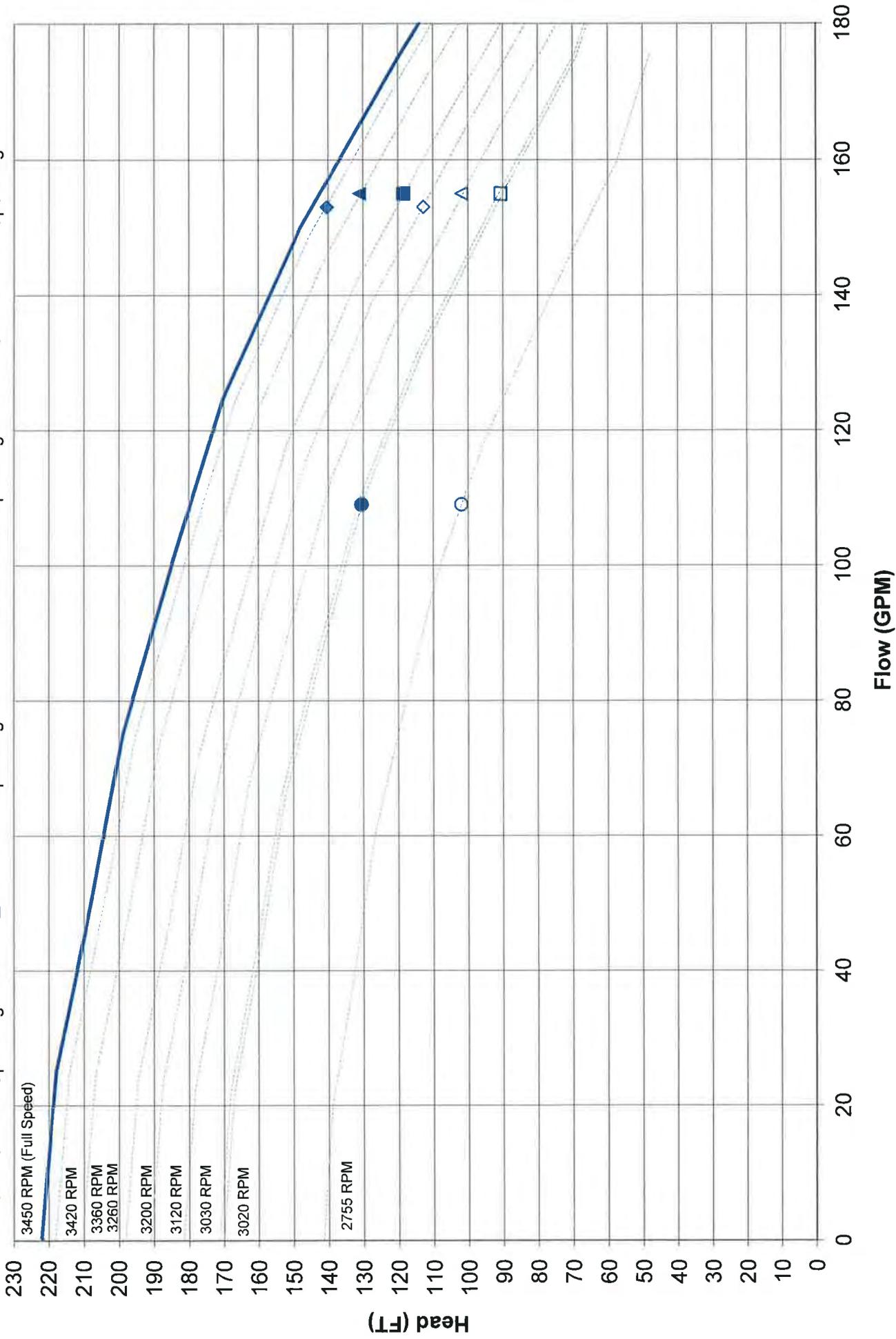
Flow (GPM)	Total Head (FT)
0	171
22	168
44	160
66	153
88	143
110	131
132	114
154	93
176	69
193	58

79.86 % of Full Speed
2755 RPM

Flow (GPM)	Total Head (FT)
0	142
20	139
40	133
60	127
80	118
100	108
120	94
140	77
160	57
176	48

Irrigation Pump Station - Pump Selection

- ◆ Zone 1 Max Operating Point
- ◆ Zone 2 Max Operating Point
- ◆ Zone 3 Max Operating Point
- ◆ Zone 4 Max Operating Point
- ◇ Zone 1 Min. Operating Point
- ◇ Zone 2 Min. Operating Point
- ◇ Zone 3 Min. Operating Point
- ◇ Zone 4 Min. Operating Point



Segment A Headloss

** 3" submersible pump riser pipe from entrance (@ pipe entrance) to just before 4"x3" reducer (@ 3" pipe)

Minor Loss Element	Quantity	Minor Loss Factor (K)	K
Butterfly Valve (Open)		1.20	0.00
Check Valve (Conventional)		4.00	0.00
Plug Valve (Open)		0.40	0.00
Gate Valve (Fully Open)		0.39	0.00
Gate Valve (3/4 Open)		1.10	0.00
Gate Valve (1/2 Open)		4.80	0.00
Gate Valve (1/4 Open)		27.00	0.00
90° Bend		0.30	0.00
45° Bend		0.23	0.00
22.5° Bend		0.15	0.00
11.25° Bend			0.00
Reducer (D2/D1 = 0.8)		0.05	0.00
Reducer (D2/D1 = 0.5)		0.07	0.00
Reducer (D2/D1 = 0.2)		0.08	0.00
Expansion (D2/D1 = 0.8)		0.03	0.00
Expansion (D2/D1 = 0.5)		0.08	0.00
Expansion (D2/D1 = 0.2)		0.13	0.00
Tee (Line Flow)		0.35	0.00
Tee (Branch Flow)		1.28	0.00
Entrance Loss	1	1.00	1.00
Outlet Loss		1.00	0.00
Sluice Gate		0.80	0.00
Total K =			1.00

Zone 1

Length (FT)	Flow (GPM)	Flow (CFS)	Diameter (IN)	Diameter (FT)	Cross Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams C Factor	S (FT/FT)
13.1	153	0.34	3.00	0.25	0.05	6.95	0.749	120	0.07626
Minor Headloss (FT)					0.000				
Pipe Friction Headloss (FT)					0.999				
Total Headloss (FT)					0.999				

Zone 2

Length (FT)	Flow (GPM) (CFS)	Diameter (IN) (FT)	Cross Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams C Factor	S (FT/FT)
13.1	155 0.35	3.00 0.25	0.05	7.04	0.77	120	0.07811
Minor Headloss (FT)				0.769			
Pipe Friction Headloss (FT)				1.023			
Total Headloss (FT)				1.792			

Zone 3

Length (FT)	Flow (GPM) (CFS)	Diameter (IN) (FT)	Cross Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams C Factor	S (FT/FT)
13.1	155 0.35	3.00 0.25	0.05	7.04	0.77	120	0.07811
Minor Headloss (FT)				0.769			
Pipe Friction Headloss (FT)				1.023			
Total Headloss (FT)				1.792			

Zone 4

Length (FT)	Flow (GPM) (CFS)	Diameter (IN) (FT)	Cross Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams C Factor	S (FT/FT)
13.1	109 0.24	3.00 0.25	0.05	4.95	0.38	120	0.04072
Minor Headloss (FT)				0.380			
Pipe Friction Headloss (FT)				0.533			
Total Headloss (FT)				0.914			

Segment B Headloss

** 4" DI pipe from 4"x3" reducer (@ 4" x 3" reducer) to just before 6"x4" reducer (@ 4" pipe)

Minor Loss Element	Quantity	Minor Loss Factor (K)	K
Butterfly Valve (Open)		1.20	0.00
Check Valve (Conventional)	1	4.00	4.00
Plug Valve (Open)		0.40	0.00
Gate Valve (Fully Open)	1	0.39	0.39
Gate Valve (3/4 Open)		1.10	0.00
Gate Valve (1/2 Open)		4.80	0.00
Gate Valve (1/4 Open)		27.00	0.00
90° Bend	5	0.30	1.50
45° Bend		0.23	0.00
22.5° Bend		0.15	0.00
11.25° Bend			0.00
Reducer (D2/D1 = 0.8)		0.05	0.00
Reducer (D2/D1 = 0.5)		0.07	0.00
Reducer (D2/D1 = 0.2)		0.08	0.00
Expansion (D2/D1 = 0.8)	1	0.03	0.03
Expansion (D2/D1 = 0.5)		0.08	0.00
Expansion (D2/D1 = 0.2)		0.13	0.00
Tee (Line Flow)	1	0.35	0.35
Tee (Branch Flow)	3	1.28	3.84
Entrance Loss		1.00	0.00
Outlet Loss		1.00	0.00
Sluice Gate		0.80	0.00
Total K =			10.11

Zone 1

Length (FT)	Flow (GPM) (CFS)	Diameter (IN) (FT)	Cross Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams C Factor	S (FT/FT)
25	153 0.34	4.30 0.36	0.10	3.38	0.177	120	0.01323
Minor Headloss (FT)				0.000			
Pipe Friction Headloss (FT)				0.331			
Total Headloss (FT)				0.331			

Zone 2

Length (FT)	Flow (GPM) (CFS)	Diameter (IN) (FT)	Cross Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams C Factor	S (FT/FT)
25	155 0.35	4.30 0.36	0.10	3.42	0.18	120	0.01355
Minor Headloss (FT)				1.841			
Pipe Friction Headloss (FT)				0.339			
Total Headloss (FT)				2.180			

Zone 3

Length (FT)	Flow (GPM) (CFS)	Diameter (IN) (FT)	Cross Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams C Factor	S (FT/FT)
25	155 0.35	4.30 0.36	0.10	3.42	0.18	120	0.01355
Minor Headloss (FT)				1.841			
Pipe Friction Headloss (FT)				0.339			
Total Headloss (FT)				2.180			

Zone 4

Length (FT)	Flow (GPM) (CFS)	Diameter (IN) (FT)	Cross Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams C Factor	S (FT/FT)
25	109 0.24	4.30 0.36	0.10	2.41	0.09	120	0.00707
Minor Headloss (FT)				0.911			
Pipe Friction Headloss (FT)				0.177			
Total Headloss (FT)				1.087			

Segment 3 Headloss

** 6" DI pipe from 6"x4" reducer (@ 6" x 4" reducer) to just before pipe transition from DI to PVC (@ 6" pipe)

Minor Loss Element	Quantity	Minor Loss Factor (K)	K
Butterfly Valve (Open)		1.20	0.00
Check Valve (Conventional)		4.00	0.00
Plug Valve (Open)		0.40	0.00
Gate Valve (Fully Open)		0.39	0.00
Gate Valve (3/4 Open)		1.10	0.00
Gate Valve (1/2 Open)		4.80	0.00
Gate Valve (1/4 Open)		27.00	0.00
90° Bend	2	0.30	0.60
45° Bend		0.23	0.00
22.5° Bend		0.15	0.00
11.25° Bend			0.00
Reducer (D2/D1 = 0.8)		0.05	0.00
Reducer (D2/D1 = 0.5)		0.07	0.00
Reducer (D2/D1 = 0.2)		0.08	0.00
Expansion (D2/D1 = 0.8)		0.03	0.00
Expansion (D2/D1 = 0.5)	1	0.08	0.08
Expansion (D2/D1 = 0.2)		0.13	0.00
Tee (Line Flow)		0.35	0.00
Tee (Branch Flow)	1	1.28	1.28
Entrance Loss		1.00	0.00
Outlet Loss		1.00	0.00
Sluice Gate		0.80	0.00
Total K =			1.96

Zone 1

Length (FT)	Flow (GPM)	Flow (CFS)	Diameter (IN)	Diameter (FT)	Cross Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams C Factor	S (FT/FT)
42	153	0.34	5.86	0.49	0.19	1.82	0.051	120	0.00293
Minor Headloss (FT)					0.000				
Pipe Friction Headloss (FT)					0.123				
Total Headloss (FT)					0.123				

Zone 2

Length (FT)	Flow (GPM) (CFS)	Diameter (IN) (FT)	Cross Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams C Factor	S (FT/FT)		
42	155	0.35	5.86 0.49	0.19	1.84	0.05	120	0.00301	
Minor Headloss (FT)				0.103					
Pipe Friction Headloss (FT)				0.126					
Total Headloss (FT)				0.230					

Zone 3

Length (FT)	Flow (GPM) (CFS)	Diameter (IN) (FT)	Cross Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams C Factor	S (FT/FT)		
42	155	0.35	5.86 0.49	0.19	1.84	0.05	120	0.00301	
Minor Headloss (FT)				0.103					
Pipe Friction Headloss (FT)				0.126					
Total Headloss (FT)				0.230					

Zone 4

Length (FT)	Flow (GPM) (CFS)	Diameter (IN) (FT)	Cross Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams C Factor	S (FT/FT)		
42	109	0.24	5.86 0.49	0.19	1.30	0.03	120	0.00157	
Minor Headloss (FT)				0.051					
Pipe Friction Headloss (FT)				0.066					
Total Headloss (FT)				0.117					

Segment 4 Headloss

** 6" PVC pipe from pipe transition (@ 6" pipe) to just before tee at Zone 2 control valve (@ 6" pipe)

Minor Loss Element	Quantity	Minor Loss Factor (K)	K
Butterfly Valve (Open)		1.20	0.00
Check Valve (Conventional)		4.00	0.00
Plug Valve (Open)		0.40	0.00
Gate Valve (Fully Open)		0.39	0.00
Gate Valve (3/4 Open)		1.10	0.00
Gate Valve (1/2 Open)		4.80	0.00
Gate Valve (1/4 Open)		27.00	0.00
90° Bend	1	0.30	0.30
45° Bend	2	0.23	0.46
22.5° Bend		0.15	0.00
11.25° Bend	2	0.10	0.20
Reducer (D2/D1 = 0.8)		0.05	0.00
Reducer (D2/D1 = 0.5)		0.07	0.00
Reducer (D2/D1 = 0.2)		0.08	0.00
Expansion (D2/D1 = 0.8)		0.03	0.00
Expansion (D2/D1 = 0.5)		0.08	0.00
Expansion (D2/D1 = 0.2)		0.13	0.00
Tee (Line Flow)		0.35	0.00
Tee (Branch Flow)		1.28	0.00
Entrance Loss		1.00	0.00
Outlet Loss		1.00	0.00
Sluice Gate		0.80	0.00
Total K =			0.96

Zone 1

Length (FT)	Flow (GPM)	Flow (CFS)	Diameter (IN)	Diameter (FT)	Cross Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams C Factor	S (FT/FT)
640	153	0.34	5.86	0.49	0.19	1.82	0.051	130	0.00253
Minor Headloss (FT)					0.000				
Pipe Friction Headloss (FT)					1.620				
Total Headloss (FT)					1.620				

Zone 2

Length (FT)	Flow (GPM) (CFS)	Diameter (IN) (FT)	Cross Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams C Factor	S (FT/FT)		
640	155	0.35	5.86	0.49	0.19	1.84	0.05	130	0.00259
Minor Headloss (FT)				0.051					
Pipe Friction Headloss (FT)				1.659					
Total Headloss (FT)				1.710					

Zone 3

Length (FT)	Flow (GPM) (CFS)	Diameter (IN) (FT)	Cross Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams C Factor	S (FT/FT)		
640	155	0.35	5.86	0.49	0.19	1.84	0.05	130	0.00259
Minor Headloss (FT)				0.051					
Pipe Friction Headloss (FT)				1.659					
Total Headloss (FT)				1.710					

Zone 4

Length (FT)	Flow (GPM) (CFS)	Diameter (IN) (FT)	Cross Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams C Factor	S (FT/FT)		
640	109	0.24	5.86	0.49	0.19	1.30	0.03	130	0.00135
Minor Headloss (FT)				0.025					
Pipe Friction Headloss (FT)				0.865					
Total Headloss (FT)				0.890					

Segment 5 Headloss

** 6" PVC pipe from tee at Zone 2 control valve (@ 6" tee, branch flow) to just after Zone 2 control valve (@ 45° elbow)

Minor Loss Element	Quantity	Minor Loss Factor (K)	K
Butterfly Valve (Open)		1.20	0.00
Check Valve (Conventional)		4.00	0.00
Plug Valve (Open)		0.40	0.00
Gate Valve (Fully Open)		0.39	0.00
Gate Valve (3/4 Open)		1.10	0.00
Gate Valve (1/2 Open)		4.80	0.00
Gate Valve (1/4 Open)		27.00	0.00
90° Bend		0.30	0.00
45° Bend	1	0.23	0.23
22.5° Bend		0.15	0.00
11.25° Bend			0.00
Reducer (D2/D1 = 0.8)		0.05	0.00
Reducer (D2/D1 = 0.5)	1	0.07	0.07
Reducer (D2/D1 = 0.2)		0.08	0.00
Expansion (D2/D1 = 0.8)		0.03	0.00
Expansion (D2/D1 = 0.5)	1	0.08	0.08
Expansion (D2/D1 = 0.2)		0.13	0.00
Tee (Line Flow)		0.35	0.00
Tee (Branch Flow)	1	1.28	1.28
Entrance Loss		1.00	0.00
Outlet Loss		1.00	0.00
Sluice Gate		0.80	0.00
Total K =			1.66

Zone 2

Length (FT)	Flow (GPM) (CFS)	Diameter (IN) (FT)	Cross Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams C Factor	S (FT/FT)
46	155 0.35	5.86 0.49	0.19	1.84	0.053	130	0.00259
Minor Headloss (FT)				0.000			
Control Valve Headloss (FT)				4.583			
Pipe Friction Headloss (FT)				0.119			
Total Headloss (FT)				4.702			



- 4" Submains
 - 2" Laterals
 - 1/8" Tubing

ZONE 2 SCALE: 1" = 60'

UNC Bingham Facility Wastewater System Improvements
Secondary Effluent Drip Irrigation System Calculations
ZONE 2

Summary

Maximum Headloss in Zone 2 Submains (FT): 0.812
 Maximum Headloss in Zone 2 Laterals (FT): 1.212
 Maximum Headloss in Zone 2 Tubing (FT): 2.769
 Total Headloss to use for Zone 2 (FT): 4.792

Submain Segment 1A									
Flow	Diameter	Cross	Velocity	Velocity	Hazen	S			
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	Williams	C Factor	(FT/FT)		
155	6.00	0.50	1.76	0.048	120	120	0.00268		
Total Headloss (FT) 0.252									

Submain Segment 1B									
Flow	Diameter	Cross	Velocity	Velocity	Hazen	S			
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	Williams	C Factor	(FT/FT)		
149.72	6.00	0.50	1.70	0.045	120	120	0.00251		
Total Headloss (FT) 0.201									

Submain Segment 1C									
Flow	Diameter	Cross	Velocity	Velocity	Hazen	S			
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	Williams	C Factor	(FT/FT)		
130.49	6.00	0.50	1.48	0.034	120	120	0.00195		
Total Headloss (FT) 0.156									

Submain Segment 1D									
Flow	Diameter	Cross	Velocity	Velocity	Hazen	S			
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	Williams	C Factor	(FT/FT)		
105	6.00	0.50	1.19	0.022	120	120	0.00130		
Total Headloss (FT) 0.104									

Submain Segment 1E									
Flow	Diameter	Cross	Velocity	Velocity	Hazen	S			
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	Williams	C Factor	(FT/FT)		
79.5	6.00	0.50	0.90	0.013	120	120	0.00078		

UNC Bingham Facility Wastewater System Improvements
Secondary Effluent Drip Irrigation System Calculations
ZONE 2

Submain Segment 1F									
Flow	Diameter	Cross	Velocity	Velocity	Hazen	S			
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	Williams	C Factor	(FT/FT)		
52.5	6.00	0.50	0.60	0.006	120	120	0.00036		
Total Headloss (FT) 0.062									

Submain Segment 1G									
Flow	Diameter	Cross	Velocity	Velocity	Hazen	S			
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	Williams	C Factor	(FT/FT)		
25.5	6.00	0.50	0.29	0.001	120	120	0.00010		
Total Headloss (FT) 0.029									

Submain Segment 1H									
Flow	Diameter	Cross	Velocity	Velocity	Hazen	S			
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	Williams	C Factor	(FT/FT)		
5.28	2.00	0.17	0.54	0.005	120	120	0.00108		
Total Headloss (FT) 0.016									

Submain Segment 1B									
Flow	Diameter	Cross	Velocity	Velocity	Hazen	S			
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	Williams	C Factor	(FT/FT)		
4.14	2.00	0.17	0.42	0.003	120	120	0.00069		
Total Headloss (FT) 0.006									

Submain Segment 1C									
Flow	Diameter	Cross	Velocity	Velocity	Hazen	S			
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	Williams	C Factor	(FT/FT)		
3.12	2.00	0.17	0.32	0.002	120	120	0.00041		
Total Headloss (FT) 0.003									

Submain Segment 1D									
Flow	Diameter	Cross	Velocity	Velocity	Hazen	S			
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	Williams	C Factor	(FT/FT)		
0.01	2.00	0.17	0.02	0.0003	120	120	0.00003		

UNC Bingham Facility Wastewater System Improvements
Secondary Effluent Drip Irrigation System Calculations

ZONE-2

Length (FT)	8	Flow (GPM)	Diameter (IN)	CFS	Gross			Hazen Williams			S
					Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	C Factor	Velocity (FT/FT)		
		8.73	2.00	0.17	0.02	0.89	0.012	120	0.00274		
Total Headloss (FT)									0.022		

Lateral Segment 2I

Length (FT)	8	Flow (GPM)	Diameter (IN)	CFS	Gross			Hazen Williams			S
					Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	C Factor	Velocity (FT/FT)		
		7.23	2.00	0.17	0.02	0.74	0.008	120	0.00194		
Total Headloss (FT)									0.015		

Lateral Segment 2J

Length (FT)	8	Flow (GPM)	Diameter (IN)	CFS	Gross			Hazen Williams			S
					Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	C Factor	Velocity (FT/FT)		
		5.85	2.00	0.17	0.02	0.60	0.006	120	0.00131		
Total Headloss (FT)									0.010		

Lateral Segment 2K

Length (FT)	8	Flow (GPM)	Diameter (IN)	CFS	Gross			Hazen Williams			S
					Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	C Factor	Velocity (FT/FT)		
		4.59	2.00	0.17	0.02	0.47	0.003	120	0.00084		
Total Headloss (FT)									0.007		

Lateral Segment 2L

Length (FT)	8	Flow (GPM)	Diameter (IN)	CFS	Gross			Hazen Williams			S
					Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	C Factor	Velocity (FT/FT)		
		3.51	2.00	0.17	0.02	0.36	0.002	120	0.00051		
Total Headloss (FT)									0.004		

Lateral Segment 2M

Length (FT)	8	Flow (GPM)	Diameter (IN)	CFS	Gross			Hazen Williams			S
					Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	C Factor	Velocity (FT/FT)		
		2.55	2.00	0.17	0.02	0.26	0.001	120	0.00028		
Total Headloss (FT)									0.002		

Lateral Segment 2N

UNC Bingham Facility Wastewater System Improvements
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ZONE-2

Length (FT)	8	Flow (GPM)	Diameter (IN)	CFS	Gross			Hazen Williams			S
					Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	C Factor	Velocity (FT/FT)		
		1.71	2.00	0.17	0.02	0.17	0.000	120	0.00013		
Total Headloss (FT)									0.001		

Lateral Segment 2O

Length (FT)	8	Flow (GPM)	Diameter (IN)	CFS	Gross			Hazen Williams			S
					Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	C Factor	Velocity (FT/FT)		
		0.99	2.00	0.17	0.02	0.10	0.000	120	0.00005		
Total Headloss (FT)									0.000		

Lateral Segment 2P

Length (FT)	8	Flow (GPM)	Diameter (IN)	CFS	Gross			Hazen Williams			S
					Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	C Factor	Velocity (FT/FT)		
		0.42	2.00	0.17	0.02	0.04	0.000	120	0.00001		
Total Headloss (FT)									0.000		

Lateral Segment 3A

Length (FT)	12	Flow (GPM)	Diameter (IN)	CFS	Gross			Hazen Williams			S
					Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	C Factor	Velocity (FT/FT)		
		25.5	2.00	0.17	0.02	2.60	0.105	120	0.01993		
Total Headloss (FT)									0.239		

Total Lateral 2 Headloss (FT) 0.646

Lateral Segment 3B

Length (FT)	8	Flow (GPM)	Diameter (IN)	CFS	Gross			Hazen Williams			S
					Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	C Factor	Velocity (FT/FT)		
		24	2.00	0.17	0.02	2.45	0.093	120	0.01781		
Total Headloss (FT)									0.143		

Lateral Segment 3C

Length (FT)	8	Flow (GPM)	Diameter (IN)	CFS	Gross			Hazen Williams			S
					Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	C Factor	Velocity (FT/FT)		
		22.5	2.00	0.17	0.02	2.30	0.082	120	0.01581		
Total Headloss (FT)									0.126		

UNC Bingham Facility Wastewater System Improvements
Secondary Effluent Drip Irrigation System Calculations

ZONE 2

Length (FT)	Flow (GPM)	Diameter (IN)	Gross		Velocity (FT/S)	Head (FT)	Hazen Williams		S
			Sectional Area (SQ. FT)	Sectional Area (SQ. FT)			C Factor	C Factor	
8	3	0.01	2.00	0.17	0.31	0.001	120	120	0.00038
Total Headloss (FT) 0.003									

Length (FT)	Flow (GPM)	Diameter (IN)	Gross		Velocity (FT/S)	Head (FT)	Hazen Williams		S
			Sectional Area (SQ. FT)	Sectional Area (SQ. FT)			C Factor	C Factor	
8	1.5	0.00	2.00	0.17	0.15	0.000	120	120	0.00011
Total Headloss (FT) 0.001									

Total Lateral 3 Headloss (FT) 1.112

Length (FT)	Flow (GPM)	Diameter (IN)	Gross		Velocity (FT/S)	Head (FT)	Hazen Williams		S
			Sectional Area (SQ. FT)	Sectional Area (SQ. FT)			C Factor	C Factor	
13	25.5	0.06	2.00	0.17	2.60	0.105	120	120	0.01993
Total Headloss (FT) 0.259									

Length (FT)	Flow (GPM)	Diameter (IN)	Gross		Velocity (FT/S)	Head (FT)	Hazen Williams		S
			Sectional Area (SQ. FT)	Sectional Area (SQ. FT)			C Factor	C Factor	
8	24	0.05	2.00	0.17	2.45	0.093	120	120	0.01761
Total Headloss (FT) 0.143									

Length (FT)	Flow (GPM)	Diameter (IN)	Gross		Velocity (FT/S)	Head (FT)	Hazen Williams		S
			Sectional Area (SQ. FT)	Sectional Area (SQ. FT)			C Factor	C Factor	
8	22.5	0.05	2.00	0.17	2.30	0.082	120	120	0.01581
Total Headloss (FT) 0.126									

Length (FT)	Flow (GPM)	Diameter (IN)	Gross		Velocity (FT/S)	Head (FT)	Hazen Williams		S
			Sectional Area (SQ. FT)	Sectional Area (SQ. FT)			C Factor	C Factor	
8	21	0.05	2.00	0.17	2.14	0.071	120	120	0.01392
Total Headloss (FT) 0.111									

UNC Bingham Facility Wastewater System Improvements
Secondary Effluent Drip Irrigation System Calculations

ZONE 2

Length (FT)	Flow (GPM)	Diameter (IN)	Gross		Velocity (FT/S)	Head (FT)	Hazen Williams		S
			Sectional Area (SQ. FT)	Sectional Area (SQ. FT)			C Factor	C Factor	
8	19.5	0.04	2.00	0.17	1.99	0.062	120	120	0.01213
Total Headloss (FT) 0.097									

Length (FT)	Flow (GPM)	Diameter (IN)	Gross		Velocity (FT/S)	Head (FT)	Hazen Williams		S
			Sectional Area (SQ. FT)	Sectional Area (SQ. FT)			C Factor	C Factor	
8	18	0.04	2.00	0.17	1.84	0.052	120	120	0.01046
Total Headloss (FT) 0.084									

Length (FT)	Flow (GPM)	Diameter (IN)	Gross		Velocity (FT/S)	Head (FT)	Hazen Williams		S
			Sectional Area (SQ. FT)	Sectional Area (SQ. FT)			C Factor	C Factor	
8	16.5	0.04	2.00	0.17	1.69	0.044	120	120	0.00891
Total Headloss (FT) 0.071									

Length (FT)	Flow (GPM)	Diameter (IN)	Gross		Velocity (FT/S)	Head (FT)	Hazen Williams		S
			Sectional Area (SQ. FT)	Sectional Area (SQ. FT)			C Factor	C Factor	
8	15	0.03	2.00	0.17	1.53	0.036	120	120	0.00747
Total Headloss (FT) 0.060									

Length (FT)	Flow (GPM)	Diameter (IN)	Gross		Velocity (FT/S)	Head (FT)	Hazen Williams		S
			Sectional Area (SQ. FT)	Sectional Area (SQ. FT)			C Factor	C Factor	
8	13.5	0.03	2.00	0.17	1.38	0.030	120	120	0.00614
Total Headloss (FT) 0.049									

Length (FT)	Flow (GPM)	Diameter (IN)	Gross		Velocity (FT/S)	Head (FT)	Hazen Williams		S
			Sectional Area (SQ. FT)	Sectional Area (SQ. FT)			C Factor	C Factor	
8	12	0.03	2.00	0.17	1.23	0.023	120	120	0.00494
Total Headloss (FT) 0.040									

UNC Bingham Facility Wastewater System Improvements
Secondary Effluent Drip Irrigation System Calculations
ZONE 2

Lateral Segment 5F												
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Gross			Hazen Williams			S	
					Flow	Diameter	Sectional Area	Velocity	Head	C Factor		Velocity
8	19.5	0.04	2.00	0.17	0.02	1.99	0.062	120	0.01213			
Total Headloss (FT)											0.097	

Lateral Segment 5G												
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Gross			Hazen Williams			S	
					Flow	Diameter	Sectional Area	Velocity	Head	C Factor		Velocity
8	18	0.04	2.00	0.17	0.02	1.84	0.052	120	0.01046			
Total Headloss (FT)											0.084	

Lateral Segment 5H												
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Gross			Hazen Williams			S	
					Flow	Diameter	Sectional Area	Velocity	Head	C Factor		Velocity
8	16.5	0.04	2.00	0.17	0.02	1.69	0.044	120	0.00891			
Total Headloss (FT)											0.071	

Lateral Segment 5I												
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Gross			Hazen Williams			S	
					Flow	Diameter	Sectional Area	Velocity	Head	C Factor		Velocity
8	15	0.03	2.00	0.17	0.02	1.53	0.036	120	0.00747			
Total Headloss (FT)											0.060	

Lateral Segment 5J												
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Gross			Hazen Williams			S	
					Flow	Diameter	Sectional Area	Velocity	Head	C Factor		Velocity
8	13.5	0.03	2.00	0.17	0.02	1.38	0.030	120	0.00614			
Total Headloss (FT)											0.049	

Lateral Segment 5K												
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Gross			Hazen Williams			S	
					Flow	Diameter	Sectional Area	Velocity	Head	C Factor		Velocity
8	12	0.03	2.00	0.17	0.02	1.23	0.023	120	0.00494			
Total Headloss (FT)											0.040	

UNC Bingham Facility Wastewater System Improvements
Secondary Effluent Drip Irrigation System Calculations
ZONE 2

Lateral Segment 5L												
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Gross			Hazen Williams			S	
					Flow	Diameter	Sectional Area	Velocity	Head	C Factor		Velocity
8	10.5	0.02	2.00	0.17	0.02	1.07	0.018	120	0.00386			
Total Headloss (FT)											0.031	

Lateral Segment 5M												
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Gross			Hazen Williams			S	
					Flow	Diameter	Sectional Area	Velocity	Head	C Factor		Velocity
8	9	0.02	2.00	0.17	0.02	0.92	0.013	120	0.00290			
Total Headloss (FT)											0.023	

Lateral Segment 5N												
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Gross			Hazen Williams			S	
					Flow	Diameter	Sectional Area	Velocity	Head	C Factor		Velocity
8	7.5	0.02	2.00	0.17	0.02	0.77	0.009	120	0.00207			
Total Headloss (FT)											0.017	

Lateral Segment 5O												
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Gross			Hazen Williams			S	
					Flow	Diameter	Sectional Area	Velocity	Head	C Factor		Velocity
8	6	0.01	2.00	0.17	0.02	0.61	0.006	120	0.00137			
Total Headloss (FT)											0.011	

Lateral Segment 5P												
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Gross			Hazen Williams			S	
					Flow	Diameter	Sectional Area	Velocity	Head	C Factor		Velocity
8	4.5	0.01	2.00	0.17	0.02	0.46	0.003	120	0.00081			
Total Headloss (FT)											0.006	

Lateral Segment 5Q												
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Gross			Hazen Williams			S	
					Flow	Diameter	Sectional Area	Velocity	Head	C Factor		Velocity
8	3	0.01	2.00	0.17	0.02	0.31	0.001	120	0.00038			
Total Headloss (FT)											0.003	

Lateral Segment 5R

UNC Bingham Facility Wastewater System Improvements
Secondary Effluent Drip Irrigation System Calculations

ZONE 2

Lateral Segment 6L		Gross		Hazen		S			
Flow	Diameter	Sectional Area	Velocity	Velocity	Williams	C Factor	(FT/FT)		
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	C Factor		(FT/FT)		
8	10.5	0.02	2.00	0.17	0.02	1.07	0.018	120	0.00386
Total Headloss (FT)								0.031	

Lateral Segment 6M		Gross		Hazen		S			
Flow	Diameter	Sectional Area	Velocity	Velocity	Williams	C Factor	(FT/FT)		
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	C Factor		(FT/FT)		
8	9	0.02	2.00	0.17	0.02	0.92	0.013	120	0.00290
Total Headloss (FT)								0.023	

Lateral Segment 6N		Gross		Hazen		S			
Flow	Diameter	Sectional Area	Velocity	Velocity	Williams	C Factor	(FT/FT)		
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	C Factor		(FT/FT)		
8	7.5	0.02	2.00	0.17	0.02	0.77	0.009	120	0.00207
Total Headloss (FT)								0.017	

Lateral Segment 6O		Gross		Hazen		S			
Flow	Diameter	Sectional Area	Velocity	Velocity	Williams	C Factor	(FT/FT)		
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	C Factor		(FT/FT)		
8	6	0.01	2.00	0.17	0.02	0.61	0.006	120	0.00137
Total Headloss (FT)								0.011	

Lateral Segment 6P		Gross		Hazen		S			
Flow	Diameter	Sectional Area	Velocity	Velocity	Williams	C Factor	(FT/FT)		
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	C Factor		(FT/FT)		
8	4.5	0.01	2.00	0.17	0.02	0.46	0.003	120	0.00081
Total Headloss (FT)								0.006	

Lateral Segment 6Q		Gross		Hazen		S			
Flow	Diameter	Sectional Area	Velocity	Velocity	Williams	C Factor	(FT/FT)		
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	C Factor		(FT/FT)		
8	3	0.01	2.00	0.17	0.02	0.31	0.001	120	0.00038
Total Headloss (FT)								0.003	

Lateral Segment 6R

UNC Bingham Facility Wastewater System Improvements
Secondary Effluent Drip Irrigation System Calculations

ZONE 2

Lateral Segment 6S		Gross		Hazen		S			
Flow	Diameter	Sectional Area	Velocity	Velocity	Williams	C Factor	(FT/FT)		
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	C Factor		(FT/FT)		
8	1.5	0.00	2.00	0.17	0.02	0.15	0.000	120	0.00011
Total Headloss (FT)								0.001	

Total Lateral 6 Headloss (FT) 1.187

Lateral Segment 7A		Gross		Hazen		S			
Flow	Diameter	Sectional Area	Velocity	Velocity	Williams	C Factor	(FT/FT)		
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	C Factor		(FT/FT)		
17	25.5	0.06	2.00	0.17	0.02	2.60	0.105	120	0.01993
Total Headloss (FT)								0.339	

Lateral Segment 7B		Gross		Hazen		S			
Flow	Diameter	Sectional Area	Velocity	Velocity	Williams	C Factor	(FT/FT)		
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	C Factor		(FT/FT)		
8	24	0.05	2.00	0.17	0.02	2.45	0.093	120	0.01781
Total Headloss (FT)								0.143	

Lateral Segment 7C		Gross		Hazen		S			
Flow	Diameter	Sectional Area	Velocity	Velocity	Williams	C Factor	(FT/FT)		
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	C Factor		(FT/FT)		
8	22.5	0.05	2.00	0.17	0.02	2.30	0.082	120	0.01581
Total Headloss (FT)								0.126	

Lateral Segment 7D		Gross		Hazen		S			
Flow	Diameter	Sectional Area	Velocity	Velocity	Williams	C Factor	(FT/FT)		
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	C Factor		(FT/FT)		
8	21	0.05	2.00	0.17	0.02	2.14	0.071	120	0.01392
Total Headloss (FT)								0.111	

Lateral Segment 7E		Gross		Hazen		S			
Flow	Diameter	Sectional Area	Velocity	Velocity	Williams	C Factor	(FT/FT)		
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	C Factor		(FT/FT)		
8	19.5	0.04	2.00	0.17	0.02	1.99	0.062	120	0.01213
Total Headloss (FT)								0.097	

UNC Bingham Facility Wastewater System Improvements
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ZONE 2

Tubing Segment 2.1										
Length (FT)	Flow (GPM)	Diameter (IN)	CFS	Cross Sectional Area		Velocity (FT/S)	Head (FT)	Hazen Williams		S (FT/FT)
				(SQ. FT)	(SQ. FT)			C Factor	C Factor	
57	1.14	0.00	0.60	0.05	0.00	1.29	0.026	120	120	0.02222
Total Headloss (FT) 1.267										

Tubing Segment 2.2										
Length (FT)	Flow (GPM)	Diameter (IN)	CFS	Cross Sectional Area		Velocity (FT/S)	Head (FT)	Hazen Williams		S (FT/FT)
				(SQ. FT)	(SQ. FT)			C Factor	C Factor	
51	1.02	0.00	0.60	0.05	0.00	1.16	0.021	120	120	0.01809
Total Headloss (FT) 0.922										

Tubing Segment 2.3										
Length (FT)	Flow (GPM)	Diameter (IN)	CFS	Cross Sectional Area		Velocity (FT/S)	Head (FT)	Hazen Williams		S (FT/FT)
				(SQ. FT)	(SQ. FT)			C Factor	C Factor	
42	0.84	0.00	0.60	0.05	0.00	0.95	0.014	120	120	0.01263
Total Headloss (FT) 0.530										

Tubing Segment 2.4										
Length (FT)	Flow (GPM)	Diameter (IN)	CFS	Cross Sectional Area		Velocity (FT/S)	Head (FT)	Hazen Williams		S (FT/FT)
				(SQ. FT)	(SQ. FT)			C Factor	C Factor	
36	0.72	0.00	0.60	0.05	0.00	0.82	0.010	120	120	0.00950
Total Headloss (FT) 0.342										

Tubing Segment 2.5										
Length (FT)	Flow (GPM)	Diameter (IN)	CFS	Cross Sectional Area		Velocity (FT/S)	Head (FT)	Hazen Williams		S (FT/FT)
				(SQ. FT)	(SQ. FT)			C Factor	C Factor	
30	0.6	0.00	0.60	0.05	0.00	0.68	0.007	120	120	0.00678
Total Headloss (FT) 0.203										

Tubing Segment 2.6										
Length (FT)	Flow (GPM)	Diameter (IN)	CFS	Cross Sectional Area		Velocity (FT/S)	Head (FT)	Hazen Williams		S (FT/FT)
				(SQ. FT)	(SQ. FT)			C Factor	C Factor	
24	0.48	0.00	0.60	0.05	0.00	0.54	0.005	120	120	0.00448
Total Headloss (FT) 0.108										

UNC Bingham Facility Wastewater System Improvements
Secondary Effluent Drip Irrigation System Calculations
ZONE 2

Tubing Segment 2.7										
Length (FT)	Flow (GPM)	Diameter (IN)	CFS	Cross Sectional Area		Velocity (FT/S)	Head (FT)	Hazen Williams		S (FT/FT)
				(SQ. FT)	(SQ. FT)			C Factor	C Factor	
15	0.3	0.00	0.60	0.05	0.00	0.34	0.002	120	120	0.00188
Total Headloss (FT) 0.028										

Tubing Segment 2.8										
Length (FT)	Flow (GPM)	Diameter (IN)	CFS	Cross Sectional Area		Velocity (FT/S)	Head (FT)	Hazen Williams		S (FT/FT)
				(SQ. FT)	(SQ. FT)			C Factor	C Factor	
9	0.18	0.00	0.60	0.05	0.00	0.20	0.001	120	120	0.00073
Total Headloss (FT) 0.007										

Tubing Segment 2.9 - 2.16										
Length (FT)	Flow (GPM)	Diameter (IN)	CFS	Cross Sectional Area		Velocity (FT/S)	Head (FT)	Hazen Williams		S (FT/FT)
				(SQ. FT)	(SQ. FT)			C Factor	C Factor	
75	1.5	0.00	0.60	0.05	0.00	1.70	0.045	120	120	0.03692
Total Headloss (FT) 2.769										

Tubing Segment 2.17										
Length (FT)	Flow (GPM)	Diameter (IN)	CFS	Cross Sectional Area		Velocity (FT/S)	Head (FT)	Hazen Williams		S (FT/FT)
				(SQ. FT)	(SQ. FT)			C Factor	C Factor	
69	1.38	0.00	0.60	0.05	0.00	1.57	0.038	120	120	0.03164
Total Headloss (FT) 2.183										

Tubing Segment 2.18										
Length (FT)	Flow (GPM)	Diameter (IN)	CFS	Cross Sectional Area		Velocity (FT/S)	Head (FT)	Hazen Williams		S (FT/FT)
				(SQ. FT)	(SQ. FT)			C Factor	C Factor	
63	1.26	0.00	0.60	0.05	0.00	1.43	0.032	120	120	0.02674
Total Headloss (FT) 1.685										

Tubing Segment 2.19										
Length (FT)	Flow (GPM)	Diameter (IN)	CFS	Cross Sectional Area		Velocity (FT/S)	Head (FT)	Hazen Williams		S (FT/FT)
				(SQ. FT)	(SQ. FT)			C Factor	C Factor	
54	1.08	0.00	0.60	0.05	0.00	1.23	0.023	120	120	0.02010
Total Headloss (FT) 0.02010										

Segment 6 Headloss

** 6" PVC pipe from tee at Zone 2 control valve (@ 6" tee, line flow) to just before tee at Zone 1 control valve (@ 6" pipe)

Minor Loss Element	Quantity	Minor Loss Factor (K)	K
Butterfly Valve (Open)		1.20	0.00
Check Valve (Conventional)		4.00	0.00
Plug Valve (Open)		0.40	0.00
Gate Valve (Fully Open)		0.39	0.00
Gate Valve (3/4 Open)		1.10	0.00
Gate Valve (1/2 Open)		4.80	0.00
Gate Valve (1/4 Open)		27.00	0.00
90° Bend		0.30	0.00
45° Bend		0.23	0.00
22.5° Bend		0.15	0.00
11.25° Bend		0.10	0.00
Reducer (D2/D1 = 0.8)		0.05	0.00
Reducer (D2/D1 = 0.5)		0.07	0.00
Reducer (D2/D1 = 0.2)		0.08	0.00
Expansion (D2/D1 = 0.8)		0.03	0.00
Expansion (D2/D1 = 0.5)		0.08	0.00
Expansion (D2/D1 = 0.2)		0.13	0.00
Tee (Line Flow)	1	0.35	0.35
Tee (Branch Flow)		1.28	0.00
Entrance Loss		1.00	0.00
Outlet Loss		1.00	0.00
Sluice Gate		0.80	0.00
Total K =			0.35

Zone 1

Length (FT)	Flow (GPM) (CFS)	Diameter (IN) (FT)	Cross Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams C Factor	S (FT/FT)
146	153 0.34	5.86 0.49	0.19	1.82	0.051	130	0.00253
Minor Headloss (FT)				0.000			
Pipe Friction Headloss (FT)				0.369			
Total Headloss (FT)				0.369			

Zone 3

Length (FT)	Flow (GPM) (CFS)	Diameter (IN) (FT)	Cross Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams C Factor	S (FT/FT)		
146	155	0.35	5.86 0.49	0.19	1.84	0.05	130	0.00259	
Minor Headloss (FT)				0.018					
Pipe Friction Headloss (FT)				0.378					
Total Headloss (FT)				0.397					

Zone 4

Length (FT)	Flow (GPM) (CFS)	Diameter (IN) (FT)	Cross Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams C Factor	S (FT/FT)		
146	109	0.24	5.86 0.49	0.19	1.30	0.03	130	0.00135	
Minor Headloss (FT)				0.009					
Pipe Friction Headloss (FT)				0.197					
Total Headloss (FT)				0.206					

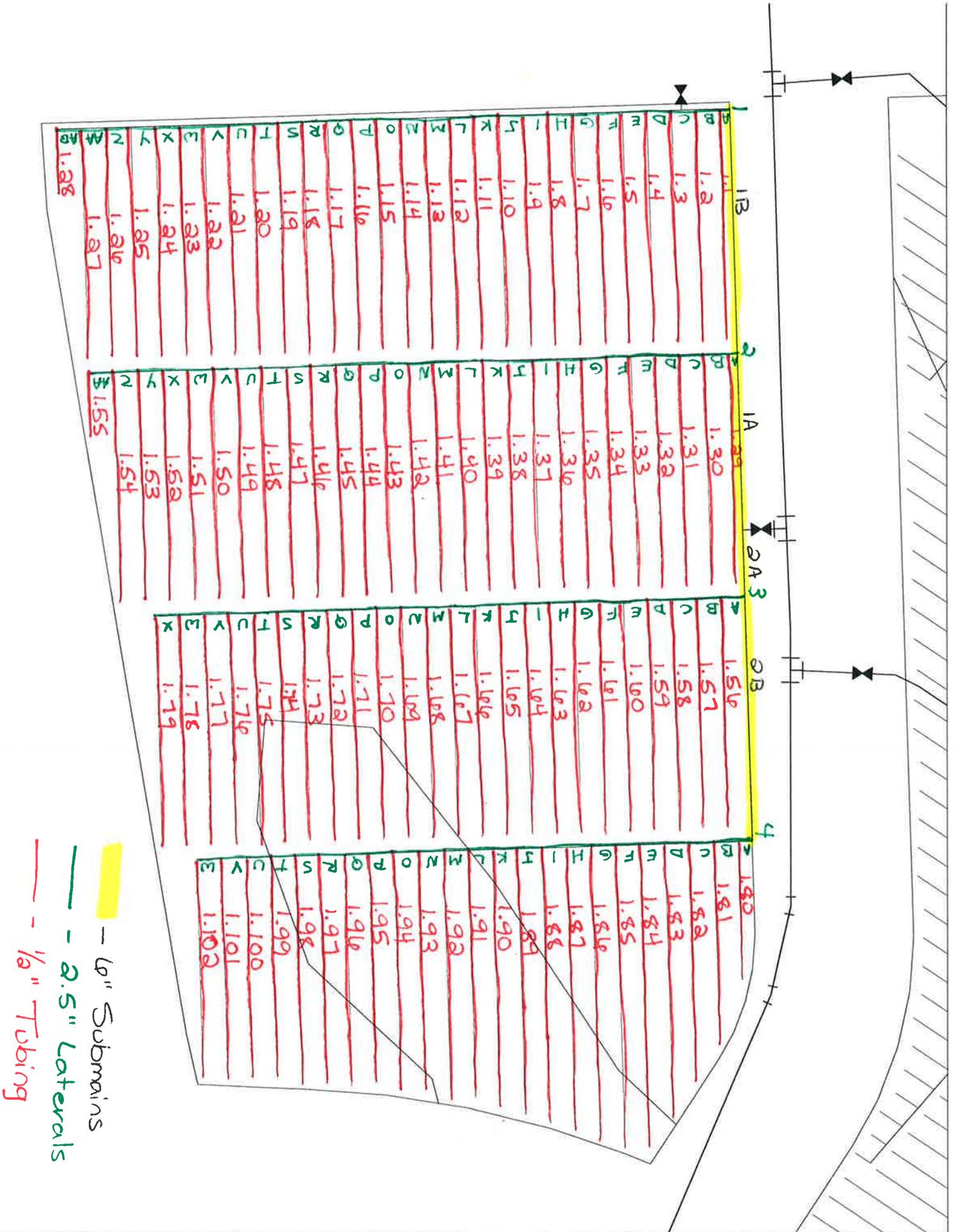
Segment 7 Headloss

** 6" PVC pipe from tee at Zone 1 control valve (@ 6" tee, branch flow) to just after Zone 1 control valve (@ 6" tee, branch flow)

Minor Loss Element	Quantity	Minor Loss Factor (K)	K
Butterfly Valve (Open)		1.20	0.00
Check Valve (Conventional)		4.00	0.00
Plug Valve (Open)		0.40	0.00
Gate Valve (Fully Open)		0.39	0.00
Gate Valve (3/4 Open)		1.10	0.00
Gate Valve (1/2 Open)		4.80	0.00
Gate Valve (1/4 Open)		27.00	0.00
90° Bend		0.30	0.00
45° Bend		0.23	0.00
22.5° Bend		0.15	0.00
11.25° Bend			0.00
Reducer (D2/D1 = 0.8)		0.05	0.00
Reducer (D2/D1 = 0.5)	1	0.07	0.07
Reducer (D2/D1 = 0.2)		0.08	0.00
Expansion (D2/D1 = 0.8)		0.03	0.00
Expansion (D2/D1 = 0.5)	1	0.08	0.08
Expansion (D2/D1 = 0.2)		0.13	0.00
Tee (Line Flow)		0.35	0.00
Tee (Branch Flow)	2	1.28	2.56
Entrance Loss		1.00	0.00
Outlet Loss		1.00	0.00
Sluice Gate		0.80	0.00
Total K =			2.71

Zone 1

Length (FT)	Flow (GPM)	Flow (CFS)	Diameter (IN)	Diameter (FT)	Cross Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams C Factor	S (FT/FT)
18	153	0.34	5.86	0.49	0.19	1.82	0.051	130	0.00253
Minor Headloss (FT)					0.000				
Control Valve Headloss (FT)					4.500				
Pipe Friction Headloss (FT)					0.046				
Total Headloss (FT)					4.546				



ZONE 1 SCALE: 1" = 40'

UNC Bingham Facility Wastewater System Improvements
Secondary Effluent Drip Irrigation System Calculations
ZONE 1

Summary

Maximum Headloss in Zone 1 Submains (FT): 0.064
 Maximum Headloss in Zone 1 Laterals (FT): 1.221
 Maximum Headloss in Zone 1 Tubing (FT): 6.108
 Total Headloss to use for Zone 1 (FT): 7.393

Submain Segment 1A									
Flow	Diameter	Cross	Velocity	Velocity	Hazen	Velocity	Velocity	Hazen	S
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT/S)	Williams	Head (FT)	Head (FT)	Williams	(FT/FT)
					C Factor			C Factor	
80.34	0.18	6.00	0.50	0.20	0.91	0.013	0.013	120	0.00079
Total Headloss (FT) 0.046									

Submain Segment 1B									
Flow	Diameter	Cross	Velocity	Velocity	Hazen	Velocity	Velocity	Hazen	S
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT/S)	Williams	Head (FT)	Head (FT)	Williams	(FT/FT)
					C Factor			C Factor	
40.92	0.09	6.00	0.50	0.20	0.46	0.003	0.003	120	0.00023
Total Headloss (FT) 0.018									

Total Submain 1 Headloss (FT) 0.064

Submain Segment 2A									
Flow	Diameter	Cross	Velocity	Velocity	Hazen	Velocity	Velocity	Hazen	S
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT/S)	Williams	Head (FT)	Head (FT)	Williams	(FT/FT)
					C Factor			C Factor	
72.66	0.16	6.00	0.50	0.20	0.82	0.011	0.011	120	0.00066
Total Headloss (FT) 0.015									

Submain Segment 2B									
Flow	Diameter	Cross	Velocity	Velocity	Hazen	Velocity	Velocity	Hazen	S
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT/S)	Williams	Head (FT)	Head (FT)	Williams	(FT/FT)
					C Factor			C Factor	
36.66	0.08	6.00	0.50	0.20	0.42	0.003	0.003	120	0.00019
Total Headloss (FT) 0.015									

Total Submain 2 Headloss (FT) 0.029

UNC Bingham Facility Wastewater System Improvements
Secondary Effluent Drip Irrigation System Calculations
ZONE 1

Lateral Segment 1A

Flow	Diameter	Cross	Velocity	Velocity	Hazen	Velocity	Velocity	Hazen	S
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT/S)	Williams	Head (FT)	Head (FT)	Williams	(FT/FT)
					C Factor			C Factor	
40.92	0.09	2.50	0.21	0.03	2.67	0.111	0.111	120	0.01614
Total Headloss (FT) 0.048									

Lateral Segment 1B

Flow	Diameter	Cross	Velocity	Velocity	Hazen	Velocity	Velocity	Hazen	S
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT/S)	Williams	Head (FT)	Head (FT)	Williams	(FT/FT)
					C Factor			C Factor	
39.42	0.09	2.50	0.21	0.03	2.58	0.103	0.103	120	0.01506
Total Headloss (FT) 0.121									

Lateral Segment 1C

Flow	Diameter	Cross	Velocity	Velocity	Hazen	Velocity	Velocity	Hazen	S
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT/S)	Williams	Head (FT)	Head (FT)	Williams	(FT/FT)
					C Factor			C Factor	
37.92	0.08	2.50	0.21	0.03	2.48	0.095	0.095	120	0.01402
Total Headloss (FT) 0.112									

Lateral Segment 1D

Flow	Diameter	Cross	Velocity	Velocity	Hazen	Velocity	Velocity	Hazen	S
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT/S)	Williams	Head (FT)	Head (FT)	Williams	(FT/FT)
					C Factor			C Factor	
36.42	0.08	2.50	0.21	0.03	2.38	0.088	0.088	120	0.01301
Total Headloss (FT) 0.104									

Lateral Segment 1E

Flow	Diameter	Cross	Velocity	Velocity	Hazen	Velocity	Velocity	Hazen	S
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT/S)	Williams	Head (FT)	Head (FT)	Williams	(FT/FT)
					C Factor			C Factor	
34.92	0.08	2.50	0.21	0.03	2.28	0.081	0.081	120	0.01204
Total Headloss (FT) 0.096									

Lateral Segment 1F

Flow	Diameter	Cross	Velocity	Velocity	Hazen	Velocity	Velocity	Hazen	S
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT/S)	Williams	Head (FT)	Head (FT)	Williams	(FT/FT)
					C Factor			C Factor	
33.42	0.07	2.50	0.21	0.03	2.18	0.074	0.074	120	0.01110
Total Headloss (FT) 0.089									

UNC Bingham Facility Wastewater System Improvements
Secondary Effluent Drip Irrigation System Calculations

ZONE 1										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	Hazen Williams	
									C Factor	S
8	13.92	0.03	2.50	0.21	0.03	0.91	0.013	120	0.00220	
Total Headloss (FT) 0.018										

Lateral Segment 1T										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	Hazen Williams	
									C Factor	S
8	12.42	0.03	2.50	0.21	0.03	0.81	0.010	120	0.00178	
Total Headloss (FT) 0.014										

Lateral Segment 1U										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	Hazen Williams	
									C Factor	S
8	10.92	0.02	2.50	0.21	0.03	0.71	0.008	120	0.00140	
Total Headloss (FT) 0.011										

Lateral Segment 1V										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	Hazen Williams	
									C Factor	S
8	9.42	0.02	2.50	0.21	0.03	0.62	0.006	120	0.00107	
Total Headloss (FT) 0.009										

Lateral Segment 1W										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	Hazen Williams	
									C Factor	S
8	7.92	0.02	2.50	0.21	0.03	0.52	0.004	120	0.00077	
Total Headloss (FT) 0.006										

Lateral Segment 1X										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	Hazen Williams	
									C Factor	S
8	6.42	0.01	2.50	0.21	0.03	0.42	0.003	120	0.00052	
Total Headloss (FT) 0.004										

Lateral Segment 1Y									
Total Headloss (FT) 0.112									

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ZONE 1										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	Hazen Williams	
									C Factor	S
8	4.92	0.01	2.50	0.21	0.03	0.32	0.002	120	0.00032	
Total Headloss (FT) 0.003										

Lateral Segment 1Z										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	Hazen Williams	
									C Factor	S
8	3.42	0.01	2.50	0.21	0.03	0.22	0.001	120	0.00016	
Total Headloss (FT) 0.001										

Lateral Segment 1AA										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	Hazen Williams	
									C Factor	S
8	1.92	0.00	2.50	0.21	0.03	0.13	0.000	120	0.00006	
Total Headloss (FT) 0.000										

Lateral Segment 1AB										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	Hazen Williams	
									C Factor	S
8	0.42	0.00	2.50	0.21	0.03	0.03	0.000	120	0.00000	
Total Headloss (FT) 0.000										

Lateral Segment 2A										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	Hazen Williams	
									C Factor	S
3	39.42	0.09	2.50	0.21	0.03	2.58	0.103	120	0.01506	
Total Headloss (FT) 0.045										

Lateral Segment 2B										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	Hazen Williams	
									C Factor	S
8	37.92	0.08	2.50	0.21	0.03	2.48	0.095	120	0.01402	
Total Headloss (FT) 0.112										

Lateral Segment 2C									
Total Lateral 1 Headloss (FT) 1.221									

UNC Bingham Facility Wastewater System Improvements
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ZONE 1										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	C Factor	S
8	18.42	0.04	2.50	0.21	0.03	1.20	0.023	120	0.00369	
Total Headloss (FT)										0.029

Lateral Segment 2P										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	C Factor	S
8	16.92	0.04	2.50	0.21	0.03	1.11	0.019	120	0.00315	
Total Headloss (FT)										0.025

Lateral Segment 2Q										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	C Factor	S
8	15.42	0.03	2.50	0.21	0.03	1.01	0.016	120	0.00265	
Total Headloss (FT)										0.021

Lateral Segment 2R										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	C Factor	S
8	13.92	0.03	2.50	0.21	0.03	0.91	0.013	120	0.00220	
Total Headloss (FT)										0.018

Lateral Segment 2S										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	C Factor	S
8	12.42	0.03	2.50	0.21	0.03	0.81	0.010	120	0.00178	
Total Headloss (FT)										0.014

Lateral Segment 2T										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	C Factor	S
8	10.92	0.02	2.50	0.21	0.03	0.71	0.008	120	0.00140	
Total Headloss (FT)										0.011

Lateral Segment 2U

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ZONE 1										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	C Factor	S
8	9.42	0.02	2.50	0.21	0.03	0.62	0.006	120	0.00107	
Total Headloss (FT)										0.009

Lateral Segment 2V										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	C Factor	S
8	7.92	0.02	2.50	0.21	0.03	0.52	0.004	120	0.00077	
Total Headloss (FT)										0.006

Lateral Segment 2W										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	C Factor	S
8	6.42	0.01	2.50	0.21	0.03	0.42	0.003	120	0.00052	
Total Headloss (FT)										0.004

Lateral Segment 2X										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	C Factor	S
8	4.92	0.01	2.50	0.21	0.03	0.32	0.002	120	0.00032	
Total Headloss (FT)										0.003

Lateral Segment 2Y										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	C Factor	S
8	3.42	0.01	2.50	0.21	0.03	0.22	0.001	120	0.00016	
Total Headloss (FT)										0.001

Lateral Segment 2Z										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	C Factor	S
8	1.92	0.00	2.50	0.21	0.03	0.13	0.000	120	0.00006	
Total Headloss (FT)										0.000

Lateral Segment 2AA

UNC Bingham Facility Wastewater System Improvements
Secondary Effluent Drip Irrigation System Calculations

ZONE 1

Lateral Segment 3L		Flow		Diameter		Gross Sectional Area		Velocity		Hazen Williams		S	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(SQ. FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	(FT/FT)	(FT/FT)	(FT/FT)
8	19.5	0.04	2.50	0.21	0.03	1.27	0.025	120	0.00410				
Total Headloss (FT)													0.033

Lateral Segment 3M		Flow		Diameter		Gross Sectional Area		Velocity		Hazen Williams		S	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(SQ. FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	(FT/FT)	(FT/FT)	(FT/FT)
8	18	0.04	2.50	0.21	0.03	1.18	0.021	120	0.00353				
Total Headloss (FT)													0.028

Lateral Segment 3N		Flow		Diameter		Gross Sectional Area		Velocity		Hazen Williams		S	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(SQ. FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	(FT/FT)	(FT/FT)	(FT/FT)
8	16.5	0.04	2.50	0.21	0.03	1.08	0.018	120	0.00301				
Total Headloss (FT)													0.024

Lateral Segment 3O		Flow		Diameter		Gross Sectional Area		Velocity		Hazen Williams		S	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(SQ. FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	(FT/FT)	(FT/FT)	(FT/FT)
8	15	0.03	2.50	0.21	0.03	0.98	0.015	120	0.00252				
Total Headloss (FT)													0.020

Lateral Segment 3P		Flow		Diameter		Gross Sectional Area		Velocity		Hazen Williams		S	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(SQ. FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	(FT/FT)	(FT/FT)	(FT/FT)
8	13.5	0.03	2.50	0.21	0.03	0.88	0.012	120	0.00207				
Total Headloss (FT)													0.017

Lateral Segment 3Q		Flow		Diameter		Gross Sectional Area		Velocity		Hazen Williams		S	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(SQ. FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	(FT/FT)	(FT/FT)	(FT/FT)
8	12	0.03	2.50	0.21	0.03	0.78	0.010	120	0.00167				
Total Headloss (FT)													0.013

Lateral Segment 3R

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ZONE 1

Lateral Segment 3S		Flow		Diameter		Gross Sectional Area		Velocity		Hazen Williams		S	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(SQ. FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	(FT/FT)	(FT/FT)	(FT/FT)
8	10.5	0.02	2.50	0.21	0.03	0.69	0.007	120	0.00130				
Total Headloss (FT)													0.010

Lateral Segment 3T		Flow		Diameter		Gross Sectional Area		Velocity		Hazen Williams		S	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(SQ. FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	(FT/FT)	(FT/FT)	(FT/FT)
8	9	0.02	2.50	0.21	0.03	0.59	0.005	120	0.00098				
Total Headloss (FT)													0.008

Lateral Segment 3U		Flow		Diameter		Gross Sectional Area		Velocity		Hazen Williams		S	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(SQ. FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	(FT/FT)	(FT/FT)	(FT/FT)
8	7.5	0.02	2.50	0.21	0.03	0.49	0.004	120	0.00070				
Total Headloss (FT)													0.006

Lateral Segment 3V		Flow		Diameter		Gross Sectional Area		Velocity		Hazen Williams		S	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(SQ. FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	(FT/FT)	(FT/FT)	(FT/FT)
8	6	0.01	2.50	0.21	0.03	0.39	0.002	120	0.00046				
Total Headloss (FT)													0.004

Lateral Segment 3W		Flow		Diameter		Gross Sectional Area		Velocity		Hazen Williams		S	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(SQ. FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	(FT/FT)	(FT/FT)	(FT/FT)
8	4.5	0.01	2.50	0.21	0.03	0.29	0.001	120	0.00027				
Total Headloss (FT)													0.002

Lateral Segment 3X		Flow		Diameter		Gross Sectional Area		Velocity		Hazen Williams		S	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(SQ. FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	(FT/FT)	(FT/FT)	(FT/FT)
8	3	0.01	2.50	0.21	0.03	0.20	0.001	120	0.00013				
Total Headloss (FT)													0.001

Lateral Segment 3Y

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ZONE 1

Lateral Segment 4L									
Length (FT)	Flow (GPM)	Diameter (IN)	Gross			Hazen Williams			S
			Flow (CFS)	Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	Velocity (FT/S)	C Factor	
8	18.12	0.04	2.50	0.21	0.03	1.18	0.022	120	0.00358
Total Headloss (FT) 0.029									

Lateral Segment 4M									
Length (FT)	Flow (GPM)	Diameter (IN)	Gross			Hazen Williams			S
			Flow (CFS)	Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	Velocity (FT/S)	C Factor	
8	16.5	0.04	2.50	0.21	0.03	1.08	0.018	120	0.00301
Total Headloss (FT) 0.024									

Lateral Segment 4N									
Length (FT)	Flow (GPM)	Diameter (IN)	Gross			Hazen Williams			S
			Flow (CFS)	Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	Velocity (FT/S)	C Factor	
8	14.88	0.03	2.50	0.21	0.03	0.97	0.015	120	0.00248
Total Headloss (FT) 0.020									

Lateral Segment 4O									
Length (FT)	Flow (GPM)	Diameter (IN)	Gross			Hazen Williams			S
			Flow (CFS)	Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	Velocity (FT/S)	C Factor	
8	13.32	0.03	2.50	0.21	0.03	0.87	0.012	120	0.00202
Total Headloss (FT) 0.016									

Lateral Segment 4P									
Length (FT)	Flow (GPM)	Diameter (IN)	Gross			Hazen Williams			S
			Flow (CFS)	Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	Velocity (FT/S)	C Factor	
8	11.76	0.03	2.50	0.21	0.03	0.77	0.009	120	0.00161
Total Headloss (FT) 0.013									

Lateral Segment 4Q									
Length (FT)	Flow (GPM)	Diameter (IN)	Gross			Hazen Williams			S
			Flow (CFS)	Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	Velocity (FT/S)	C Factor	
8	10.26	0.02	2.50	0.21	0.03	0.67	0.007	120	0.00125
Total Headloss (FT) 0.010									

Lateral Segment 4R

Total Lateral 4 Headloss (FT) 0.856

UNC Bingham Facility Wastewater System Improvements
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ZONE 1

Lateral Segment 4S									
Length (FT)	Flow (GPM)	Diameter (IN)	Gross			Hazen Williams			S
			Flow (CFS)	Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	Velocity (FT/S)	C Factor	
8	8.76	0.02	2.50	0.21	0.03	0.57	0.005	120	0.00093
Total Headloss (FT) 0.007									

Lateral Segment 4T									
Length (FT)	Flow (GPM)	Diameter (IN)	Gross			Hazen Williams			S
			Flow (CFS)	Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	Velocity (FT/S)	C Factor	
8	7.26	0.02	2.50	0.21	0.03	0.47	0.003	120	0.00066
Total Headloss (FT) 0.005									

Lateral Segment 4U									
Length (FT)	Flow (GPM)	Diameter (IN)	Gross			Hazen Williams			S
			Flow (CFS)	Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	Velocity (FT/S)	C Factor	
8	5.76	0.01	2.50	0.21	0.03	0.38	0.002	120	0.00043
Total Headloss (FT) 0.003									

Lateral Segment 4V									
Length (FT)	Flow (GPM)	Diameter (IN)	Gross			Hazen Williams			S
			Flow (CFS)	Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	Velocity (FT/S)	C Factor	
8	4.32	0.01	2.50	0.21	0.03	0.28	0.001	120	0.00025
Total Headloss (FT) 0.002									

Lateral Segment 4W									
Length (FT)	Flow (GPM)	Diameter (IN)	Gross			Hazen Williams			S
			Flow (CFS)	Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	Velocity (FT/S)	C Factor	
8	2.88	0.01	2.50	0.21	0.03	0.19	0.001	120	0.00012
Total Headloss (FT) 0.001									

Lateral Segment 4X									
Length (FT)	Flow (GPM)	Diameter (IN)	Gross			Hazen Williams			S
			Flow (CFS)	Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	Velocity (FT/S)	C Factor	
8	1.44	0.00	2.50	0.21	0.03	0.09	0.000	120	0.00003
Total Headloss (FT) 0.000									

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ZONE-1										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	C Factor	S
90	1.8	0.00	0.60	0.05	0.00	2.04	0.065	120	0.05173	
Total Headloss (FT)										4.655

ZONE-1										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	C Factor	S
87	1.74	0.00	0.60	0.05	0.00	1.97	0.061	120	0.04858	
Total Headloss (FT)										4.227

ZONE-1										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	C Factor	S
84	1.68	0.00	0.60	0.05	0.00	1.91	0.056	120	0.04553	
Total Headloss (FT)										3.824

ZONE-1										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	C Factor	S
81	1.62	0.00	0.60	0.05	0.00	1.84	0.052	120	0.04257	
Total Headloss (FT)										3.448

ZONE-1										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	C Factor	S
78	1.56	0.00	0.60	0.05	0.00	1.77	0.049	120	0.03970	
Total Headloss (FT)										3.096

ZONE-1										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	C Factor	S
75	1.5	0.00	0.60	0.05	0.00	1.70	0.045	120	0.03692	
Total Headloss (FT)										2.769

Tubing Segment 1.99 - 1.102

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ZONE-1										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Velocity	Head (FT)	C Factor	S
72	1.44	0.00	0.60	0.05	0.00	1.63	0.041	120	0.03423	
Total Headloss (FT)										2.465

Segment 8 Headloss

** 6" PVC pipe from tee at Zone 1 control valve (@ 6" tee, line flow) to just before tee at Zone 3 control valve (@ 6" pipe)

Minor Loss Element	Quantity	Minor Loss Factor (K)	K
Butterfly Valve (Open)		1.20	0.00
Check Valve (Conventional)		4.00	0.00
Plug Valve (Open)		0.40	0.00
Gate Valve (Fully Open)		0.39	0.00
Gate Valve (3/4 Open)		1.10	0.00
Gate Valve (1/2 Open)		4.80	0.00
Gate Valve (1/4 Open)		27.00	0.00
90° Bend		0.30	0.00
45° Bend		0.23	0.00
22.5° Bend		0.15	0.00
11.25° Bend		0.10	0.00
Reducer (D2/D1 = 0.8)		0.05	0.00
Reducer (D2/D1 = 0.5)		0.07	0.00
Reducer (D2/D1 = 0.2)		0.08	0.00
Expansion (D2/D1 = 0.8)		0.03	0.00
Expansion (D2/D1 = 0.5)		0.08	0.00
Expansion (D2/D1 = 0.2)		0.13	0.00
Tee (Line Flow)	1	0.35	0.35
Tee (Branch Flow)		1.28	0.00
Entrance Loss		1.00	0.00
Outlet Loss		1.00	0.00
Sluice Gate		0.80	0.00
Total K =			0.35

Zone 3

Length (FT)	Flow (GPM) (CFS)	Diameter (IN) (FT)	Cross Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams C Factor	S (FT/FT)	
39	155	0.35 5.86	0.49	0.19	1.84	0.053	130	0.00259
Minor Headloss (FT)				0.000				
Pipe Friction Headloss (FT)				0.101				
Total Headloss (FT)				0.101				

Zone 4

Length (FT)	Flow (GPM) (CFS)	Diameter (IN) (FT)	Cross Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams C Factor	S (FT/FT)		
39	109	0.24	5.86	0.49	0.19	1.30	0.03	130	0.00135
Minor Headloss (FT)				0.009					
Pipe Friction Headloss (FT)				0.053					
Total Headloss (FT)				0.062					

Segment 9 Headloss

** 6" PVC pipe from tee at Zone 3 control valve (@ 6" tee, branch flow) to just after Zone 3 control valve (@ 45° elbow)

Minor Loss Element	Quantity	Minor Loss Factor (K)	K
Butterfly Valve (Open)		1.20	0.00
Check Valve (Conventional)		4.00	0.00
Plug Valve (Open)		0.40	0.00
Gate Valve (Fully Open)		0.39	0.00
Gate Valve (3/4 Open)		1.10	0.00
Gate Valve (1/2 Open)		4.80	0.00
Gate Valve (1/4 Open)		27.00	0.00
90° Bend		0.30	0.00
45° Bend	1	0.23	0.23
22.5° Bend		0.15	0.00
11.25° Bend			0.00
Reducer (D2/D1 = 0.8)		0.05	0.00
Reducer (D2/D1 = 0.5)	1	0.07	0.07
Reducer (D2/D1 = 0.2)		0.08	0.00
Expansion (D2/D1 = 0.8)		0.03	0.00
Expansion (D2/D1 = 0.5)	1	0.08	0.08
Expansion (D2/D1 = 0.2)		0.13	0.00
Tee (Line Flow)		0.35	0.00
Tee (Branch Flow)	1	1.28	1.28
Entrance Loss		1.00	0.00
Outlet Loss		1.00	0.00
Sluice Gate		0.80	0.00
Total K =			1.66

Zone 3

Length (FT)	Flow (GPM) (CFS)	Diameter (IN) (FT)	Cross Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams C Factor	S (FT/FT)
39	155 0.35	5.86 0.49	0.19	1.84	0.053	130	0.00259
Minor Headloss (FT)				0.000			
Control Valve Headloss (FT)				4.500			
Pipe Friction Headloss (FT)				0.101			
Total Headloss (FT)				4.601			

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ZONE 3

Summary

Maximum Headloss in Zone 3 Submains (FT): 0.650
 Maximum Headloss in Zone 3 Laterals (FT): 0.766
 Maximum Headloss in Zone 3 Tubing (FT): 4.655
 Total Headloss to use for Zone 3 (FT): 6.071

Submain Segment 1A		Gross		Hazen Williams		S
Flow (GPM)	Diameter (IN)	Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	C Factor	(FT/FT)
155	6.00	0.20	1.76	0.048	120	0.00268
Total Headloss (FT)						0.297

Submain Segment 1B		Gross		Hazen Williams		S
Flow (GPM)	Diameter (IN)	Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	C Factor	(FT/FT)
80	6.00	0.20	1.60	0.040	120	0.00225
Total Headloss (FT)						0.180

Submain Segment 1C		Gross		Hazen Williams		S
Flow (GPM)	Diameter (IN)	Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	C Factor	(FT/FT)
80	6.00	0.20	1.21	0.023	120	0.00133
Total Headloss (FT)						0.107

Submain Segment 1D		Gross		Hazen Williams		S
Flow (GPM)	Diameter (IN)	Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	C Factor	(FT/FT)
80	6.00	0.20	0.82	0.010	120	0.00065
Total Headloss (FT)						0.052

Submain Segment 1E		Gross		Hazen Williams		S
Flow (GPM)	Diameter (IN)	Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	C Factor	(FT/FT)
80	6.00	0.20	0.41	0.003	120	0.00018
Total Headloss (FT)						0.014

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ZONE 3

Total Submain 1 Headloss (FT) 0.650

Lateral Segment 1A		Gross		Hazen Williams		S
Flow (GPM)	Diameter (IN)	Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	C Factor	(FT/FT)
5	2.50	0.03	0.91	0.013	120	0.00221
Total Headloss (FT)						0.011

Lateral Segment 1B		Gross		Hazen Williams		S
Flow (GPM)	Diameter (IN)	Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	C Factor	(FT/FT)
8	2.50	0.03	0.80	0.010	120	0.00172
Total Headloss (FT)						0.014

Lateral Segment 1C		Gross		Hazen Williams		S
Flow (GPM)	Diameter (IN)	Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	C Factor	(FT/FT)
8	2.50	0.03	0.69	0.007	120	0.00130
Total Headloss (FT)						0.010

Lateral Segment 1D		Gross		Hazen Williams		S
Flow (GPM)	Diameter (IN)	Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	C Factor	(FT/FT)
8	2.50	0.03	0.59	0.005	120	0.00098
Total Headloss (FT)						0.008

Lateral Segment 1E		Gross		Hazen Williams		S
Flow (GPM)	Diameter (IN)	Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	C Factor	(FT/FT)
8	2.50	0.03	0.50	0.004	120	0.00072
Total Headloss (FT)						0.006

Lateral Segment 1F		Gross		Hazen Williams		S
Flow (GPM)	Diameter (IN)	Sectional Area (SQ. FT)	Velocity (FT/S)	Head (FT)	C Factor	(FT/FT)
8	2.50	0.03	0.50	0.004	120	0.00072
Total Headloss (FT)						0.006

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Total Headloss (FT)		0.000		Total Lateral 1 Headloss (FT)		0.061	
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Total Lateral 1 Headloss (FT) 0.061

Lateral Segment 2A		Flow		Diameter		Gross Sectional Area		Velocity		Hazen Williams		S	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	120	Velocity Head (FT)	(FT/FT)	(FT/FT)	(FT/FT)
5	34.74	0.08	2.50	0.21	0.03	2.27	0.080	120	0.01192				
Total Headloss (FT)						0.060							

Lateral Segment 2B		Flow		Diameter		Gross Sectional Area		Velocity		Hazen Williams		S	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	120	Velocity Head (FT)	(FT/FT)	(FT/FT)	(FT/FT)
8	33.18	0.07	2.50	0.21	0.03	2.17	0.073	120	0.01095				
Total Headloss (FT)						0.088							

Lateral Segment 2C		Flow		Diameter		Gross Sectional Area		Velocity		Hazen Williams		S	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	120	Velocity Head (FT)	(FT/FT)	(FT/FT)	(FT/FT)
8	31.62	0.07	2.50	0.21	0.03	2.07	0.066	120	0.01002				
Total Headloss (FT)						0.080							

Lateral Segment 2D		Flow		Diameter		Gross Sectional Area		Velocity		Hazen Williams		S	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	120	Velocity Head (FT)	(FT/FT)	(FT/FT)	(FT/FT)
8	30.06	0.07	2.50	0.21	0.03	1.96	0.060	120	0.00912				
Total Headloss (FT)						0.073							

Lateral Segment 2E		Flow		Diameter		Gross Sectional Area		Velocity		Hazen Williams		S	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	120	Velocity Head (FT)	(FT/FT)	(FT/FT)	(FT/FT)
8	28.5	0.06	2.50	0.21	0.03	1.86	0.054	120	0.00827				
Total Headloss (FT)						0.066							

Lateral Segment 2F		Flow		Diameter		Gross Sectional Area		Velocity		Hazen Williams		S	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	120	Velocity Head (FT)	(FT/FT)	(FT/FT)	(FT/FT)
8	17.58	0.04	2.50	0.21	0.03	1.15	0.021	120	0.00338				

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Total Headloss (FT)		0.060		Total Lateral 1 Headloss (FT)		0.061	
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Total Lateral 1 Headloss (FT) 0.061

Lateral Segment 2G		Flow		Diameter		Gross Sectional Area		Velocity		Hazen Williams		S	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	120	Velocity Head (FT)	(FT/FT)	(FT/FT)	(FT/FT)
8	25.38	0.06	2.50	0.21	0.03	1.66	0.043	120	0.00667				
Total Headloss (FT)						0.053							

Lateral Segment 2H		Flow		Diameter		Gross Sectional Area		Velocity		Hazen Williams		S	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	120	Velocity Head (FT)	(FT/FT)	(FT/FT)	(FT/FT)
8	23.82	0.05	2.50	0.21	0.03	1.56	0.038	120	0.00593				
Total Headloss (FT)						0.047							

Lateral Segment 2I		Flow		Diameter		Gross Sectional Area		Velocity		Hazen Williams		S	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	120	Velocity Head (FT)	(FT/FT)	(FT/FT)	(FT/FT)
8	22.26	0.05	2.50	0.21	0.03	1.46	0.033	120	0.00523				
Total Headloss (FT)						0.042							

Lateral Segment 2J		Flow		Diameter		Gross Sectional Area		Velocity		Hazen Williams		S	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	120	Velocity Head (FT)	(FT/FT)	(FT/FT)	(FT/FT)
8	20.7	0.05	2.50	0.21	0.03	1.35	0.028	120	0.00458				
Total Headloss (FT)						0.037							

Lateral Segment 2K		Flow		Diameter		Gross Sectional Area		Velocity		Hazen Williams		S	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	120	Velocity Head (FT)	(FT/FT)	(FT/FT)	(FT/FT)
8	19.14	0.04	2.50	0.21	0.03	1.25	0.024	120	0.00396				
Total Headloss (FT)						0.032							

Lateral Segment 2L		Flow		Diameter		Gross Sectional Area		Velocity		Hazen Williams		S	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	120	Velocity Head (FT)	(FT/FT)	(FT/FT)	(FT/FT)
8	17.58	0.04	2.50	0.21	0.03	1.15	0.021	120	0.00338				

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8	32.76	0.07	2.50	0.21	0.03	2.14	0.071	120	0.01070
Total Headloss (FT)									

Lateral Segment 3C									
		Flow		Diameter		Cross Sectional Area		Hazen Williams	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	(FT/FT)
8	31.2	0.07	2.50	0.21	0.03	2.04	0.065	120	0.00977
Total Headloss (FT)									

Lateral Segment 3D									
		Flow		Diameter		Cross Sectional Area		Hazen Williams	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	(FT/FT)
8	29.64	0.07	2.50	0.21	0.03	1.94	0.058	120	0.00889
Total Headloss (FT)									

Lateral Segment 3E									
		Flow		Diameter		Cross Sectional Area		Hazen Williams	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	(FT/FT)
8	28.08	0.06	2.50	0.21	0.03	1.84	0.052	120	0.00804
Total Headloss (FT)									

Lateral Segment 3F									
		Flow		Diameter		Cross Sectional Area		Hazen Williams	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	(FT/FT)
8	26.52	0.06	2.50	0.21	0.03	1.73	0.047	120	0.00724
Total Headloss (FT)									

Lateral Segment 3G									
		Flow		Diameter		Cross Sectional Area		Hazen Williams	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	(FT/FT)
8	24.96	0.06	2.50	0.21	0.03	1.63	0.041	120	0.00647
Total Headloss (FT)									

Lateral Segment 3H									
		Flow		Diameter		Cross Sectional Area		Hazen Williams	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	(FT/FT)
8	23.4	0.05	2.50	0.21	0.03	1.53	0.036	120	0.00574

UNC Bingham Facility Wastewater System Improvements
Secondary Effluent Drip Irrigation System Calculations
ZONE 3

Total Headloss (FT)									
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Lateral Segment 3I									
		Flow		Diameter		Cross Sectional Area		Hazen Williams	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	(FT/FT)
8	21.84	0.05	2.50	0.21	0.03	1.43	0.032	120	0.00605
Total Headloss (FT)									

Lateral Segment 3J									
		Flow		Diameter		Cross Sectional Area		Hazen Williams	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	(FT/FT)
8	20.28	0.05	2.50	0.21	0.03	1.33	0.027	120	0.00441
Total Headloss (FT)									

Lateral Segment 3K									
		Flow		Diameter		Cross Sectional Area		Hazen Williams	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	(FT/FT)
8	18.72	0.04	2.50	0.21	0.03	1.22	0.023	120	0.00390
Total Headloss (FT)									

Lateral Segment 3L									
		Flow		Diameter		Cross Sectional Area		Hazen Williams	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	(FT/FT)
8	17.16	0.04	2.50	0.21	0.03	1.12	0.020	120	0.00323
Total Headloss (FT)									

Lateral Segment 3M									
		Flow		Diameter		Cross Sectional Area		Hazen Williams	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	(FT/FT)
8	15.6	0.03	2.50	0.21	0.03	1.02	0.016	120	0.00271
Total Headloss (FT)									

Lateral Segment 3N									
		Flow		Diameter		Cross Sectional Area		Hazen Williams	
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	(SQ. FT)	(FT/S)	Head (FT)	C Factor	(FT/FT)
8	14.04	0.03	2.50	0.21	0.03	0.92	0.013	120	0.00223

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Total Headloss (FT)									
0.078									
Lateral Segment 4E									
Flow	Diameter	Sectional Area	Velocity	Velocity	Hazen	Williams	C Factor	S	
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	Williams	C Factor		(FT/FT)	
8	29.64	0.07	2.50	0.21	1.94	0.058	120	0.00889	
Total Headloss (FT)									
0.071									
Lateral Segment 4F									
Flow	Diameter	Sectional Area	Velocity	Velocity	Hazen	Williams	C Factor	S	
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	Williams	C Factor		(FT/FT)	
8	28.08	0.06	2.50	0.21	1.84	0.052	120	0.00804	
Total Headloss (FT)									
0.064									
Lateral Segment 4G									
Flow	Diameter	Sectional Area	Velocity	Velocity	Hazen	Williams	C Factor	S	
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	Williams	C Factor		(FT/FT)	
8	26.52	0.06	2.50	0.21	1.73	0.047	120	0.00724	
Total Headloss (FT)									
0.058									
Lateral Segment 4H									
Flow	Diameter	Sectional Area	Velocity	Velocity	Hazen	Williams	C Factor	S	
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	Williams	C Factor		(FT/FT)	
8	24.96	0.06	2.50	0.21	1.63	0.041	120	0.00647	
Total Headloss (FT)									
0.052									
Lateral Segment 4I									
Flow	Diameter	Sectional Area	Velocity	Velocity	Hazen	Williams	C Factor	S	
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	Williams	C Factor		(FT/FT)	
8	23.4	0.05	2.50	0.21	1.53	0.036	120	0.00574	
Total Headloss (FT)									
0.046									
Lateral Segment 4J									
Flow	Diameter	Sectional Area	Velocity	Velocity	Hazen	Williams	C Factor	S	
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	Williams	C Factor		(FT/FT)	
8	21.84	0.05	2.50	0.21	1.43	0.032	120	0.00505	

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Total Headloss (FT)									
0.040									
Lateral Segment 4K									
Flow	Diameter	Sectional Area	Velocity	Velocity	Hazen	Williams	C Factor	S	
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	Williams	C Factor		(FT/FT)	
8	20.28	0.05	2.50	0.21	1.33	0.027	120	0.00441	
Total Headloss (FT)									
0.035									
Lateral Segment 4L									
Flow	Diameter	Sectional Area	Velocity	Velocity	Hazen	Williams	C Factor	S	
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	Williams	C Factor		(FT/FT)	
8	18.72	0.04	2.50	0.21	1.22	0.023	120	0.00380	
Total Headloss (FT)									
0.030									
Lateral Segment 4M									
Flow	Diameter	Sectional Area	Velocity	Velocity	Hazen	Williams	C Factor	S	
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	Williams	C Factor		(FT/FT)	
8	17.16	0.04	2.50	0.21	1.12	0.020	120	0.00323	
Total Headloss (FT)									
0.026									
Lateral Segment 4N									
Flow	Diameter	Sectional Area	Velocity	Velocity	Hazen	Williams	C Factor	S	
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	Williams	C Factor		(FT/FT)	
8	15.6	0.03	2.50	0.21	1.02	0.016	120	0.00271	
Total Headloss (FT)									
0.022									
Lateral Segment 4O									
Flow	Diameter	Sectional Area	Velocity	Velocity	Hazen	Williams	C Factor	S	
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	Williams	C Factor		(FT/FT)	
8	14.04	0.03	2.50	0.21	0.92	0.013	120	0.00223	
Total Headloss (FT)									
0.018									
Lateral Segment 4P									
Flow	Diameter	Sectional Area	Velocity	Velocity	Hazen	Williams	C Factor	S	
(GPM)	(IN)	(SQ. FT)	(FT/S)	Head (FT)	Williams	C Factor		(FT/FT)	
8	12.48	0.03	2.50	0.21	0.82	0.010	120	0.00179	
Total Headloss (FT)									
0.014									

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0.064

Lateral Segment 5F									
Flow	Diameter	Gross		Velocity	Hazen		Velocity	S	
(GPM)	(IN)	(SQ. FT)	(SQ. FT)	(FT/S)	Williams	(SQ. FT)	Head (FT)	Williams	(FT/FT)
(CFS)	(FT)				C Factor			C Factor	
30.93	2.50	0.07	0.03	2.02	120	0.063	0.063	120	0.00962
Total Headloss (FT) 0.048									

Lateral Segment 5G									
Flow	Diameter	Gross		Velocity	Hazen		Velocity	S	
(GPM)	(IN)	(SQ. FT)	(SQ. FT)	(FT/S)	Williams	(SQ. FT)	Head (FT)	Williams	(FT/FT)
(CFS)	(FT)				C Factor			C Factor	
30.69	2.50	0.07	0.03	2.01	120	0.062	0.062	120	0.00948
Total Headloss (FT) 0.028									

Lateral Segment 5H									
Flow	Diameter	Gross		Velocity	Hazen		Velocity	S	
(GPM)	(IN)	(SQ. FT)	(SQ. FT)	(FT/S)	Williams	(SQ. FT)	Head (FT)	Williams	(FT/FT)
(CFS)	(FT)				C Factor			C Factor	
29.13	2.50	0.06	0.03	1.90	120	0.056	0.056	120	0.00861
Total Headloss (FT) 0.017									

Lateral Segment 5I									
Flow	Diameter	Gross		Velocity	Hazen		Velocity	S	
(GPM)	(IN)	(SQ. FT)	(SQ. FT)	(FT/S)	Williams	(SQ. FT)	Head (FT)	Williams	(FT/FT)
(CFS)	(FT)				C Factor			C Factor	
28.89	2.50	0.06	0.03	1.89	120	0.055	0.055	120	0.00848
Total Headloss (FT) 0.042									

Lateral Segment 5K									
Flow	Diameter	Gross		Velocity	Hazen		Velocity	S	
(GPM)	(IN)	(SQ. FT)	(SQ. FT)	(FT/S)	Williams	(SQ. FT)	Head (FT)	Williams	(FT/FT)
(CFS)	(FT)				C Factor			C Factor	
28.65	2.50	0.06	0.03	1.87	120	0.054	0.054	120	0.00835
Total Headloss (FT) 0.033									

Lateral Segment 5L									
Flow	Diameter	Gross		Velocity	Hazen		Velocity	S	
(GPM)	(IN)	(SQ. FT)	(SQ. FT)	(FT/S)	Williams	(SQ. FT)	Head (FT)	Williams	(FT/FT)
(CFS)	(FT)				C Factor			C Factor	
27.09	2.50	0.06	0.03	1.77	120	0.049	0.049	120	0.00753
Total Headloss (FT) 0.030									

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Lateral Segment 5M									
Flow	Diameter	Gross		Velocity	Hazen		Velocity	S	
(GPM)	(IN)	(SQ. FT)	(SQ. FT)	(FT/S)	Williams	(SQ. FT)	Head (FT)	Williams	(FT/FT)
(CFS)	(FT)				C Factor			C Factor	
26.91	2.50	0.06	0.03	1.76	120	0.048	0.048	120	0.00743
Total Headloss (FT) 0.030									

Lateral Segment 5N									
Flow	Diameter	Gross		Velocity	Hazen		Velocity	S	
(GPM)	(IN)	(SQ. FT)	(SQ. FT)	(FT/S)	Williams	(SQ. FT)	Head (FT)	Williams	(FT/FT)
(CFS)	(FT)				C Factor			C Factor	
25.35	2.50	0.06	0.03	1.66	120	0.043	0.043	120	0.00666
Total Headloss (FT) 0.027									

Lateral Segment 5O									
Flow	Diameter	Gross		Velocity	Hazen		Velocity	S	
(GPM)	(IN)	(SQ. FT)	(SQ. FT)	(FT/S)	Williams	(SQ. FT)	Head (FT)	Williams	(FT/FT)
(CFS)	(FT)				C Factor			C Factor	
25.2	2.50	0.06	0.03	1.65	120	0.042	0.042	120	0.00658
Total Headloss (FT) 0.026									

Lateral Segment 5P									
Flow	Diameter	Gross		Velocity	Hazen		Velocity	S	
(GPM)	(IN)	(SQ. FT)	(SQ. FT)	(FT/S)	Williams	(SQ. FT)	Head (FT)	Williams	(FT/FT)
(CFS)	(FT)				C Factor			C Factor	
23.64	2.50	0.05	0.03	1.55	120	0.037	0.037	120	0.00585
Total Headloss (FT) 0.023									

Lateral Segment 5Q									
Flow	Diameter	Gross		Velocity	Hazen		Velocity	S	
(GPM)	(IN)	(SQ. FT)	(SQ. FT)	(FT/S)	Williams	(SQ. FT)	Head (FT)	Williams	(FT/FT)
(CFS)	(FT)				C Factor			C Factor	
23.52	2.50	0.05	0.03	1.54	120	0.037	0.037	120	0.00579
Total Headloss (FT) 0.046									

Lateral Segment 5R									
Flow	Diameter	Gross		Velocity	Hazen		Velocity	S	
(GPM)	(IN)	(SQ. FT)	(SQ. FT)	(FT/S)	Williams	(SQ. FT)	Head (FT)	Williams	(FT/FT)
(CFS)	(FT)				C Factor			C Factor	
21.96	2.50	0.05	0.03	1.44	120	0.032	0.032	120	0.00510
Total Headloss (FT) 0.041									

UNC Bingham Facility Wastewater System Improvements
Secondary Effluent Drip Irrigation System Calculations

ZONE 3

Length (FT)	Flow (GPM)	Diameter (IN)	Gross			Velocity (FT/S)	Head (FT)	Hazen Williams		S
			Sectional Area (SQ. FT)	Area (SQ. FT)	C Factor			C Factor		
8	3.12	0.01	2.50	0.21	0.03	0.20	0.001	120	120	0.00014
Total Headloss (FT) 0.001										

Lateral Segment 5AF

Length (FT)	Flow (GPM)	Diameter (IN)	Gross			Velocity (FT/S)	Head (FT)	Hazen Williams		S
			Sectional Area (SQ. FT)	Area (SQ. FT)	C Factor			C Factor		
8	1.56	0.00	2.50	0.21	0.03	0.10	0.000	120	120	0.00004
Total Headloss (FT) 0.000										
Total Lateral 5 Headloss (FT) 0.766										

Tubing Segment 3.1

Length (FT)	Flow (GPM)	Diameter (IN)	Gross			Velocity (FT/S)	Head (FT)	Hazen Williams		S
			Sectional Area (SQ. FT)	Area (SQ. FT)	C Factor			C Factor		
90	1.8	0.00	0.60	0.05	0.00	2.04	0.065	120	120	0.05173
Total Headloss (FT) 4.655										

Tubing Segment 3.2

Length (FT)	Flow (GPM)	Diameter (IN)	Gross			Velocity (FT/S)	Head (FT)	Hazen Williams		S
			Sectional Area (SQ. FT)	Area (SQ. FT)	C Factor			C Factor		
84	1.68	0.00	0.60	0.05	0.00	1.91	0.056	120	120	0.04553
Total Headloss (FT) 3.824										

Tubing Segment 3.3

Length (FT)	Flow (GPM)	Diameter (IN)	Gross			Velocity (FT/S)	Head (FT)	Hazen Williams		S
			Sectional Area (SQ. FT)	Area (SQ. FT)	C Factor			C Factor		
75	1.5	0.00	0.60	0.05	0.00	1.70	0.045	120	120	0.03692
Total Headloss (FT) 2.769										

Tubing Segment 3.4

Length (FT)	Flow (GPM)	Diameter (IN)	Gross			Velocity (FT/S)	Head (FT)	Hazen Williams		S
			Sectional Area (SQ. FT)	Area (SQ. FT)	C Factor			C Factor		
69	1.38	0.00	0.60	0.05	0.00	1.57	0.038	120	120	0.03164
Total Headloss (FT) 2.183										

UNC Bingham Facility Wastewater System Improvements
Secondary Effluent Drip Irrigation System Calculations

ZONE 3

Length (FT)	Flow (GPM)	Diameter (IN)	Gross			Velocity (FT/S)	Head (FT)	Hazen Williams		S
			Sectional Area (SQ. FT)	Area (SQ. FT)	C Factor			C Factor		
63	1.26	0.00	0.60	0.05	0.00	1.43	0.032	120	120	0.02674
Total Headloss (FT) 1.685										

Tubing Segment 3.6

Length (FT)	Flow (GPM)	Diameter (IN)	Gross			Velocity (FT/S)	Head (FT)	Hazen Williams		S
			Sectional Area (SQ. FT)	Area (SQ. FT)	C Factor			C Factor		
57	1.14	0.00	0.60	0.05	0.00	1.29	0.026	120	120	0.02222
Total Headloss (FT) 1.267										

Tubing Segment 3.7

Length (FT)	Flow (GPM)	Diameter (IN)	Gross			Velocity (FT/S)	Head (FT)	Hazen Williams		S
			Sectional Area (SQ. FT)	Area (SQ. FT)	C Factor			C Factor		
51	1.02	0.00	0.60	0.05	0.00	1.16	0.021	120	120	0.01809
Total Headloss (FT) 0.922										

Tubing Segment 3.8

Length (FT)	Flow (GPM)	Diameter (IN)	Gross			Velocity (FT/S)	Head (FT)	Hazen Williams		S
			Sectional Area (SQ. FT)	Area (SQ. FT)	C Factor			C Factor		
42	0.84	0.00	0.60	0.05	0.00	0.95	0.014	120	120	0.01263
Total Headloss (FT) 0.530										

Tubing Segment 3.9

Length (FT)	Flow (GPM)	Diameter (IN)	Gross			Velocity (FT/S)	Head (FT)	Hazen Williams		S
			Sectional Area (SQ. FT)	Area (SQ. FT)	C Factor			C Factor		
36	0.72	0.00	0.60	0.05	0.00	0.82	0.010	120	120	0.00950
Total Headloss (FT) 0.342										

Tubing Segment 3.10

Length (FT)	Flow (GPM)	Diameter (IN)	Gross			Velocity (FT/S)	Head (FT)	Hazen Williams		S
			Sectional Area (SQ. FT)	Area (SQ. FT)	C Factor			C Factor		
30	0.6	0.00	0.60	0.05	0.00	0.68	0.007	120	120	0.00678
Total Headloss (FT) 0.203										

UNC Bingham Facility Wastewater System Improvements
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ZONE 3									
Length (FT)	Flow (GPM)	Diameter (IN)	CFS (GPM)	Cross		Velocity (FT/S)	Velocity Head (FT)	Hazen Williams	
				Sectional Area (SQ. FT)	Area (SQ. FT)			C Factor	S
12	0.24	0.00	0.60	0.05	0.00	0.27	0.001	120	0.00124
Total Headloss (FT) 0.015									

Tubing Segment 3.114									
Length (FT)	Flow (GPM)	Diameter (IN)	CFS (GPM)	Cross		Velocity (FT/S)	Velocity Head (FT)	Hazen Williams	
				Sectional Area (SQ. FT)	Area (SQ. FT)			C Factor	S
9	0.18	0.00	0.60	0.05	0.00	0.20	0.001	120	0.00073
Total Headloss (FT) 0.007									

Tubing Segment 3.115									
Length (FT)	Flow (GPM)	Diameter (IN)	CFS (GPM)	Cross		Velocity (FT/S)	Velocity Head (FT)	Hazen Williams	
				Sectional Area (SQ. FT)	Area (SQ. FT)			C Factor	S
7.5	0.15	0.00	0.60	0.05	0.00	0.17	0.000	120	0.00052
Total Headloss (FT) 0.004									

Tubing Segment 3.116 - 3.117									
Length (FT)	Flow (GPM)	Diameter (IN)	CFS (GPM)	Cross		Velocity (FT/S)	Velocity Head (FT)	Hazen Williams	
				Sectional Area (SQ. FT)	Area (SQ. FT)			C Factor	S
6	0.12	0.00	0.60	0.05	0.00	0.14	0.000	120	0.00035
Total Headloss (FT) 0.002									

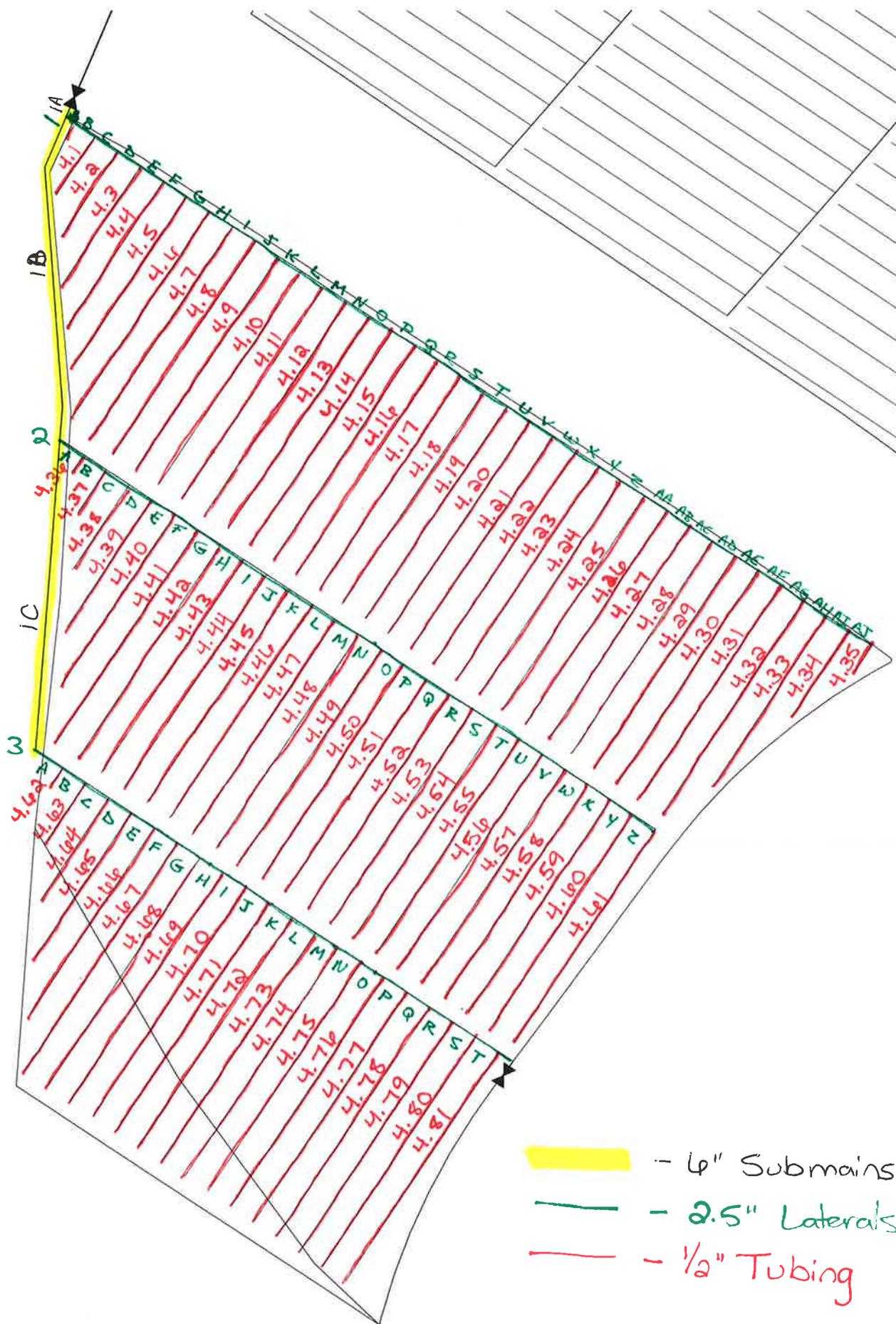
Segment 10 Headloss

** 6" PVC pipe from tee at Zone 3 control valve (@ 6" tee, line flow) to just after Zone 4 control valve (@ 45° elbow)

Minor Loss Element	Quantity	Minor Loss Factor (K)	K
Butterfly Valve (Open)		1.20	0.00
Check Valve (Conventional)		4.00	0.00
Plug Valve (Open)		0.40	0.00
Gate Valve (Fully Open)		0.39	0.00
Gate Valve (3/4 Open)		1.10	0.00
Gate Valve (1/2 Open)		4.80	0.00
Gate Valve (1/4 Open)		27.00	0.00
90° Bend		0.30	0.00
45° Bend	1	0.23	0.23
22.5° Bend		0.15	0.00
11.25° Bend	2	0.10	0.20
Reducer (D2/D1 = 0.8)		0.05	0.00
Reducer (D2/D1 = 0.5)	1	0.07	0.07
Reducer (D2/D1 = 0.2)		0.08	0.00
Expansion (D2/D1 = 0.8)		0.03	0.00
Expansion (D2/D1 = 0.5)	1	0.08	0.08
Expansion (D2/D1 = 0.2)		0.13	0.00
Tee (Line Flow)	1	0.35	0.35
Tee (Branch Flow)		1.28	0.00
Entrance Loss		1.00	0.00
Outlet Loss		1.00	0.00
Sluice Gate		0.80	0.00
Total K =			0.93

Zone 4

Length (FT)	Flow (GPM) (CFS)	Diameter (IN) (FT)	Cross Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams C Factor	S (FT/FT)
247	109	0.24 5.86 0.49	0.19	1.30	0.026	130	0.00135
Minor Headloss (FT)				0.000			
Control Valve Headloss (FT)				6.100			
Pipe Friction Headloss (FT)				0.334			
Total Headloss (FT)				6.434			



ZONE 4 SCALE: 1" = 40'

UNC Bingham Facility Wastewater System Improvements
Secondary Effluent Drip Irrigation System Calculations
ZONE 4

Summary
 Maximum Headloss in Zone 4 Submains (FT): 0.067
 Maximum Headloss in Zone 4 Laterals (FT): 2.264
 Maximum Headloss in Zone 4 Tubing (FT): 3.448
 Total Headloss to use for Zone 4 (FT): 5.779

Submain Segment 1A										
Length (FT)	(GPM)	Flow (CFS)	Diameter (IN)	Diameter (FT)	Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams		S
								C Factor	120	
6	109	0.24	6.00	0.50	0.20	1.24	0.024	120	0.00140	
Total Headloss (FT)						0.008				

Submain Segment 1B										
Length (FT)	(GPM)	Flow (CFS)	Diameter (IN)	Diameter (FT)	Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams		S
								C Factor	120	
96	62.5	0.14	6.00	0.50	0.20	0.71	0.008	120	0.00050	
Total Headloss (FT)						0.048				

Submain Segment 1C										
Length (FT)	(GPM)	Flow (CFS)	Diameter (IN)	Diameter (FT)	Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams		S
								C Factor	120	
92	27.9	0.06	6.00	0.50	0.20	0.32	0.002	120	0.00011	
Total Headloss (FT)						0.010				
Total Submain 1 Headloss (FT)						0.067				

Lateral Segment 1B										
Length (FT)	(GPM)	Flow (CFS)	Diameter (IN)	Diameter (FT)	Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams		S
								C Factor	120	
10	46.5	0.10	2.50	0.21	0.03	3.04	0.143	120	0.02045	
Total Headloss (FT)						0.204				

Lateral Segment 1C										
Length (FT)	(GPM)	Flow (CFS)	Diameter (IN)	Diameter (FT)	Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams		S
								C Factor	120	
8	46.08	0.10	2.50	0.21	0.03	3.01	0.141	120	0.02011	
Total Headloss (FT)						0.161				

UNC Bingham Facility Wastewater System Improvements
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ZONE 4

Length (FT)	(GPM)	Flow (CFS)	Diameter (IN)	Diameter (FT)	Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams		S
								C Factor	120	
8	46.08	0.10	2.50	0.21	0.03	3.01	0.141	120	0.02011	
Total Headloss (FT)						0.161				

Lateral Segment 1D										
Length (FT)	(GPM)	Flow (CFS)	Diameter (IN)	Diameter (FT)	Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams		S
								C Factor	120	
8	45.48	0.10	2.50	0.21	0.03	2.97	0.137	120	0.01963	
Total Headloss (FT)						0.157				

Lateral Segment 1E										
Length (FT)	(GPM)	Flow (CFS)	Diameter (IN)	Diameter (FT)	Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams		S
								C Factor	120	
8	44.64	0.10	2.50	0.21	0.03	2.92	0.132	120	0.01896	
Total Headloss (FT)						0.152				

Lateral Segment 1F										
Length (FT)	(GPM)	Flow (CFS)	Diameter (IN)	Diameter (FT)	Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams		S
								C Factor	120	
8	43.62	0.10	2.50	0.21	0.03	2.85	0.126	120	0.01817	
Total Headloss (FT)						0.145				

Lateral Segment 1G										
Length (FT)	(GPM)	Flow (CFS)	Diameter (IN)	Diameter (FT)	Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams		S
								C Factor	120	
8	42.42	0.09	2.50	0.21	0.03	2.77	0.119	120	0.01725	
Total Headloss (FT)						0.138				

Lateral Segment 1H										
Length (FT)	(GPM)	Flow (CFS)	Diameter (IN)	Diameter (FT)	Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams		S
								C Factor	120	
8	40.98	0.09	2.50	0.21	0.03	2.68	0.111	120	0.01619	
Total Headloss (FT)						0.129				

Lateral Segment 1I										
Length (FT)	(GPM)	Flow (CFS)	Diameter (IN)	Diameter (FT)	Sectional Area (SQ. FT)	Velocity (FT/S)	Velocity Head (FT)	Hazen Williams		S
								C Factor	120	
8	40.98	0.09	2.50	0.21	0.03	2.68	0.111	120	0.01619	
Total Headloss (FT)						0.129				

UNC Bingham Facility Wastewater System Improvements
Secondary Effluent Drip Irrigation System Calculations

ZONE 4

Total Headloss (FT)										
0.039										
Lateral Segment 1V										
Flow	Diameter	Cross	Velocity	Velocity	Hazen	Velocity	Velocity	Hazen	Williams	S
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT)	C Factor	(FT)	(FT/FT)	C Factor	(FT/FT)	(FT/FT)
8	19.98	0.04	2.50	0.21	0.03	1.31	0.026	120	120	0.00429
Total Headloss (FT)										
0.034										
Lateral Segment 1W										
Flow	Diameter	Cross	Velocity	Velocity	Hazen	Velocity	Velocity	Hazen	Williams	S
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT)	C Factor	(FT)	(FT/FT)	C Factor	(FT/FT)	(FT/FT)
8	18.48	0.04	2.50	0.21	0.03	1.21	0.023	120	120	0.00371
Total Headloss (FT)										
0.030										
Lateral Segment 1X										
Flow	Diameter	Cross	Velocity	Velocity	Hazen	Velocity	Velocity	Hazen	Williams	S
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT)	C Factor	(FT)	(FT/FT)	C Factor	(FT/FT)	(FT/FT)
8	16.98	0.04	2.50	0.21	0.03	1.11	0.019	120	120	0.00317
Total Headloss (FT)										
0.025										
Lateral Segment 1Y										
Flow	Diameter	Cross	Velocity	Velocity	Hazen	Velocity	Velocity	Hazen	Williams	S
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT)	C Factor	(FT)	(FT/FT)	C Factor	(FT/FT)	(FT/FT)
8	15.48	0.03	2.50	0.21	0.03	1.01	0.016	120	120	0.00267
Total Headloss (FT)										
0.021										
Lateral Segment 1Z										
Flow	Diameter	Cross	Velocity	Velocity	Hazen	Velocity	Velocity	Hazen	Williams	S
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT)	C Factor	(FT)	(FT/FT)	C Factor	(FT/FT)	(FT/FT)
8	13.98	0.03	2.50	0.21	0.03	0.91	0.013	120	120	0.00221
Total Headloss (FT)										
0.018										
Lateral Segment 1AA										
Flow	Diameter	Cross	Velocity	Velocity	Hazen	Velocity	Velocity	Hazen	Williams	S
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT)	C Factor	(FT)	(FT/FT)	C Factor	(FT/FT)	(FT/FT)
8	12.48	0.03	2.50	0.21	0.03	0.82	0.010	120	120	0.00179
Total Headloss (FT)										
0.014										

UNC Bingham Facility Wastewater System Improvements
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ZONE 4

Lateral Segment 1AB										
Flow	Diameter	Cross	Velocity	Velocity	Hazen	Velocity	Velocity	Hazen	Williams	S
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT)	C Factor	(FT)	(FT/FT)	C Factor	(FT/FT)	(FT/FT)
8	10.98	0.02	2.50	0.21	0.03	0.72	0.008	120	120	0.00142
Total Headloss (FT)										
0.011										
Lateral Segment 1AC										
Flow	Diameter	Cross	Velocity	Velocity	Hazen	Velocity	Velocity	Hazen	Williams	S
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT)	C Factor	(FT)	(FT/FT)	C Factor	(FT/FT)	(FT/FT)
8	9.48	0.02	2.50	0.21	0.03	0.62	0.006	120	120	0.00108
Total Headloss (FT)										
0.009										
Lateral Segment 1AD										
Flow	Diameter	Cross	Velocity	Velocity	Hazen	Velocity	Velocity	Hazen	Williams	S
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT)	C Factor	(FT)	(FT/FT)	C Factor	(FT/FT)	(FT/FT)
8	7.98	0.02	2.50	0.21	0.03	0.52	0.004	120	120	0.00078
Total Headloss (FT)										
0.006										
Lateral Segment 1AE										
Flow	Diameter	Cross	Velocity	Velocity	Hazen	Velocity	Velocity	Hazen	Williams	S
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT)	C Factor	(FT)	(FT/FT)	C Factor	(FT/FT)	(FT/FT)
8	6.48	0.01	2.50	0.21	0.03	0.42	0.003	120	120	0.00053
Total Headloss (FT)										
0.004										
Lateral Segment 1AF										
Flow	Diameter	Cross	Velocity	Velocity	Hazen	Velocity	Velocity	Hazen	Williams	S
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT)	C Factor	(FT)	(FT/FT)	C Factor	(FT/FT)	(FT/FT)
8	4.98	0.01	2.50	0.21	0.03	0.33	0.002	120	120	0.00033
Total Headloss (FT)										
0.003										
Lateral Segment 1AG										
Flow	Diameter	Cross	Velocity	Velocity	Hazen	Velocity	Velocity	Hazen	Williams	S
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT)	C Factor	(FT)	(FT/FT)	C Factor	(FT/FT)	(FT/FT)
8	3.48	0.01	2.50	0.21	0.03	0.23	0.001	120	120	0.00017
Total Headloss (FT)										
0.001										

UNC Bingham Facility Wastewater System Improvements
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ZONE 4

Lateral Segment 2J										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Cross			Hazen Williams		S
					Flow	Diameter	Sectional Area	Velocity	Head (FT)	
8	25.5	0.06	2.50	0.21	0.03	1.67	0.043	120	0.00673	
Total Headloss (FT) 0.054										

Lateral Segment 2K										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Cross			Hazen Williams		S
					Flow	Diameter	Sectional Area	Velocity	Head (FT)	
8	24	0.05	2.50	0.21	0.03	1.57	0.038	120	0.00602	
Total Headloss (FT) 0.048										

Lateral Segment 2L										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Cross			Hazen Williams		S
					Flow	Diameter	Sectional Area	Velocity	Head (FT)	
8	22.5	0.05	2.50	0.21	0.03	1.47	0.034	120	0.00534	
Total Headloss (FT) 0.043										

Lateral Segment 2M										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Cross			Hazen Williams		S
					Flow	Diameter	Sectional Area	Velocity	Head (FT)	
8	21	0.05	2.50	0.21	0.03	1.37	0.029	120	0.00470	
Total Headloss (FT) 0.038										

Lateral Segment 2N										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Cross			Hazen Williams		S
					Flow	Diameter	Sectional Area	Velocity	Head (FT)	
8	19.5	0.04	2.50	0.21	0.03	1.27	0.025	120	0.00410	
Total Headloss (FT) 0.033										

Lateral Segment 2O										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Cross			Hazen Williams		S
					Flow	Diameter	Sectional Area	Velocity	Head (FT)	
8	18	0.04	2.50	0.21	0.03	1.18	0.021	120	0.00353	
Total Headloss (FT) 0.028										

Lateral Segment 2P

UNC Bingham Facility Wastewater System Improvements
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ZONE 4

Lateral Segment 2Q										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Cross			Hazen Williams		S
					Flow	Diameter	Sectional Area	Velocity	Head (FT)	
8	16.5	0.04	2.50	0.21	0.03	1.08	0.018	120	0.00301	
Total Headloss (FT) 0.024										

Lateral Segment 2R										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Cross			Hazen Williams		S
					Flow	Diameter	Sectional Area	Velocity	Head (FT)	
8	15	0.03	2.50	0.21	0.03	0.98	0.015	120	0.00252	
Total Headloss (FT) 0.020										

Lateral Segment 2S										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Cross			Hazen Williams		S
					Flow	Diameter	Sectional Area	Velocity	Head (FT)	
8	13.5	0.03	2.50	0.21	0.03	0.88	0.012	120	0.00207	
Total Headloss (FT) 0.017										

Lateral Segment 2T										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Cross			Hazen Williams		S
					Flow	Diameter	Sectional Area	Velocity	Head (FT)	
8	12	0.03	2.50	0.21	0.03	0.78	0.010	120	0.00167	
Total Headloss (FT) 0.013										

Lateral Segment 2U										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Cross			Hazen Williams		S
					Flow	Diameter	Sectional Area	Velocity	Head (FT)	
8	10.5	0.02	2.50	0.21	0.03	0.69	0.007	120	0.00130	
Total Headloss (FT) 0.010										

Lateral Segment 2V										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Cross			Hazen Williams		S
					Flow	Diameter	Sectional Area	Velocity	Head (FT)	
8	9	0.02	2.50	0.21	0.03	0.59	0.005	120	0.00098	
Total Headloss (FT) 0.008										

UNC Bingham Facility Wastewater System Improvements
Secondary Effluent Drip Irrigation System Calculations

ZONE 4

Lateral Segment 3H										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Cross		Velocity (FT/S)	Head (FT)	Hazen Williams	
					Flow (GPM)	Sectional Area (SQ. FT)			C Factor	S
8	21.06	0.05	2.50	0.21	0.03	1.38	0.029	120	120	0.00472
Total Headloss (FT) 0.038										

Lateral Segment 3I										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Cross		Velocity (FT/S)	Head (FT)	Hazen Williams	
					Flow (GPM)	Sectional Area (SQ. FT)			C Factor	S
8	19.44	0.04	2.50	0.21	0.03	1.27	0.025	120	120	0.00407
Total Headloss (FT) 0.033										

Lateral Segment 3J										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Cross		Velocity (FT/S)	Head (FT)	Hazen Williams	
					Flow (GPM)	Sectional Area (SQ. FT)			C Factor	S
8	17.82	0.04	2.50	0.21	0.03	1.16	0.021	120	120	0.00347
Total Headloss (FT) 0.028										

Lateral Segment 3K										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Cross		Velocity (FT/S)	Head (FT)	Hazen Williams	
					Flow (GPM)	Sectional Area (SQ. FT)			C Factor	S
8	16.2	0.04	2.50	0.21	0.03	1.06	0.017	120	120	0.00291
Total Headloss (FT) 0.023										

Lateral Segment 3L										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Cross		Velocity (FT/S)	Head (FT)	Hazen Williams	
					Flow (GPM)	Sectional Area (SQ. FT)			C Factor	S
8	14.58	0.03	2.50	0.21	0.03	0.95	0.014	120	120	0.00239
Total Headloss (FT) 0.019										

Lateral Segment 3M										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Cross		Velocity (FT/S)	Head (FT)	Hazen Williams	
					Flow (GPM)	Sectional Area (SQ. FT)			C Factor	S
8	12.96	0.03	2.50	0.21	0.03	0.85	0.011	120	120	0.00192
Total Headloss (FT) 0.015										

Lateral Segment 3N

UNC Bingham Facility Wastewater System Improvements
Secondary Effluent Drip Irrigation System Calculations

ZONE 4

Lateral Segment 2O										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Cross		Velocity (FT/S)	Head (FT)	Hazen Williams	
					Flow (GPM)	Sectional Area (SQ. FT)			C Factor	S
8	11.34	0.03	2.50	0.21	0.03	0.74	0.009	120	120	0.00150
Total Headloss (FT) 0.012										

Lateral Segment 3O										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Cross		Velocity (FT/S)	Head (FT)	Hazen Williams	
					Flow (GPM)	Sectional Area (SQ. FT)			C Factor	S
8	9.72	0.02	2.50	0.21	0.03	0.64	0.006	120	120	0.00113
Total Headloss (FT) 0.009										

Lateral Segment 3P										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Cross		Velocity (FT/S)	Head (FT)	Hazen Williams	
					Flow (GPM)	Sectional Area (SQ. FT)			C Factor	S
8	8.1	0.02	2.50	0.21	0.03	0.53	0.004	120	120	0.00081
Total Headloss (FT) 0.006										

Lateral Segment 3Q										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Cross		Velocity (FT/S)	Head (FT)	Hazen Williams	
					Flow (GPM)	Sectional Area (SQ. FT)			C Factor	S
8	6.48	0.01	2.50	0.21	0.03	0.42	0.003	120	120	0.00053
Total Headloss (FT) 0.004										

Lateral Segment 3R										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Cross		Velocity (FT/S)	Head (FT)	Hazen Williams	
					Flow (GPM)	Sectional Area (SQ. FT)			C Factor	S
8	4.86	0.01	2.50	0.21	0.03	0.32	0.002	120	120	0.00031
Total Headloss (FT) 0.003										

Lateral Segment 3S										
Length (FT)	(GPM)	(CFS)	(IN)	(FT)	Cross		Velocity (FT/S)	Head (FT)	Hazen Williams	
					Flow (GPM)	Sectional Area (SQ. FT)			C Factor	S
8	3.24	0.01	2.50	0.21	0.03	0.21	0.001	120	120	0.00015
Total Headloss (FT) 0.001										

Lateral Segment 3T

UNC Bingham Facility Wastewater System Improvements
Secondary Effluent Drip Irrigation System Calculations

ZONE 4

Tubing Segment 4.37		Cross			Hazen Williams			
Flow	Diameter	Sectional Area	Velocity	Velocity	Head	C Factor	S	
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT/S)	(FT)		(FT/FT)	
15	0.3	0.00	0.60	0.05	0.34	0.002	120	0.00188
Total Headloss (FT)								0.028

Tubing Segment 4.38		Cross			Hazen Williams			
Flow	Diameter	Sectional Area	Velocity	Velocity	Head	C Factor	S	
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT/S)	(FT)		(FT/FT)	
30	0.6	0.00	0.60	0.05	0.68	0.007	120	0.00678
Total Headloss (FT)								0.203

Tubing Segment 4.39		Cross			Hazen Williams			
Flow	Diameter	Sectional Area	Velocity	Velocity	Head	C Factor	S	
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT/S)	(FT)		(FT/FT)	
45	0.9	0.00	0.60	0.05	1.02	0.016	120	0.01435
Total Headloss (FT)								0.646

Tubing Segment 4.40		Cross			Hazen Williams			
Flow	Diameter	Sectional Area	Velocity	Velocity	Head	C Factor	S	
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT/S)	(FT)		(FT/FT)	
60	1.2	0.00	0.60	0.05	1.36	0.029	120	0.02443
Total Headloss (FT)								1.466

Tubing Segment 4.41 - 4.61		Cross			Hazen Williams			
Flow	Diameter	Sectional Area	Velocity	Velocity	Head	C Factor	S	
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT/S)	(FT)		(FT/FT)	
75	1.5	0.00	0.60	0.05	1.70	0.045	120	0.03692
Total Headloss (FT)								2.769

Tubing Segment 4.62		Cross			Hazen Williams			
Flow	Diameter	Sectional Area	Velocity	Velocity	Head	C Factor	S	
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT/S)	(FT)		(FT/FT)	
6	0.12	0.00	0.60	0.05	0.14	0.000	120	0.00035
Total Headloss (FT)								0.002

Tubing Segment 4.63

UNC Bingham Facility Wastewater System Improvements
Secondary Effluent Drip Irrigation System Calculations

ZONE 4

Tubing Segment 4.64		Cross			Hazen Williams			
Flow	Diameter	Sectional Area	Velocity	Velocity	Head	C Factor	S	
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT/S)	(FT)		(FT/FT)	
21	0.42	0.00	0.60	0.05	0.48	0.004	120	0.00350
Total Headloss (FT)								0.074

Tubing Segment 4.65		Cross			Hazen Williams			
Flow	Diameter	Sectional Area	Velocity	Velocity	Head	C Factor	S	
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT/S)	(FT)		(FT/FT)	
36	0.72	0.00	0.60	0.05	0.82	0.010	120	0.00950
Total Headloss (FT)								0.342

Tubing Segment 4.66		Cross			Hazen Williams			
Flow	Diameter	Sectional Area	Velocity	Velocity	Head	C Factor	S	
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT/S)	(FT)		(FT/FT)	
51	1.02	0.00	0.60	0.05	1.16	0.021	120	0.01809
Total Headloss (FT)								0.922

Tubing Segment 4.67		Cross			Hazen Williams			
Flow	Diameter	Sectional Area	Velocity	Velocity	Head	C Factor	S	
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT/S)	(FT)		(FT/FT)	
66	1.32	0.00	0.60	0.05	1.50	0.035	120	0.02914
Total Headloss (FT)								1.923

Tubing Segment 4.67 - 4.81		Cross			Hazen Williams			
Flow	Diameter	Sectional Area	Velocity	Velocity	Head	C Factor	S	
(GPM)	(IN)	(SQ. FT)	(FT/S)	(FT/S)	(FT)		(FT/FT)	
81	1.62	0.00	0.60	0.05	1.84	0.052	120	0.04257
Total Headloss (FT)								3.448

DIMENSIONS AND WEIGHTS

MODEL NO.	FIG.	HP	MOTOR SIZE	DISCH. SIZE	DIMENSIONS IN INCHES					APPROX. SHIP WT.
					A	B	C	D	E	
150S20-1	A	2	4"	3" NPT	27.3	13.6	13.7	3.75	5.2	55
150S50-2	A	5	4"	3" NPT	41.1	23.6	17.5	3.75	5.2	75
150S75-3	A	7 1/2	4"	3" NPT	50.9	29.6	21.3	3.75	5.2	92
150S75-4	A	7 1/2	4"	3" NPT	54.7	29.6	25.1	3.75	5.2	97
150S100-5	A	10	4"	3" NPT	72.8	43.9	28.9	3.75	5.2	151
150S75-4	A	7 1/2	6"	3" NPT	49.9	24.2	25.7	5.38	5.6	135
150S100-5	A	10	6"	3" NPT	54.9	25.4	29.5	5.38	5.6	148
150S150-6	A	15	6"	3" NPT	61.3	28.0	33.3	5.38	5.6	167
150S150-7	A	15	6"	3" NPT	65.0	28.0	37.0	5.38	5.6	169
150S150-8	A	15	6"	3" NPT	68.8	28.0	40.8	5.38	5.6	174
150S200-9	A	20	6"	3" NPT	75.2	30.6	44.6	5.38	5.6	191
150S200-10	A	20	6"	3" NPT	79.0	30.6	48.4	5.38	5.6	193
150S200-11	A	20	6"	3" NPT	82.8	30.6	52.2	5.38	5.6	198
150S250-12	A	25	6"	3" NPT	89.0	33.1	55.9	5.38	5.6	235
150S250-13	A	25	6"	3" NPT	92.8	33.1	59.7	5.38	5.6	238
150S250-14	A	25	6"	3" NPT	96.6	33.1	63.5	5.38	5.6	242
150S300-15	A	30	6"	3" NPT	103.0	35.7	67.3	5.38	5.6	260
150S300-16	A	30	6"	3" NPT	106.8	35.7	71.1	5.38	5.6	262
150S300-17	A	30	6"	3" NPT	110.5	35.7	74.8	5.38	5.6	266
150S400-18	A	40	6"	3" NPT	119.4	40.8	78.6	5.38	5.6	306
150S400-19	A	40	6"	3" NPT	123.2	40.8	82.4	5.38	5.6	308
150S400-20	A	40	6"	3" NPT	127.0	40.8	86.2	5.38	5.6	323
150S400-21	A	40	6"	3" NPT	130.8	40.8	90.0	5.38	5.7	334
150S400-22	A	40	6"	3" NPT	134.5	40.8	93.7	5.38	5.7	338
150S400-23	A	40	6"	3" NPT	138.3	40.8	97.5	5.38	5.7	340
150S500-24	A	50	6"	3" NPT	162.2	57.8	104.4	5.38	6.1	442
150S500-25	A	50	6"	3" NPT	166.0	57.8	108.2	5.38	6.1	444
150S500-26	A	50	6"	3" NPT	169.8	57.8	112.0	5.38	6.1	446
150S500-27	A	50	6"	3" NPT	173.6	57.8	115.8	5.38	6.1	448
150S500-28	A	50	6"	3" NPT	183.4	63.8	119.6	5.38	7.1	450
150S600-29	A	60	6"	3" NPT	193.7	63.8	129.9	5.38	7.1	448
150S600-31	A	60	6"	3" NPT	201.3	63.8	137.5	5.38	7.1	452
150S600-33	A	60	6"	3" NPT	208.8	63.8	145.0	5.38	7.1	456
150S500-24	A	50	8"	3" NPT	143.2	38.8	104.4	7.50	7.5	492
150S500-25	A	50	8"	3" NPT	147.0	38.8	108.2	7.50	7.5	495
150S500-26	A	50	8"	3" NPT	150.8	38.8	112.0	7.50	7.5	497
150S500-27	A	50	8"	3" NPT	154.6	38.8	115.8	7.50	7.5	499
150S500-28	A	50	8"	3" NPT	158.4	38.8	119.6	7.50	7.5	501
150S600-29*	B	60	8"	3" NPT	169.7	41.8	127.9	7.50	7.5	539
150S600-31*	B	60	8"	3" NPT	177.3	41.8	135.5	7.50	7.5	543
150S600-33*	B	60	8"	3" NPT	184.8	41.8	143.0	7.50	7.5	547
150S750-36*	B	75	8"	3" NPT	201.8	47.4	154.4	7.50	7.5	592
150S750-39*	B	75	8"	3" NPT	213.1	47.4	165.7	7.50	7.5	598

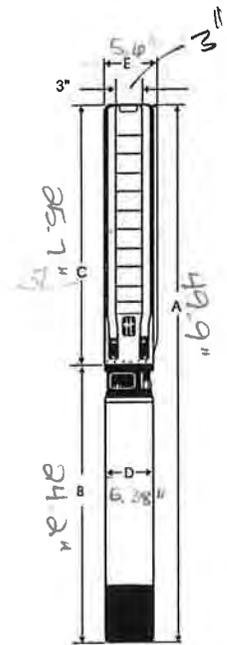


Fig. A

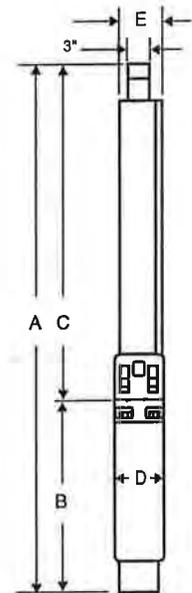


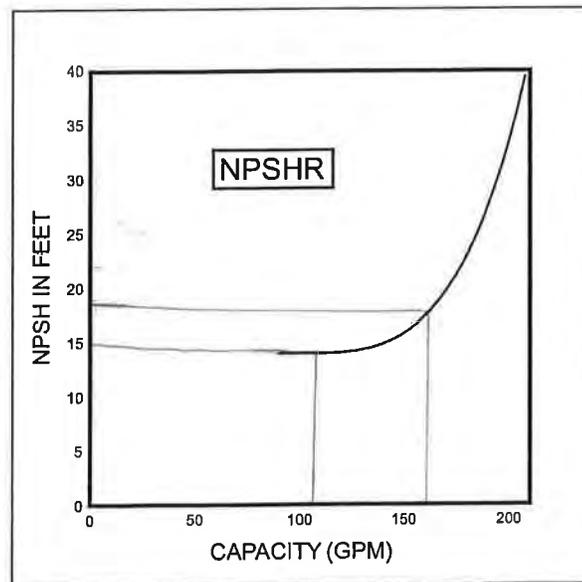
Fig. B

NOTES: All models suitable for use in 6" wells, unless otherwise noted.
 Weights include pump end with motor in lbs.
 * Built into sleeve 3" NPT discharge, 8" min. well dia.

MATERIALS OF CONSTRUCTION

COMPONENT	CYLINDRICAL SHAFT (1-39 Stgs.)
Check Valve Housing	304 Stainless Steel
Check Valve	304 Stainless Steel
Diffuser Chamber	304 Stainless Steel
Split Cone Nut	304 Stainless Steel
Split Cone	304 Stainless Steel
Impeller	304 Stainless Steel
Suction Interconnector	304 Stainless Steel
Inlet Screen	304 Stainless Steel
Seal Ring Support Plate	304 Stainless Steel
Straps	304 Stainless Steel
Cable Guard	304 Stainless Steel
Priming Inducer	304 Stainless Steel
Coupling	316/329 Stainless Steel**
Pump Shaft	431 Stainless Steel
Intermediate Bearings	NBR
Impeller Seal Ring	NBR/PPS
Check Valve Seat	NBR/316 Stainless Steel
Top Bearing	NBR/304 Stainless Steel
Upthrust Disc	Carbon/Graphite
Upthrust Stop Washer	304 Stainless Steel
8" Motor Adaptor Plate	304 Stainless Steel
Sleeve*	316 Stainless Steel
Sleeve Flange	304 Stainless Steel

NOTES: Specifications are subject to change without notice.
 *Required for 29-39 stage models.
 ** 4" Coupling made of 316 Stainless Steel.



PERFORMANCE CURVES

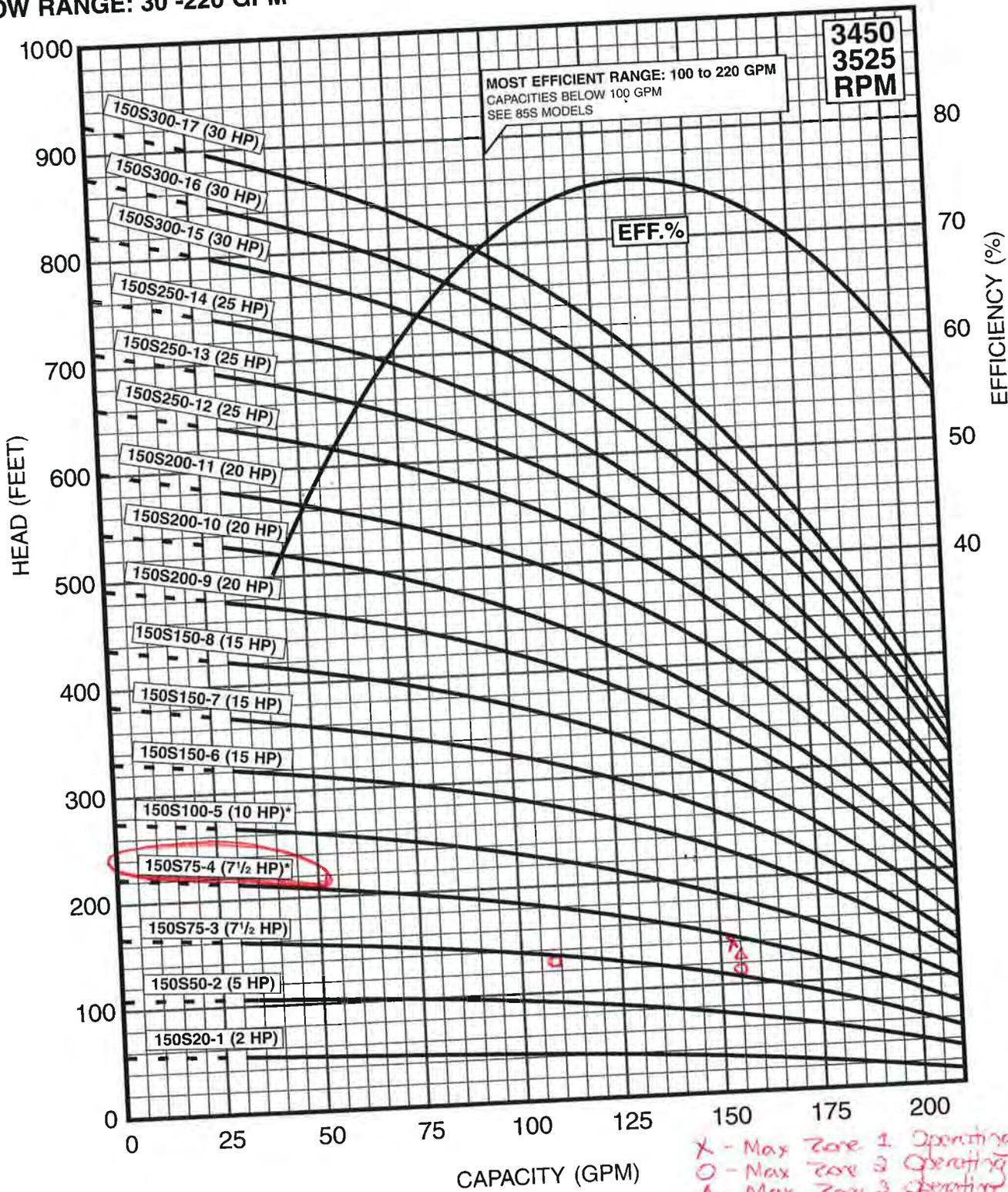
150 GPM

MODEL 150S

FLOW RANGE: 30 -220 GPM

OUTLET SIZE: 3" NPT

NOMINAL DIA. 6"



SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

4" MOTOR STANDARD, 2-10 HP/3450 RPM

6" MOTOR STANDARD, 7.5-60 HP/3450 RPM.

8" MOTOR STANDARD, 75 HP/3525 RPM.

* Alternate motor sizes available.

Performance conforms to ISO 9906 Annex A
@ 5 ft. min. submergence.

Technical Data

Table A

Minimum Water Flow Requirements for Submersible Pump Motors

MOTOR DIAMETER	CASING OR SLEEVE I.D. IN INCHES	MIN. FLOW PAST THE MOTOR (GPM)
4"	4	1.2
	5	7
	6	13
	7	21
	8	30
6"	6	10
	7	28
	8	45
	10	85
	12	140
	14	198
	16	275
8"	8	10
	10	55
	12	110
	14	180
10"	16	255
	10	30
	12	85
	14	145
	16	220
	18	305

NOTES:

1. A flow inducer or sleeve must be used if the water enters the well above the motor or if there is insufficient water flow past the motor.
2. The minimum recommended water velocity over 4" motors is 0.25 feet per second.
3. The minimum recommended water velocity over 6, 8, and 10" motors is 0.5 feet per second.

Table B

Guide for Engine-Driven Generators in Submersible Pump Applications

MOTOR HP SINGLE OR THREE PHASE UNITS	MINIMUM KILOWATT RATING OF GENERATOR FOR THREE-WIRE SUBMERSIBLE PUMP MOTORS	
	EXTERNALLY REGULATED GENERATOR	INTERNALLY REGULATED GENERATOR
0.33 HP	1.5 KW	1.2 KW
0.50	2.0	1.5
0.75	3.0	2.0
1.0	4.0	2.5
1.5	5.0	3.0
2.0	7.5	4.0
3.0	10.0	5.0
5.0	15.0	7.5
7.5	20.0	10.0
10.0	30.0	15.0
15.0	40.0	20.0
20.0	60.0	25.0
25.0	75.0	30.0
30.0	100.0	40.0
40.0	100.0	50.0
50.0	150.0	60.0
60.0	175.0	75.0
75.0	250.0	100.0
100.0	300.0	150.0
125.0	375.0	175.0
150.0	450.0	200.0
200.0	600.0	275.0

NOTES:

1. Table is based on typical 80°C rise continuous duty generators with 35% maximum voltage dip during start-up of single-phase and three-phase motors.
2. Contact the manufacturer of the generator to assure the unit has adequate capacity to run the submersible motor.
3. If the generator rating is in KVA instead of kilowatts, multiply the above ratings by 1.25 to obtain KVA.

Table C

Transformer Capacity Required for Three-Phase Submersible Pump Motors

THREE-PHASE MOTOR HP	MINIMUM TOTAL KVA REQUIRED*	MINIMUM KVA RATING FOR EACH TRANSFORMER	
		2 TRANSFORMERS OPEN DELTA OR WYE	3 TRANSFORMERS DELTA OR WYE
1.5	3	2	1
2	4	2	1-1/2
3	5	3	2
5	7-1/2	5	3
7.5	10	7-1/2	5
10	15	10	5
15	20	15	7-1/2
20	25	15	10
25	30	20	10
30	40	25	15
40	50	30	20
50	60	35	20
60	75	40	25
75	90	50	30
100	120	65	40
125	150	85	50
150	175	100	60
200	230	130	75

* Pump motor KVA requirements only, and does not include allowances for other loads.



- MEMO
- TELEPHONE
- FIELD REPORT
- CONFERENCE

DATE: 4-12-11 TIME: _____

AUTHOR: Stephanie Kellogg

PROJECT: Bingham Wd System Improvements CLIENT: UNC

SUBJECT: Irrigation PS - NPSH Calcs PROJ. NO. 1488 - 0032

@ Lowest Flow Rate (108 gpm for Zone 4)
 $NPSH_R = 15 \text{ ft.}$

@ Highest Flow Rate (158.4 gpm for Zone 2)
 $NPSH_R = 18 \text{ ft.}$

@ LWL in wetwell

$$\begin{aligned} NPSH_A &= S - h_{f_0} + 2.31 (P - P_{vp}) \\ &= 1 \text{ ft} - 0 + 2.31 (14.7 \text{ psi} - 0.256 \text{ psi}) \\ &= 34.37 \text{ ft.} \end{aligned}$$

In all cases $NPSH_R > NPSH_A$

ACTION

COPY:

Filter System Quotation

To: <u>McKim & Creed</u>	Date: 12/19/2012
Attn: <u>Stephanie Kellogg</u>	Page: 1 of 1
Phone: <u>(919) 233 5261 x 141</u>	Quote #: <u>MC-1S134-121912B</u>
Fax: _____	Job Name: <u>UNC Bingham Wastewater System</u>
E-mail: <u>skellogg@mckimcreed.com</u>	<u>Improvements</u>

Information Required for Detailed Quotation:

System Flow Rate: 109-155 GPM	Min. Flow for Flushing: SAF1500: 26 GPM	<i>Additional</i>
Line Size: Please provide information	SAF3,000: 50 GPM	
System Operating Pressure: As needed	Minimum: 35 PSI	Maximum: 150 PSI
System Operating Temperature: Ambient		Maximum: 120 F
Water Source: Secondary treated effluent water/ holding pond	Water Use: Irrigation (Drip)	
Stated / Maximum TSS: 5 PPM (at the effluent of the secondary wastewater)		
Filtration Degree Desired: 177 µ		
Power Source: Please provide information	HZ: 60	
Description of Application:		
Special Requirements:		
Product Information:		
Construction: <i>Housing Material:</i> Epoxy Coated Carbon Steel	<i>Screen Material:</i> Stainless Steel 316L	
<i>Special Features:</i>		

Filter System Option(1):

Item	Quantity	Part Number and Description	Net Price
1	1	Model 3-7048-1110-3500, 4" SAF-1500 automatic self cleaning filter body, epoxy coated carbon steel	\$ 17,397.00
2	1	Model 13-7083-0013, 130 micron SAF-1500 screen element, stainless steel 316, weave-wire	Included
3	1	Model 82-81-3350-0271, Type 'C' control panel 230/460V AC, 3-phase, with 24V AC solenoids	Included
TOTAL LIST PRICE			\$ 17,397.00

Filter System Option(2):

Item	Quantity	Part Number and Description	Net Price
4	1	Model 3-6041-1110-3500, 4" SAF-3000 automatic self cleaning filter body, epoxy coated carbon steel	\$ 19,657.00
5	1	Model 13-6083-0013, <u>130 micron</u> SAF-3000 screen element, stainless steel 316, weave-wire	Included
6	1	Model 82-81-3350-0271, Type 'C' control panel 230/460V AC, 3-phase, with 24V AC solenoids	Included
TOTAL LIST PRICE			\$ 19,657.00

Adder: (for option 1 or 2)

7	1	Model SW-04-005, 4" check valve	\$ 336.00
8	3	Model B8-04-007-G, 4" butterfly valve - gear operated (Isolation & by-pass)	\$ 1,149.00
TOTAL LIST ADDER			\$ 1,485.00

9	1	Model 66-7001-1110, Spare parts Kit for SAF1500 (For one filter)	\$ 1,327.00
10	1	Model 66-6001-1110, Spare parts Kit for SAF3000 (For one filter)	\$ 1,327.00

Technical notes:

1. A non-return check valve is required at the outlet of each filter. **Back flow will damage the filter.**
2. Flushing according to pressure differential or time interval.
3. Flushing line should have no interruption on flow and minimum restriction.

Commercial notes

1. Prices are valid for thirty (30) days from date of issue.
2. Freight charges will be added to total price at the time of order.
3. Amiad's **standard Terms and Conditions** will apply to all orders. A copy of these Terms and Conditions will be supplied upon request.

FOB Shipping Point: Mooresville, NC

Terms of Payment: Net 30 days

Delivery: 4-6 weeks

(On approved credit)

Please feel free to contact me or your Regional Sales Manager/Representative for additional details, questions, or comments.

Regional Sales Mgr.: Cosmo Kinsey

Phone Number: (843) 709 5168

E-mail: cosmo@amiadusa.com

Thank you for choosing Amiad Filtration Systems, we supply clear solutions to your water filtration problems.

Best regards,
Hetti Perera
Applications Engineer
(704) 235 6450

** Find manufacturer specs here:*

*S: 11488/0032/30-Equip/30-Individual Vendor File
Drip Irrigation/Disc Filters*



From: Cosmo Kinsey <Cosmo@amiadusa.com>
Sent: Wednesday, December 19, 2012 3:00 PM
To: Stephanie Kellogg; Chuck Riley
Cc: Matt Aguiar; Brenda Wooley; Wayne@RiversAssociates.com;
 James@riversassociates.com
Subject: FW: UNC Bingham Wastewater System Improvements Project - Drip Irrigation Design
Attachments: MC-1S134-121912B.pdf; SAF-3000 Specifications - CSI Format 06.09.05.doc; SAF-1500 Specifications - CSI Format 06.09.05.doc; 15mc81_d 4" SAF 1500 Modular.dwg; 15mc81_d 4" SAF 1500 Modular .pdf; SAF-1500_04inch__INSTALLATION_w00752 (Inch.).dwg; Automatic_SAF-3000-04inch__DIM 30b080_d.pdf; Automatic_SAF-3000-04inch__DIM 30b080_d.dwg; SAF-3000_04inch__INSTALLATION_w04300.pdf; SAF-3000_04inch__INSTALLATION_w04300.dwg

Stephanie,

Please find the quote attached along with the technical drawings as requested. Also note as we discussed earlier, I suggest you specify the 3000 series. The price difference is negligible. Twice the screen area results in 4X the run time between cleanings. This will allow for periodic heavy loading.

Please review them along with the following info:

- Clean pressure loss across the filter:
SAF 1500: 0.6 psi @ 150 GPM
SAF 3000: 0.5 psi @ 150 GPM
- Maximum dirty pressure loss across the filter would be 7 psi (right before backwashing with DP/for both filters)
- Backwash flow and pressure requirement for each filter (SAF1500: 26 GPM @35 PSI/ SAF3000: 50 GPM @ 35 PSI)

Please note that we have quoted our standard MatcoNorca check valve and gear operated butterfly valves.

LMK if you have any questions or need additional info.

Regards,
Cosmo



Amiad USA 120-J Talbert Road Mooresville, NC 28117

 Please consider the environment before printing this e-mail

From: Cosmo Kinsey
Sent: Wednesday, December 19, 2012 12:20 PM
To: Stephanie Kellogg; Hetti Perera
Cc: Chuck Riley; Matt Aguiar
Subject: RE: UNC Bingham Wastewater System Improvements Project - Drip Irrigation Design

Hetti,
Please prepare quote for:

McKim and Creed
1730 Varsity Drive, Suite 500
Raleigh, NC 27606

Attn: Stephanie Kellogg, Tel 919.233.5261 x141, SKellogg@mckimcreed.com
Job Name: UNC Bingham Wastewater System Improvements Project - Drip Irrigation Design
FOB: Amiad
Pricing: List

4" SAF 3000/130 micron w/ Type C controller

OPTION 1:

4" SAF 1500/130 micron w/ Type C controller

Parameters:

Source: Secondary Effluent Water Lagoon
Flow Rate: 109 - 155 gpm
Minimum Operating Pressure: 40 psi
Filtration Requirement: Drip 177 Micron
3 Phase power

Please include:

Specifications
Drawings (CAD)
Oval information

Thank you,
Cosmo



Cosmo Kinsey
Eastern Regional Sales
C: 843-709-5168 (SC)
F: 704-662-3155 (NC)
cosmo@amiadusa.com
www.amiadusa.com

www.pepfilters.com

120-J TALBERT STREET MOORESVILLE, NC. 28117

From: Stephanie Kellogg [<mailto:SKellogg@mckimcreed.com>]
Sent: Wednesday, December 19, 2012 9:00 AM
To: Hetti Perera
Cc: Chuck Riley; Cosmo Kinsey
Subject: RE: UNC Bingham Wastewater System Improvements Project - Drip Irrigation Design

Hetti,

I haven't heard from Cosmo regarding this project yet nor have I received the requested technical information. I am still working through the last little bit of design for our drip field and subsequent hydraulic calculations. As mentioned earlier, I will forward this information along when I have it, but I believe you told me that it wasn't absolutely necessary for you to have this before you could give me a preliminary design. We are under an extremely tight schedule since we have to re-submit this project to the regulatory agency. Can you give me an idea of when you think you can get me the requested drawings and technical information? I appreciate your willingness to help McKim & Creed design a filter system for our drip field and supply us with the necessary technical information to use your product as the basis for design.

Thanks,

Stephanie

From: Hetti Perera [<mailto:hetti@amiadusa.com>]
Sent: Friday, December 14, 2012 12:04 PM
To: Stephanie Kellogg
Cc: Chuck Riley; Cosmo Kinsey
Subject: RE: UNC Bingham Wastewater System Improvements Project - Drip Irrigation Design

Stephanie,

Thanks for the info.

I already discussed this project with Cosmo Kinsey who handles the projects on the irrigation sector of your territory.

You will be contacted by Cosmo to discuss this project in more details.

As promised during our discussion, I will be able to give you our proposal by the end of the day Monday (12/17/2012).

All the technical information that you have requested regarding our system will be sent by then.

Please call/email if you have any questions or need additional info.

Regards,
Hetti

Hetti Perera
Applications Engineer



P: 704 235 6450
 F: 704 662 3155
www.amiadusa.com
www.pepfilters.com



Amiad USA 120-J Talbert Road Mooresville, NC 28117

Please consider the environment before printing this e-mail

From: Stephanie Kellogg [<mailto:SKellogg@mckimcreed.com>]

Sent: Friday, December 14, 2012 11:41 AM

To: Hetti Perera

Cc: Chuck Riley

Subject: UNC Bingham Wastewater System Improvements Project - Drip Irrigation Design

Hetti,

Thanks for agreeing to help us with the basis of design for filters before the drip irrigation system at UNC's Bingham Facility. I found some estimates of the water quality you can expect to see before your filters:

BOD5 = 4 mg/L

TSS = 5 mg/L

TN = 25 mg/L

Ammonia-N = 15 mg/L

Nitrate N = 10 mg/L

Phosphorous = 5 mg/L

This is the estimated water quality for the effluent of the secondary wastewater treatment system, but it will be pumped from the treatment plant effluent into a holding pond before being pumped to your filters. This means the water quality could change significantly in the holding pond and those numbers may not be accurate after the water has been sitting in the holding pond. However, I mentioned on the phone that we were going to have a well screen in the wetwell of the irrigation pump station to filter out any large debris, leaves, etc. from the water prior to pumping through your filters and into the system. I've attached the technical specification section with the detail of that well screen to this email for your information.

Also, you asked about operating pressures for your filters and I mentioned that I did not have the pumps redesigned yet. That is true but I do have an idea of what kind of pressures I'd like to see at the emitters in the drip fields. I'd like to see anywhere from 30psi to 40psi at the emitters in the drip fields and I'm working on the hydraulic calculations based on our main, header, and lateral design to estimate the minimum pressure that I would need to see downstream of your filters. I will send along this information as soon as I have it. When you send your technical information I'll need an estimate of pressure loss through the filters both clean and right before backwashing. I'll also need ample details on the filter backwash cycle so I can make sure I have provided everything your system needs in order to function optimally.

Thank You,

Stephanie Kellogg, EI | Engineer Intern

Tel 919.233.5261 x141

1730 Varsity Drive, Suite 500 | Raleigh, NC 27606

SKellogg@mckimcreed.com | <http://www.mckimcreed.com>



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To send me a file larger than 10MB [please click here](#)

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SAF Filters		
flow rates	filtration degrees	min. operating pressure
up to 400 m³/h (1,760 US gpm)	800-10 micron	2 bar (30 psi)

The automatic self-cleaning filter - suitable for more applications than ever.



features:

- Large filter area, reliable operating mechanism and simple construction make the SAF filter the ideal solution for filtration of poor quality water to very fine filtration degrees
- Automatic flushing according to pressure differential and/or according to time
- No interruption of downstream flow during flushing
- Robust and reliable Self-Cleaning mechanism even on marginal operation conditions.
- Minimal volume of reject water allows excellent operation in continuous flush mode
- Applications: Water supply systems, Irrigation systems, Cooling Water, Waste Water Treatment, Industrial Pre-Filtration, etc.
- Industries: manufacturing, mining, water and waste water treatment plant, turf and agriculture, etc.

How the SAF Filters work

General

The Amiad SAF Series are sophisticated, yet easy-to-operate automatic filters, with a self-cleaning mechanism driven by an electric motor.

The "SAF" filters support flow-rates of up to 400 m³/h (1,760 gpm), with various screens designed to cover a range of 800-10 micron: filtration degree, and are available in inlet/outlet diameters of 2"-10".

The Filtering Process

Raw water enters the filter inlet (1) through the coarse screen (2) which protects the cleaning mechanism from large debris. The water passes through the fine screen (3), trapping dirt particles which accumulate inside the filter. Clean water flows through the filter outlet (4).

The gradual dirt buildup on the inner screen surface causes a filter cake to develop, with a corresponding increase in the pressure differential across the screen. A pressure differential switch senses the pressure differential and when it reaches a pre-set value, the cleaning process begins.

The Self-Cleaning Process

Cleaning of the filter is carried out by the suction scanner (5) which spirals across the screen; the open exhaust valve creates a high velocity suction stream at the nozzles tip which "vacuums" the filter cake from the screen. During the self-cleaning process, which takes between 20 to 40 seconds, filtered water continues to flow downstream.

The Control System

Two types of control boards are available for the SAF filters: PLC or Electro-Mechanical Relay and Timer.

The self-cleaning cycle begins under any one of the following conditions:

1. Receiving a signal from the Pressure Differential Switch (6)
2. Time interval parameter set at the control board
3. Manual Start

The control board also provides:

Optional continuous flush operation mode

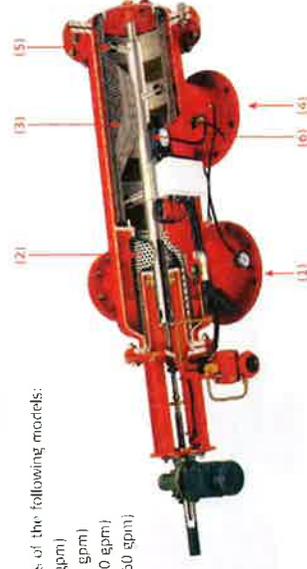
Flush cycles counter

Alarm or an alternative reaction at malfunction mode: open a bypass, shut-off a pump, etc.

"SAF" Models

Amiad's "SAF" product line consists of the following models:

- SAF-1500 for up to 80 m³/h (350 gpm)
- SAF-3000 for up to 150 m³/h (660 gpm)
- SAF-4500 for up to 250 m³/h (1,100 gpm)
- SAF-6000 for up to 400 m³/h (1,760 gpm)



Technical Specifications

Filter Type	SAF 1500	SAF 3000	SAF 4500	SAF 6000
General Data				
Maximum flow rate*	80 m ³ /h (352 US gpm)	150 m ³ /h (660 US gpm)	250 m ³ /h (1100 US gpm)	400 m ³ /h (1760 US gpm)
Inlet/Outlet diameter (mm)	2" 3" 4" (50 80 100)	3" 4" 6" (80 100 150)	4" 6" 8" (100 150 200)	6" 8" 10" (150 200 250)
Standard filtration (degrees)	Weave Wire Screen 800, 500, 300, 200, 130, 100, 80, 50, 25, 10 micron			
Min. working pressure	2 bar (30 psi) * For lower pressure please consult manufacturer			
Max. working pressure	10 bar (145 psi)	10 bar (145 psi)	16 bar (232 psi) upon request	10 bar (145 psi)
Max. working temperature	50°C (122°F)	50°C (122°F)	60°C (140°F) 95°C (203°F) upon request	60°C (140°F) 95°C (203°F) upon request
Electrical Supply	3 phase, 220 / 380 / 440 VAC 50 / 60 Hz			
Weight (empty)	86 kg (190 lb)	110 kg (242.5 lb)	160 kg (353 lb)	250 kg (551 lb)
* Consult Amiad for optimum flow depending on filtration degree & water quality.				
Flushing Data				
Minimum flow for flushing (at 2 bar - 30 psi)	6 m ³ /h (26 US gpm)	11 m ³ /h (48 US gpm)	15 m ³ /h (66 US gpm)	25 m ³ /h (110 US gpm)
Water to waste volume per filter cycle (at 2 bar - 30 psi)	25 liter (7 US gallon)	64 liter (17 US gallon)	83 liter (22 US gallon)	280 liter (74 US gallon)
Flushing cycle time	15 seconds	20 seconds	20 seconds	40 seconds
Exhaust valve	2"	2"	2"	2"
Flushing criteria	50 mm	50 mm	50 mm	50 mm
	Differential pressure of 0.5 bar (7psi), time intervals and manual operation			
Screen Data				
Filter area	1500 cm ² (323 in ²)	3000 cm ² (645 in ²)	4500 cm ² (697 in ²)	6000 cm ² (930 in ²)
Screen types	Four layer Weave Wire stainless steel 316L Molded Weave Wire stainless steel 316L			
Control and Electricity				
Rated operation voltage	3 phase, 220/380/440 VAC 50/60 Hz			
Electric motor	1/4 HP	1/4 HP	1/4 HP	1/4 HP
Current consumption	0.6 Amp	0.6 Amp	0.6 Amp	0.8 Amp
Control voltage	24 VAC 12V or 24V VDC upon request			
Construction Materials*				
Filter housing	Epoxy-coated carbon steel 37-2			
Filter lid	SMC Polyester / Epoxy-coated carbon steel 37-2			
Cleaning mechanism	Stainless steel 316L, Acetal			
Exhaust valve	Epoxy-coated cast iron, Natural rubber			
Seals	Synthetic nitrile, Teflon			
Control	Aluminum, Brass, Stainless steel, PVC, Nylon			

* Amiad offers a variety of construction materials. Consult us for specifications.

a m i a d f i l t r a t i o n s o l u t i o n s



industry

Automotive, Aviation, Ballast Treatment, Electronics, Food & Beverage, Mining, Oil & Gas, Petrochemical, Power Generation, Pulp & Paper

municipal

Potable Water, Waste Water, Desalination, Backwash Water, High Rise Buildings, Pre-filtration to Avoid Backflow

irrigation

High Pressure Wash & Clean, Recirculation, Greenhouses

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Fax: 86 510 87134999. E-mail: market@taiyang.cc

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E-mail: info@amiadfrance.com

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E-mail: info@amiad.de

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Yurt Oria Sarayli, Suray, Ankara, Tel: 90 312 8155266/7,
Fax: 90 312 8155268. E-mail: info@fils-turk.com

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E-mail: jsk@iam2.vsnl.net.in

Manufacturer & Headquarters

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Amiad Australia Pty Ltd, 138 Northcorp Boulevard,
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Fax: 61 3 93585888. E-mail: amiad@amiad.com.au

NP000957/08 2009

a m i a d f i l t r a t i o n s o l u t i o n s

AMIAD Automatic Filters

SAF-3000 FILTER

Serial number:	_____
Order number:	_____
Catalog number:	_____
Filtration degree:	_____
Tested by:	_____

Control board type:	_____
Catalog number:	_____
Job number:	_____
Program version:	_____

Installation, Operation and Maintenance Instructions

AMIAD Automatic Filters

SAF-3000 FILTER

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SAFETY INSTRUCTIONS

General Safety Instructions

- Amiad filtration products always operate as components in a larger system. It is essential for the system designers, installers and operators to comply with all the relevant safety standards.
- Prior to installation, operation, maintenance or any other type of action carried out on the filter, read carefully the installation and operation instructions
- During installation, operation or maintenance of the filter all conventional safety instructions should be observed in order to avoid danger to the workers, the public or to property in the vicinity.
- Please note: The filter enters into a flushing mode automatically, without prior warning.
- No change or modification to the equipment is permitted without a written notification given by the manufacturer or by its representative, on the manufacturer's behalf.
- Always observe standard safety instructions and good engineering practices whilst working in the filter's vicinity
- Use the filter only for its intended use as designed by Amiad, any misuse of the filter may lead to undesired damage and may affect your warranty coverage. Please consult with Amiad prior to any non-regular use of this equipment. "CE" Designation on your unit is in accordance with regulations for placing on the market per the applicable European Council Safety Directives. It does not allow using the filter not to the initial purpose it was ordered and designed for.

Installation

General

- Install the filter according to the detailed installation instructions provided with the filter by the manufacturer and according to the description given in this manual.
- Make sure to leave enough clearance so as to enable easy access for future treatments and safe maintenance operations.
- The user should arrange suitable lighting at the area of the filter to enable good visibility and safe maintenance.
- The user should arrange suitable platforms and safety barriers to enable easy and safe access to the filter without climbing on pipes and other equipment. The user should verify that any platform, barrier, ladder or other such equipment is built, installed and used in accordance with the relevant local authorized standards.
- Check and re-tighten all bolts during commissioning and after the first week of operation.
- Use only appropriate standard tools and equipment operated by qualified operators when installing, operating and maintaining the filter.
- When installation is required in hazardous environment sites, underground or high above ground, make sure that the site design and the auxiliary equipment are appropriate and that installation procedures are carried out in accordance with the relevant standards and regulations.
- Ensure walking areas about the installation are slip free when wet.

Shipment and transporting

- Shipping and transporting the filter must be done in a safe and stable manner and in accordance with the relevant standards and regulations.
- For shipping, lifting and positioning the filter, use only approved lifting equipment and authorized employees and contractors.

Electricity

- Electric wiring should be performed by an authorized electrician only, using standardised and approved components.
- Install a lockable main power cut-off switch close to the control panel.
- If due to site constraints, the control panel is installed without a clear line-of sight of the filter, an additional lockable power disconnect cut-off switch should be installed near each filter unit.
- Installation of the filter should be performed so as to avoid direct water splashing on the electrical components or on the control panel.
- After all service operations restore settings to the electrical box and remove the key after locking box door.

Pneumatics

- Install a lockable main cut-off switch, featured with a pressure release mechanism, on the compressed air supply line close to the control panel.
- If the control panel is installed far away and there is no eye contact with the filter, a lockable compressed air cut-off switch, featured with a pressure release mechanism, should be installed near each filter unit.
- The user should make sure that the compressed air supplied to the filter never exceeds the maximum designated pressure for this filter. Install an air-pressure reduction valve on the compressed air supply line upstream of the filter's pneumatic inlet port and an overpressure strain relief valve for protection against overpressure.

Hydraulics

- Extra safety devices should be installed on hot water applications to avoid skin burn danger.
- The user should install a manual Water Cut-off Valve next to the filter's inlet port.
- In cases where the downstream piping network downstream of the filter is pressurized an additional manual Water Cut-off Valve should be installed next to the filter outlet port.
- The user should make sure that the system includes a Pressure Release / Drainage Valve to enable release of residual pressure prior to any maintenance procedure performed on the filter.
- The user should make sure that the filter is never exposed to water pressure exceeding the maximum designated pressure for this filter, if needed a Pressure Reduction Valve should be installed upstream of the filter's water inlet port.
- Please note that the maximum working pressure indicated at the filter's specifications table includes the pressure caused by fluid hammer and pressure surge effects.

Civil Engineering

- Make sure that the filter installation is done by Amiad qualified technicians.
- Make sure that any civil engineering work at the installation site such as construction, lifting, welding, etc. is done by qualified workers / technicians / contractors and in accordance with the relevant local standards.
- While using lifting equipment, make sure that the filter or the lifted part is chained securely and in a safe manner.
- Do not leave lifted equipment if there is no necessity. Avoid working below lifted equipment.
- Wear a safety helmet while using lifting equipment.
- Make sure that the flooring is sloped to for drainage and to avoid accumulation of liquids.

Commissioning

- Read carefully the Commissioning and the First Start-up Operation instructions prior to any attempt to operate the filter.
- In order to achieve maximum performance and smooth operation of the filter it is crucial to perform the Startup and First Operation procedures exactly as described in this manual.
- Commissioning the filter should be done by an authorized Amiad technician, do not attempt to commission the filter unaccompanied since this may lead to undesired damage and may affect your warranty coverage.

Operation and Control

- Do not operate the filter before reading carefully and being familiar with its operation instructions.
- Observe the safety stickers on the filter and never perform any operation contradicting the instructions given.
- Never operate or use the filter for purposes other than its original design and operational envelope.

DESCRIPTION OF FILTER OPERATION

Filtering process:

The SAF-3000 is a sophisticated yet easy-to-operate automatic filter, with a self-cleaning mechanism driven by an electric motor. The SAF-3000 is designed to work with various types of screens in filtration degrees from 10 to 500 micron, and is available in 3", 4" and 6" inlet/outlet diameter.

The water enters through the inlet pipe into the coarse screen from outside in, and through the fine screen from inside out. The "filtration cake" accumulates on the fine screen surface and creates head loss to devalon.

The coarse screen is designed to protect the cleaning mechanism from large dirt particles. Usually, it does not accumulate large quantities of suspended solids and is not cleaned automatically.

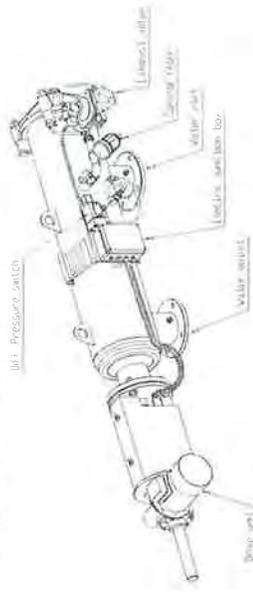
Self-cleaning process:

The SAF 3000 initiates the self-cleaning process when either the pressure differential across the screen reaches a pre-set value or the flush timer reaches its preset timed interval.

The fine screen filter element is cleaned by the suction scanner, which rotates in a spiral movement while removing the filtration cake from the screen, and expels it out through the exhaust valve.

A 2-way (fwd/rev) drive unit that is attached to the scanner by a threaded shaft; rotates the scanner and provides the linear movement.

The exhaust valve is activated for the duration of the cleaning cycle by a 3-way solenoid. During the 20 seconds self-cleaning process, filtered water continues to flow downstream.



System Operation modes:

The filtration system may be found in one of the following modes:

1. **Filtering mode:** This is the normal operating status. The flush mode is idle and the power light on the control board is lit
2. **Flush mode:** The motor and exhaust valve activate according to the previously described self-cleaning process
3. **Continuous flushing mode:** It is possible to activate the self-cleaning mechanism continuously by setting the SW1 switch in the control board to "CONT." position.
4. **Malfunction mode:** If the filter malfunctions, the self-cleaning operation stops, the malfunction light on the control board is turned on and a 24V AC external output is activated

The filtration system enters a malfunction mode under any of the following conditions:

- 1st. A continuous signal from the pressure differential switch longer than the PD fault time-out (default value=15 minutes) indicates that the filter is unable to clean itself.
- 2nd. The motor Over Load protector was activated, either manually or due to actual over load.
- 3rd. Limit Switch malfunction- (usually, simultaneous activation of both limit switches)

Initiation of self-cleaning:

The filter initiates the self-cleaning process under any one of the following conditions:

1. **PD flush-** The Pressure Differential Switch (PDS) closes a free potential contact signal when the pressure differential across the screen reaches the pre-set value (usually 0.5 bar =7 msi). The control board registers the signal and activates the flushing cycle.
2. **Test flush-** Manually pressing the "TEST" push button on the control board door activates a single flushing cycle.
3. **Timed flush - SW1** must be in the DP/Time position. The T1 timer in the control panel activates the flushing cycles at time intervals, regardless of the pressure differential. The timer resets after every flushing cycle. The PD flush mode is active in this mode as well.
4. **Continuous flush - SW1** must be in cont position. In this mode the filter flush continuously. This mode is for use in extraordinary circumstances and for a limited time. Please consult with the manufacturer regarding the uses of this mode.

Control system:

Two types of control boards are available: PLC Type and Relay Type. See Appendix A or B for details.

MAINTENANCE

General inspection

Initiate a flush cycle by closing the 3/4" valve at the low pressure sensing port of the pressure differential switch for 5 seconds. Check that the exhaust valve opens, that the scanner moves properly, and when it reaches the limit switch - verify that the exhaust valve closes.

Weekly maintenance:

1. Perform a general inspection as described above.
2. Clean the 3/4" filter connected to the exhaust solenoid. (Close the 3/4" valve and activate a flush cycle in order to release pressure and then unscrew the filter bowl).
3. Check that there is grease on the drive shaft, and drive bushing. Add grease, if necessary.
4. Check for any leakage from the scanner shaft. If necessary, replace the sealing nut internal O-ring (7.7)

Changing the sealing nut internal O-ring:

1. Close the inlet valve to the filter and release the pressure.
2. Remove the cover (23) from the drive shaft housing (7) by unscrewing the wing nuts (23.6).
3. If the Suction Scanner is in the outer position, operate a flush cycle and bring it to the inner position.
4. Remove the split pin (10.2) and pull out the connecting pin (10.1).
5. Operate a flush cycle.
6. Power down the unit when the drive shaft is half way through its cycle. The drive shaft is now separated from the suction scanner.
7. Unscrew the sealing nut (7.5).
8. Remove the used internal O-ring and clean the O-ring seat.
9. Insert a new O-ring (7.7)
10. Apply some grease on the external O-ring and on the shaft.
11. Tighten the sealing nut (7.5)
12. Re-connect the drive shaft to the suction scanner shaft.
13. Operate the control board and open the filter inlet valve.

Maintenance prior to long term shutdown (end of season):

The following must be done if the filter will not be in operation for longer than a month.

1. Perform a flush cycle (if possible, with a closed downstream valve).
2. Release pressure from the filter.
3. Power down the unit when the drive shaft is half way and none of the limit switches is pressed.
4. Disconnect the power supply to the control board.
5. Grease the drive shaft and the drive bushing.
6. Clean the 3/4" control filter.
7. Clean the coarse screen.

Maintenance prior to renewing filter operation:

1. Connect the control board to the power supply.
2. Check proper operation of the filter, especially noting proper rotation.
3. Grease the drive shaft and the drive bushing.
4. If necessary, change the sealing nut internal O-ring.

IMPORTANT!!!

THE DRIVE SHAFT MUST BE LUBRICATED WITH HEAVY-DUTY, WATER RESISTANT GREASE THAT WILL NOT OXIDIZE. (SHELL, DARINA EP-2 OR SIMILAR).

Cleaning the coarse screen:

1. Close the filter inlet valve.
2. Release pressure from the filter by performing a flush cycle.
3. Remove the filter lid (1), pull out the flushing chamber (2) with its seal (2.1).
4. Pull out the coarse screen (3) and clean it.
5. Insert the coarse screen (3) in its position, so that it rests on its supports.
6. Insert the flushing chamber (2). Make sure the seal is on top of the chamber centering ring with its opening facing the inside of the filter housing. The insertion should be done at a slight angle and in a circular motion.
7. Close and tighten the filter lid.

PLC CONTROL PANEL (TYPE "D" – SAF SERIES)

Description of control panel components:

1. Pilot lights:
 - Yellow - lights ON when power is on.
 - Red - lights ON when the control panels enters malfunction mode.
2. Push buttons:
 - TEST - Manual operation of a flushing cycle.
 - RESET - clears the malfunction mode.
3. Flushing counter:
 - Counts the flushing cycles that occurred. Used for follow-up on the system operation.
4. Timer T1 (0-30 hours):
 - Allows timed flushing cycles. The timer is reset with each flushing cycle.
 - To cancel timed flushing, set selector SW1 to "PRESS. ONLY".
 - Changing the switch to "CONT." will cause the filter to flush continuously regardless of pressure differential or time.
5. Motor protector:
 - This switch protects the motor in case of short-circuit or overload. It is important to set amperage according to the label of the motor. When this switch is tripped, the fault light will blink.
6. Contactors CU and CD:
 - Controls direction of motor rotation.
7. Transformer:
 - Electric supply to the various control components.
8. 2 x 6 Amp. and 1 x 4 Amp. Circuit breakers:
 - Short-circuit protection for the control system.
9. PLC:
 - A Programmable Logic Controller responsible for the control panel operation according to a preset program.

Stages of cleaning cycle:

1. The exhaust valve opens to atmosphere.
 2. Five seconds delay.
 3. The motor starts rotating the suction scanner shaft until it reaches limit switch "B" (T.L.S.).
 4. The exhaust valve closes.
- The suction scanner remains at limit switch B until the next flushing cycle. In the next flushing cycle, it will move from L.S B to L.S "A" (B.L.S.).
- In some versions of control panels, the suction scanner automatically returns to position "A" at the end of the flushing cycle. In this case the flushing cycle always begins from L.S. "A" (B.L.S.).
- NOTE:** The limit switches are wired as Normally Closed contacts (NC). Therefore, when the "Limit Switch Plate" reaches the limit switch, the contact opens and the PLC receives "NO SIGNAL".
- ### Requests for flushing cycle:
- a. PDS (Pressure Differential Switch)
 - b. Timer 0-30 Hr.
 - c. TEST button activation
 - d. Continuous flushing

PDS operation:

The PDS constantly monitors the pressure differential between the inlet and outlet of the "SAF" filter. When the PDS senses a preset value (usually 0.5 bar=7 PSI) there is a delay of three (3) seconds before the flush cycle begins. At the end of the cleaning cycle, if the pressure differential signal remains, the filter will continue to clean itself for 15 minutes before entering into malfunction mode.

Timer operation:

Flush according to time is available through a built in timer. It is possible to preset the intervals between flush cycles, regardless of the pressure differential.

The recommended default is between 6-8 hours.

In order to cancel the timer operation, simply turn the timer selector SW1 to its middle position.

"TEST" operation:

The "TEST" button activates a manual self-cleaning cycle, in order to test the filter operation.

Continuous flushing:

The filter flushes continuously regardless of pressure differential or time. It is recommended that this mode be used for a limited duration only - in order to overcome extreme dirt load situations.

Malfunction modes:

The system recognizes two malfunction modes:

- 1) Mechanical fault
- 2) Clogging fault (DP Fault).

Mechanical fault:

Occurs under any of the following conditions:

- a. The over load motor protector is tripped.
Find and correct the fault reason, clear the fault mode by pressing the O.L. motor protector to the ON position.

- b. Limit switch failure.

The motor has been activated and there is no signal from a limit switch for more than 35 seconds. The problem might be with one of the limit switches or the drive mechanism. Find and correct the fault, clear the fault mode by pressing the RESET push-button.

- c. Both limit switches signal "OPEN" simultaneously.

This may be a result of a limit switch failure, wrong wiring or wiring break off.

- Find and correct the fault, clear the fault mode by pressing the RESET push-button.

- d. The motor is rotates in the wrong direction.

The PLC recognizes this mode in case that CD (contactor down) is ON and a signal is received from limit switch "B" (top limit switch).

The following procedure will rectify this situation:

Manually activate whichever Contactor forces the driveshaft disk to rotate towards the halfway point between the two limit switches. (Pressing the plastic bridge on the contactor with a small screwdriver can do this).

Turn off power to the control panel and reverse any two phases to change direction of rotation. (in a DC controller, reverse the two wires to the motor).

Power up the controller and press the RESET button.

Note: Pressing the RESET button or turning power off and then back on without performing the above-mentioned instructions will NOT release the system from a fault condition!

In a mechanical fault mode, the fault light blinks.

Requests for flushing cycle:

- PDS (Pressure Differential Switch)
- Timer 0-30 Hr.
- TEST button activation
- Continuous flushing

PDS operation:

The PDS constantly monitors the pressure differential between the inlet and outlet of the "SAF" filter.

When the PDS senses a preset value (usually 0.5 bar=7 PSI) there is a delay of three seconds (T0) before the flush cycle begins. At the end of the cleaning cycle, if the pressure differential signal remains, the filter will continue to clean itself for the time duration preset on T2 (recommended 18 minutes) before entering into DP Fault mode.

Timer operation:

Flush according to time is available through a built in timer. The recommended default is between 6-8 hours. In order to cancel the timer operation, simply turn the timer switch SW1 to its middle position.

"TEST" operation:

The "TEST" button activates a manual self-cleaning cycle, in order to test the filter operation.

Continuous flushing:

The filter flushes continuously regardless of pressure differential or time. It is recommended that this mode be used for a limited duration only - in order to overcome extreme dirt load situations.

Malfunction modes:

The filter will enter into a malfunction mode under the following conditions:

- The motor protector Over Load trips due to amperage over load or a short circuit in the motor.
 - The PDS transmits a continuous signal for longer than the value preset on timer T2.
 - Both limit switches signal "OPEN" simultaneously. This may be a result of limit switch failure, improper wiring or a loose wire.
- When the filter enters a malfunction mode, the red fault light is lit on the control panel door, flushing stops and fault outputs are activated.

Fault output No. 1 in positions F/1 & 2 at the terminal strip is a free potential contact, suitable for connecting to an external control system.

Fault output No. 2 in positions F/3 & 4, supplies 24 V AC in order to activate a solenoid for an automatic by-pass, main inlet valve or relay of a pump.

In order to cancel malfunction mode, press the "RESET" push button.

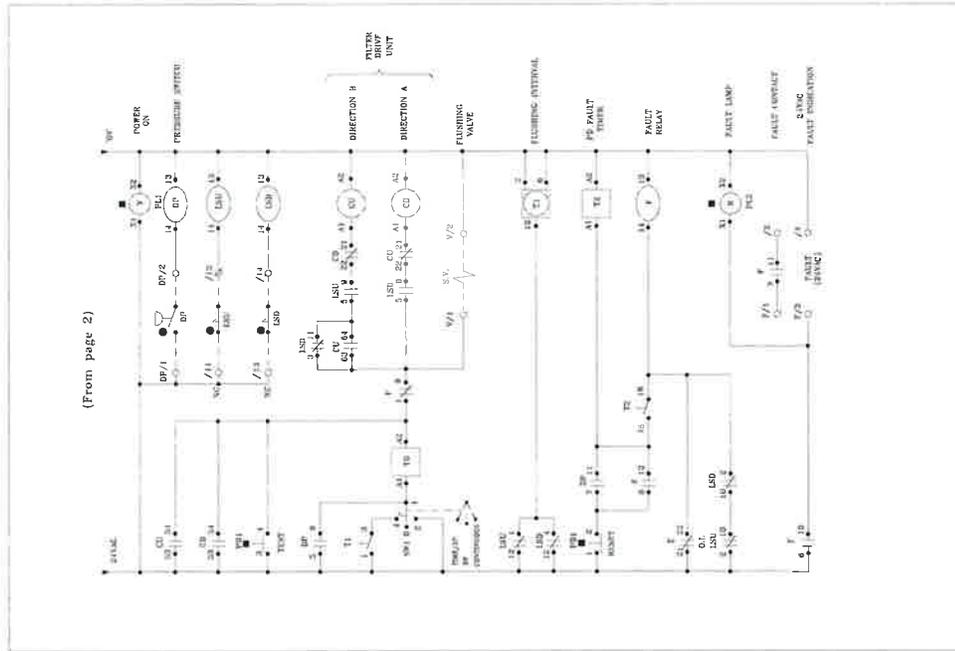
PLEASE NOTE:

If the suction scanner limit switch plate does not touch either of the two limit switches, the motor will start only when a flush cycle request is received.

Startup Procedure:

- Check that wiring between the filter and the control panel is done according to the provided wiring diagram.
- Verify that the "Limit Switch Plate" is located halfway between the two limit switches and that the motor protector (Over Load) is switched off.
- Switch "ON" all circuit breakers (except the motor O.L.).
- Set selector SW1 to the middle position (PD only).
- Switch "ON" the motor O.L., press the TEST push-button and check the rotation direction of the motor. If the motor rotates counterclockwise i.e. the suction scanner moves upward (outward from the filter), stop it immediately by switching "OFF" the O.L. Change motor direction by switching any two phases. If the motor rotates clockwise i.e. the suction scanner moves downward (inward towards the filter), let it continue until it reaches the inner limit switch and stops.
- Press the "TEST" push button and verify that the filter is functioning according to the above description.
- Open the water supply and pressurize the system. It is highly recommended that first "wet" operation is done with static pressure and no flow i.e. the outlet valve is closed and the by-pass of the system is open.
- Operate a flushing cycle by pressing the test push-button. Verify that everything is working properly as described above.
- Operate a flushing cycle by closing the 1/4" Manometer Valve of the PD switch for 5 seconds and then reopening.
- If everything is functioning as described, open the outlet valve of the filter, and gradually close the by-pass valve.
- Set T1 to 4 - 8 hours and turn selector SW1 to the upper position (PD & Time). Follow and monitor the functioning of the filtration system, change T1 setting if required.

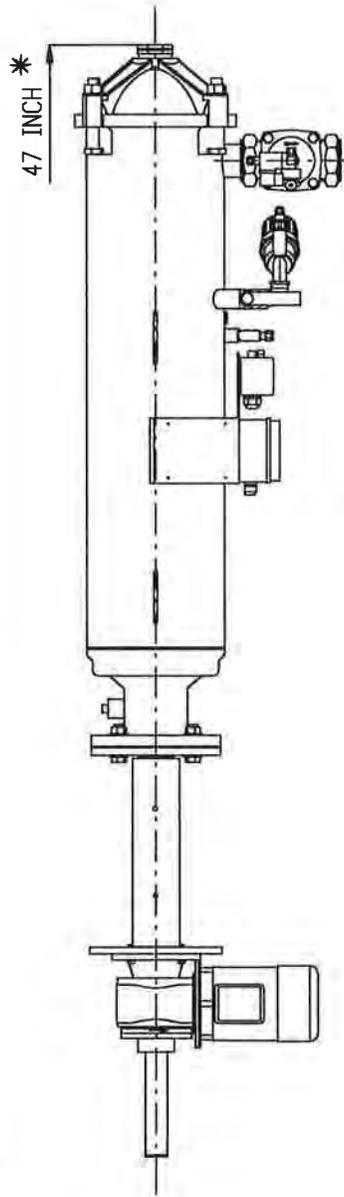
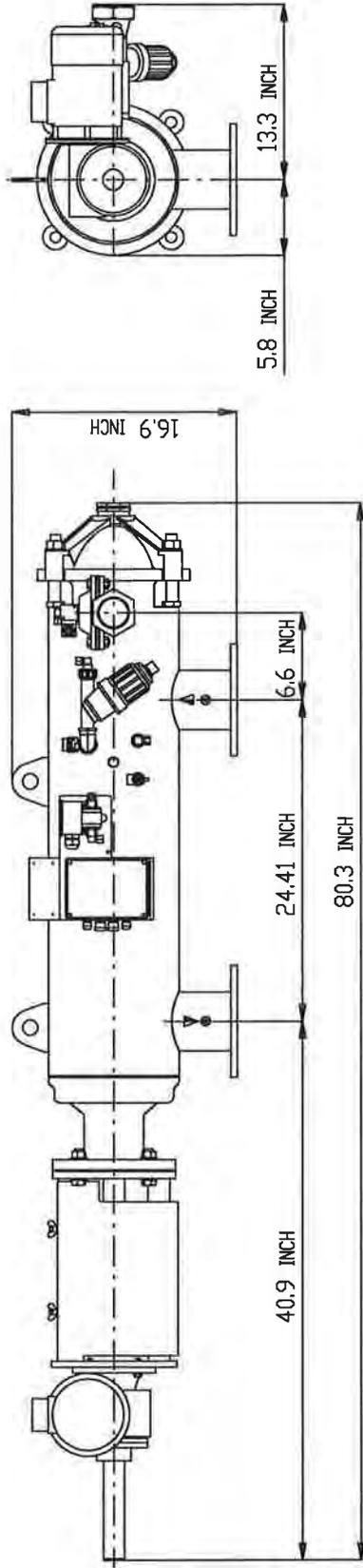
Electrical Diagram (page 2 – Control)



Electrical Diagram

ITEM	QTY	DESCRIPTION	TYPE	MANUFACTURE
25	-	MOUNTING RAILS-DIN 35	RDS-1100	KAKU
24	-	CONDUIT-COVERS	T1-E25-40/60	IBOCO
23	-	WIRES	H05(7)V-K	GENIUS/BICC
22	-	GROUNDING TERMINALS	CLIP FIX 35	PHOENIX
21	1	TERMINALS	UK5N 4m ² m	PHOENIX
20	1	TRANSFORMER	100VA-460V/24VAC	HULDA
19	4	BASE For RELAY	RT704	ASION
18	4	RELAY	57.04-24VAC	ASION
17	1	SELECTOR SWITCH 1-0-2	SF119F	hager
16	1	TIMER +BASE	AT11DN	Autonics
15	1	TIMER ON LINE	MAR1	GROUZENT
14	1	TIMER ON LINE	MASS	GROUZENT
13	1	PUSH BUTTON	CPI-10B-01	ABB
12	1	PUSH BUTTON	CPI-10G-10	ABB
11	1	PILOT LIGHT	PL16-22D-RED	SALZER
10	1	PILOT LIGHT	PL16-22D-YELLOW	SALZER
9	1	CIRCUIT BREAKER	SZ01M C4	ABB
8	1	CIRCUIT BREAKER	SH201 2XC6	ABB
7	2	CNTACT BLOCK	100-FA11/FA20	ALLEN BRADLEY
6	2	CONTACTOR	100-C09J01 4KW	ALLEN BRADLEY
5	1	CNTACT BLOCK	140M-C-AFA11	ALLEN BRADLEY
4	1	CIRCUIT BREAKER	140M-C2E-B10	ALLEN BRADLEY
3	1	HANDLE+SAFETY	194L-HC41-175	ALLEN BRADLEY
2	1	MAIN SWITCH 3X12A,460V	194E-E12-1753	ALLEN BRADLEY
1	1	ENCLOSURE	AE1045 500x400x210	RITTAL

BILL OF MATERIAL



4" SAF-3000 FILTER

CAT.ND. 03-6031-11xx-4x00

DRAWING NO. 30B080

DIMENSIONS IN INCH

DRAWN BY: JANNA

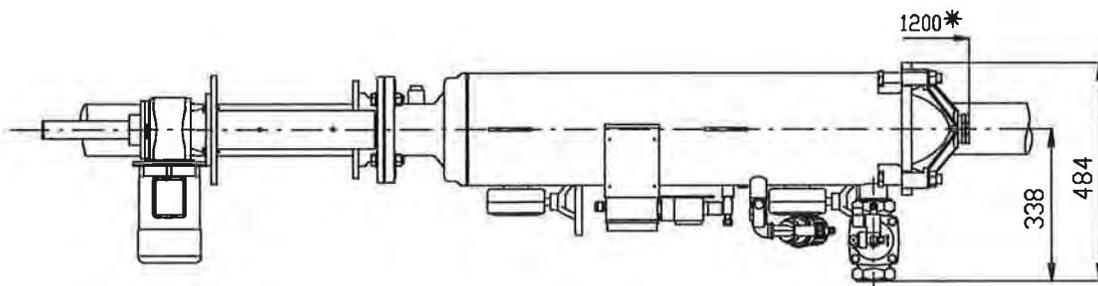
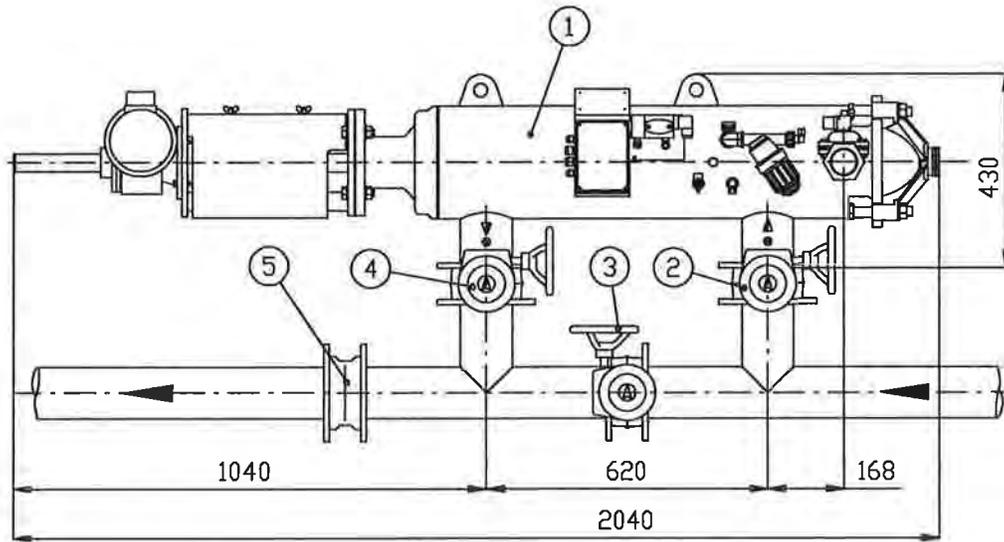
APPRV:



DATE: 13/11/02

SIGNED:

PROPERTY OF AMIAD FILTRATION SYSTEMS, ALL RIGHTS RESERVED.



* APPROX. LENGTH REQUIRED FOR MAINTNANCE

- KEY:
1. 4" SAF-3000 FILTER
 2. 4" INLET BUTTERFLY VALVE
 3. 4" BY-PASS BUTTERFLY VALVE (option)
 4. 4" DOWNSTREAM BUTTERFLY VALVE (recommended)
 5. 4" NON RETURN CHECK VALVE (option)



PROJECT:

4" SAF-3000 FILTER

DRAWN: JANNA	20/04/03	DRAWING NO.	W04300
CHECK:		SIZE: A4	SCALE: 1/15
QUOTATION NO.:		DIMENSIONS IN: MM	

amiad 
filtration systems

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Tel: 972-4-6909500 ,Fax: 972-4-6909391

DO NOT SCALE DRAWING.

**SAMPLE CSI FORMAT SPECIFICATIONS
for the
AMIAD SAF-3000 SCANNER FILTER**

SECTION 11XXXX

AUTOMATIC SELF-CLEANING FILTERS

PART 1 GENERAL

1.01 SUMMARY

- A. Contractor shall provide all labor, materials, equipment and incidentals required to furnish and install the self-cleaning filters, motors, exhaust valves, system controls and accessories.

1.02 RELATED SECTIONS

- A. Section 013300 - Submittal Procedures
- B. Section 016000 - Product Requirements.
- C. Section 017823 - Operation and Maintenance Data
- D. Section 099000 - Painting and Coating
- E. Section XXXXXX - Instrumentation and Control—General Requirements
- F. Section XXXXXX - Valves
- G. Section 16XXXX - Electric Motors
- H. ???

1.03 REFERENCES

- A. American Society of Mechanical Engineers (ASME): B16.5, Pipe Fittings and Flange Fittings
- B. National Electrical Manufacturer’s Association (NEMA): 250 Enclosures for Electrical Equipment (1,000 Volts Maximum

1.04 SYSTEM DESCRIPTION

- A. The self-cleaning filter system shall remove all particles larger than _____ microns from the influent. The filter(s) shall fit in the space on the plans.

- B. Service Conditions shall be:

System flow rate (GPM)	
Quantity of filters in system	
System source water	
System operating pressure (PSI)	
System operating temperature (°F)	
Power Source, (V AC, Phase, Hertz)	

1.05 SUBMITTALS

A. Product Data

1. Manufacturer’s descriptive literature, illustrations, specifications, identification of materials of construction and engineering data.
2. Operation and Maintenance Data: As specified in Section 017823 - Operation and Maintenance Data.

B. Shop Drawings: Submit complete detailed shop drawings including physical layout of the filter, drive unit and control equipment, piping diagrams and field wiring diagrams, control diagrams and a complete description of the control system, manufacturer’s installation instructions, and equipment operating characteristics.

1.06 QUALITY ASSURANCE

A. Manufacturer’s Qualifications: Manufacturer shall have a minimum of five (5) years experience in the production of substantially similar equipment.

1.07 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle all products and materials as specified in Section 016000 – Product Requirements.

1.08 MAINTENANCE

A. General: Furnish the following spare parts plainly tagged, marked for identification and for reordering and properly boxed:

Quantity	Product Description

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Filters: Acceptable manufacturers are listed below.

1. Amiad Filtration Systems, Filter Model SAF-3000
- 2.

B. Differential Pressure Switches: Acceptable manufactures are listed below.

1. Midwest
2. United Electric

C. Limit Switches: Acceptable manufactures are listed below.

1. Pizzato
2. Allen Bradley
3. Honeywell

D. Solenoids: Acceptable manufactures are listed below.

1. ASCO
2. Gemsol

E. Electric Motors: Acceptable manufactures are listed below.

1. Baldor
2. STM

F. Gear Drive: Acceptable manufactures are listed below.

1. STM

- G. Transformers: Acceptable manufacturers are listed below.
 - 1. Hulda
- H. Reset Timers and Repeat Cycle Timers: Acceptable manufacturers are listed below.
 - 1. Omron
 - 2. Crouzet
- I. Control Panel Enclosures: Acceptable manufacturers are listed below.
 - 1. Himel
- J. Valves: Acceptable manufactures are listed below.
 - 1. Raphael
 - 2. Bermad
 - 3. Matco-Norca

2.2 EQUIPMENT

A. Filter

1. The filter unit shall be an automatic, self-cleaning type. The body of the filter shall be carbon steel (ST 37-2). The filter cover shall be SMC polyester. The inside and outside of the body shall be coated with red multi-layer polyester. The body shall contain two raised face flange connections drilled with dimensions conforming to 150-pound ANSI. The cover shall be removable to facilitate maintenance. The maximum operating pressure of the filter body shall be 150 PSI and the maximum operating temperature shall be 120°F. Minimum operating pressure during the cleaning cycle shall be 30 PSI (*40 PSI for 50 & 25 micron filtration 50 PSI for 10 micron*).
2. Inlet and outlet flange connections shall be _____ inches in diameter.
3. The filter system shall have a clean-screen pressure drop of no greater than _____ PSI at a flow rate of _____ GPM.
4. Cleaning shall be accomplished by an electric motor driven rotating cleaning element made of Type 316L stainless steel that simultaneously moves linearly as a result of a threaded-shaft/fixed-threaded-bearing mechanism. This linear movement shall be limited by two normally closed limit switches and monitored by the PLC in the control panel. The cleaning element, called a "suction scanner," shall have three radially oriented nozzles of circular cross section, each of which shall have a thread mounted polyacetal nozzle cap with a circular orifice for sacrificial wear. The sum of the cross sectional areas of the three nozzle orifices shall not exceed 0.51 square inches. The velocity created at the nozzle head shall be 30 feet per second. The motor drive for the rotating cleaning element shall turn the cleaning element at no more than 24-rpm, shall be suitable for operation with _____-volt, _____-phase, 60-hertz current and shall be minimum 1/4-horsepower. The cleaning cycle shall last for no more than 20 seconds.
5. The filter shall have a removable cylindrical four-layer filtration element made entirely of Type 316L stainless steel weave-wire screen with a _____ micron filtration degree. First, against the dirty liquid, shall be a 3000-micron square-weave woven-wire layer. Next shall be the fine weave-wire layer providing the solids removal. A second 3000-micron square-weave woven-wire layer shall make up the third layer. The fourth layer surrounding the entire cylinder is a welded wedge-wire grid providing structural strength. The total effective filtration area of the cylindrical filtration element shall be 465 square inches. Filtration elements with filtration degrees ranging from 500-microns to 10-microns shall be interchangeable in the same filter body.
6. The cleaning system for the filter shall include a 2-inch hydraulic diaphragm valve operated by the pressurized liquid on the upstream side of the cleaning element. The body of this valve shall be polyester coated cast iron.

B. Controls

1. The filter control panel shall be complete factory wired. It shall contain all required control and power elements to provide automatic self-cleaning system operations as described herein. The filter control panel shall include main power disconnect switch, starters, transformer, Programmable Logic Control (PLC), relays, timers, alarm logic modules, Time & DP - DP Only - Continuous three position toggle selector switch (where DP = differential pressure), indicating lights, mounting brackets and

accessories, wiring harnesses, terminal strips, wiring and an enclosure with keyed handle and hinged front door.

2. The automatic self-cleaning system shall provide continuous or intermittent operation of the cleaning cycle based on the position of the Time & DP - DP Only - Continuous selector switch. The cleaning cycle shall open the hydraulic diaphragm exhaust valve and start the motor to rotate the cleaning element for the required cleaning interval. After the cleaning interval is completed, the cleaning cycle shall stop the motor of the rotating cleaning element, close the exhaust valve and reset the cleaning cycle for the next operation.
3. With the selector switch in the CONTINUOUS mode, the cleaning cycle shall operate continuously to clean the filter. In the CONTINUOUS selector position the timers and differential pressure switch shall be overridden.
4. With the selector switch in the TIME&DP position, timers shall intermittently initiate the cleaning cycle at preset adjustable intervals ranging from 0 to 24 hours for the length of time necessary to complete one cleaning cycle.
5. A differential pressure switch shall be arranged on the filter or across the inlet and outlet piping of the filter to override the timer in the TIME&DP mode or acting alone in the DPONLY mode to initiate the cleaning cycle whenever a differential pressure across the filter exceeds a preset value. The differential pressure switch shall continue to operate the cleaning cycle until the differential pressure across the filter returns to normal or an adjustable timer inside the control panel elapses. If the cleaning cycle continues until this preset timer elapses, then the control panel shall shut down the cleaning operation completely causing the red alarm FAULT light to glow on the cover of the control panel and send a 24 volt AC alarm signal to terminals 12 and 13 inside the control panel.
6. A "TEST" button shall be located on the control panel door that will initiate a cleaning cycle upon demand.
7. A "RESET" button shall be located on the control panel door.
8. Indicating lights for the control panel shall include a control circuit "energized" indicating light (green lens) and a "malfunction" indicating light (red lens) both located on the control panel door.
9. The control panel enclosure shall be a NEMA 4 enclosure with interior backplate. The control panel shall be designed for wall mounting and shall only require conduit connections and lug wiring connections to the terminal strips in the field.
10. Components of each control panel shall be Underwriter's Laboratory listed. *(Standard control panel is not UL approved, but has UL listed components. Please specify if UL approval is required.)*
11. *(Optional interfaces. Please choose which items are necessary. Please consult with the manufacturer for clarification or additional needs.)* External Interfaces: Provide the following interfaces as a part of the control system for monitoring and control.
 - a. Flush in progress – relay contact closure output
 - b. System fault alarm – relay contact closure output
 - c. Remote flush - _____ V AC input
 - d. Remote pause - _____ V AC input

C. Motors

1. Motors shall meet the requirements of Section XXXXXX

D. Pressure Differential Switch

1. The nonadjustable differential pressure switch shall be preset at 7-psi and enclosed in a NEMA 4 enclosure and shall be suitable for up to 240V AC/DC.. The differential pressure switch shall have an easy to read "pointer & dial" gauge and shall be the fully automatic diaphragm type differential pressure switch.

E. Valves

1. Valves shall meet the requirements of Section XXXXXX

F. Piping

2.3 ACCESSORIES

- A. Equipment Anchor Bolts: CONTRACTOR shall provide anchor bolts as specified in Section XXXXXX.

- B. Equipment Identification Plates: CONTRACTOR shall provide _____ identification plate securely mounted on each separate equipment component and control panel(s) in a readily visible location as specified in Section XXXXXX.

2.4 FINISHES
A. Prepare, prime and finish coat in accordance with manufacturer's standard coating.

2.5 SOURCE QUALITY CONTROL
A. The filter shall conform to international quality code: ISO-9001.

PART 3 EXECUTION

3.1 INSTALLATION
A. Install the filter in accordance with the manufacture's recommendations and approved shop drawings.

3.2 FIELD QUALITY CONTROL
A. Manufacturer's Field Services: Provide _____ day(s) of service at the site by a qualified representative of the system manufacturer to inspect the installation of their respective unit, make any necessary adjustments, test the equipment, place the equipment in initial hands-free operation and instruct the operating personnel in its operation and maintenance in accordance with Section XXXXXX.

END OF SECTION