Coos Bay SCADA Master Plan

Coos Bay, Oregon

The Automation Group, Inc.

http://www.tag-inc.us

Contents

Acronyms and Abbreviations

API	Application Programming Interface
CDMA/FDD	Code Division Multiple Access with Frequency Division Duplex
COTS	Commercial off-the-shelf
DPW	Department of Public Works
ETL	Extract, Transform and Load
FES	Fixed-End Service
HMI	Human Machine Interface I/O input/output
IP	Internet Protocol
KVM	Keyboard, Video Mouse
LCD	liquid crystal display
LED	light emitting diode
MBPS	million bits per second
MPLS	Multi-Protocol Label Switching
MS-ADO	Microsoft ActiveX Directory Objects
NAT	Network Address Translation
PLC	programmable logic controller
RFP	request for proposal
RSS	received signal strength
SCADA	Supervisory Control and Data Acquisition
TAG	The Automation Group
VPN	Virtual Private Network
WLAN	Wireless Local Area Network
WWTP	wastewater treatment plant

SCADA Master Plan Executive Summary

Introduction:

The City of Coos Bay requires an integrated Supervisory Control and Data Acquisition (SCADA) system that provides for monitoring and control of the city's wastewater collection system. The SCADA system will provide managerial and operational access to data for all facilities to meet the needs of facility operations and maintenance staff, managers, and engineers.

The current system provides no method for remote monitoring of pump stations, and many are not employing the use of onsite PLC's. Additionally, there is very limited automation control of the WWTP's with no redundancy. The current system deficiencies combined with the fact that Coos Bay continues to grow in population, increases the need for a SCADA system that will improve operations and maintenance effectiveness and efficiency. The SCADA system is also needed for use in collecting operations and maintenance information and in responding to emergencies for all facilities.

Recommendations

The products and methodology selected for the City of Coos Bay are the result of considerations involving available local support from vendors/service providers, products that are regularly used in the Water/Wastewater markets, availability of replacement components, and overall system complexity requirements.

We recommend the implementation of a City-wide SCADA system which includes a hybrid mix of traditional wireless products and emerging cellular technology. Each pump station is to house an Allen-Bradley CompactLogix processor for local control and linked back to the main plant HMI computer either through a radio network or a cellular system. The SCADA plan takes into account the existing sites and provides design intent for future pump stations. The SCADA system will provide plant staff with valuable field information that is currently unavailable through automated means. This information can then be used to report the status of the system as a whole as well as event alarming and remote indication of pump status. The master HMI computer will be the portal by which the plant staff can view historical and real time data on the WWTP and the collection system. The HMI will operate using Allen-Bradley RS Studio a using customized application tailored to the City of Coos Bay's needs.

Existing Facility Control Systems

The City of Coos Bay currently has two treatment plants which are stand alone systems. Each of the treatment plants is entirely controlled with a single PLC and without an active reporting software server. Additionally neither of the treatment plants has been set up with a SCADA system that can provide the operator with a comprehensive view of the process. There is also no redundant PLC so if for any reason the primary PLC were to become inoperable the entire process would require manual operation.

Currently all pump stations are stand alone systems with no automated method for statistics gathering or coordination of flow rates. The only communications possible from pump stations are prerecorded messages from auto dialers for alarming which is an inflexible system when it comes to generating alarm history reports and notification of key personnel. Additionally, not all pump stations are equipped for communications as several do not have on site PLC's. Currently there is one cell phone that all auto dialers are set to call when there is a problem, and this system is heavily dependent on that cell phone being functional and there is no backup for this system in case any part of it fails.

Network Architecture

The proposed SCADA system is composed of the following three components including:

1. Collection System Network
2. WWTP networks
3. Operations Network

1. Collection System Network

This network will be made up of radio links between the pump stations and the main WWTP's. These radio links will be capable of providing usage statistics such as pump hours and wet well level. The radio links will also be capable of modifying wet well level set points as well as remotely forcing pump activity in order to prepare for an influx of storm water due to predicted weather conditions. For this network to be effective all pump stations must have on site PLC control with wireless security measures to ensure that the network cannot be tampered with as well as adequate physical security to ensure that this network and the onsite equipment are not compromised.

2. **WWTP Networks**
These networks will reside within the WWTPs and provide operators with access to information from the Collection System Network as well as WWTP operations. There will be two separate networks one at each WWTP which will only have access to the pump stations radio links which are connected to the respective WWTP. These networks will provide operators with access to control all necessary functions of the local facility. It is highly suggested that the operators computers be housed in a separate climate controlled and access controlled room to ensure proper long term operation. KVM extenders would then be used to allow operators to interact with the system.

3. **Operations Network**
This network will consist of a secured VPN link between both of the WWTP Networks and will allow only very limited remote modification of operator variables and pump station set points. This network will be primarily used to develop comprehensive statistics for maintenance planning and administrative oversight. This Secured VPN link will require both a software key and password in order to be sure that only qualified systems are allowed in this network as it could utilize the internet to provide the connection between the two WWTP Networks.

Implementation

In order to implement the recommendations, request for proposal (RFP) process is recommended.

Continuous and long-term support of the SCADA system is recommended to promote accurate, responsive and reliable SCADA system performance and to maintain a viable SCADA system as technology continues to rapidly evolve. This support should include periodic major upgrades, migration to newer hardware and software, as well as routine preventive maintenance and software update installation work.

Alternatives Evaluation and Recommendations

1.1 Introduction

Several alternatives were evaluated for the entire Supervisory Control and Data Acquisition (SCADA) system. Evaluations included controllers, communications, and control centers for the collection system, wastewater treatment plants (WWTPs), and for the overall SCADA system as follows.

- For the pump stations we recommend using the Compact Logix platform due to its cost effective design, software compatibility, and features.
- TAG Recommends the network protocol to be Ethernet. Ethernet is cost effective, compatible, scalable, and reliable.
- Operator interface is available on the SCADA system, using the HMI software that is designed for Rockwell’s software. Remote sites that require localized operator interface, can use physical pushbutton stations, or touch panel HMI devices. A cost effective solution for remote sites would be an Allen Bradley Panel View.

The pump station control panel will house at least one PLC which will provide primary control for all pump station operations. This will include signaling pumps to start and measuring wet well level. In addition to the primary control all pump stations must have secondary control which is independent of the PLC in the event of a failure or an incorrect set point. This secondary control will consist of an additional HI HI level float which will immediately cause the pump station to begin pumping down the wet well as quickly as possible this event should also trigger an alarm condition.

The WWTP control centers will house the SCADA system PC's, PLC concentrator for gathering remote site data, and associated hardware.

An Operations Data/Control Center will be utilized to house the Rockwell Software data collection and storage software. Access to historical data and system control will be password protected as indicated in the Ethernet Network Configuration section. Reporting will be in reference to the Historical Data Collection section.

1.2 Recommendations

1.2.1 Controllers

Controller recommendations include:

Recommended is the Allen Bradley CompactLogix platform, Catalog Number 1769-L32E and the 1769-L34E depending on requirements of the location, the master controller at each waste water treatment plant to be a Control Logix 1756-l61. This system has proven to be reliable, cost effective and expandable.

1.2.2 Collection System Communications Recommendations

The network links between the WWTP and the remote pump stations can be achieved with radio devices such as those offered by DataLink. The Type and frequency appropriate for the site requirements. Where these systems cannot function at an acceptable level, these sites can be linked using a system that uses cellular technology. This technology requires a service plan, therefore the radios would be used wherever possible first. This would allow the network to be expanded without the use of multiple repeater sites.

The protocol to be used over the radio networks as well as at the local pump stations and WWTP's shall be Ethernet as it is reliable, very flexible, supports routing over diverse networks, and can use combinations of a broad range of communications alternatives. Other advantages of the Ethernet include scalability, flexibility, and life-cycle cost effectiveness. Scalability will allow the network to grow as required to incorporate future anticipated pump stations and, if desired, integrate with the WWTP network. Flexibility will reduce the risk of wholesale network replacement, allow the communication network to adapt to technological improvements, and allow the City of Coos Bay to use several communication technologies in combination or to migrate the network from one communication technology to others.

1.2.3 WWTP Communications Recommendations

As shown on the block diagram in Appendix A, the recommended network topology for each primary

WWTP is an industrial grade switch using Ethernet protocol that provides continued operation after failure of a single link or switch.

1.2.4 Operations Data Collection Network Communications Recommendations

As shown on the block diagram in Appendix A, the recommended operations data collection network protocol is Ethernet, due to its reliability, and compatibility.

1.2.5 Local Operator Interface

Operator interface is available on the SCADA system, using the HMI software that is designed for Rockwell's software. Remote sites that require localized operator interface, can use physical pushbutton stations, or touch panel HMI devices. A cost effective solution would be an Allen Bradley component Panel View.

1.2.6 Collection System Control Center Recommendation

Housing the control center in an environmentally-controlled space with physical access restricted and monitored is recommended. The physical location is only limited by the requirement that the control center have reliable power and access to reliable digital data telephone service.

1.2.7 WWTP Control Center Recommendation

As shown in the block diagram in Appendix A, providing separate control centers and control rooms at each of the primary WWTPs is recommended. Locating the control center in an environmentally-controlled space with physical access restricted and monitored is also recommended. Control centers will house workstation and server computers. A separate environmentally-controlled control room housing workstation operator interfaces is also recommended. Each operator interface will include a keyboard, video display, mouse and speakers connected to the workstation computer in the control center using a single Category 6 cable and a pair of Keyboard, Video Mouse (KVM) extenders. Separation of the operator interface from the workstation computer is recommended to limit access to computer media drives and communications ports. The control center and control room for each of the WWTPs should be located in close proximity to each other on the WWTP site, and in a location with reliable power and access to reliable digital data wireline telephone service or high speed Internet.

Multiple workstations and redundant servers are recommended at each WWTP control center to improve reliability and ease upgrades and patches. Providing alarm messaging capabilities which include voice notification to roving operations and maintenance staff of alarms is also recommended to reduce the need for personnel to be physically located in each WWTP control center.

Combining treatment plant historical data collection with collection system historical data at a common Operations Data/Control Center is recommended to ease maintenance, access and use.

1.3 Evaluation

1.3.1 Controllers

Table 1-1 shows the comparison of the three controllers that were evaluated as part of this SCADA Master Plan.
The Allen Bradley CompactLogix was chosen for its reliability, expandability, and Cost effectiveness.

TABLE 1-1
Controller Comparison

Controller	Environmental	Monitoring & Control	Communications	Operator Interface	+/-
Allen-Bradley Compact-Logix with PanelViewPlus 400 Operator Interface	Suitable for industrial environment 140 degrees F	Full-featured Supports 4 of the IEC61131-3 languages Modular	Ethernet & Async. Serial 3rd party MODBUS modules avail. Native CIP protocol	Wide selection available Can significantly increase cost	High cost (-) Large Market Share (+) Redundancy only with ControlLogix PAC CPUs (-) Separate terminal blocks (+) Not hot swappable modules (-)
Allen-Bradley ControlLogix	Suitable for industrial environment 140 degrees F	Full-featured Supports 4 of the IEC61131-3 languages Modular	Ethernet & Async. Serial 3rd party MODBUS modules avail. Native CIP protocol	Graphical HMI RSView Can use 3rd party HMI's	High Cost (-) Large Market Share (+) Redundancy (+) Hot swappable modules (+) Separate terminal blocks (+) modules (-)
Allen-Bradley MicroLogix	Suitable for industrial environment 140 degrees F	Feature limited Ladder logic programming Modular	Ethernet & Async. Serial 3rd party MODBUS Native CIP protocol	Text HMI RSView Can use 3rd party HMI's	Low Cost (+) Large Market Share (+)

1.3.1.1 Collection System Controllers

The preferred processor platform for the collection system is the CompactLogix for its expandability, and cost effectiveness.

1.3.1.2 WWTP Controllers

The recommended processor platform for the WWTP is the ControlLogix for its greater storage capacity, and processing speed.

1.3.2 Collection System Communications Evaluation

All of the eight alternatives listed in Table 1-2 are capable of using the recommended collection system pump station interface and satisfying pump station requirements. However, the private point to multipoint radios will provide the best solution. Where these radios cannot function acceptably due to terrain, natural or manmade obstacles, the digital Cellular system can augment the communication system. The limited use of the Digital Cellular system will reduce the operation costs due to service plan requirements.

TABLE 1-2
Communication Alternatives Comparison

Alternative	Owner	Cost	Limiting Factors	Advantage / Disadvantage
Private Point-to-Multi-point Radio (Licensed or Unlicensed)	City or DPW	Capital - High Annual - Low	Permitting Licensing Line-of-Site	In control of own destiny (+) Low to medium data rate (-) Link reliability (-) Disaster recovery (-) Scalability issues (-)
Digital Cellular	Provider	Capital - Low Annual - Medium	Provider coordination Latency Moving target Evolving technology	Good scalability (+) Low to medium data rate (+) Disaster recovery probably better than private (+) No SLA (-)
WLAN 802.11n/s	City, DPW or Provider	**City/DPW owns**: Capital – High Annual – Low **Provider owns**: Capital – Low Annual – High	City/DPW owns: Permitting Network design Provider owns: Same as for Digital Cellular	Good scalability (+) Medium to high data rate(+) SLA if Provider owned (+) Disaster recovery depend on implementation (+/-)
WiMAX 802.16e	Provider	Capital – Low Annual – High	Same as for Digital Cellular	Probably Same as for Digital Cellular
Dark Fiber	City, DPW or Provider	**City/DPW owns**: Capital – V High Annual – Low **Provider owns**: Capital – Low Annual – High	City owns: Right-of-way Provider owns: Coordination	Good Scalability (+) High data rate (+) Good reliability (+)
Other Fiber	Shared with other public agencies or provider	Capital - Low Annual - Variable	Coordination with users or provider Throughput Privacy	High data rate (+) Good reliability (+) Depends on owner, SLA, maintenance level, and degree of over subscription (+/-)
Digital Wireline	Provider	Capital - Low Annual - High	Provider coordination Moving target Evolving technology	Good scalability (+) Medium to high data rate(+) Disaster recovery (+) No SLA for DSL (-)
Analog Wireline	Provider	Capital - Low Annual - Low	May not be available Dated technology	Low data rate (-) Reliability (-) Scalability (-)

Implementation Plan

2.1 Introduction

The implementation plan describes how the SCADA system will be designed, delivered, and supported. The plan is broken down into phases that include;

1. Development of SCADA System
2. Development of local PLC Systems
3. Development of remote PLC systems
4. Telemetry development
5. SCADA system installation
6. Incorporate local PLC systems
7. Incorporate remote PLC systems
8. Refine SCADA and HMI system

2.2 Recommendations

TAG recommends using an RFP process to provide selection of a single qualified collection system SCADA provider and a WWTP SCADA provider for 5 years. This will allow the City of Coos Bay to select the most qualified provider and include needed maintenance, support and future collection system or WWTP work in a single contract, thereby assuring critical component and overall design consistency across all pump stations or WWTPs for 5 years.

After 5 years, the contract of the selected Contractor can be renewed for another 5 years, or another RFP can be used to select a provider for ongoing support and upgrade of the existing collection system or WWTP SCADA system, and for any additions to the SCADA system.

Long-term SCADA support is critical to its success. Therefore, recommended design and delivery approaches are structured to facilitate long-term support. In addition to maintaining, and providing routine preventive maintenance and software update installation, support is intended to include upgrade and migration to maintain a viable SCADA as technology continues to rapidly evolve. Tables 2-1A and B shows some typical cost considerations for SCADA components.

TABLE 2-1A

SCADA Life-Cycle Cost Considerations

Component	**Annual Costs**	**Acquisition Cost**	**Annual Service Cost**
Computers (Workstations and Servers)	Replacement Every 3 Years	$2,500	
Network Appliances	Replacement Every 5 Years	$1,500	
DCS Controllers, PLCs and RTUs	Replacement Every 10 Years	$4,000	
Software	15-20% Per Year + Periodic New Releases	$5,000	$500-$700
Control System Support	5-15% Per Year		Varies
Cellular SCADA	12 x Monthly Bill + Services Outside SLA	$2,495	$540

TABLE 2-1B
SCADA Life-Cycle Cost Considerations

	Acquisition Cost	Monthly Service	Maintenance	20 yr. projected Total
Monitoring Only				
Aquavx SCADA	$2,495	$45/mo	$1,000 (two lifecycles)	$14,295
Monitoring + Control				
CompactLogix + Radio	$4,500	0	$9,000 (two lifecycles)	$13,500
Aquavx SCADA + PLC	$4,495	$50/mo	$7,000 (two lifecycles)	$23,495

Procurement of critical components is another important element of the plan. Critical components are defined as those that, if not consistent from site-to-site and from project-to-project, will significantly and negatively impact the Department of Public Works ability to maintain the SCADA long-term. Therefore, the delivery of critical components is separately addressed for each of the two major SCADA systems: collection system and WWTPs.

2.3 Design Criteria

SCADA Design Criteria addressing pump stations and plants are included in Appendixes C through F for use in preparation and review of RFPs, design instructions, and/or documents. Before each use, update Design Criteria as required to keep current, incorporate missing elements, and make corrections.

2.4 Standard Pump Station Design Documents

The purpose of the standard pump station design documents is to provide pump station design guidance for developers for a range of pump stations expected to be included in development projects. For development projects likely to have pump stations not addressed by the standard pump station design documents, include a current version of the Design Criteria document and specific design instructions for the nonstandard pump stations.

In general, the standard pump station design documents should be updated to bring them into compliance with the Design Criteria in the appendices. The existing standard pump station drawings should be updated to create standard control system drawings for each type of pump station likely to be included in developer projects. Also, the existing standard pump station specifications should be updated to create standard control system specifications for each type of pump station included in developer projects.

2.5 Procurement

As stated above, an RFP process is recommended for procurement (including design, installation, and maintenance) of the collection system SCADA and the WWTP SCADA components based upon the recommendations outlined in this master plan. RFPs will be written for each system, since the systems can be implemented separately.

2.5.1 Collection System Request for Proposals Content

Inclusion of the following design instructions in the collection system RFP is recommended:

1. A narrative describing the work and expected delivery schedule. In the narrative, include a SCADA overview including monitoring and control requirements, network communications and communications interfaces. Use references to included design criteria and standard design documents to clarify requirements and reduce duplication.

2. Scope of Work.

3. Project schedule

4. SCADA Block Diagram

5. Pump Station Design Criteria

6. Pump Station Standard input/output (I/O) list

7. Standard Loop Specifications

8. When applicable, standard pump station SCADA design documents for the standard pump station(s) with monitoring and control system(s) that most closely resembles the monitoring and control system(s) for the pump station(s) that will be designed along with narrative describing required deviations from the standard documents, if any.

2.5.2 Collection System RFP Scope of Work

Provide a comprehensive summary of the scope of work including:

1. List all tasks to be performed by the provider. Clearly define important deliverables and sequencing requirements. Also, include coordination requirements, a list of communications service provider and utility contacts and ample references to the design criteria.

2. Define programmable logic controller (PLC) and human machine interface application programming requirements, including instructions on how to use the Standard Loop Specifications.

3. Define coordination requirements for any other work expected to be in progress during construction

4. Define pump station outage restrictions and coordination requirements

5. Define support requirements

2.5.3 WWTP Request for Proposals Content

Inclusion of the following in design instructions in the WWTP RFP is recommended:

1. A narrative describing the work and expected delivery schedule. In the narrative, include a SCADA overview including monitoring and control requirements, network communications and communications interfaces. Use references to included design criteria and standard design documents to clarify requirements and reduce duplication.

2. Scope of Work

3. Project schedule

4. SCADA Block Diagram

5. WWTP Design Criteria

6. WWTP Standard input/output (I/O) list

7. Standard Loop Specifications

2.5.4 WWTP RFP Scope of Work

Provide a comprehensive summary of the scope of work including:

1. List all tasks to be performed by the provider. Clearly define important deliverables and sequencing requirements. Also, include coordination requirements, a list of communications service provider and utility contacts and ample references to the design criteria.

2. Define control system controller, workstation and server application programming requirements, including instructions on how to use the Standard Loop Specifications

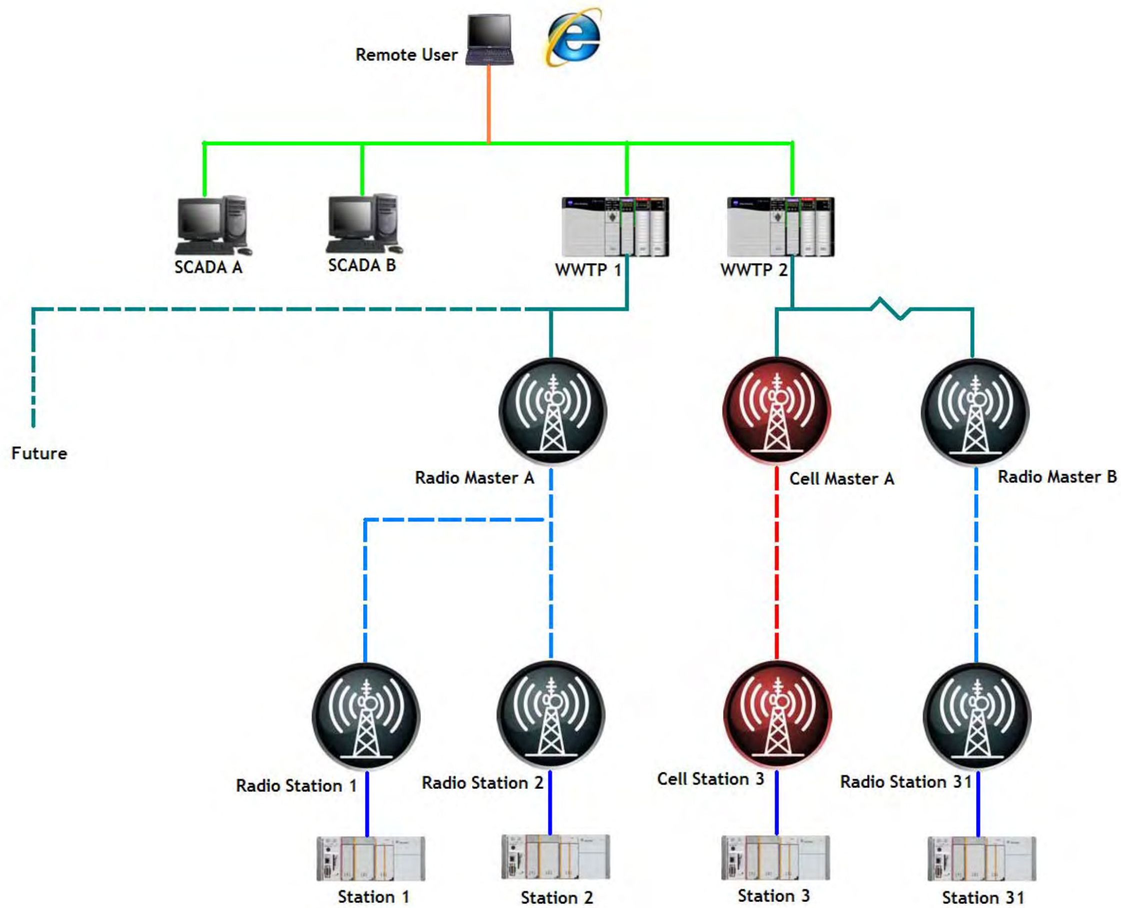
3. Define coordination requirements for any other work expected to be in progress during construction

4. Define equipment outage restrictions and coordination requirements

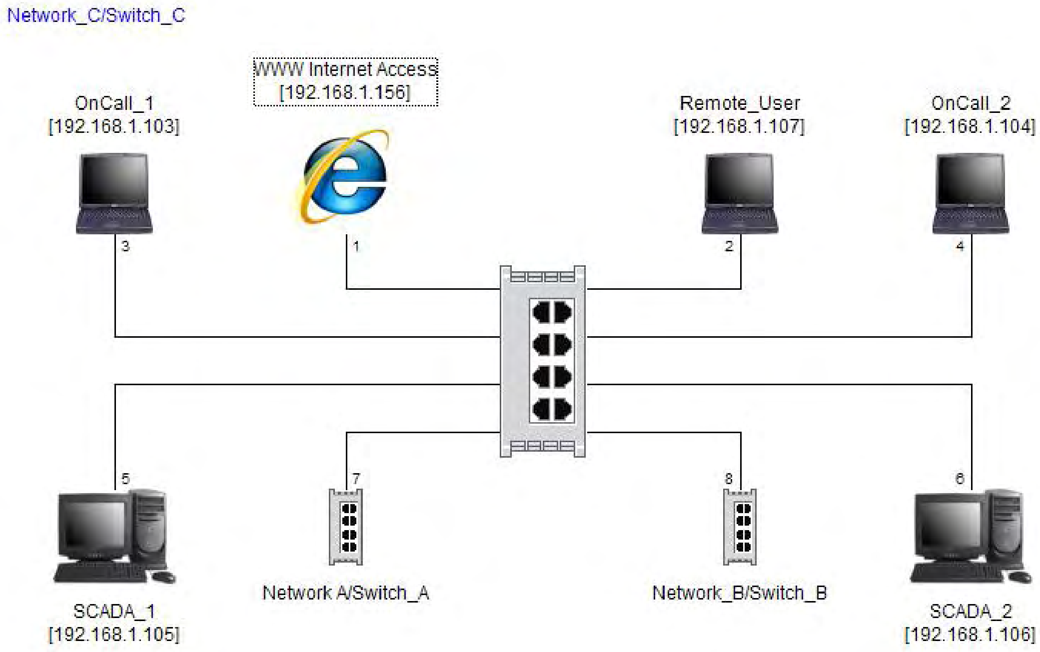
5. Define support requirements

Appendix A Block Diagrams

Ethernet Network Topology Concept;



Network 'Network_C'



Network_C

Switch_C

A#192.168.1.156, WWW Internet Access, GENERIC ETHERNET/IP

A#192.168.1.107, Remote_User, LAPTOP PC

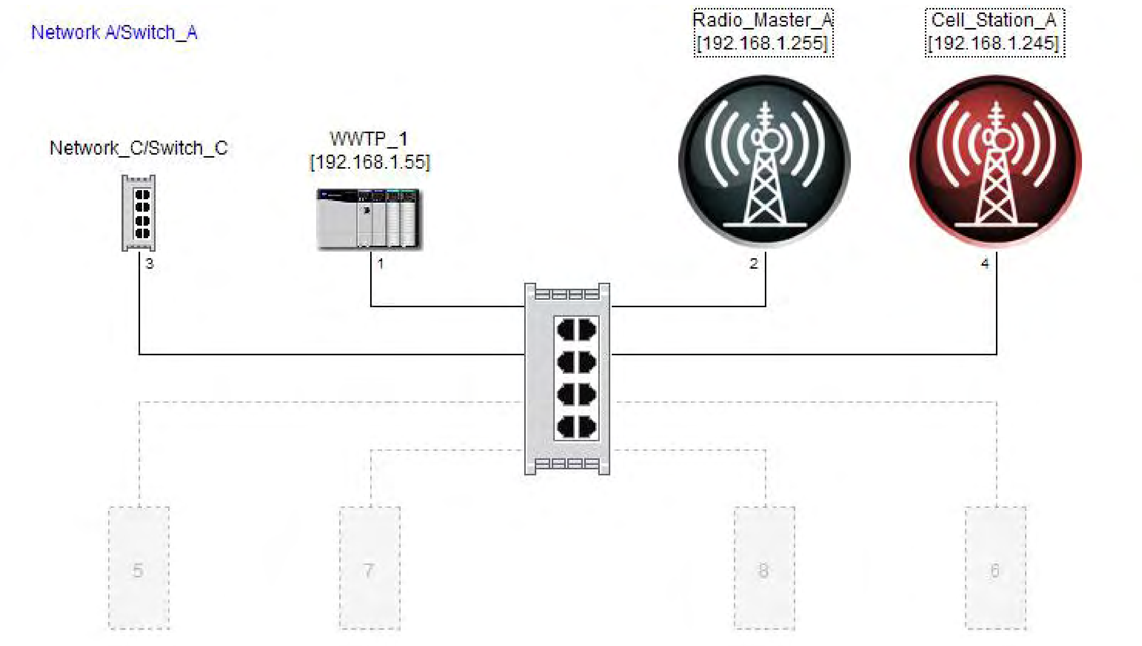
A#192.168.1.103, OnCall_1, LAPTOP PC

A#192.168.1.104, OnCall_2, LAPTOP PC

A#192.168.1.105, SCADA_1, DESKTOP PC

A#192.168.1.106, SCADA_2, DESKTOP PC

Network 'Network A'



Network A

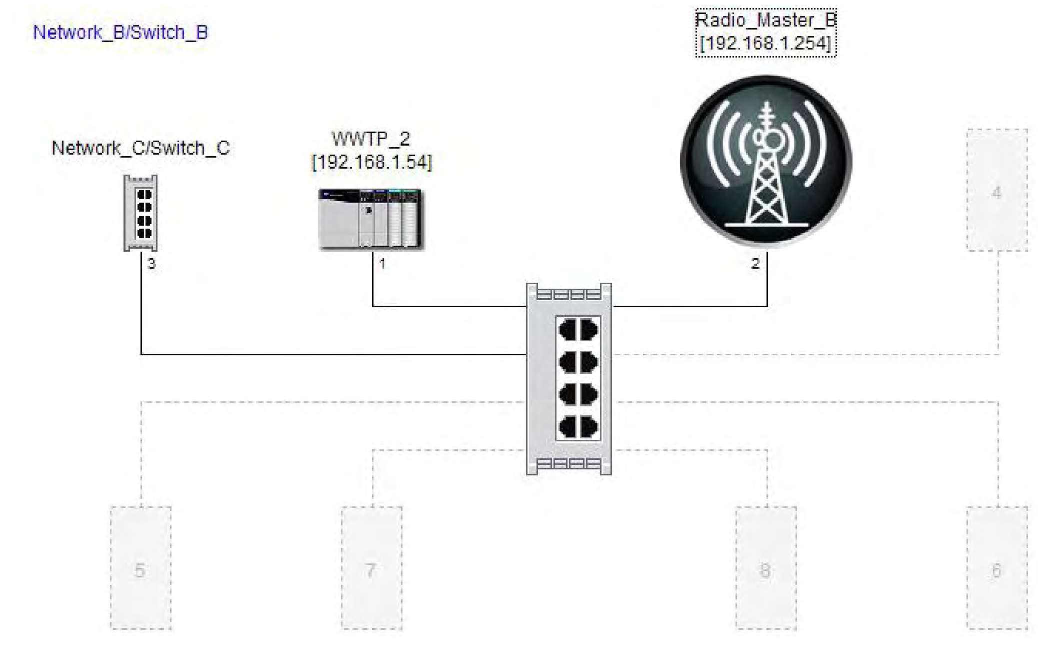
Switch_A

A#192.168.1.55, WWTP_1, [1], 1756-ENBT

A#192.168.1.255, Radio_Master_A, GENERIC ETHERNET/IP

A#192.168.1.245, Cell_Station_A, GENERIC ETHERNET/IP

Network 'Network_B'



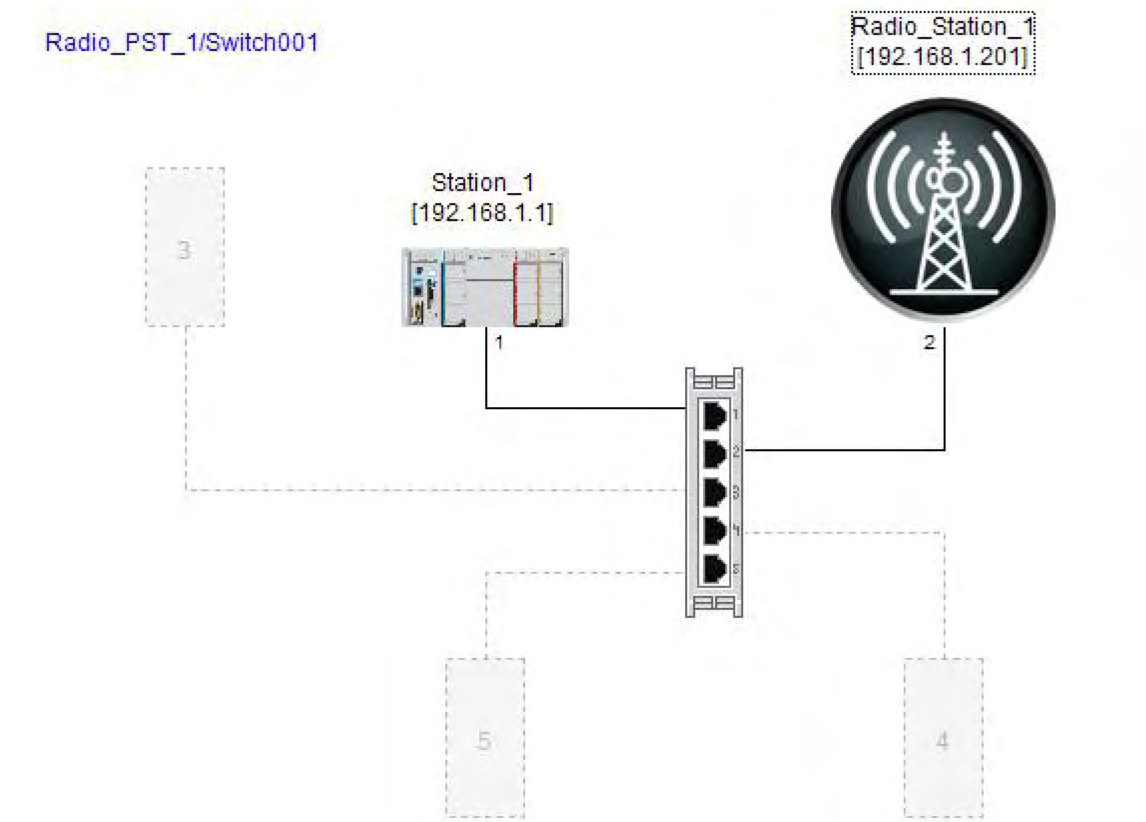
Network_B

Switch_B

A#192.168.1.54, WWTP_2, [1], 1756-ENBT

A#192.168.1.254, Radio_Master_B, GENERIC ETHERNET/IP

Network 'Radio_PST_1'



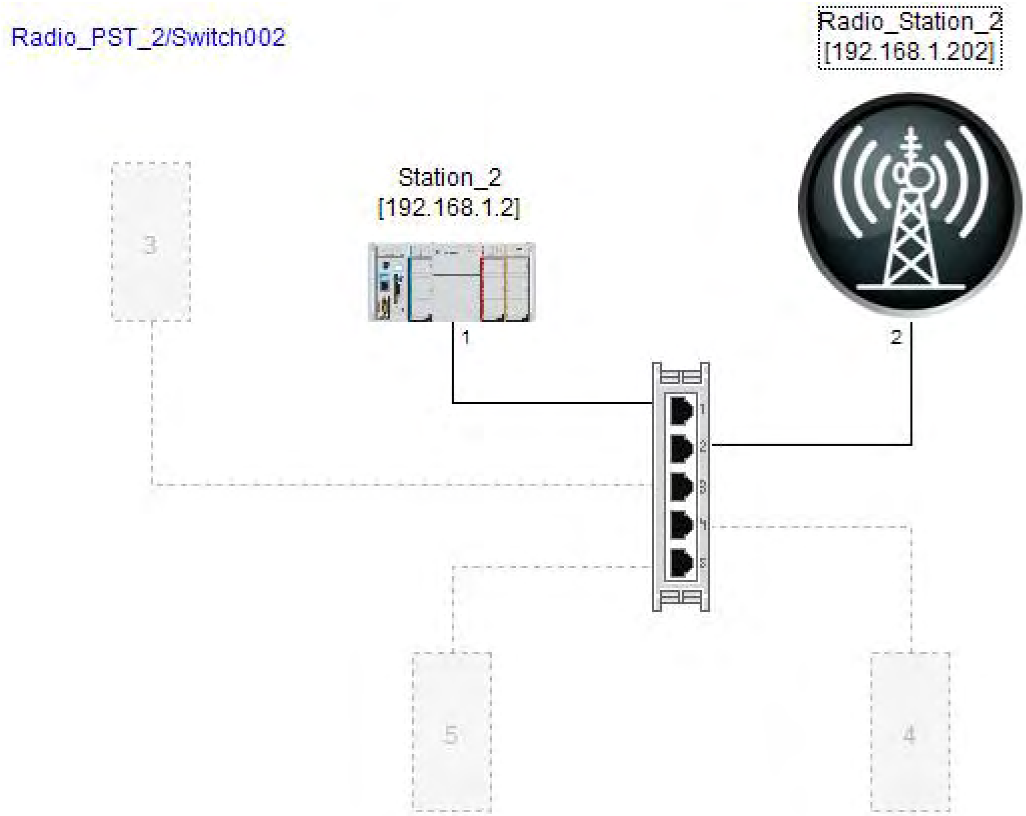
Radio_PST_1

Switch001

A#192.168.1.1, Station_1, [0], 1769-L32E

A#192.168.1.201, Radio_Station_1, GENERIC ETHERNET/IP

Network 'Radio_PST_2'



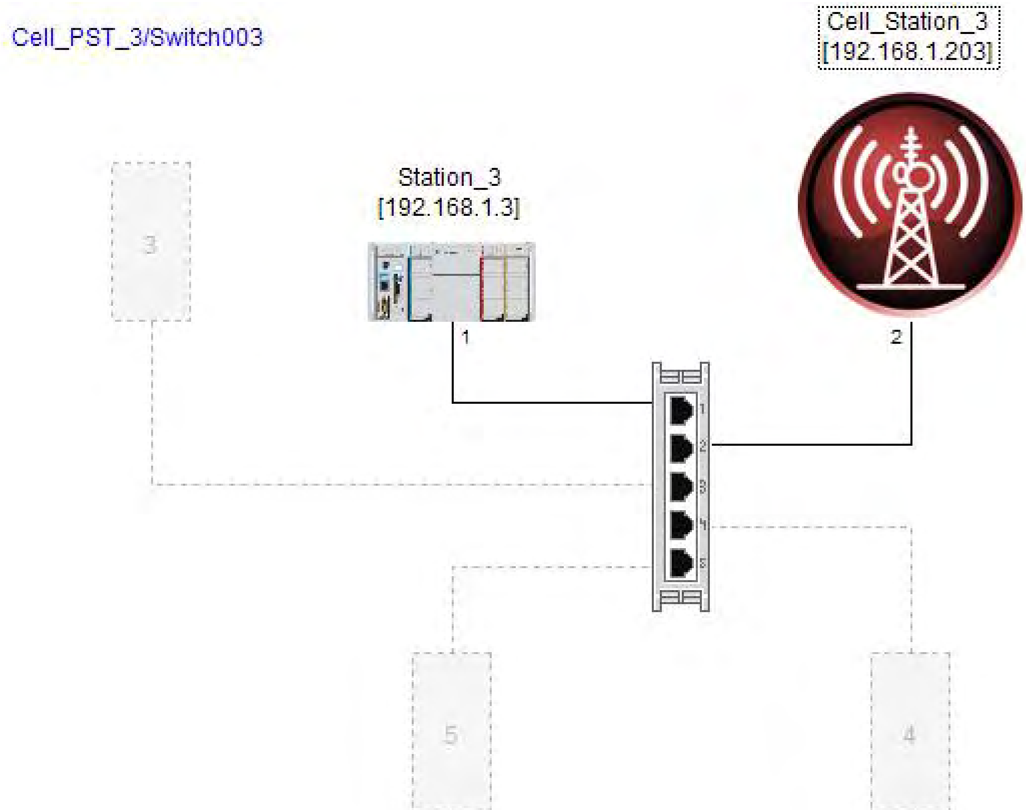
Radio_PST_2

Switch002

A#192.168.1.2, Station_2, [0], 1769-L32E

A#192.168.1.202, Radio_Station_2, GENERIC ETHERNET/IP

Network 'Cell_PST_3'



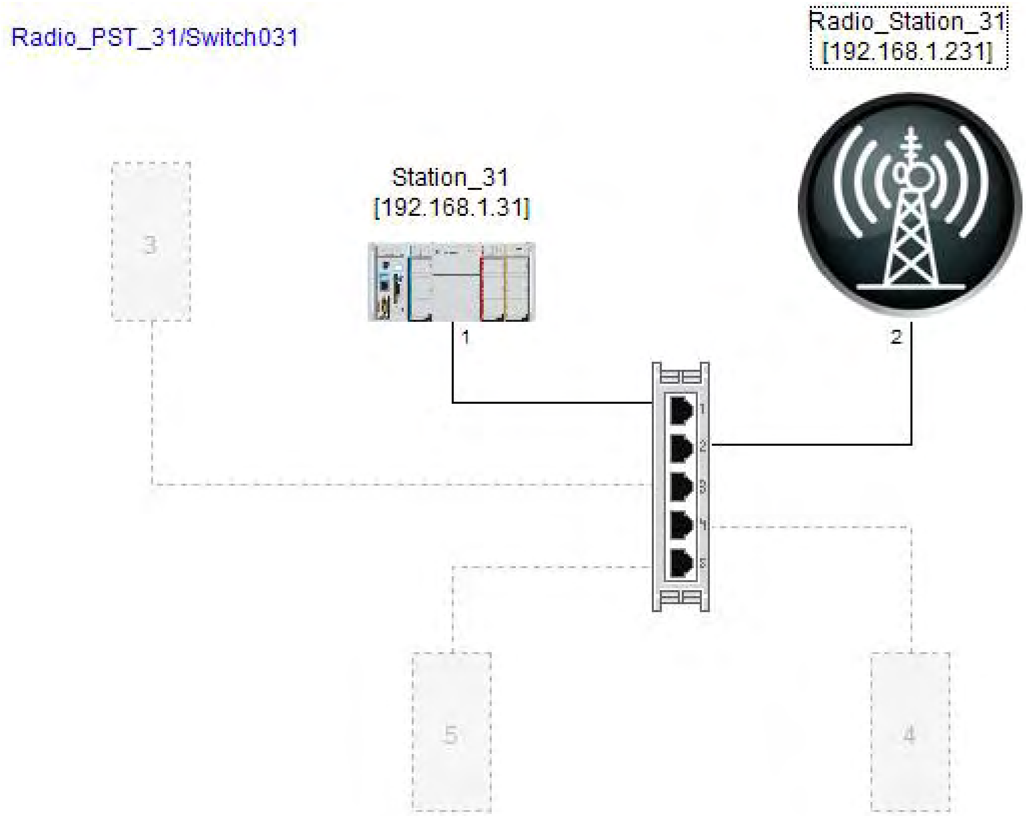
Cell_PST_3

Switch003

A#192.168.1.3, Station_3, [0], 1769-L32E

A#192.168.1.203, Cell_Station_3, GENERIC ETHERNET/IP

Network 'Radio_PST_31'



Radio_PST_31

Switch031

A#192.168.1.31, Station_31, [0], 1769-L32E

A#192.168.1.231, Radio_Station_31, GENERIC ETHERNET/IP

Appendix B Design Criteria

1.0 Introduction and Overview

1.1 Purpose

The purpose of this technical memorandum is to define the City of Boos Bay's Supervisory Control and Data Acquisition System (SCADA). Major SCADA components covered by this document include:

- Collection Pump Stations
- Wastewater Treatment Plants (WWTPs)
- The Collection System Control Center
- WWTP Control Centers
- The Collection System wireless communications network as required.

Criteria provided include the following:

- SCADA Background and Overview
- Terminology and acronym definitions
- Standards and codes list
- Physical design criteria
- Network and other communications requirements
- Functional requirements
- Applications programming requirements
- Documentation requirements
- Testing requirements
- Support requirements
- Pump station specific criteria
- WWTP specific criteria
- Collection Control Center specific criteria
- WWTP Control Center specific criteria
- Collection wireless network specific criteria

1.2 Background & Overview

The SCADA system project for the City of Coos Bay will include installing SCADA systems at the WWTP locations and gathering data from remote sites with the intention to notify and inform of system conditions. The following is a list of the major SCADA system goals and the basis for the design:

- **Increase Operational Reliability of Collection and Treatment:** Collection system SCADA improvements are expected to reduce the chances of pump station spillage and overflow. Treatment plant SCADA improvements are expected to improve treatment performance and effluent quality.
- **Ease of Access:** Managers and engineers will have easy access to real-time and historical data including regulatory reporting, management oversight, collection system and treatment capacity and quality analysis and improvements planning.
- **Improve Collection System and Treatment Facility Planning:** Existing control systems have limited data archiving ability. The upgraded SCADA systems will provide more, easily accessible and organized data to support planning efforts. The improved data archives can be

used by the City of Coos Bay to improve collection and treatment systems understanding thereby allowing City of Coos Bay to make better informed decisions regarding upgrading and expanding the wastewater systems.

- **Reduce Operating Costs:** Once Pump Station and WWTP staffs have gained confidence in the upgraded SCADA systems, labor savings will occur because of improved plant operations efficiencies and a reduction of the number of visits to each pump station.
- **Support Facilities Information Management (FIM) Tasks:** The upgraded SCADA systems will provide information in a format that is easily transferred to maintenance management or asset management software. As an example, the elapsed run time of process equipment can be downloaded from the SCADA system to a FIM system. This data can be used by the FIM system for scheduling maintenance activities.
- **Network Isolation:** Isolating the Operations Data Center on a separate network with controlled access from both the Business and Operations Networks provides isolation and protection of the Operations Network and the four control center networks thereby improving the availability and integrity of both the Operations Data Center and Process Control Networks.

The following additional general design criteria have been established for design and construction of the SCADA systems:

- **Routine Maintenance Requirements:** The SCADA systems must be capable of being maintained on a day-to-day basis by the City of Coos Bay staff. Day-to-day activities are not expected to include any applications programming or system configuration work. Someone with a working knowledge of computer operating systems, computer networks and the applications being used will be required to periodically review security, event and activity logs, and perform maintenance. Also, periodic (frequency to be determined) maintenance by someone with detailed knowledge of SCADA applications and computer operating systems will be required to install software upgrades and patches, to review system logs, to groom files, and perform other system-level activities, which can be completed by TAG or others.
- **Additional Staff Needs:** Either training of existing staff members or adding staff will be required to perform the day-to-day duties listed above and other SCADA System O&M activities. SCADA system designers are expected to work with the City of Coos Bay to identify specific skill requirements during design. The monthly and quarterly maintenance activities are expected to be provided as part of a renewable annual service agreement.
- **Training Requirements:** Training requirements, including course identification and training source, are expected to be identified during design**.**
- **Application Programming Templates:** SCADA system designs are expected to include templates to ease the amount of custom programming required to add pump stations or common plant equipment such as pump stations.
- **Environmental Design Provisions:** Equipment, such as RTUs and panels, are expected to be located to reduce environmental impacts and hazards; and designed to withstand environmental conditions and mitigate hazards present.
- **Communications Reliability:** Reliable wireless and network communications, as well as ample, easy to access and use communications diagnostics including statistics are required, as is the ability to effectively continue operation during temporary communications failures. Design wireless communications links to work reliably during abnormal weather conditions such as heavy rain, high wind and temperature inversion.
- **User Access Tailored to Job Responsibilities.** Tailor each users access to job responsibilities. Work with the City of Coos Bay to determine user access requirements in the HMI program. Managers will generally have broad view only access. Supervisors are expected to have monitoring, control and preset parameter adjustment access for areas they are responsible for and view only access to associated areas. Operators will generally have monitoring and

control. Maintenance workers will have access tailored to their needs and responsibilities including the ability to modify configurations and applications programming.

- **Network Security Provisions:** Reasonable network and communications security controls in compliance with the current version of the National Institute of Standards and Technology (NIST) Special Publication (SP) 800-82 are required. Security controls include, but are not limited to, access control, intrusion detection and virus protection.
- **Modular Design, Common Components for All Sites**: Use the same manufacturer and model number components for all similar applications.
- **Alarm Segregation, Categorization, Prioritization and Conditioning:** Segregate [i.e. Collection/Treatment], categorize and prioritize alarms. Alarms will be conditioned to eliminate nuisance and all but critical unavoidable alarms. For example: Pump station alarms, except for LOW BATTERY, INTRUSION and HIGH HIGH LEVEL will be disabled during pump station power outages. Develop specific alarm conditioning rules during design and finalize them during construction. Route some alarms [i.e. pump station pump fail] directly to maintenance personnel with operations receiving a follow-up alarm if the original alarm is not acknowledged within a preset interval. Prevent communications failure alarms from being repeated each time the failed link is accessed.
- **Physical Security:** Work with process plant manager to establish physical security requirements for pump stations and plants. For control centers and data centers, locate all computers [servers and workstations] in locked adequately air conditioned rooms with reliable conditioned electric power. Limit access to those responsible for the maintenance of the control centers. Use Keyboard, Video Mouse (KVM) extenders to support a keyboard, dual monitors, a mouse, and dual speakers in the control room for each workstation.

1.3 SCADA System Overview

The simplified SCADA block diagram in Appendix A shows an overview of the complete SCADA system. Major elements include the following:

1. Data storage
2. Data Collection
3. Data generation
4. Operator interface

1.4 Terminology

Terminology and acronyms used in this Technical Memorandum are shown in Table 1-1.

TABLE 1-1
Terminology And Acronyms

Term Or Acronym	**Meaning**
ADO	ActiveX Data Objects
API	Applications Programming Interface
APPLICATION SOFTWARE	Software to provide functions unique to this project and that are not provided by standard software alone. Configuring data bases, tables, displays, reports, parameter lists, ladder logic, and control strategies required to implement functions unique to this project
CMMS	Computerized Maintenance Management System
DCS	Distributed Control System
DMARC	The point of demarcation for utilites. It is the interface point where all facilities on one side are maintained by the utility provider and all facilities on the other are maintained by the City.
DMZ	Demilitarized Zone
DPW	City of Coos Bay Department of Public Works
FES	Fixed End Service
FIM	Facilities Information Management
HMI	Human Machine Interface

1.5 Standards and Codes

The following organizations have generated standards that are to be used as guides in assuring quality and reliability of components and systems; govern nomenclature; define parameters of configuration and construction in addition to specific details outlined in this document.

- ISA, Instrumentation, Systems and Automation Society
- UL, Underwriters Laboratories
- AWWA, American Water Works Association
- NEMA, National Electrical Manufactures Association
- OSHA, Occupational Safety and Health Administration
- ANSI, American National Standards Institute
- DHS, Department of Homeland Security
- NFPA, National Fire Protection Association
- NIST, National Institute of Standards and Technology
- SAMA, Scientific Apparatus Manufacturers Association
- IEEE, Institute of Electrical and Electronic Engineers
- NEC, National Electrical Code(ANSI/NFPA-70)
- API, American Petroleum Institute RP550 Manual on Installation of Refinery

Instruments and Control Systems (API RP550)

2.0 Physical Design Criteria

2.1 Introduction & Overview

This section defines general SCADA system physical design criteria.

2.2 Control Strategy & Naming Conventions

CONTROL STRATEGY

TAGS
A shorthand tag number notation is used in the Loop Specifications.

S	**10**	**AFD**	**05**	**01**	**SF**
Facility Code	Unit Process	ISA designation of process and function	Loop Number	Unit Number	Clarifying Abbreviation

2.3 General System Requirements

2.3.1 City Product Standards

It is the intent of this document to develop a set of reference standards in the design and implementation of automated control systems located within the City's Treatment Plants and collection system.

2.3.2 Single Point of Failure

In general, single points of failure are to be avoided. This does not mean that all control and equipment has to be duplicated, but there are specific components for which redundancy is required for safety or continued operation. Redundancy is required for the following components:

- HMI I/O Servers
- Master PLC's
- Historical data scanners installed on operator workstations
- Switches at each tier in the WWTP star LANs

Components for which redundancy is not required include the following:

- RTU's
- Instruments

2.3.3 Color Coding of Pilot Devices

The following are standard color coding associations. These can be modified to meet required standards. Unless noted otherwise, use the following color code for lenses of indicating lights.

Function	Color
On or Open	Red
Off or Closed	Green
Alarms	Amber
Automatic or Remote	White
Manual or Local	Blue

2.3.4 Nameplates

All individual panels, instruments, and panel mounted devices shall be provided with nameplates. Use plastic laminate nameplates having white letters on a black background.
Individual control switches and pushbuttons shall have customized legend plates which indicate function. These specifications can be modified to meet required standards.

2.3.5 Accessibility and Mounting

All control equipment shall be mounted in an easily accessible location. Equipment or piping shall not have to be removed to access controls. All controls shall be mounted within five feet of finished floor.
All NEC clearance requirements shall be met for the appropriate voltage level.
All equipment and instrument tubing shall be rigidly installed. It is intended that after installation a slight to moderate pressure on the installed device shall not move it and in no circumstance should it sway back and forth if pressure is suddenly removed.

2.4 Field Mounted Instrumentation

2.4.1 General

Provide instruments that return automatically and immediately to accurate measurement upon restoration of power after a power failure, except where specifically noted.
Use single source manufacturer for each instrument type. Use the same manufacturer for different instrument types whenever possible.
Provide instrumentation of rugged construction designed for site conditions. Provide only new, standard, first-grade materials throughout, conforming to standards established by Underwriter's Laboratories (UL), Inc., and so marked or labeled, together with manufacturer's brand or trademark.
Instrument enclosures shall be NEMA rated for the environment. In hazardous areas, meet the NEC Class, Group, and Division as shown or specified. Submergence rated enclosures shall be provided in areas subject to flooding.
Provide instrument transmitters that produce isolated 4-20 mA dc analog signals. Follow ISA-S50.1.
Use linear, direct reading indicators unless otherwise specified.
Analyzers must be removable from the process lines without disrupting the process.

2.4.2 Installation

Unless readily accessible for viewing and calibration from floor elevation, do not install electrical transmitters process piping. Mount equipment on instrument racks, stands or in enclosures near the sensor

at a level that permits viewing from floor elevation.
Install instrumentation and auxiliary devices to be accessible for maintenance. Provide space between instruments, equipment, and piping for ease of removal and servicing. Include panel layouts to include ergonomic factors associated with maintaining the equipment. In general, install instrumentation to be accessible from floor level or grade.

2.4.3 Maintenance and Troubleshooting

The continued, useful operation of a control system depends on effective maintenance and calibration. The availability of complete system documentation and the installation of proper test connections greatly assist in maintenance and calibration. During the design of the I&C system, every effort must be made to make the system as easy to maintain and troubleshoot as possible.

2.4.4 Pressure Measurement Pressure and Differential Pressure Transmitter

Diaphragm type pressure transmitters will be used for gauge, differential pressure and absolute pressure measurement applications. Rosemount “Smart” pressure transmitters or equal will be used.

Pressure Gauges

For pressure gauges, solid-front, glycerin-filled units will be used. For most pressure ranges, Bourdon-tube elements will be used. Diaphragm or bellows type elements will be used for low pressure ranges. Dial size is to be 4 1/2 inches minimum. Accuracy shall be two percent of span. Scale range shall be such that normal operating pressure lies between 50 and 80 percent of scale range. Dresser/Ashcroft and Ametek U.S. Gauge are the preferred manufacturers.

Pressure Diaphragm Seals

Diaphragm seals will be sued to protect pressure instruments from corrosion and to keep solids out of instruments when they are connected to pipelines. Typical manufacturers are Dresser/Ashcroft and Ametek.
Isolation valves and calibration ports will be provided for pressure instruments.

Pressure Switches

Units shall be the diaphragm sealed piston actuator type with automatic reset and snap action switch. Acceptable manufacturers are Ashcroft B Series, or United Electric.

2.4.5 Flow Measurement Electromagnetic Flow Element and Transmitter

Magnetic flow meters will be used for sludge service. A minimum flow velocity of 5 fps through the flow meter will be maintained for primary sludge and 3 fps for secondary sludge. Magnetic flow tubes require a minimum of five diameters of straight pipe upstream and two diameters of straight pipe downstream. Typical manufacturers will be ABB/Fischer & Porter or Rosemount or equal.

Flow Element and Transmitter, Thermal Mass Flow

Airflow measurement for air applications will utilize thermal dispersion technology for flow measurement. Venturi tubes of orifice plates are not acceptable.The flow element must be installed through a hot tap assembly to facilitate cleaning flow elements without isolating the pipe line. A dirt/moisture separator should be installed upstream of the flow element. The straight approach must be at least 10 diameters upstream and 10 diameters downstream from the flow element.
Transmitter will be remote (nonintegral) from the meter, and shall be NEMA 4X rated. Transmitter shall include local LCD display of both the instantaneous flowrate and totalized flow.

Acceptable manufacturers are Fluid Components (FCI) or Kurz Instruments.

2.4.6 Level Measurement

Ultrasonic type level sensors and transmitters will be used for level measurement, except for Collection Systems Pump Stations. All ultrasonic level transmitters shall be microprocessor-based devices with external keypads, LCD display, and shall be programmable without the use of potentiometers. Transmitter enclosures shall be NEMA 4X rated. Units shall be temperature compensated. The ultrasonic units will be Siemens/Milltronics, Endress and Hauser, or STI.

Float and displacer type level switches will be used in sump pump applications and for high level alarms. Floats shall be watertight and shall have a diameter of at least 4 inches. Floats shall be internally weighted and mechanically switched. Floats containing mercury shall not be used. Acceptable manufacturers are Contegra, Siemens, Anchor Scientific or equal.

2.4.7 Analytical Measurement Dissolved Oxygen Analyzer and Transmitter

Dissolved Oxygen measurement will utilize luminescent response to emitted light for DO measurement. Luminescent DO sensors with compatible transmitters will be used for dissolved oxygen measurement. The Luminescent DO sensors will be Hach sc100 LDO Analysis System.

pH Analyzer and Transmitter

Unit shall electromechanically measure pH without requiring electrolyte flow. Provide a complete unit consisting of the following:

- Element
- Transmitter
- Cable
- Junction Box
- Expendables

Units shall have integral temperature compensation. Accuracy shall be better than 0.05 pH units with 24 hour zero stability of 0.01 pH units. Indicator shall be LCD or LED. Transmitter enclosure shall be NEMA 4X. Acceptable manufacturers are Hach.

Turbidity Analyzer and Transmitter, Low Range

The unit shall measure turbidity of high quality filtered water. Principle of operation shall be light scatter detection measurement. Range can be as high as 0-100 NTU, but is usually set for much lower ranges in clean water applications. The resolution shall be 0.001 NTU. Unit shall include a bubble trap and vent. Provide a complete unit consisting of the following:

- Element
- Analyzer/Transmitter
- Cable
- Mounting Hardware
- Lamp Units
- Calibration Kit
- Expendables

Transmitter enclosure shall be NEMA 4X. Acceptable manufacturers are Hach.

Residual Chlorine Analyzer and Transmitter

Unit shall measure continuously the chlorine residual of the sample process stream. Unit shall measure either free or total chlorine residual, field selectable. Principle of operation shall be amperometric with pH buffering. Provide a complete unit consisting of the following:

- Analyzer/transmitter unit
- Mounting hardware
- Sample tubing connectors
- Reagent
- Expendables
- Sample Conditioning System

Sensitivity shall be better than 0.001 mg/l with a 4-second maximum response time. Unit shall have integral temperature compensation. Transmitter enclosure shall be NEMA 4X. Acceptable manufacturers are Hach.

Combustible Gas Detection System

Combustible-gas detectors must be provided in accordance with NFPA 820. Each area should be analyzed for the types of gases that may be present (heavier-than-air gases or lighter-than-air gases), with detectors located appropriately. For example, in screen rooms, combustible-gas detectors should be installed along the ceiling and floor because both heavier-than-air combustible gases (such as gasoline vapors) and lighter-than-air combustible gases (such as methane) may be present. Combustible gas detectors with silicon/H2S poisoning-resistant cells should be specified.

Combustible gas must be treated as a critical alarm. The alarm must be connected to a local annunciator and interfaced to the PLC.

Typical manufacturers are MSA and General Monitors.

Total Suspended Solids (TSS) Analyzers

TSS measurement will utilize a nephelometric method where light is passed through the sample and the amount of reflected light is measured. Hach SOLITAX sc sensors and sc100 controllers will be used for TSS analysis.

2.4.8 Temperature Measurement Temperature Transmitters

Units shall be 3 or 4 wire RTDs with integral two wire transmitters. Elements shall be 100ohm platinum conforming to SAMA Standard RC 21-4 accuracy specifications. However, vibrating can damage this unit. Ten ohm copper RTDs must be used in large motor windings and thermocouples must be considered for all ranges in vibration applications. Acceptable manufacturers are Foxboro or Rosemount.

Temperature Indicators and Gauges

The preferred temperature gauge is pressure gauge with a vapor-pressure temperature element. The long-term stability is better than bi-metal units, but bi-metal may be necessary in small vessels because of element size. Mercury thermometers are not acceptable.

Dial size shall be 4 1/2 inches minimum. Acceptable manufacturers are Ashcroft, Ametek and U.S. Gauge Division.

Thermocouples

Thermocouples (T/C) must be used for applications in which the operation temperature is greater than 300 degrees Fahrenheit. The specific application must be the basis for choosing the T/C and extension wire used. Thermowells must be used for thermocouple liquid applications and must be made of 316 stainless steel. Thermowells must not be used for gas applications unless the line cannot be depressurized easily for T/C maintenance.

2.5 Control Panels

2.5.1 General

Control Panels located indoors shall be painted steel or fiberglass, NEMA 12, as manufactured by Hoffman or equal. Enclosures shall be provided with corrosion inhibitors.
Control Panels outdoors will be 316 stainless steel, NEMA 4X. Provide outdoor enclosures with sunshields, thermostatically controlled space heaters, and corrosion inhibitors.
Control Panels Indoors in hose-down or corrosive areas should be NEMA 4X, fiberglass or stainless steel.
Provide louvers, forced ventilation, or air conditioners as required to prevent temperature build-up within the enclosure and maintain equipment within equipment temperature ratings as required.

2.5.2 Signal Isolation and I/O

Unless otherwise indicated or required for a specific application, all PLC I/O shall meet the following:
For pump stations, provide 24VDC discrete inputs. For WWTP, provide 24VDC discrete inputs.
Provide discrete output modules with dry contact relay outputs rated at 120 VAC.
Provide isolated 4-20 mA analog inputs. Except for 4 wire transmitter loops, provide power supplies for all 4-20 mA signals from the control panel.
Provide isolated 4-20 mA analog outputs.

2.5.3 Distribute I/O Between Modules

To comply with general philosophy of no single point of failure, terminate I/O for related equipment on different I/O modules, where practical. For example, if there are 4 high service pumps, terminate digital inputs for two pumps onto one I/O module, and digital inputs for the other two pumps on a separate I/O module. When multiple racks are provided, the I/O modules should be in separate racks with separate power supplies.

2.5.4 Panel Power Distribution, I/O, and Loop Powering Practices

Provide individual fuses for each 4-20 mA signal loop.
Provide individual fuses for each group of discrete inputs for a common piece of equipment.

2.5.5 Termination of Wiring

All PLC I/O wiring shall be terminated on terminal. Tag and mark all terminal blocks and individual wiring.
All wiring from the field shall terminate on separate numbered terminal blocks.
Separate groups of terminal blocks shall be provided for the following:

- Discrete inputs
- Discrete outputs
- Analog inputs
- Analog outputs.
- Each different voltage level.
- Each different voltage source within the panel.
- All outside voltage sources of a like voltage level should be grouped together, and shall also be labeled and provided with individual disconnects.

2.5.6 Conduit Entry

Conduit entry into panels will generally be through the top or bottom. Neatly coil and securely fasten all cabling away from equipment and entrance doors rather than laying in the bottom of the enclosure.

2.5.7 Pilot Devices and Controls

Provide oiltight/watertight, heavy duty pilot devices and controls. Miniature type devices are not acceptable.

Where contacts switch 115 volt signals, provide contacts rated 10 amps at 115 volts ac minimum. Where contacts switch low voltage dc signals, provide contact material of gold or gold flashing over silver and rated 1 A at 28 Volts dc.

Provide transformer type pilot lights utilizing LED lamps. On the panel, provide either push to test type or a common lamp test button pilot lights. Pilot lights shall allow for lens and bulb replacement through the front of the unit.

2.5.8 Relays and Timers

Where contacts switch 115 volt signals, provide contacts rated 10 amps at 115 volts ac minimum. Where contacts switch low voltage dc signals, provide contact material of gold or gold flashing over silver and rated 1 A at 28 Volts dc.

2.5.9 4-20 mA Loop Indicators

Indicators shall be of the digital panel mounted type, rather than the analog gauge type.

2.6 Lightning Surge Protection and Backup Power Requirements

2.6.1 Grounding Requirements

Provide ground conductors and ground control panels in accordance with NEC.

2.6.2 UPS Requirements

In general, provide either a UPS or battery power back up for all control panels, PLCs, computers, and communications equipment.
Provide the on-line type UPS that and provides power conditioning to the load and shall automatically revert to line power after batteries are discharged without requiring manual reset.
As a minimum UPSs provided for the Data Center, WWTP Control Centers, and Collection System Control Center will have the capacity for maintaining control center operation for one hour. For the Collection Control System local PLC monitoring and control, provide battery backup power capable of maintaining the PLC and communications interface in operator for four hours.
UPS receptacles to be color coded and identified as for UPS supplied equipment only. Where generators are provided, the UPS shall be powered by the emergency generator bus such that in the event of a power failure the UPS is functional for the duration the emergency generator is operating.
Provide UPS power to communications equipment provided by the communications service providers. Coordinate with provider to determine specific equipment being provided and power requirements.
It is not intended that printers, copiers, or individual instruments be required to be connected to the UPS system.
It is not required that auxiliary control panel components such as space heaters, receptacles, fans, etc. be connected to UPS power.

For facilities with several loads requiring UPS power, a single large facility UPS with power distribution to loads is preferred over individual UPS located in panels or equipment enclosures. Consult with DPW to determine acceptable configuration of UPS power distribution.
For UPSs with distribution panels, provide bypass switches and isolation breakers so that the UPS can be isolated and taken out of service for maintenance without disturbing the loads it powers.
UPSs shall provide auxiliary contact outputs connected to the PLCs and DCSs for UPS alarm, UPS Fail, Main Power Fail, and UPS bypassed.

2.6.3 Discrete Signal Line Protection

Surge protection is not required.

2.6.4 Analog Signal Line Surge Protection

4-20 mA signal circuits with any portion of the circuit traveling outside a building shall be provided with a surge protective device at each end of the circuit.

2.6.5 Telephone Circuit Surge Protection

Unless DPW considers the protection provided by the utility to be adequate, provide surge protection devices at the DMARC location between the phone line and DPW equipment.

2.6.6 Power Supply Surge Protection

Provide power surge protection at each source power connection to each power distribution panel.
Provide power surge protection at the alternating current source power connection to each instrument and control panel and at each voltage level within a panel.
Provide power surge protection at the source power connection to each UPS.

2.7 Control, Communications, and Power Cabling and Media Requirements

2.7.1 General

Except for designated direct-burial installations, install all cabling [copper and fiber optic] in conduit. Separate copper and fiber optic cabling. Install fiber optic cable inside innerduct in conduit. Individual conduit runs shall be kept to a minimum and control cabling may be combined in common conduits and routed to centralized terminal boxes to the greatest extent possible. Wherever combined control cables are split out of a common conduit, provide a terminal box. Note that different control voltages shall not be combined.
To minimize the effects of lightning and surges, underground control and communication cabling routed outside the building confines shall meet the following requirements:

- Use fiber optic cable where practical for underground or outdoor communication between PLC components.
- Where individual control or monitoring signals must be routed outside, minimize the routing lengths. Evaluate cost effectiveness of installing a separate remote I/O cabinet near the monitored equipment.

2.7.2 Conductor Labeling

Wire labels shall be provided for each individual conductor and multi-conductor cable at all termination points including termination/junction boxes. Labeling of “through” wiring [that is conductors not terminated or spliced] at pull boxes will not be required.

2.7.3 Fiber Optic Cable

Install all fiber optic cable with at least 50 percent spare fibers and a minimum of two spare fibers. Provide 50/125 micron, multi-mode or 9/125 micron single mode fiber optic cable. Selection between single mode and multi-mode fiber optic cable will be based on data rate and distance.
Terminate all fiber optic cable(including spares) in fiber optic patch panels and satisfy test criteria. When any fibers in a cable are terminated in a patch panel, terminate all fibers in that cable. Use patch cables installed in conduit for connection of transceivers to patch panels. Provide all patch panels indoors with NEMA 1 enclosures. Provide all panels outdoors in NEMA 4X enclosures.

2.7.4 Shielded Twisted Cabling

Provide shielded twisted pair or triad cabling for all analog signal circuits. Provide an appropriate level of spare pairs or triads. For single circuits, spares are not required.

2.7.5 Multi-conductor Control Cable

Provide multi-conductor control cabling for all discrete signal wiring.
Multi-conductor control cable shall be used over single conductor control cable due to ease of identifying individual conductors by color as well as individual conductor labeling.
Each multi-conductor control cable should provide at least 25 percent spare conductors.

2.7.6 Local Area Network and Telephone Cable and Components

All Local Area Network (LAN) and telephone cabling and components shall be listed and rated as “Category 6” and satisfy test criteria. LAN and telephone cabling is to be routed in such a way that it will minimize proximity to alternating current wiring, transformers and lighting ballasts. LAN cabling shall satisfy test criteria for operation at 100 Mbps.

2.8 Network and Server Rack Construction Requirements

Locate network and computer racks in a physically secure location with access limited to those responsible for operation and maintenance of the components and applications housed in the racks. Provide both adequate, reliable temperature and humidity control and reliable, quality electric power. Also, provide UPS capacity for maintaining complete network operation for one hour. Provide a minimum 3 feet of clearance both directly in front and behind the rack. Provide racks with both front and back access for computer and network equipment.

2.8.1 Layout

In general, install heavy equipment near or at the bottom of the rack. However, install UPSs near the top. For racks that require ventilation, install fans or cooling system at the top and bottom.
Provide horizontal cable management above patch panels and switches with a minimum of 1 rack-mount unit of cable management for every 2 units of switches and patch panels. Provide vertical cable management along both sides of the rack. Add power strips as necessary to ease access and power cable

management.
Provide shelves for any equipment that is not rack-mountable. Use shelves that are deeper than the equipment it is supporting. For heavy equipment, include drawer glides.

2.8.2 Power Supply

Provide one or more, as required, dedicated 120V power circuit for each rack. Locate the power distribution panel sourcing the power circuits inside the physically secure space housing the racks served..

2.9 Security Requirements

2.9.1 Network and Computer Security

Provide SCADA network and computer security as shown, described herein and in compliance with the current version of NIST SP 800-82. Network and computer security includes access control, virus protection, and intrusion detection and prevention. Access controls include controls provided by network appliances such as routers and firewalls, user authentication and role-based access limitations, as well as appliance and operating system configuration to disable unnecessary or high risk services, limit access, and establish secure user names and passwords. Coordinate with DPW to establish secure networks and computer systems.

2.9.2 Physical Security

Coordinate with DPW to establish physical security requirements for pump stations and plants. For control centers and data centers, locate all computers, including both servers and workstations, in a locked temperature controlled room with reliable conditioned power. Limit access to the control centers to the staff performing maintenance on the system. Use KVM extenders to support a keyboard, dual monitors, mouse, and dual speakers in the control room for each workstation.
All control panels are required to be pad-lockable and have door closed switches. Control panels at collection system locations are to include a panel intrusion alarm. Certain collection system location panels may be required to be capable of accepting a Gate OPEN, Door OPEN, INTRUSION (alarm from an intrusion detector), and AUTHORIZED INTRUDER discrete inputs. Video intrusion alarm assessment, when required, is expected to be provided separately and not require control panel expansion. Necessity of video intrusion assessment or intrusion monitoring via discrete inputs will be determined during design and may significantly impact digital cellular network monthly costs. When necessary, design video intrusion systems to include local digital video recorders with the following capabilities:

1. Suitable for installation in industrial, NEMA 4X areas.
2. Capable of storing 30 days of video for each camera at 4 frames per second (fps).
3. Capable of producing event clips which start a preset time before the event and end a preset time after the event.

Design intrusion detection systems to eliminate false negative and minimize false negative events. For intrusion alarm assessment provide fixed cameras with manually adjustable lenses capable of full color operation at 2.4 lux reflected light level and a 50 IRE sensitivity of
0.59 lux. Design lighting systems to provide adequate illumination for proper camera operation and to maintain a contrast ratio of better than 4:1.

3.0 Network and Other Communication Requirements

3.1 Overview

The following three types of networks are anticipated:

1. A digital cellular wireless network for connection of the pump stations and wireless mobile laptops to the collection system process control network.
2. Local area networks (LANs) at each of the WWTP for interconnecting PLC components, the Collection System Control Center for interconnecting PLC and HMI components, each pump station for interconnecting the PLC, digital cellular modem, and at the operations data center for interconnecting PLC components.
3. A digital wire line network for interconnecting the Operations Data Center, the three WWTP Control Centers and the Collection System Control Center.

3.2 Digital Cellular Network

This network type will be used at the locations that cannot be serviced by point to multipoint radios.
It also will include the use of wireless internet access cards for mobile laptop computers to access SCADA system.

3.3 Local Area Networks

Provide LANs that provide both redundant switches and redundant media for each LAN connected computer or controller. Use the same network topology for all LANs except the pump station LAN's. Work with the PLC provider to assure that the LAN design satisfies PLC requirements, can be configured and maintained by the PLC provider, and can be monitored by the PLC system. For LAN components installed outside the control centers and data center, use industrially hardened appliances.
For pump stations provide a single industrially hardened switch supporting necessary protocols and suitable for installation in the pump station environment, if required.
There may also be plant applications where a wireless LAN (WLAN) alternative is adequate and cost effective. For these applications address reliability, capacity and security issues on a case-by-case basis.

4.0 Functional Requirements

4.1 General Requirements

Requirements for environmental, physical security, reliability and redundancy apply equally to all computers, communications and network equipment.
Requirements for pump stations and control equipment located in electrical rooms and process areas differ and are addressed individually.

4.2 Monitoring and Control

4.2.1 Local Autonomous Control

At local equipment control panels or motor control centers, provide stand-alone, local autonomous equipment control such that the equipment is not dependent on communications links or operator intervention.
It is intended that all automatic control and equipment sequencing be accomplished through PLC's. It is intended that all equipment sequencing for motor restart after a power outage be programmed into the PLC. Hardwired time delay relays in individual starters are not required. Since most equipment is controlled in a remote manual mode, automatic restart generally applies only to restoration of last state after a power failure.

4.2.2 Hard-Wired Backup Control

Hard-wired backup controls are not required for most equipment, but need to be evaluated for each piece of equipment.
Specifically, contacts on the level transmitter provide hard-wired logic to maintain limited pump station operation in the event of a or PLC malfunction.

4.2.3 Local Manual Control

The local control panel or motor control center operator interface will provide for local manual equipment control that will override PLC control. It is intended that local manual control will be used primarily for maintenance functions and not operation. Hard-wired safety interlocks such as HIGH motor temperature will prevent manual equipment operation.

4.2.4 Equipment Protection and Safety

In general hardwire protective devices which are required for electrical protection and personnel safety directly into individual equipment controllers or starters to eliminate reliance on PLC controllers.

4.2.5 Maintained Versus Momentary Controls

It is intended that all discrete outputs from the PLCs or DCS controllers to individual equipment controllers be maintained contact outputs such that seal in contacts are not required in the control circuit.

4.2.6 PLC Monitoring of Equipment Status

As a minimum, each equipment controller and control station shall provide isolated, maintained contacts to the PLC to monitor each of the following:
• Equipment Running/Stopped.
• Equipment in Auto and ready to operate.
• Equipment Fail.

4.2.7 Control of Variable Speed Drives

Use analog interfaces to variable speed drives for speed monitoring and control, status monitoring, and drive control, as well as for monitoring other useful information such as motor current and drive diagnostics.
In general, provide local manual control at the drive. However, some critical applications may require local manual start/stop or even speed control at the equipment.

4.2.8 Local Operator Interface

In general, local operator interface requirements shall be evaluated for each piece of equipment.

However, for pump station applications, provide local operator interfaces that, as a minimum, include the following indicators and controls:

- Common FAIL Beacon
- Motor Elapsed Runtime Meters
- Pump ON, HIGH Moisture, HIGH Temperature Indication
- Motor Current Indication with a Phase (A, B, C) selector
- Wetwell Level Indication
- Wetwell HIGH HIGH and LOW level pressure switch alarm indication
- Pump Station Discharge Pressure
- Pump Station Discharge Flow for new or replacement pump stations.

4.2.9 Remote Operator Interface

Remote operator interface requirements include provisions for HAND/OFF/AUTO (HOA) selectors for remote manual override control and duplication of the indicators and controls of the local operator interface. Also provide any additional monitoring and control displays and pop-ups required to support automated sequencing and analog control, if required.

4.3 Alarm Segregation, Categorization, Prioritization, and Conditioning

4.3.1 Alarm Conditioning

Alarm conditioning in addition to that provided by each PLC will be required to account for conditions external to the plant and to further reduce nuisance alarms and improve alarm response. For example, suppress FAIL alarms and performance alarms such as LOW FLOW should be for equipment for which the power has failed. Provide supervisor adjustable de-bounce delays to reduce nuisance alarms for analog variables.

Develop specific alarm conditioning rules during design and finalize them during construction. The goal is that any critical alarm requires immediate attention and that other alarms require timely action. Log events or low priority alarms that aren’t annunciated for which a response can be scheduled.

4.3.2 Logical Alarm Summary Displays

A logical alarm summary presentation on alarm summary displays at WWTP HMI is required to ease the decision process during emergencies.

4.3.3 Alarm Prioritization

Alarms prioritization is required with only critical and important alarms presented on alarm summaries. Log other, lower priority, alarms and place them in categories such as Plant Performance, Plant Capacity, etc to ease performance analysis and maintenance scheduling.

4.4 Trending and Reporting

4.4.1 Historical Trending

Easy access and flexible graphical presentation of historical trend data appropriate for process is required to support operational analysis and maintenance planning. To prevent loss of data, also provide an automated easy to use process for periodically archiving historical trend data to removable media.

4.4.2 Plant Historical Data

Provide historical data on the operator workstations in each plant control center to collect plant historical data.

4.4.3 Collection System Historical Data

If required, a workstation and scanner in the Collection System Control Center to collect collection system historical data.

4.4.4 Relational Database Interface

The historical database is expected to be proprietary with both an applications programming interface (API) and a Microsoft ActiveX Data Objects (ADO) interface. Either the API or ADO interface can be used by a custom applications program to recall selected data from the historical database.

4.4.5 CMMS Interface

It is possible that a computerized maintenance management system (CMMS) or other information management system interface will be required for the historical data servers to support preventative maintenance scheduling.

4.4.6 Reporting Application

Provide a single reporting application for producing reports from the historical database.

4.4.7 Operation Reports

Work with DPW to determine operational reporting needs and develop an automated system for producing reports using the reporting software. Determine which report variables are measurements and which must be manually entered, for lab analysis for example. Configure the reporting system to provide forms for manual data entry and for maintaining the manual entries in the historical data records.

4.4.8 Regulatory and Performance Reports Regulatory Reports

Work with DPW to determine regulatory reporting needs and develop an automated system for producing reports using the reporting system. For the collection systems regulatory reports are generally not required. However, internal management reports are needed that summarize periodic collection system performance to track performance against the consent decree.

Performance Reports

Monthly performance reports may be needed to track system performance, maintenance activity, significant events, as well as operating and maintenance costs.

4.5 Access for Mobile Operators and Maintenance Staff

4.5.1 Notification of Critical Alarms

Mobile operators and maintenance staff need to receive notification of appropriate critical alarms.

4.5.2 Critical Alarm Delivery Method

A flexible system that is capable of being reconfigured to use the best available delivery alternative is required for forwarding appropriate critical alarms to mobile staff.
Initially, the most likely method of delivery will be text messaging to cell phones. However, as communications technologies continue to evolve, the delivery system needs to be easily reconfigured to take advantage of current technologies. The existing DPW cell phone contract does not support text messaging. So, it's possible that voice messaging will have to be used.

4.5.3 Critical Alarm Assignment Method

An easy to use configuration tool is needed for selecting critical alarms for mobile delivery and assigning those alarms to one or more mobile staff.

4.5.4 Mobile Laptop Workstations

Provide Collection System operators and maintenance staff with mobile laptop computers and digital cellular wireless cards linking the cards to the private digital cellular network for use in monitoring collection system performance and in resolving collection system problems. These laptops will use browser access to the Collection System HMI servers to display graphics displays, view process trends, and review alarm summaries.

4.6 SCADA System Service, Support, Upgrade and Migration

4.6.1 System, Service, Support, Upgrade and Migration Schedule

Provide a projected schedule of recurring expenses for system service, support, upgrade and migration to DPW for use in preparing annual budgets. Provide a schedule that can be easily updated by DPW on a annual basis to make adjustments as necessary expenses and expense costs vary.
Prepare a draft schedule early in design so that C-P can consider these costs when making technology and equipment selections. Update the schedule routinely throughout design and construction of the SCADA system. Include all of the items listed below, as well as any others that are being considered for the SCADA system.
Work with providers and manufacturers to determine the appropriate service/support product suites for DPW and in developing SLA covering services provided, performance parameters, response times and provider penalties for failure to comply with stipulated performance and response times.

4.6.2 Service

Service fees include monthly fees for items such as out-sourced data centers, ISP, outsourced communications links, leased SCADA components, as well as annual hardware and software service agreements. Except for out-sourced communication link technicians, these services are generally delivered by remote service provider staff and using service provider facilities.

4.6.3 Support

Support is needed for repair, upgrade and routine maintenance of specialty SCADA hardware and software such as computers, PLCs and HMI software installed at DPW facilities and out-sourced data centers. In contrast to the service item, support is routinely delivered by technicians and engineers that actually visit the site to perform physical inspection, maintenance, repair and upgrade. Some support services, such as software service patch installation, may be delivered by remote technicians under DPW supervision using secure communications links.

4.6.4 Upgrade

Periodic upgrades are needed to keep hardware and software current. Upgrades are less frequent, less expensive and better scheduled than system support work. Upgrades usually require outages and configuration adjustments. To reduce disruption typically one of several workstations or redundant servers is upgraded, tuned and put back on line before others are upgraded.

4.6.5 Migration

Migration is needed to allow moving from one application, platform, service, topology or media to a replacement application, platform, service, topology or media. Migration needs usually are driven by technological advancement, market conditions or evolving DPW needs.

5.0 Application Programming Requirements

5.1 General Requirements

Provide for delivery of the following from the SCADA integrator:

- PLC application programming.
- OWS Workstations and HMI application programming plant including updates to OWS software screens including communications, runtime, totalizers, and reporting software.

6.0 Coordination and Submittal Requirements

Coordinate the work as follows:

- During design, submit and incorporate DPW comments at major design milestones.
- Provide and conduct routine coordination meetings with representatives of all parties during construction and starting with a pre-construction meeting.
- Facilitate DPW review and adjudicate DPW comments on all submittals.
- Coordinate testing activities.
- Facilitate DPW participation and adjudicate DPW issues in all testing.
- Maintain and coordinate resolution of punch lists for all testing and inspection activities.

Provide the following submittals:

- Design submittals including Schematic Design, Design Development, and Contract Document.

- Component submittals for all contractor furnished components
- Plans showing equipment layouts and locations
- Assembly submittals for all assemblies Cable plans showing cable routing
- Installation details showing equipment and assemble
- Electronic and hard copies of all O&M information and manuals

7.0 Documentation Standards

7.1 Naming and Numbering Standards

Use the tag numbering and naming standards described in Section 2.2.

7.2 Drawings, Control Strategy Descriptions, Data Sheets and Lists

7.2.1 General

Provide design and construction documentation conforming to the following standards. Inclusion of detailed PLC and DCS panel drawings in the Contract Documents is intended to clarify requirements for bidders providing more competitive bids.

When Required	Description
Included in Contract Documents	Loop Diagrams
Preliminary Construction Submittal Prior to Procurement	
Final Prior to Field Testing	
Included in Contract Documents.	Ladder Logic Diagrams
Preliminary Construction Submittal Prior to Procurement	
Final Prior to Field or Factory Testing as applicable	
Prior to Field or Factory Testing as applicable	Interconnection Wiring Diagrams
Included in Contract Documents	Panel Layouts and Schedules
Preliminary Construction Submittal Prior to Procurement	
Final Prior to Field or Factory Testing as applicable	
Prior to Factory Testing	Data Cable Plans
Included in Contract Documents	Typical Mounting and Installation Details
Included in Contract Documents	Control Strategies/Loop Descriptions
Included in Contract Documents	Control System Block Diagram
Preliminary Construction Submittal Prior to Procurement	
Final Prior to Field or Factory Testing as applicable	
Included in Contract Documents.	Programmable Controller I/O/DCS Controller List
Preliminary Construction Submittal Prior to Procurement	

When Required	Description
Prior to Procurement	Instrument Data Sheets
Prior to Installation	Field Cable and Wire Schedule or Plans
Included in Contract Documents	Control Room Layout Floor Plans
Preliminary Construction Submittal Prior to Procurement	
Final Prior to Field Testing	

7.2.2 Drawings Loop Diagrams

Detailed loop diagrams shall be provided for all control loops. Typical diagrams may not be used. At a minimum, loop diagrams shall include content required by ANSI/ISA S5.4 Instrument Loop Diagrams. In addition to the minimum standards set by ANSI/ISA-5.4, the following information must also be included on the loop diagrams.

- Specific location of each device, such as area, panel location, racks number, etc.
- Instrumentation, equipment, and component descriptions, manufacturers, and model numbers.
- Signal ranges and calibration information, including set point values for switches and alarm and shutdown devices
- PLC related items such as Input/Output (I/O) type and address, PLC rack number, PLC slot number, PLC point number, PLC number, and PLC equipment manufacturer and part numbers.

The loop diagrams must depict the complete wiring of each control loop. References to shop drawings or manufacturers' shop drawings for continuation of wiring will not be acceptable except where such reference is to contact inputs or relay outputs. Divide each loop diagram into areas for PLC, panel, and field.

Ladder Logic Diagrams

For discrete control and power circuits provide electrical ladder diagrams. Include devices related to discrete functions that require electrical connections. Show unique rung numbers on the diagram and depict and identify all terminal connections. Show each circuit individually and show names corresponding to other drawings or documentation for circuits entering and leaving an enclosure or panel. Include the following as a minimum:

- Terminals: Location (enclosure number, terminal junction box number, or motor control center number), terminal strip number, and terminal block number.
- Discrete Components:
- Tag number, terminal numbers and location
- Switching Action, set point value and units, and process variable description
- I/O points: PLC/DCS cabinet unit number, I/O tag number, I/O address, terminal numbers and terminal strip numbers.
- Relay Coils:
- Tag Number and its function
- Contact location by ladder number and sheet number

- Relay Contacts: Coil tag number, function, and coil location (ladder rung and sheet number)
- Ground wires, surge protectors and connections

Interconnection Wiring Diagrams

Interconnection wiring diagrams for control panels and PLC enclosures shall be provided. The interconnection wiring diagrams are to show the control or PLC panel internal wiring and the associated interconnections with field elements and equipment. "Typical" diagrams or "typical" wire lists may not be used; show each circuit individually. The diagrams must depict the complete interconnection wiring. References to shop drawings or manufacturers' shop drawings for continuation of wiring will not be acceptable except where such reference is to contact inputs or relay outputs.
As a minimum, the interconnection wiring diagrams will show the following.

- Panel instrumentation and control components’ tag number, description, terminals, scale range, and calibration information (such as setpoints).
- Internal terminal strip number and terminal number assignments.
- Internal wire number assignments.
- General location of devices such as field or panel.
- All point-to-point interconnections with identifying numbers of electrical cable or wire.
- Field element tag number, description, terminals, location (e.g. "FIELD", enclosure, MCC number), and signal range and calibration information (such as setpoints).
- Circuit name or field wire numbers for wires entering or leaving a panel.
- PLC related items such as Input/Output (I/O) type and address, PLC rack number, PLC slot number, PLC point number, PLC number, and PLC components part numbers.
- Overall panel power wiring showing primary source of panel power, voltages, branch circuits, and power connections to panel and field devices.
- Energy sources of devices (field, panel, or otherwise) such as electrical power. Identify voltage and other applicable requirements. For electrical sources, identify circuit or disconnect numbers.

Panel Layout and Schedules

Detailed drawings of the construction and layout of all control panels and PLC/DCS enclosures must be provided. The drawings should show the following.

- Scale Drawings: Show dimensions and location of panel mounted devices, doors, louvers, and subpanels, internal and external.
- Construction Details showing panel NEMA rating, enclosure dimensions, panel configuration (e.g. type of mounting), panel material, internal backplate dimensions, and other construction details.
- Instrumentation and control components schedule include item number, tag designations, nameplate inscriptions, instrument scale, and any other special information and remarks required for clarity.
- Bill of materials indicating item identifier, tag number, description, manufacturer, model number, and quantity.
- Construction Notes: Panel wire color schemes, wire and terminal block numbering and labeling scheme.

If possible, the components schedule and bill of materials should appear on the same drawing as the panel layout.

Data Cable Plans

Provide sufficient documentation to illustrate data cable routing and installation conformance to cable, PLC, communication hardware manufacturer installation specifications and requirements.

Typical Mounting and Installation Details
Typical mounting and installation details shall be developed for all instruments and control system components. To maintain quality and consistency, these details should be used whenever possible. Provide enough detailed information to avoid confusion and prevent field instruments and panels from being improperly mounted, installed, and used. In general the instrument installation should conform to standard industry practices as shown in American Petroleum Institute Recommended Practice 550 (API RP 550), "Manual on Installation of Refinery Instruments and Control Systems" and other standard references such as the "Instrument Engineers Handbook" (B. Liptak, Chilton Book Co) and "Instrumentation Handbook for Water and Wastewater Treatment Plants" (R. Skretner, Lewis Publishers).

Floor Plans of Control Room Layout
Develop floor plans for all new and modified control rooms. Location plans shall be sufficiently detailed so as to allow determination of usability.

Location Plans
Develop location plans which show locations of instruments, panels, and equipment.
Control System Block Diagrams
Provide block diagrams that are more detailed versions of those included in these design criteria and depict the following:

- Locations, interconnection and physical topology of PLCs and computer workstations and their in-plant communications networks.
- Data communications cabling. Show type of cable (coaxial, fiber optic) and connections.
- Individual PLC configuration including number of racks, power supplies, I/O cards, etc.

7.2.3 Control Strategies / Loop Descriptions

Develop standard Loop Specifications as well as existing PLC programs and operator interface and data processing functions. Provide two sets of narratives for PLCs; one set for use before the SCADA upgrade and modifications to support the SCADA upgrade. The narrative shall be a concise, easy-to-follow description of the control sequence, algorithm, and interfaces with other strategies and equipment. Narrative descriptions may be supplemented by logic diagrams.

7.2.4 PLC I/O List and Settings

Develop PLC I/O list using the latest version of Microsoft Excel®. Include all PLC I/O list parameters with the exception of the I/O mapping address (PLCADDR); the PLCADDR, which will be added during application software development.

7.2.5 Instrument Data Sheets

Provide instrumentation data sheets for all instrumentation and panel components. Data sheets provided are to be similar to ISA data sheets, ISA standard ISA-S20 Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves. Data sheets for instrumentation and control components shall include the following information, as applicable:
Instrument tag number

- Instrument type
- Instrument location or service
- Manufacturer and complete model number
- Size and scale range

- Set points
- Materials of construction
- Power requirements
- Mounting type
- Options included

7.2.6 Field Cable and Wire Schedule or Plans

All field wire, cables, and circuits shall be documented either on schedules or drawings. A field cable and wire schedule should include as a minimum the following information:

- Field cable and wire tag/number. Field cable and wire tagging scheme is outlined under "Field Cable and Wire Numbering System" heading.
- Indicate the quantity, type, and size of wire or cable (as applicable)
- Indicate origination of circuit
- Indicate destination of circuit

If drawings are used, include the above information, as a minimum, on the drawings.

8.0 Testing Procedures and Test Documentation

8.1 General

Factory Demonstration Tests, Operational Readiness Tests, and Performance Acceptance Tests are required for all work.
All tests performed may be witnessed by a representative of the City’s staff or their designee. Coordinate schedules and activities associated with all tests with the City’s staff.
Submittal requirements for each set of tests include draft test procedures, final procedures reflecting City review comments and completed test documentation including the initials of the person completing the tests and the signature of the witness.

8.2 Factory Demonstration Test (FDT)

Test fabricated panels, enclosures, or systems at their assembly location (referred to herein as "factory"). Test and verify panel power wiring, panel internal point-to-point wiring, and panel functions such as indicating lights, switch operation, and indicator operation. Simulate inputs and outputs for field primary elements, field final control elements, PLCs, and all other equipment excluded from the test to demonstrate that the panel or system is interconnected and operational. Include PLCs in the test. Correct any deficiencies found prior to shipment of equipment and panels to site. Failed Factory Demonstration Test shall be repeated and may be witnessed by the City.

8.3 Operational Readiness Test (ORT)

Conduct Operational Readiness Test (ORT) to inspect, test, and document that each system or subsystem being commissioned is ready for operation. For well field panels, test each panel separately just prior to startup. Test all loop, power, and interconnection wiring for proper termination and functionality. Complete loop status reports and component calibration sheets for each component. Use loop status reports to organize and track inspection, adjustment, and calibration of each loop and include the following.

- Project name

- Loop number
- Loop description
- Tag number for each component.
- Checkoffs/Signoffs for each component: Tag/identification, installation, termination wiring, termination tubing, calibration/adjustment
- Checkoffs/Signoffs for the loop: Panel interface terminations, I/O interface terminations with PLCs
- I/O Signals for PLCs are operational: Received/sent, processed, adjusted
- Total loop operational
- Space for comments

Component calibration sheet for each active instrument and panel component (except simple hand switches, lights, gauges, and similar items) and each PLC I/O module shall include the following:

- Project name
- Loop number
- Component tag number or I/O module number
- Manufacturer
- Model number/serial number
- Summary of Operational Readiness requirements, for example: − Indicators and
- Recorders scale and chart ranges. − Transmitters/converters input and output ranges. Computing elements' function. Controllers, action (direct/reverse) and control modes
- (PID). − Switching elements, unit range, differential (fixed/adjustable), reset (auto/manual). − I/O Modules: Input or output.
- Calibrations, for example, but not limited to: − Analog Devices: Actual inputs and outputs at 0, 10, 50, and 100 percent of span,
- rising and falling. − Discrete Devices: Actual trip points and reset points. − Controllers: Mode settings (PID). − I/O Modules: Actual inputs or outputs of 0, 10, 50, and 100 percent of span, rising and falling.

Correct any deficiencies encountered during the ORT prior to startup.

8.4 Performance Acceptance Tests (PAT):

Once ORT has been completed and facility has been started up, perform a witnessed Performance Acceptance Test (PAT) for each completed system or subsystem to demonstrate compliance with contract documents. Demonstrate each required function on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis. For wellfield panels, the PAT will be conducted immediately following the deficiency correction for the ORT.

Perform local and manual tests for each loop before proceeding to remote and automatic modes. Where possible, verify test results using visual confirmation of process equipment and actual process variables. Exercise and observe new and existing devices as needed to verify correct signals to and from such devices and to confirm overall system functionality. Test verification by means of disconnecting wires, measuring signal levels, or simulation is acceptable only where direct operation of equipment is not practical.

PAT forms shall include:

- Project name
- Loop number
- Loop functional requirements
- Brief description of the demonstration test
- Cite required test results which will verify proper performance
- Space for signoff by witness

9.0 Operations and Maintenance Manuals

Provide Operations and Maintenance Manuals in electronic form for all work. Provide manuals with enough detail to allow operation, removal, installation, adjustment, calibration, maintenance and procurement of spare parts for each component. Develop manuals in a stepwise process including manual outline, preliminary manual and final manual submittals.

10.0 Training

Provide the following training:

- PLC maintenance and applications programming training for each type PLC provided. Provide standard manufacturer's training classes for five of the City's staff. Include all tuition, travel costs from the Coos Bay area, and per diem costs for all staff for the duration of the training.
- Application programming training for each computer software application provided. Provide standard manufacturer's training classes for five of the City's staff. Include all tuition, travel costs from the Coos Bay area, and per diem costs for all staff for the duration of the training.
- Operations training of the HMI graphical user interface. Provide application-specific training in the use of the graphics provided, report production, trending, historical data collection and storage, and all other custom software and programming associated with this implementation. Include on-site training for up to 15 of the City's staff.

11.0 Spare Parts and Maintenance Service Agreements

Spare parts and maintenance support requirements will be determined during design.

Appendix C Pump Station Facility Design Criteria

Pump Station Facility Design Criteria

Future pump stations will use identical system design as current locations.

Appendix D WWTP Facility Design Criteria

Wastewater Treatment Plants Facility Design Criteria

Future additions to the facility will use identical system design as current location.

Appendix E Pump Station Design Spreadsheet

Item	Pump Station 1	Pump Station 2	Pump Station 3	Pump Station 4	Pump Station 5
Address	690 Front Street	834 1st Street	WWTP Plant 1 headworks	299 S 10th Street	2006 Woodland Dr
Results of Radio Study	Good	Good	Good	Good	Adequate
Current Level Control	PLC MicroLogix	PLC MicroLogix	No Data	No Data	No Data
Suggested Level Control	PLC CompactLogix	PLC CompactLogix	PLC CompactLogix	PLC CompactLogix	PLC CompactLogix
Suggested Network Link	900Mhz Radio	900Mhz Radio	900Mhz Radio	900Mhz Radio	900Mhz Radio
Utilization	High	High	High	Medium	Medium

Item	Pump Station 6	Pump Station 7	Pump Station 8	Pump Station 9	Pump Station 10
Address	400 Kruse	421 N Morrison St	1812 Newmark Ave.	1890 Southwest Blvd.	2699 woodland
Results of Radio Study	Good	Marginal	Marginal	Marginal	No Signal
Current Level Control	PLC Unknown	PLC Unknown	No Data	No Data	No Data
Suggested Level Control	PLC CompactLogix	PLC CompactLogix	PLC CompactLogix	PLC CompactLogix	PLC CompactLogix
Suggested Network Link	900Mhz Radio	900Mhz Radio	900Mhz Radio	900Mhz Radio	Cellular
Utilization	High	High	Medium	Medium	High

Item	Pump Station 12	Pump Station 13	Pump Station 14	Pump Station 16	Pump Station 17
Address	3000 Ocean Blvd.	2366 SE Ocean Blvd.	150 Mill St	999 Lakeshore Dr.	699 6th Street
Results of Radio Study	Adequate	No Signal	Adequate	Marginal	Good
Current Level Control	No Data	No Data	No Data	No Data	No Data
Suggested Level Control	PLC CompactLogix	PLC CompactLogix	PLC CompactLogix	PLC CompactLogix	PLC CompactLogix
Suggested Network Link	900Mhz Radio	Cellular	900Mhz Radio	900Mhz Radio	900Mhz Radio
Utilization	Medium	Medium-High	Medium	Medium-Low	High

Item	Pump Station 18	Pump Station 19	Pump Station 20	Pump Station 21
Address	545 Whitty	321 9th Ave	1465 Old Wireless Ln.	1742 Coos River Hwy.
Results of Radio Study	Good	Adequate	No Signal*	No Data
Current Level Control	PLC Unknown	PLC Unknown	No Data	No Data
Suggested Level Control	PLC CompactLogix	PLC CompactLogix	Relay Logic	Relay Logic
Suggested Network Link	900Mhz Radio	900Mhz Radio	Cellular	Cellular
Utilization	Low	Medium	Low	Low

All radio signal strength readings were measured from the Blossom Hill Repeater site. An omni-directional antenna was temporarily installed at 40ft on the existing tower. Sites were rated “Good” when signal to noise ratio exceeded 30dB, “Adequate” when signal to noise ratios were between 20-30 dB and “Marginal” when signal to noise ratios were below 20dB. While a margin of 30dB is recommended for reliable full bandwidth communications, the nature of SCADA systems is such that occasional data retransmissions do not adversely affect the total system. The antennas used for testing as well as the antenna feed lines were of a temporary nature and the use of permanent antennas and feed lines can increase the signal to noise ratio substantially. The equipment used for the test included 900 mHz spread spectrum radios which do not require a license and are typical for SCADA telemetry systems.

A 900 mHz spread spectrum unlicensed radio system could provide complete coverage of the sites tested with the addition of a repeater in the northern part of town. The repeater antennas and feed lines should be optimized to provide the most system gain that is economically possible. Due to the possibility of other transmitting equipment on the repeater site(s) a band pass window filter should be used to reduce the possibility of harmful interference to the SCADA system. Masts, antenna types and feed line choices should be optimized at all sites to provide the best signal. The 900 mHz band is a shared, non-licensed band, there is no control or protection against interference from other 900 mHz devices or users.

A lower frequency, lower throughput radio network could be designed in a licensed UHF portion of the spectrum. Signals in this spectrum penetrate foliage better and have greater range than the 900 mHz signals, but at a cost of data throughput. Depending on the PLC messaging format, the amount of data requested, and the frequency of that data being requested, a UHF system may provide a more reliable solution but likely with increased latency. A UHF system would require frequency coordination and licensing with the FCC, but operates without competition from other users on the same frequency.

Appendix F WWTP Design Narrative

The controls at the existing plants will be migrated to the new HMI SCADA system via the existing control network at each plant. As new processes are brought online they will be integrated into the plant overall control system.

Appendix G Standard Loop Specifications

LOOP SPECIFICATIONS

The Loop Specifications are divided into the following Sections:

- **Definitions:** This Section defines basic functions and other terms used in subsequent sections (Global Functions Modular Functions and Unit Processes).
- **Global Functions** required for all applicable variables and are not listed in the Unit Process Loop Specifications.
- **Modular Functions** include extensive references to the definitions and are included by reference in the subsequent Unit Process Loop Specifications.
- **Unit Process Loop Specification** are included for each Unit Process and include extensive references to Definitions and Modular Functions.

DEFINITIONS

VARIABLE:

Any signal (discrete, analog, or pulse frequency), (input, output, or calculated). Pulse frequency signals are a type of analog signal. Provide the same processing and functions for pulse frequency signals as are provided for analog signals.

DISPLAY (Tag):

Display variables on appropriate Human Machine Interface (HMI) displays. Display status for discrete variables such as ON/OFF/FAIL status for motors and OPEN/CLOSE/FAIL status for valves. Display value, and totalizer value when appropriate, for analog variables such as process variables, Set points, drives speeds, and valve positions. To prevent clutter and to ease operation, some displayed variables will not normally appear on displays but will be accessible through easily identifiable point-and-click targets. Runtime and totalizer counters are an example of variables that might not normally appear.

PRESENT:

A discrete signal is present when the contact producing the input is closed or the signal exceeds its true state value.

TRUE:

A condition is true when it exists. The open/closed (or high/low) state of a discrete signal representing that condition will depend on the configuration of the device producing the discrete signal.

ALARM:
Sound the alarm tone, indicate the alarm condition on appropriate HMI displays, and add to the HMI alarm summary display. Upon acknowledgement, silence the alarm tone and indicate the alarm condition on appropriate HMI displays and the alarm summary display. Remove acknowledged alarms from the alarm summary once they are cleared. Log alarm occurrence, acknowledgement, and clearance in the alarm log file. Unless otherwise noted or shown, provide alarm logic that resets automatically when the acknowledged alarm condition clears. Display alarms as follows:

- Display flashing yellow when Alarm is present and is Unacknowledged.
- Display steady yellow when Alarm is present and is Acknowledged.
- Display ceases when Alarm clears and is or has been Acknowledged.

ON (RUNNING):
The equipment or adjustable speed motor is ON when the equipment or motor drive ON status contact is closed. A constant speed motor is ON when a motor normally open auxiliary motor contact (M-Contact) from the motor is closed. For adjustable speed motors, use the ON status variable or contact from the drive that is TRUE when the drive is in operation.

TREND:
At intervals appropriate for the variable being trended, place the current value of analog variable, along with a time and date stamp, into a historical trend file for that variable. Display the trend on selectable HMI screens with appropriate scaling and units.

CLOSE FAIL:
A valve is commanded-to-close, but is not confirmed closed within a preset time. Unless otherwise noted, a valve is confirmed closed by receiving Close limit switch contact from the valve.

POSITION FAIL:
A modulating valve is commanded to a Set Point position, but the valve is not confirmed to be within a preset percentage of Set Point within a preset time.

OPEN FAIL:
A valve is commanded-to-open, but is not confirmed open within a preset time. Unless otherwise noted, a valve is confirmed open by receiving OPEN limit switch contact from the valve.

RUN FAIL:
A motor is commanded-to-run, but is not confirmed running within a preset time. Unless otherwise noted, running is confirmed by receiving an ON status M-contact from the motor's starter.

START:
Issue a maintained Run command.

STOP:
Cease the maintained Run command.

TOTALIZE:
Integrate flow type variable with respect to time. Unless otherwise noted includes password protected operator reset that sets the totalized value to zero.

ELAPSED RUN TIME:
Calculate the total time that a motor or piece of equipment has been in operation. For equipment and constant speed motors, use starter M-contacts to detect when the equipment or motor is running. For adjustable speed motors, use the ON status variable or contact from the drive that is TRUE when the drive is in operation. For valves, calculate the time that the valve is open. Unless otherwise noted, include password protected operator reset that sets elapsed run time to zero.

CYCLE COUNT:
Count the number of cycles a piece of equipment, valve, or motor undergoes. For equipment and motors, one cycle is defined as the transition from OFF to ON. For valves, one cycle is defined as the transition from CLOSED to OPEN.

SINGLE-ACTION INITIATION:
Provide logic to perform a sequence of events after receiving a single initiation command. For example: Provide logic to complete a backwash sequence upon receiving a backwash initiation command.

TWO-MODE FEEDBACK CONTROL:
Maintain a process variable at a Set Point value by means of feedback control of a control variable such as pump speed or valve position using both proportional and integral action. During startup tune the loop by adjusting proportional band and integral time settings. Provide a Set Point Deviation Alarm that is activated when the process variable deviates by more than x percent from Set Point for a sustained time. Provide password protected access to tuning parameters such as proportional band and reset rate.
Parameters Defined in the Specific Unit Process Loop Description:
Process Variable.
Process Variable Set Point.
Controlled Device.
Set Point Deviation Alarm Set Point.

NETWORK CONNECTED PACKAGE SYSTEMS:
Network connect package systems are defined as those package control systems that are connected to the Ethernet network.

GLOBAL FUNCTIONS TAGS:

Provide unique tags for each variable based on the following specification Format:

10	5	AFD	1	SF
Unit Process	Loop Number	ISA designation of process and function	Unit Number	Clarifying Abbreviation

Refer to Design Criteria for Unit Process number assignments and conventions.

AUTOMATIC (PLC) CONTROL:
Automatically sequences AVAILABLE equipment in accordance with these loop specifications.

MANUAL (PLC) CONTROL
For equipment automatically sequenced by a PLC, provide AUTO/MANUAL selection and remote manual control of AVAILABLE equipment from HMI workstations. Use manual control pop-up displays to reduce clutter. For equipment not sequenced by a PLC, provide remote manual control of AVAILABLE equipment from HMI workstations. Use manual control pop-up displays to reduce clutter.

BUMPLESS TRANSFER
Configure all "software" Manual/Auto switches to provide "bumpless transfer."
Manual to Auto Transition:

a) Once the transition occurs, immediately start the device if the Auto Mode so commands.
b) For modulating devices, initially maintain the last manual control variable output value on transition to Auto. After the transition, enable the automatic control algorithm to commence incrementally from the final manual value.

Auto to Manual Transition:

a) If a device has been running in Auto, configure so it continues to run once placed in Manual.
b) If a device has not been running in Auto, configure so it does not run once placed in Manual.
c) If an adjustable speed device has been running at a certain speed in Auto, configure so it runs at the same speed once placed in Manual.
d) For all modulating devices, maintain the last analog control variable output value on transition to Manual.

RECOVERY AFTER A POWER OUTAGE
For facilities with generators, provide a Generator Load Display to be used by operators to manage generator load as follows:

1. Place each individual load (Pump, etc.) equal to or greater than 75 kW in load on a separate line with columns for "Load" in kW and "Generator Status."
2. Lump remaining loads into a single "Base Load" line at the bottom of the table.
3. Use submittal information to determine actual load values.
4. Work with the Owner to establish which loads "Generator Status" will initially be

"Enabled" and which will be "Disabled." Refer to Section 26 32 13.13, Diesel Engine Generator Set, Supplement , Table 1 for load enabling priority.

5. Provide password protected HMI editing of Load Entries and Toggling of the Enabled/Disabled Generator Status for each load. Disallow toggling and permanently Enable the Status of the "Base Load" line.
6. Calculated and prominently display on each page of the Generator Load Display the "Total Generator Load" value which is the sum of all currently Enabled Loads.

Use the Generator Status for each load and power source information such as Normal Power Available, Power Failed, Generator ON, OPEN/CLOSE positions of MAIN, TIE and Generator breakers from the Generator PLC to manage generator load as follows:

1. Except for the "Base Load," disable all loads included on the Generator Load Display on power failure.
2. Once the generator power is available, wait for an adjustable delay set between 15 and 60 seconds. Sequentially Enable loads whose Generator Status is "Enabled," waiting for an adjustable delay set between 15 and 60 seconds between enabling loads. Refer to Section 26 32 13.13, Diesel Engine Generator Set, Supplement Table 1 for load enabling priority.
3. Once utility power is restored, disable all loads except for the "Base Load." Once the Tiebreaker OPEN and Main Breaker CLOSED status is confirmed, wait for an adjustable delay set between 15 and 60 seconds. Sequentially Enable ALL loads waiting for an adjustable delay set between 15 and 60 seconds between enabling loads. Refer to Section 26 32 13.13, Diesel Engine Generator Set, Table 1 for load enabling priority.

Make provisions for easy modification of the power recovery sequence for the addition of a second utility feed to recover from a power outage for the following scenarios:

1. Utility Source 1 (Bus A) fails. Generator powers loads using future load enabling table.
2. Future Utility Source 2 (Bus B) fails. Generator power loads using future load enabling table.
3. Both Utility Sources 1 and 2 (Bus A and B) fail. Generator powers both loads using future load enabling table.

Refer to Section 26 32 13.13, Diesel Engine Generator Set for generator monitoring, control and historical data handling requirements. Coordinate with the generator supplier in developing generator displays and historical data processing. Make all generator system displays and data available on the plant process control SCADA network.

DISPLAY (TAG)
Display all discrete and all analog variables.

ADJUSTABLE PARAMETER ACCESS
Provide for HMI operator entry and adjustment of parameters designated as "operator adjustable" or "operator entry."
Provide password protected HMI display of and entry/modification of all other adjustable parameters including, but not limited to, Set Points, tuning coefficients (for example proportional and integral), timer presets, control sequence presets, and alarm trip points.
Present these parameters in an efficient easily navigated format. Provide adequate information to

allow the facility maintenance staff to easily identify each variable. The intent is to allow the maintenance staff to tune facility performance and operation without having to alter the PLC program.
Provide for PLC programmer entry and adjustment of parameters designated as “preset” or “preset but adjustable.”

NUISANCE ALARM SUPPRESSION
Provide nuisance alarm suppression by conditioning alarm signals. For example disable all but selected alarms when power is off, and include startup delays, momentary excursion delays, and contact bounce delays. Suppress dysfunctional alarms during and immediately following power outages.

ALARM PRIORITIZATION
Prioritize alarms into two levels: critical and noncritical. Provide separate colors and audible tones for critical and noncritical alarms. Use red for critical alarms and yellow for noncritical alarms. Log but don’t alarm events that do not require an immediate action.
Categorize alarms into unit process categories.

DISABLE ALARM PROCESSING:
1. Selectable by the supervisor on a point-by-point basis.
2. Does not prevent point status from being shown on graphic process displays.
3. Maintain summary of disabled alarms

RUN FAIL ALARM
Provide run fail alarms for each motor. Upon motor run fail, remove the run command.

EQUIPMENT OR MOTOR FAIL ALARM
Provide fail alarms for each fail condition. Upon fail, remove the run command.

OPEN FAIL ALARM
Provide open fail alarms for each nonmodulating valve with OPEN position feedback. Upon open fail, remove the open command.

CLOSE FAIL ALARM
Provide close fail alarms for each nonmodulating valve with CLOSED position feedback. Upon close fail, remove the close command.

POSITION FAIL ALARM
Provide position fail alarms for each modulating valve with position feedback.

TOTALIZERS
Provide 6-digit totalizers for all flow type variables [flow, chemical feed rate, etc.]. Select least significant digit values that result in 0.5-2.0 counts per minute at full-scale flow.

ELAPSED RUN TIME INDICATORS
Provide elapsed run time counters for each motor and electrical equipment item. Include open

position for valves with either electric or pneumatic operators.
Increment counters after each tenth of an hour of operation. Maintain a nonresetable 99,999.9 hour cumulative counter that rolls over to zero after 99,999.9 hours. Indicate runtime counters on appropriate HMI displays. Perform all logic in the PLC.

CYCLE COUNTERS
Provide cycle counters for each motor and electrical equipment. Include OPEN/CLOSE (non-modulating) valves with either electric or pneumatic operators.
Maintain a nonresetable 99,999 start cumulative counter that rolls over to zero after 99,999 counts. Indicate counters on appropriate HMI displays. Start counter logic will be performed in the PLC/RTU.

ALARM CONTACT INPUTS
Alarm: Discrete contact inputs representing abnormal conditions or identified as alarms on the P&IDs.

HISTORICAL DATA COLLECTION
Trend all required analog variables storing at appropriate time intervals.
Maintain storage of required data files for designated time.
Provide a procedure for archiving to CD or DVD trend, log, and alarm summary files on a monthly basis.

Reports: Reports shall be provided as required, examples include:
1. Monthly Operations Report.
2. Monthly Equipment Runtime Report.
3. Monthly Chemical Use Report.

Reports Content:
1. Report data as identified by the Owner.
2. Minimum, maximum, and average for each process variable over the time period identified by the report.
3. Monthly totals in the case of flows, runtimes, or other data required.

COMMUNICATIONS WATCHDOG (applies to any PLC or SCADA link).
Create a watchdog function to alarm at the HMI if any of the PLCs do not communicate within a preset time or when any PLC is unable to communicate with any I/O base. To avoid nuisance alarming, make the preset at least three times the nominal update period for the specific device. This nominal update period will be noted during startup. Provide at the HMI a means of disabling communications alarming for use by the operator during extreme conditions such as storms or network outages. Additionally, when communications watchdog alarms is disabled, display a message at the HMI indicating this condition.
For PLC controlled equipment operating under HMI Manual control, maintain equipment in the last state following a loss of communications. For PLC controlled equipment under automatic PLC control, maintain automatic equipment control and sequencing during a loss of communications.

ETHERNET NETWORK CONFIGURATION

1. Topology: HIPER-Ring. Disable Rapid Spanning Tree protocol.
2. Flow Control: Enable IGMP snooping.
3. Segmentation:
    a. If necessary to maintain I/O and HMI update frequencies, use separate EBNT modules on separate VLANs for I/O and HMI functions.
    b. Keep all messaging, including HMI messaging, on a single VLAN.
4. Access Control:
    a. Limit SNMP access to that required for network management displays.
    b. Limit HMI server access to that required for supporting HMI functional requirements.
    c. Limit access to Remote I/O bases to that required for supporting I/O functions.

HMI Password/Security:

Provide password protected HMI access to prevent unauthorized users from making changes from operator workstation(s).
Provide the following Security Levels:

1. Engineer Level: Access to all data parameters.
2. Supervisor Level: Access to alarm limits, alarm inhibit status, scan inhibit status, and all operator level functions, as well as all adjustable parameters.
3. Operator Level: Set Points, control commands and all operator adjustable parameters.
4. Display Level: No changes allowed.

PACKAGE SYSTEMS HMI AND PLC SOFTWARE INTEGRATION AND DEVELOPMENT

Fully integrate the monitoring and control of network connected package systems into the HMI so that I/O, tag numbers, graphic colors, the operator interface including pop up screens, monitoring and control functions and global functions are, within the package system's process monitoring and control capabilities, as shown, noted and specified, and consistent with those provided for the rest of the plant. Fully implement, to the degree possible, global functions.

AFD MONITORING AND CONTROL INTEGRATION

Fully integrate the monitoring and control of connected AFDs into the HMI so that I/O, tag numbers, monitoring and control functions and global functions are as shown, noted and specified. Fully implement relevant global functions.

FUTURE EQUPMENT

Where future equipment is shown or noted in contract documents, provide all PLC/HMI code and PLC/HMI tags and graphics for the future equipment. Indicate the unavailable status of all future equipment on HMI screens by means of distinctive color and text. Set the HMI tags off scan and disable alarming for all future equipment. Disable PLC logic for future equipment.

ESS FUNCTIONS

As shown and noted, and in accordance with Electronic Security Systems (ESS) specifications.

MODULAR FUNCTIONS ALTERNATION

Change assignments (alternate) a group of controlled equipment in a predetermined automatic sequence.

Provide a LEAD selector for each controlled equipment group.
When the LEAD selector is in the AUTO position, provide alternation that is triggered automatically.

See Specific Unit Process Requirements for:

Controlled Equipment Group: <List of equipment groups.>
Group Selection Criteria: <List selection criteria for each group.>
Alternation Trigger: <List alternation triggers for each group.>

ANALYSIS ALARM
ALARM: Concentration, High and Low. Disable inappropriate alarms such as low turbidity.

FLOW ALARM
ALARM: High and Low Flow.

LEVEL ALARM
ALARM: High and Low Level.

CHEMICAL LEAK ALARM
ALARM: [Change-in-Level]/[Elapsed Time While All Pumps Off] > Preset.
Change in Level = [Level] – [Level at Time the Last Chemical Feed Pump Stopped]
Elapsed Time While All Pumps Off = [Time since Last Chemical Feed Pump Stopped]
Disable and Rest the Alarm while any chemical feed pump on.

PRESSURE ALARM
ALARM: High and Low Pressure.

CURRENT ALARM
ALARM: High Current.

SPEED ALARM
ALARM: Low Speed.

TEMPERATURE ALARM
ALARM: High and Low Temperature.

WEIGHT ALARM
ALARM: High and Low Weight.

CHEMICAL SOLUTION MASS FLOW

Use Solution Demand for Chemical Solution Mass Flow.

DOSE CONTROL
Accept operator entry of Dose. Calculate Demand using: [Solution Demand] = 34.775 x [Dose] x [Treated Stream Flow]/[Solution Strength] Solution Demand = [lbs/hr] of solution
Dose = [mg/l] of chemical
Treated Stream Flow = [mgd]
Solution Strength = [%] by weight of chemical in the chemical solution

Provide for operator entry of Dose and Solution Strength for each chemical.
Calculate Chemical Feed Pump Speed Adjust Output as follows:
[Pump Capacity] = 500.7 x [Density]/[Calibration Factor]
[Chemical Feed Pump Speed Adjust Output] = 100 x [Solution Demand]/[Pump Capacity]
Density = [g/cm3]
Calibration Factor = [Minutes/Gallon] of Solution
Chemical Feed Pump Speed Adjust Output = [%]
Solution Demand = [lbs/hr] of solution
Pump Capacity = [lbs/hr] of solution

Provide for operator entry of Calibration Factor for each chemical feed pump.
For chemical addition of the finished water (FW) line into the Clearwell, calculate Treated Stream Flow as follows:
Treated Stream Flow = [Raw Water Flow] x [Recovery Factor]/100
Recovery Factor = [Membrane Filtration System Discharge Flow]/[Raw Water Flow]
Provide for operator adjustment on Recovery Factor. Initially set Recovery Factor at 95%

******END OF LOOP SPECIFICATIONS******

City of Coos Bay SCADA Master Plan

Supplement A – Visualization Package Comparison

Summary: each of the major visualization packages has its unique position in the marketplace based on what they felt was the most advantageous to the client base served; however, they also all contain the same basic elements and concepts. The application for the City of Coos Bay is one that does not require any specialty software that either of the big three providers offer exclusively. Each package, properly developed, would provide an application that performed well at comparable prices. TAG recommends using the **Factory Talk View SE** HMI application based on its coordination with the PLC platform that the City will be using (RSLogix5000) and the ease of integration that it would afford. A pricing comparison for unlimited tagging is included in this document to serve as a basis of financial comparison. It is extraordinarily difficult to compare the pricing with the packages in any form other than unlimited and may be overkill for the project at hand. Each of the three product packages offers lower tag/screen pricing platforms and is scalable as requirements grow.

Factory Talk SE [recommended]

- Distributed and scalable architecture that supports distributed-server/multi-user applications with redundancy
- FT View is part of the scalable and unified suite of monitoring and control solutions
- Premier integration with Logix-based controllers allows faster and more accurate system implementation
- System-wide TAG reuse: Maximize productivity by directly accessing tag information in the ControlLogix controller. Define tags once and use multiple times throughout the system without the need to define HMI tags
- Security tools
- Alarm/event timestamp
- Redundancy
- Scalability
- Common Services Platform: Unique data is created once then re-used

Proficy HMI/SCADA

- Flexible/scalable integrated solution that provides superior process visualization, data acquisition, analytics and supervisory control of your operations
- Distributed Client/Server architecture
- Utilizes Thin Client Capability leveraging Microsoft Terminal Services Client

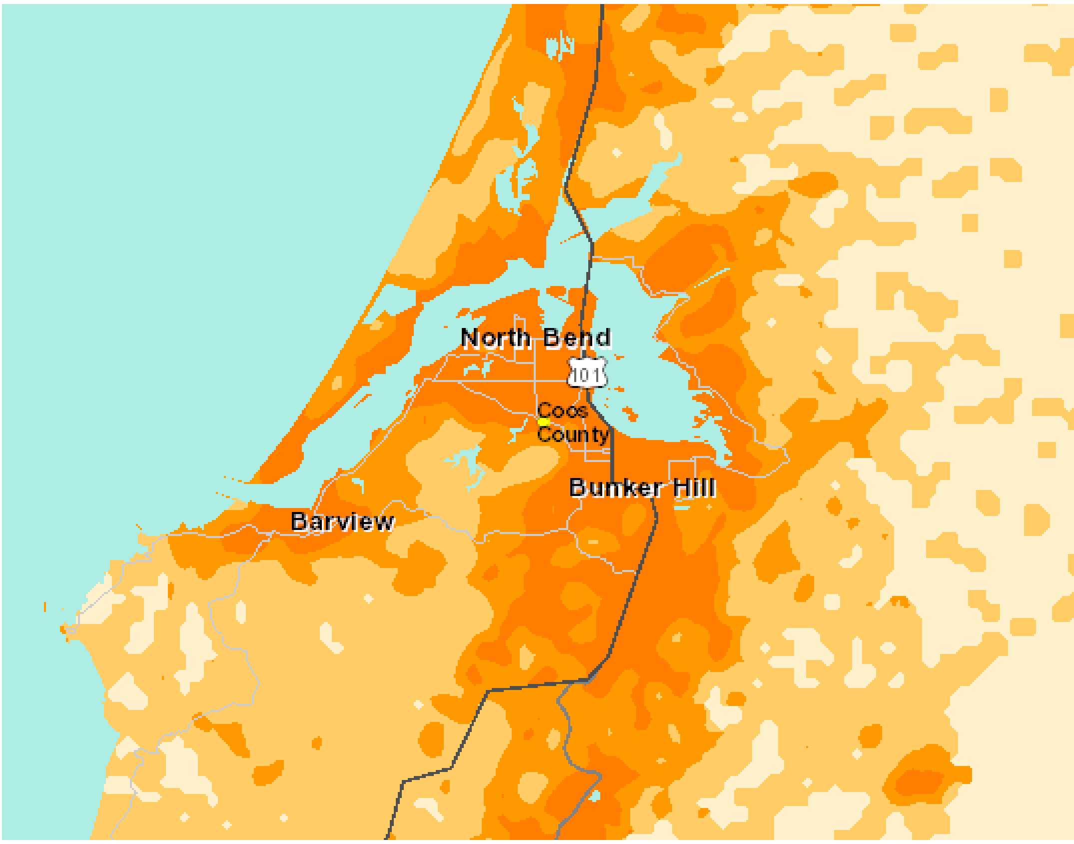
- Advanced Failover Database Synchronization and Alarm Synchronization
- Integrated Change Management software

Wonderware System Platform

- Flexible Component-based development
- Centralized development, deployment, and maintenance
- Scalable architecture
- Comprehensive Alarm Management
- Object-based development

	Wonderware System Platform	**Rockwell FT VewSE**	**GE iFix Plus SCADA**
Licensing	Tags	Displays	Tags
Development Package	4400	2330	3400
Redundant Server Package	14000	27950	23000
Sample 5 client package	20000	11650	13635
Historian	8000	7500	11200
	$46,400	**$49,430**	**$51,235**

Supplement B - AT&T Coverage Map



Voice Coverage Legend

- Best
- Good
- Moderate
- Partner
- No Service Available

3G/Mobile Broadband Coverage

Show 3G Coverage

Important Information About the Coverage Map

Map may include areas served by unaffiliated carriers, and may depict their licensed area rather than an approximation of the coverage there. Actual coverage area may differ substantially from map graphics, and coverage may be affected by such things as terrain, weather, foliage, buildings and other construction, signal strength, customer equipment and other factors. AT&T does not guarantee coverage. Charges will be based on the location of the site receiving and transmitting the call, not the location of the subscriber.