UiT THE ARCTIC UNIVERSITY OF NORWAY

School of Business & Economics

Commercialization of Energy Recovery Micro-Turbine Technology

Technical and Market development study for the product developed by QRRNT AS

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Masters' Thesis in Business Creation and Entrepreneurship – June 2018

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To,

My Mother & Father,

Your sacrifices have allowed me to grow into what I am today, and for that I am forever grateful.

Acknowledgement

This entire Masters' wouldn't have been possible had it not been for the support of my lovely wife Bhoomi. You are a superwoman, who took up the responsibility of supporting not only yourself, but our son, your job, and me, single handedly. It was because of your unwavering support that I was able to live in a different city and pursue my Masters' with a strong focus and determination. I dedicate this thesis to you.

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Abstract

This thesis explores the avenues of commercialization for the energy recovery product developed by QRRNT AS, specifically for land based industries.

This thesis has four chapters which are co-related. The Introductory chapter introduces QRRNT, its product, and the importance of the topic. This chapter gives an outline of the entire thesis to follow. It discusses the research questions that the thesis is attempting to answer and the choice of relevant theoretical frameworks adopted for each of the sub-chapters. Methodology adopted to gather data and its relevance is discussed subsequently. Thereafter, the Innovation study attempts to study the product's innovativeness and diffusion potential. Technical know-how, innovativeness, Techno Economic Evaluation & Intellectual property considerations with respect to the product are explored in this chapter. Then the impact of the Innovation study is used to determine how to best position and place the innovation in market so that maximum adoption of the innovation can happen in the least amount of time. This is discussed and elaborated thoroughly in the chapter of Market Study. The chapter starts with the macro analysis which affect marketing activities for QRRNT. Thereafter, the need for a comprehensive Marketing Strategy Model is discussed and it goes on to derive the same. Its implications are discussed subsequently. Finally, the chapter ends with discussing other functional strategies and discussion on competitors. Thereafter a concise business plan is presented as the final chapter. Chapter-wise conclusions are provided at the end while the conclusion for the entire thesis as a whole is provided in the Introduction.

The findings show that QRRNT has an excellent chance of diffusion of its innovation. The product is unique in many respects and provides a previously unexplored source of energy recovery for industries. The main factor that can inhibit the innovation diffusion is the ancillary costs associated with this innovation. QRRNT must also consider Internationalization and lowering production costs, to better target markets which get more 'bang for the buck' in terms of energy and environmental savings. Thus, QRRNT has to arrive at a good combination of geographic location, capital costs, electricity costs, environmental impact & economic impact to maximize its chances of innovation diffusion. This will help QRRNT identify potential customers and the ones that will be most likely to adopt it.

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1 Introduction

The role of universities is ever evolving. In addition to them being cornerstones of education and research, they are also now expected to be catalysts for change in the economic context. The trend is to provide assistance for research ideas which has the potential for commercialization. Figure 1, from the Research Council of Norway, shows that, increasingly, an idea is viewed through the prism of the following for activities. The *need for research* & *research activities* for the *Research components* of the prism, as well as, *benefit to Society* & *benefit to the company*, which form the *Commercial components* of the prism. Thus, Governmental policies and funding bodies are systematically aligning their research grants with ideas that are pre-disposed towards its commercialization.

Figure 1: Research & Commerce go hand in hand (extracted from forksningsradet.no)

Traditionally Oil & Gas sector has been a huge driver of economic growth and employment in Norway. With the rationalization (or crash?) of Oil prices, countries like Norway are looking for new avenues to boost their economic and employment activity. Compared to its Nordic neighbours, Norway fares very poorly on the start-up as a catalyst for value creation (Techcrunch, 2016). To give a snapshot, Nordics account for only 8% of the European GDP, but account for a staggering 50% of the European start-ups that exceed USD 1 Billion in valuation (KPMG, 2017). Thus, Norway has a lot of 'catching-up' to do compared to its Nordic neighbours.

Thus, it becomes imperative that the universities take an *entrepreneurial turn* (Foss & Gibson, 2015) to add economic value in new spheres of industrial & economic activity. This can be achieved by two means, *Academic Entrepreneurship* & *Entrepreneurial Education* (Foss & Gibson, 2015). Academic Entrepreneurship focuses on the commercialization of knowledge and research findings whereas Entrepreneurial Education focuses on building entrepreneurial competency thereby resulting in potential increased economic activity.

The Business Creation & Entrepreneurship (BCE) program at UiT-The Arctic University of Norway provides an opportunity on both fronts viz. Academic Entrepreneurship and Entrepreneurial education to commercialize research and development not only in the University context, but help start-ups successfully transition from idea to market. This Masters' thesis is an example of *Entrepreneurial Education* in action as it focusses on commercialization and related issues for a real-world start-up.

QRRNT AS is a Norwegian start-up established in early 2017. It is headquartered in Trondheim. It has its offices in the incubator space called NTNU Accel. At present, there are 4 employees. More details on the company structure is attached in Appendix 1. They have developed a novel energy recovery micro-turbine which opens up a previously untapped avenue of energy recovery for energy intensive & polluting industries. This micro-turbine recovers energy from flowing water in pipes which otherwise goes waste. Energy is recovered from excess pressure and flow from running water (or any fluid in principle) through pipes. More details of the technology are covered in the Innovation study.

1.1 Importance of Topic

With rising capital costs in investments to exploit available energy resources combined with detrimental environmental effects to the environment, energy production has become a complicated issue. Add to that, the low price of crude oil and the economic incentive of increasing production, then the focus aptly changes from energy *production* to energy *efficiency*. Energy *recovery* can be considered as a sub-set of energy efficiency.

It can be useful to understand the energy efficiency technology adoption in terms of drivers and barriers. Energy efficiency, especially in manufacturing sector, has been recognized as a focus area since the share of manufacturing industries in greenhouse gas emissions is huge.

The drivers of energy efficiency can be broadly split into Organizational, Economic, Market, Policy, and Firm size (Solnørdal & Foss, 2018). Despite having clear advantages, and so many drivers for energy efficiency, the permeability and diffusion of energy efficiency (and by extension energy recovery) technologies has been abysmally low (Reddy, 1991). Like drivers for energy efficiency, barriers for energy efficiency have also been identified. They can be categorized into Economic non-market failure, Economic Market failure, Behavioural, Institutional, Organizational & Physical (Chai & Yeo, 2012). Discussion of Drivers & Barriers on energy recovery is beyond the scope of this treatise and therefore not discussed further. One more observation is that, even if the competition is considered, this particular type of energy recovery technology has also not permeated 'en masse' as on date.

A start-up like QRRNT has its own set of challenges in terms of financial and personnel resources and limited window of opportunity for commercialization. It is already dealing with many unknowns as far as marketing and customers are concerned. It becomes even more complex and difficult, when on top of that, a start-up has to go through this labyrinth (shown in Figure 2) of other factors like energy drivers & barriers which can either assist or inhibit their product's commercialization.

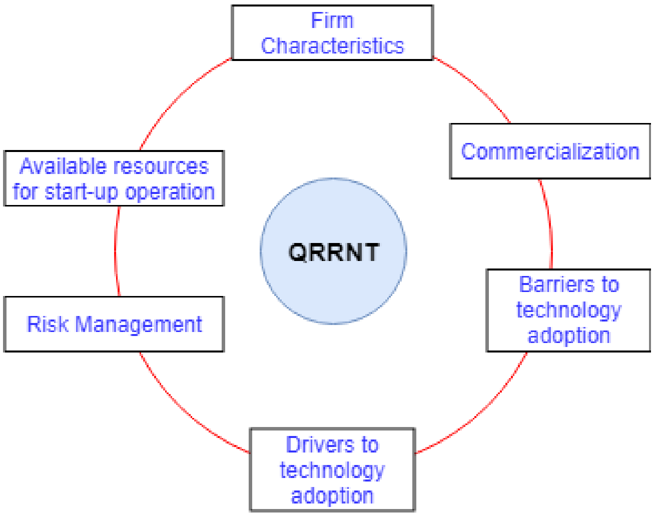

Figure 2: The QRRNT labyrinth of selected factors affecting commercialization

This thesis is written from the view point of a start-up and thus the commercialization strategy developed for QRRNT takes into account the interplay of the drivers, barriers, macro-environment, economics, market etc. at a grassroot level. It is hoped that the commercialization strategy presented here can be taken as a roadmap for other start-ups who have developed an industrial product. QRRNT considers its product novel with its specific set of advantages and hopes to be the first to actively commercialize its energy recovery technology.

1.2 Research Question

The primary research question that the thesis will answer is

Which is the best path for QRRNT to commercialize its product innovation considering its Innovation and Market characteristics?

Answering this question will touch upon all aspects and all chapters covered in this thesis. First it will begin by understanding the technology and assessing its innovation *diffusion* potential. Then other factors apart from the 'product' will be analysed as a 'package'. The sub-research question that the innovation chapter will try to answer is

Which innovation framework(s) should QRRNT use to correctly position its innovation to ensure successful commercialization?

Understanding the innovation and its positioning will pave the way for approaching the market which is done in the Market study. In the market study many factors are analysed, with the ultimate goal of developing a Marketing Strategy Model for QRRNT. The sub-research question that the market study will try to answer is

Which marketing strategy will ensure QRRNT's rapid commercialization?

A concise Business Plan is later discussed marking the end of this thesis. The objective of the business plan is to find out the pains and the needs of the prospective customer, give an estimation on profits, the market, and associated risks for this undertaking.

Thus, the 'birds-eye' view of the objective is to ensure that any strategy discussed in any of the chapters in the thesis is with a focus on commercializing the product as soon as possible, while taking cognizance of the risks and challenges along the way.

1.3 Choice of Theoretical frameworks

A summary of the frameworks used in this thesis is given in Figure 3.

1.3.1 For the Innovation Study

For a start-up, *codification*, *ranking*, or *classifying* innovation serves little to no purpose. If an innovation is considered radical, incremental, or disruptive, is of no use to a start-up, if there are no customers for it. Therefore, innovation theories that focus on innovation adoption or *diffusion* are selected to analyse the innovation positioning. They are discussed next.

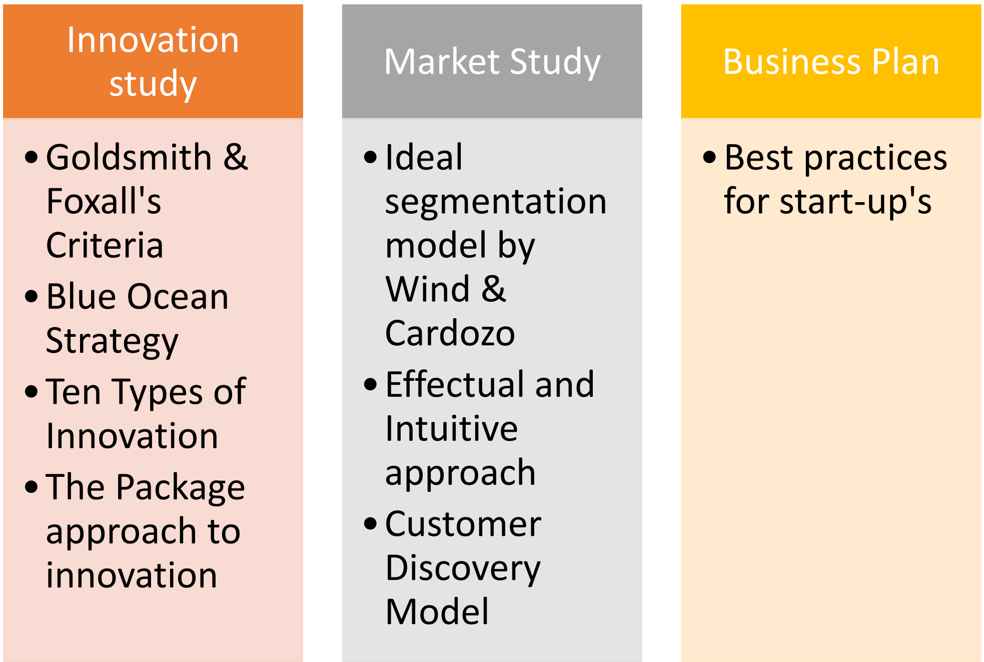

Figure 3: Theoretical Frameworks employed in this thesis

Goldsmith & Foxall's Criteria

This criterion is a simple yardstick to *measure* innovativeness. What does 'new' mean? To argue that something is new or innovative, it must have at least three qualities; *Recency*, *Originality & Similarity* (Goldsmith & Foxall, 2003). As one might say that it is a 'new' car, the innovation must be 'recent' in its category as well as its market. A thing can be new, but not original. To highlight its innovativeness, it must be original. Thus, for a car, the statement changes to not only being a new car, but a car that uses a fuel injection system (for e.g.). Finally, to stand out completely, it must be dis-similar to comparable products. Thus, it must be a new car which for the *first* time uses a fuel injection system. Thereby implying that no other car in the market uses the same technology.

Thus, a product's perceived newness can affect its innovation diffusion in three ways, viz. *Behavioural*, *Global Trait*, *Consumer Innovativeness*, & *Domain Specific Innovativeness* (Goldsmith & Foxall, 2003). The behavioural perspective classifies the consumers as innovators or non-innovators depending on their purchase of a new product. Global Traits is identification of personality traits which identify someone as a 'Creative and original' person. This might *not* be applicable or an important parameter for innovation *diffusion*. Consumer Innovativeness is an attempt to identify the consumer or a group of consumers who are the 'early adopters' or the 'new brand tryers' of an innovation. Domain specific innovation is identification of innovative consumers in a specific domain. This is can be used as a differentiator in perceived newness of an innovation.

Blue Ocean Strategy

"Competing in overcrowded industries is no way to sustain high performance. The real opportunity is to create blue oceans of uncontested market space" (Kim & Mauborgne, 2004).

This succinct statement summarizes what the Blue Ocean Strategy is all about. A red ocean is akin to an ocean full of sharks (metaphor for competitors), and infighting between themselves leads to a lot of bloodshed thereby leading to a 'red' ocean. Blue ocean is the exact opposite, a space to call one's own.

A red ocean means that one has to compete in existing market space, beat the competition, exploit existing demand, being tied to the value/cost trade-off and align the entire company's activities with either the choice of differentiation *or* low cost. Thus, for a start-up, it is a costly proposition along with drainage of time and resources.

In contrast, blue ocean aspires to create uncontested market space by making the competition irrelevant. In blue oceans one can not only capture but *create* new demand. It also has the added advantage of breaking the value/cost trade off and one can concentrate the activities of a firm in pursuit of differentiation *and* low cost.

Since this theory places the innovation positioning and market positioning together, this theory is used to analyse innovation positioning for QRRNT.

Ten Types of Innovation

"The most certain way to fail is to focus *only* on products. Successful innovators use many types of innovation" (Keeley, Walters, Pikkel, & Quinn, 2013).

This theory approaches the successful diffusion of innovation through an eco-system perspective. This approach allows one to 'diagnose' as well as 'enrich' innovation. It identifies ten attributes (or framework components) to systematically analyse and avoid errors of omission. The attributes are arranged in a way that on reading the attributes from left to right involves staying away from the customers to being right in the middle of customers and end-users. The first set of attributes beginning on the left-hand side are the *configuration* attributes. They include *Profit Model*, *Network*, *Structure & Process*. In the middle lies the *offering* attributes, and they include *Product Performance* & *Product System.* At the end one has the *experience* attributes which include *Service, Channel, Brand* & *Customer Engagement.*

Forcing an innovation through the sieve of so many attributes forces the management to think realistically as to how their innovation is positioned in the market. Not all attributes are to be fulfilled to ensure successful innovation diffusion, but the more attributes are filled, the chances of an innovation being successful increases exponentially. Understanding this framework thoroughly helps identify gaps and opportunities. Attributes in a nutshell, explaining the ten types of innovation are given in Table 1.

Innovation Type	Examples	Tactics
Product	Corning (tough thin glass), Intuit (tax software)	New functionality, ease of use, customisation, performance, safety, style, environmental sensitivity
Product system	Microsoft (Office), Mozilla (Firefox)	Complements, extensions, plug-ins, modular system, bundling, platforms
Service	7-Eleven (Japan: bill payment), Zappos (customer-centric culture)	Loyalty programs, self-service, concierge, experience management, try before you buy, guarantees
Channel	M-Pesa (mobile payment), Amazon (Kindle), Nike (stores), Nespresso (stores, clubs)	Go-direct, cross-selling, diversification, flagship stores, multi-level marketing, non-traditional channels
Brand	Virgin ('fun' companies), Intel (Inside), Trader Joe's (destination labels)	Brand extension/leverage, co-branding, certification, private label, transparency, values alignment
Customer engagement	Apple (annual conference), FourSquare ('mayorships'), Blizzard (World of WarCraft)	Community, personalisation, status, experience simplification, curation, autonomy
Process	Zara (apparel design), Hindustan Lever (sachets), Zipcar (rentals), Toyota (Lean), Ikea (flat-packs)	Crowdsourcing, lean production, IP, localisation, on-demand production, predictive analytics, process automation, standardisation, user involvement
Structure	FabIndia (local community ownership), Southwest Airlines (only one type of aircraft)	Competency centre, corporate university, decentralised management, incentives, IT integration, knowledge management, outsourcing, organisational design
Profit model	Gillette (stick + blades), Hilti (power tools on loan), Schibsted Media (freemium classifieds)	Ad-supported, auction, bundling, low cost, financing, freemium, licensing, membership, microbilling, forced scarcity, risk-sharing, switchboard
Network	GlaxoSmithKline (co-innovation), Natura (research network with universities)	Alliances, coopetition, M&A, open innovation, supply chain integration, franchising

Table 1: The 10 types of innovation framework. (Extracted from https://yourstory.com/2013/10/ten-types-of-innovation-book-review/)

The Package Approach to Innovation

The Package Approach to Innovation is also a way to stay away from the Product innovation prism. It mainly addresses the following issues around an 'idea'. *Idea Description, Value vision and situation of use,* & *Developmental and financial needs estimation.* This approach has the advantage to be adapted as per the innovators need. An Idea Evaluation report format as suggested by the Package Approach (Alänge & Lundqvist, 2013) is currently in use amongst many Technology Transfer Offices (TTO's) in Norway. Since it also includes analysis on Intellectual Properties, Freedom to Operate & Financial projections, it can serve as a ready reference to potential investors interested in the idea/innovation. Value vision description is also an important factor in the Package Approach since the innovator is forced to think whether the innovation is 'a random' thing or whether it has some value to 'other users' apart from the innovator. This exercise alone is a good determinant on the diffusion or commercialization of the innovation in question. The next logical question is to quantify the market for the innovation. That too forms part of the Idea Evaluation report.

The Package Approach to Innovation inexorably links the innovation to its diffusion by considering Intellectual Property issues, Market study & Financial estimation.

1.3.2 For the Market Study

At the outset it must be stated, that a product which is as novel in its function, as the product developed by QRRNT, the entire market appears undifferentiated. On working with the project, first hand, it was soon clear that there is a clear mismatch or gap between marketing theory and practice. This is glaringly evident when one puts it in the context of a new *Industrial* product in a *Start-up.* A cursory glance on the marketing theory literature available in academia reveals the fact that majority of them are focussed on *Consumer* products in *established firms.* Literature on marketing theories focussing on industrial products are quite few. Therefore, use of classical market segmentation and positioning strategies are avoided as they are deemed unnecessary.

The focus of the chapter is to formulate a Marketing Strategy Model (MSM) which will work for QRRNT considering its unique product positioning & innovation positioning. In the Market Study Chapter an adapted 'ideal' segmentation model from Wind & Cardozo (1974) is used. This forms the 'exoskeleton' or the outline of the Marketing strategy. Entire model is based on collection of primary data received through email and telephone conversations from industry players. Only the discussion on the macro-segments is based on secondary data. The segmentation model and other important aspects of the model are explained in short in the following paragraphs.

The Ideal Segmentation Model by Wind & Cardozo

This is one of the few academic literatures available which deal specifically with *Industrial* marketing (in this case; market segmentation). Wind & Cardozo comment not only on the marketing theories being primarily rooted in consumer markets, but also say that industrial segmentation approaches are more of a hit and miss and more likely as an afterthought of a failed marketing strategy. They also employ the 'screening' method of identification of attractive macro-segments. The original approach by Wind & Cardozo is reproduced in Figure 4. For the adapted MSM, the start is similar to the original model, wherein the Organization characteristics or Primary parameters selected are Product & External variables. The next step involves the selection of acceptable macro segments in the original model. In the adapted model, two steps take place before that happens. They are discussed below.

Effectual approach to decision making

First, the Total Available Market is defined through the *effectual* and *intuitive* approach. Effectual approach has its roots in cognitive sciences which take into account the decision-making process adopted by the *Entrepreneur* (since it is a start-up) in contrast to a *Marketing Manager* who uses *predictive* approaches. More details on these concepts are provided in 3.4 in the Market Study. Using the effectual and intuitive approach introduces uncertainty in the model.

Customer Discovery Approach

Second, the Customer Discovery Model (Blank, 2013) is employed to reduce uncertainty. The Customer Discovery Model helps identify the potential customers through 'First friendly contacts' wherein the problem presentation and matching the customer needs to the product features take place. This match-making finally leads to the selection of acceptable macro segments. Thereafter the Customer Validation Model (Blank, 2013) is employed to select the Target segment on which the sales effort will be concentrated. The adapted MSM model for QRRNT is reproduced in Figure 5.

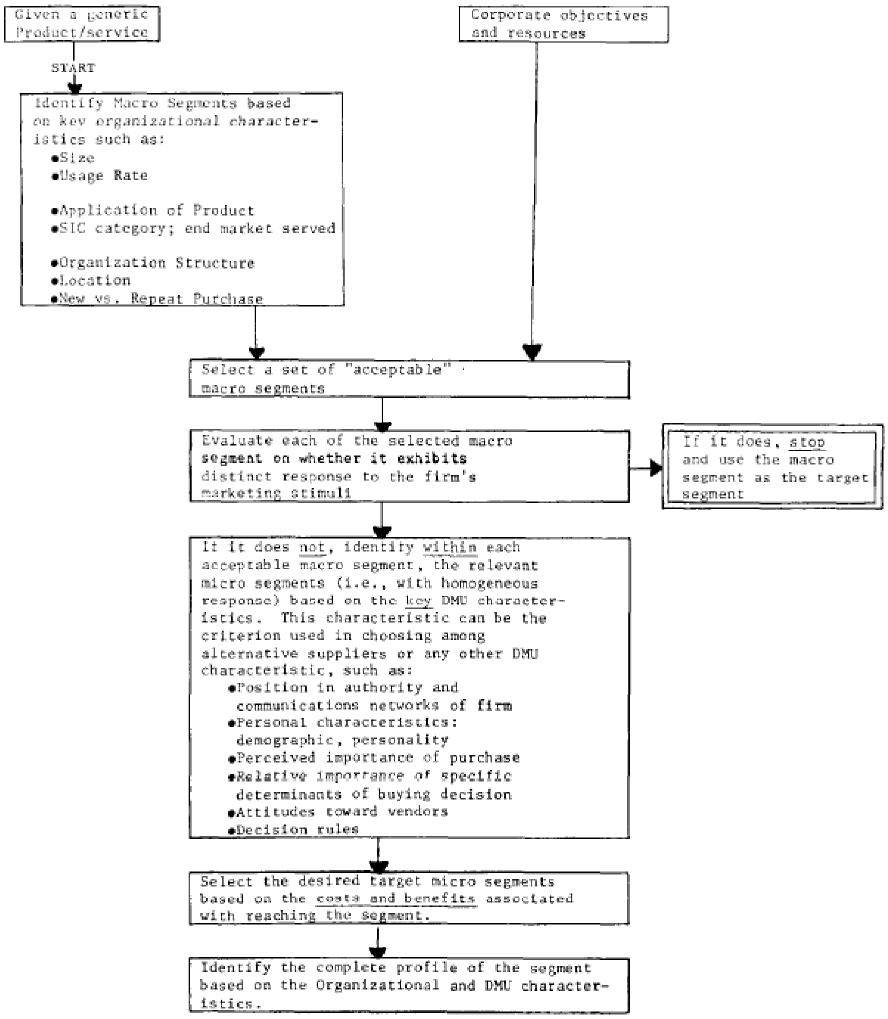

Figure 4: The Original Model (extracted from the original paper)

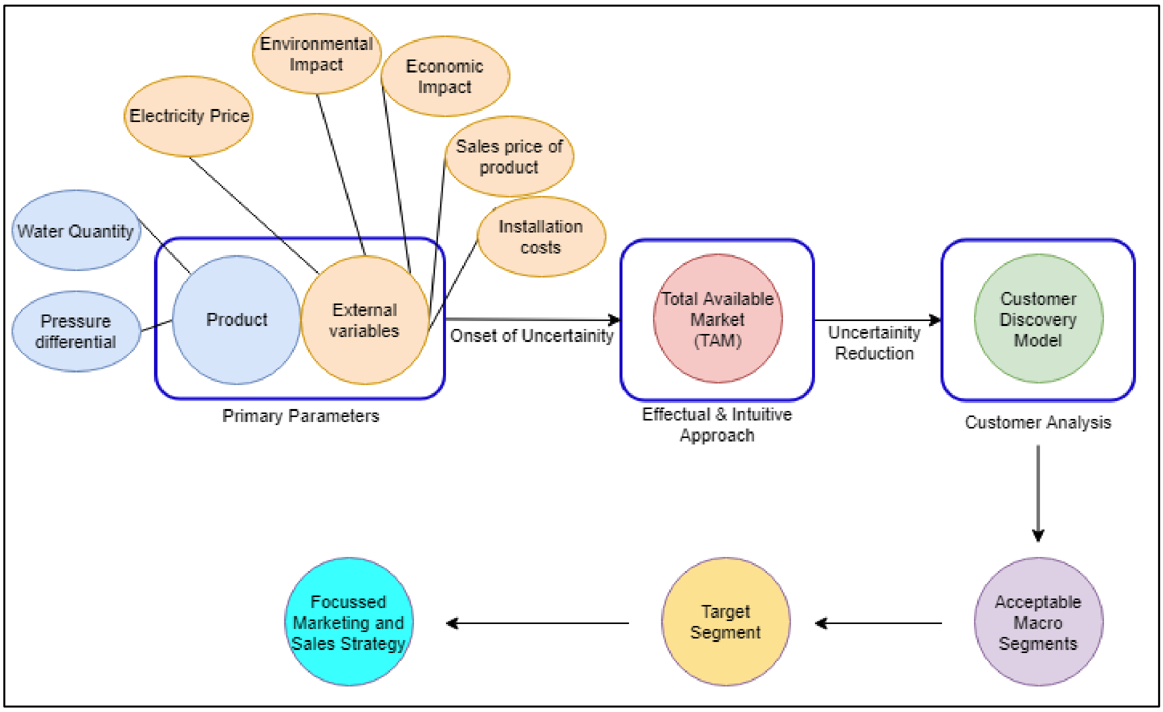

Figure 5: Adapted MSM model for QRRNT

Thus, for a new industrial product, following the adapted Wind & Cardozo model touches upon all the necessary segments required to position and segment the market. The implications of the MSM model are subsequently discussed and the chapter ends with other functional strategies that QRRNT can adopt. The entire process has been explained in the Market study (Chapter 3).

1.3.3 For the Business Plan

Giving a 'theoretical' context to a business plan is paradoxical in nature. There is this old saying which says that the business plan is outdated the day that is written. Business plans are not static documents and have to be kept regularly updated. A written business plan, in the long run is not as important as planning the business itself. However, having a written business plan is the first step in planning the business. It forces entrepreneurs to take a realistic stock on their position and the future plan that they wish their enterprise should take. Any business plan should have an accurate reflection of the three constituencies , *Market, Investors* & *Producer* (Rich & Gumpert, 1985). The market should include existing as well as prospective clients and the planned product use. Investors are needed for financial as well as other resources and an Idea of the entrepreneur and his/her vision is also important to be known.

Since an overriding objective for a start-up is to secure funding, having a business plan is the first step in securing a potential interview (let alone funding) with an investor. A convincing business plan makes a start-up more likely to succeed (Greene & Hopp, 2017). For the purposes of this thesis, a generic format of a business plan is employed. The business plan is a snapshot of the discussions taken up in the Innovation & Market studies and is discussed in Chapter 4.

1.4 Research and Design Methodology

The thesis follows a Case-Study methodology. Since the research question also is trying to determine 'how' a certain thing can be achieved, using the case-study methodology is apt. As mentioned in section 1.1, this thesis focusses on the start-up and the entire 'labyrinth' of factors surrounding it which affects its commercialization. As this is a real-life study where the solution was present before market study (for the land based industries) was carried out, the work was more about testing the assumptions rather than making them. Unlike other 'pure' research based approaches where the objective is to comment on the possibility of successful commercialization, here the objective was to find the most probable way for successful commercialization. This thesis employs both qualitative and quantitative approaches for data collection and deduction, making this a mixed approach. The types of data used have been classified below in Figure 6.

Figure 6: Methodology adopted for this thesis

Macro level factors were analysed using secondary data. They were primarily for understanding the policy level initiatives, Economic & Environmental factors that affect the use of micro-turbines. Data was collected for Norwegian Electric Market and the EU legislations that affect the EU countries. The Economic aspects were also calculated using technical theoretical data. Most of the first-hand data was sent via-email and some of the data collection also happened via interviews and skype calls. The primary purpose was to limit the market, which was based on a selected industry's water usage details. After this first round of email exchanges, a few follow up phone calls, and meetings were done to understand the customer needs via the assumptions made by QRRNT. Meetings with industry players were useful in forming the marketing strategy as well as getting insights which might aid or inhibit the adoption of the product developed by QRRNT. Most of the data collection exercise was employed in the Market study and more elaboration is done in Chapter 3.

1.5 Limitations

There are certain limitations to this thesis. Time is a luxury all would like to have, and when it concerns a topic like developing commercialization strategies for a new Industrial product, a semester's time is woefully short. More gestation period is required to observe the implications of the strategies suggested. Whether QRRNT stays or pivots is left to be seen.

As far as business models are concerned, a new avenue was recently considered. In this the value proposition of QRRNT's product as a pressure reduction device (PRD) was to be exploited, since QRRNT's energy recovery device is also a pressure reduction device. QRRNT is currently researching if they can collaborate with an existing PRD manufacturer and 'white label' their goods. As it is a work in progress, due to paucity of time the results cannot be included in this thesis. Prima facie, this also gives a quick route to commercialization of QRRNT's product.

The author was working in the capacity of a Business Development Intern for QRRNT, a part of their team. This had the distinct disadvantage of researching competitor's products as they would be reluctant to share details, both technical and commercial, with somebody in the same market as them. For the Customer Discovery part, a lot of important industries did not choose to respond, despite repeated reminders.

Lastly, this work includes lot of assumptions and recommendations which are the author's own and are his best estimates with the data available on date.

1.6 Conclusion

The main objective of the thesis topic was to find out the best route to commercialization for QRRNT's product. As far as the product features and it's 'package' go, it can be concluded that QRRNT's product is pre-disposed to a high degree of innovation diffusion (outlined in Chapter 1). But an analysis of macro-environmental factors identifies significant risks which can inhibit the successful adoption of the innovation (outlined in Chapter 3). Critical risks have been mentioned in the business plan (outlined in Chapter 4).

QRRNT individually cannot influence this part, however it is discussed nevertheless, since it affects QRRNT significantly. The policy initiatives available in Norway are quite conducive to environmental products and innovation, therefore it begs the question as to why more energy recovery technologies are not ubiquitous yet. For QRRNT, the ancillary costs surrounding its product have been found to be quite significant, therefore as a proof of concept, the national innovation and grant bodies should absorb more risk on behalf of the customer so that there is even more impetus on adoption of the innovation. For the pilot program offered by Innovasjon Norge, the scope should be widened to include not only product costs but product and installation costs as well. Thus, there is a strong link between policy initiatives at the state/national level and the adoption of innovation in this case.

However, keeping the status quo intact and taking a holistic perspective of other factors discussed in this thesis, a multi-pronged strategy for QRRNT's product commercialization is suggested next. All of this rests on the assumption that the required investment and cash injection is acquired in time by QRRNT so that day to day operations are not affected.

1.6.1 Business model diversification

QRRNT over time will have to move away from the direct sales model as it will be too slow and resource consuming for effective value realization. QRRNT will have to diversify into new business models, either simultaneously or make a complete shift. Important partners have been identified across various business models which will make the commercialization process quicker. They have been discussed in the business plan chapter. The advantage of diversification is twofold. Diversification of Business Models and identifying important partners have the advantage of negating ancillary costs associated with the innovation which has been a significant roadblock till now. Another advantage is that it also sets the stage for eventual exit of the company in the form of an outright sale to potential partners once the partners involved see the worth of the product and are able to secure successful sales.

1.6.2 Internationalization & New Markets

In the market study chapter, a host of external variables affecting the product have been identified viz. *price of electricity, environmental impact, economic impact, sales price* & *installation costs.* A correct combination of these external variables in addition to the product features have to be identified to have the best possible chance to make a sale. This analysis automatically gives the impetus for internationalization to QRRNT. Norway produces almost 100% clean energy and the prices of electricity are very low. Therefore, the trend for QRRNT should be to find markets which are quite opposite in nature. Thus, QRRNT should consider putting business development efforts in Asian countries like India & China. Even other countries like Estonia in Europe have significantly higher electricity prices and larger carbon footprint compared to Norway. QRRNT should start focussing on identifying value chains and potential partners in other geographies as well. The Customer Discovery Model employed has identified a match between a few industries and QRRNT's product. More such industry verticals need to be identified.

1.6.3 Lowering production costs

Since Norway has one of the highest per capita income in the world, the purchasing power parity principles will make the cost of the product quite prohibitive in many geographies if it is produced in Norway. QRRNT has an agreement in principle with some manufacturers in Poland to reduce production costs. This is a welcome step in the right direction, but there is a potential for further price reduction if the manufacturing is shifted to Asia. This obviously has to be taken into consideration alongside issues of rise in shipping costs and quality control *only if* the target market is Norway and Europe. As mentioned in 1.6.2, it makes sense to take the production to the countries which have the least manpower costs (and consequently least manufacturing costs). These countries in Asia, incidentally are also large greenhouse gas emitters. The management in QRRNT are currently avoiding these geographies for concerns of Intellectual property theft and quality control issues. A relook on this stance is warranted. Less production costs will lead to higher adoption of the innovation not only in Europe but worldwide as well.

1.6.4 Product development roadmap

Apart from ancillary costs, the customer demands on the product features has the potential to be the second biggest inhibitor in the diffusion of the innovation. Remote data viewing as to the health of the turbine, smart electronics, redundancy in design, protection of downstream assets etc., are certain features that can be the difference between a sale or no-sale for certain customers. It is not practical for QRRNT at this stage to engineer a separate product for each potential customer, therefore, it is recommended that QRRNT establishes a product development roadmap at the end of its pilot testing program to gradually incorporate additional features in the product.

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2 Innovation Study

2.1 Introduction

As outlined in 1.3.1, the theories chosen to discuss the innovation potential are discussed from the viewpoint of *diffusion* rather than *codification.* The innovation study aims to analyse the innovation and *innovativeness* of the product developed by QRRNT with the final goal of paving the way to market with a view to realize the maximum value that can be unlocked out of this innovation. This chapter begins by explaining the basics of the technology in layman terms and is simplified as far as possible. It explains the difference between traditional hydro power generation and how it differs from the hydro power generation in QRRNT's case. Thereafter it moves on the main theme of analysing the innovation through the frameworks described in 1.3.1. Then a Techno-Economic Evaluation (TEE) is carried out. In the TEE, the innovation and product characteristics are analysed together with first hand feedback from reliable sources and similar pilot case studies conducted elsewhere. In the TEE many of the factors which could inhibit the innovation adoption are identified. A brief discussion on the Intellectual Property strategies follows before ending the chapter with a conclusion.

2.2 Technology Basics

2.2.1 Commercial Hydro Power Generation

To make sense of the innovation being analysed, a discussion on the present way of commercial hydro power generation is warranted. The use of flowing water to get work done in the form of water wheels is at least 2000 years old, first employed by the Greeks. The first hydro-power plant was constructed in 1831 by Michael Faraday. In its essence, a hydro power plant works on the principle as shown in the figure below.

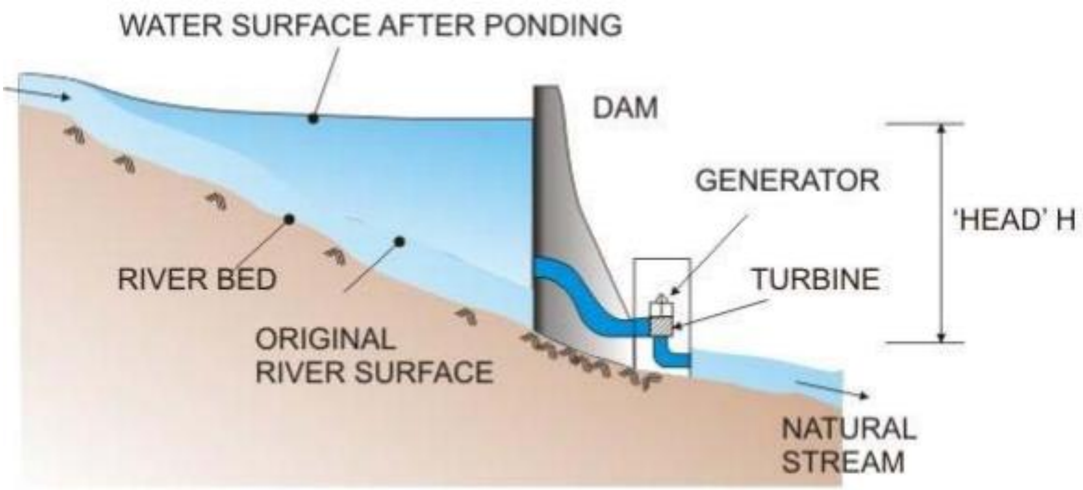

Figure 7: Typical Hydro Power Generation (extracted from Figure 1 http://nptel.ac.in/courses/105105110/pdf/m5l01.pdf)

A structure like a Dam is created to hold back the water upstream, thereby raising the water level. This raise of water level is called the ‘head’, this ‘head’ of water available is crucial for power generation (refer Figure 7). The more the flow (discharge of the river in this case), and ‘head’, the more the power generated. The water goes from the dam sluices (vents) into a turbine and rotates the propeller blades. The propeller blades are connected to a generator mechanism (for e.g., a row of magnets) and power is generated. Thus, commercial generation of power happens through *high head* and *high-pressure* systems.

2.2.2 Moving to Micro-Turbines

Any source of flowing water has the potential of energy to be recovered. Even the water flowing from house-taps has the potential to generate electricity, if connected to a generator. Thus, ultimately, it is the economic feasibility of generating electricity that determines which types of flow and head are considered desirable and which are not.

In its simplest form the product developed by QRRNT is an extension of the same principle as described in 2.2.1, with the major difference being that this product brings efficient generation of electricity from *low pressure* systems, such as water flowing through pipes. A schematic

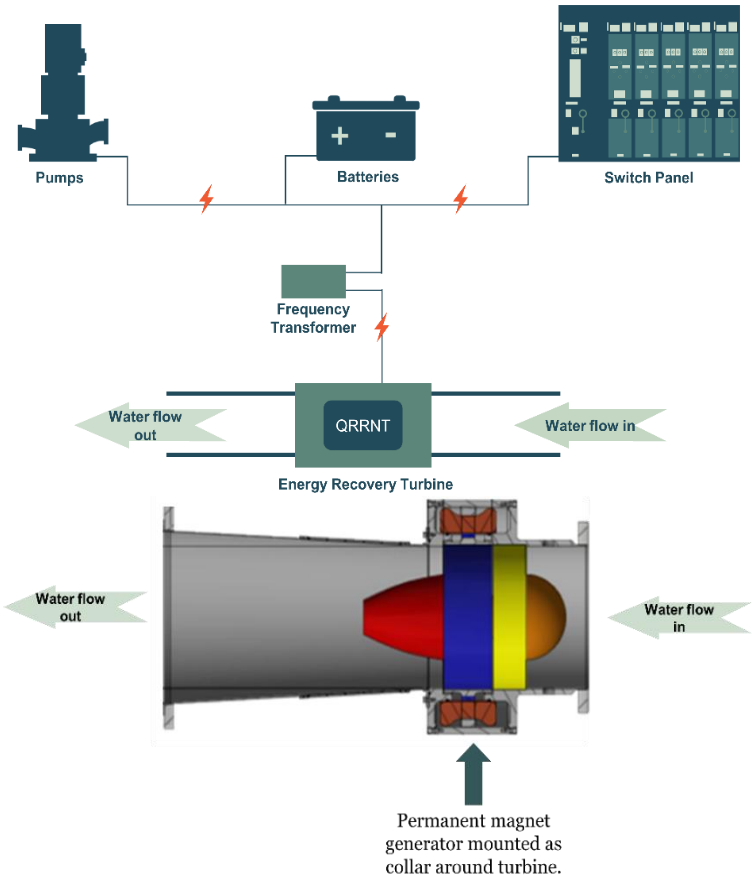

Figure 8: Simplistic representation of QRRNT's solution

diagram of the QRRNT solution is provided in Figure 8. Thus, it provides avenues for industries to recover lost energy flowing through pipes and save costs and also reduce their carbon footprint in the process. The competitive advantages of the product offered by QRRNT are discussed in the Market Study.

2.2.3 Use as a Pressure Reduction Device

Every energy recovery device using this principle is also a pressure reduction device. Energy is extracted from excess pressure. Any regulation of pressure has potential to recover energy. Thus, this gives QRRNT an additional value proposition for customers who primarily will use it a pressure reduction device. More details on the customer value proposition is given in the business plan (Chapter 4).

2.3 Assessing the Innovativeness of the Invention

One example of an academic definition of the word innovation is “Innovation is an iterative process initiated by the perception of a new market and/or new service opportunity for a technology based invention which leads to development, production, and marketing tasks striving for the commercial success of the invention” (OECD, 1991). On the other end, the dictionary definition of the word ‘innovation’ is the introduction of something new or a new idea, method, or device (Merriam-Webster, 2017). With such a wide definition of innovation itself, it is no surprise that different segments of society have developed their own understanding and definition of the word. Therefore, it is a natural consequence that different tools have been employed over time to measure innovation. However there seems to be still no consensus on characterizing, standardizing, defining, or measuring innovation.

This paper is making a conscious attempt to stay away from *codifying* innovation. Previous literature has attempted to identify the characteristics of the technological innovation process (Nieto, 2004), or devise innovation scales like Radical, New, Discontinuous, Incremental & Imitative innovations (Garcia & Calantone, 2002) etc. This approach to understand innovation is useful only when employed in hindsight and are mostly relevant in purely academic contexts. For our case, which is a real-life scenario, it is important to analyse the innovativeness of the product through the viewpoint of *diffusion* of the innovation. Only if there is widespread adoption of the innovation there is revenue generation and only then a start-up remains in operation. Thus, diffusion of an innovation is of paramount importance. Diffusion leads to observable parameters for the *measurement* of innovation and innovation is required to be measured because of the following reasons (Goldsmith & Foxall, 2003).

- To enlist the co-operation of innovators in refining and improving new products.
- To enhance the speed of new product diffusion in order to generate cash flow.
- Early adopters promote new products to other buyers.
- Early adopters are often heavy users of the product category.
- Early adopters help create a ‘market leader’ image.
- Some may want to stop the diffusion of an undesirable innovation.

In academic literature, unfortunately the stress on ‘innovativeness’ is usually from a *product development* perspective. This usually results in a one dimensional and myopic evaluation of developmental efforts (Tatikonda & Montoya-Weiss, 2001). If innovation is considered as a process then it is important to consider human behaviour and diffusion theories to measure the effectiveness of an innovation. This view is further strengthened from the fact that any innovation defined as a ‘radical’ one in the academic sense can turn out to be non-radical in the literal sense if there is low adoption from the intended recipients of that particular innovation.

Innovation diffusion is a characteristic with which the type of innovation moves from adjectives to observable action. The focus shifts from product to the customer since in a real-life business case, one innovates for the customer (user). Since ours is a real-life scenario, it makes sense to narrow the focus down to innovation positioning and measurement which considers the parameter of diffusion. It also has the advantage of capturing insights in the potential market for the innovation. In this regard, the innovation positioning in the ALA case has been analysed using the following methods. Goldsmith & Foxall’s Innovation definition and characteristics, Blue Ocean Strategy (Kim & Mauborgne), Ten Types of Innovation (Keeley, et al) & Package approach to Innovation (Alänge & Lundqvist). These approaches have been selected as it considers not only the product but the entire ‘package’ or the eco-system) surrounding the innovation. These theories lay emphasis on the fact that relying on product innovation alone is a sure-shot way to failure. Analysis of other factors which either inhibit or assist the innovation is critical.

2.3.1 Goldsmith & Foxall’s criteria

This analysis is done from a product development context. The three criterion are *Recency, Originality* & *Similarity* (Goldsmith & Foxall, 2003). These have been explained in detail in section 1.3.1. These concepts are applied to QRRNT’s product next.

Recency: The idea is *not* recent. Products utilizing the same principle of recovering energy from low pressure systems are already in the market. But the idea of Recency, can be thought of in a broader context of innovation adoption. Since this idea has not yet been widely adopted, in a way it can be said that the product *is* recent.

Originality: The product features *are* original. There aren't many products currently available that keep the direction of flow unchanged while recovering energy, have a high product efficiency in recovering energy and can also fit in tight spaces due to its size. Thus, on most accounts QRRNT's product *can* be considered as original.

Similarity: Many products exist on the similar *principle*. But if one differentiates the product from the principle on the grounds of its product features then this product is *dis-similar*. One distinguishes here between products that can recover energy from river streams versus the products that can recover energy from pipe flow.

Thus, one can see that QRRNT's energy recovery solution can be considered as innovative on most counts. The most critical factors are the product features, efficiency, small installation footprint due to its size to name a few. This analysis has the advantage of giving a head start to marketing strategy in terms of product differentiation amongst many energy recovery products.

2.3.2 Blue Ocean Strategy

It is relevant to consider Blue Ocean Strategy for QRRNT because, the Blue Ocean Strategy clearly links the innovation to market through innovation diffusion (Kim & Mauborgne, 2004). A detailed explanation of the concepts is done in section 1.3.1. The basic premise of the strategy is that one should create oceans of 'uncontested space' akin to blue oceans, rather than spend money and resources in gaining an advantage over the competitors in a 'contested space' akin to red oceans. Since this strategy renders competition irrelevant to a large extent, this is especially valuable to start-ups who have limited financial and manpower resources. QRRNT has only a few direct and indirect competitors and thus does not have to wander far to finds it's blue ocean. Since the product is quite novel, it will not be able to reap the benefits as far as profits are concerned. QRRNT will have to invest some time and resources in educating the customers and carving out its niche in the market before full rewards of this strategy can be reaped.

For QRRNT, the Blue Ocean Strategy is used in combination with the *marginal markets* approach (Fiore, 2012). This approach ensures that after the Blue Ocean is identified, it is useful to consider the customers which no one has approached or considered yet. QRRNT has employed the Customer Discovery Model to identify the marginal markets where the strategy is employed to match the needs of the prospective customers with their product through this approach. Thus, QRRNT can employ the Blue Ocean Strategy, Marginal markets approach & the Customer Discovery Model for market identification and eventual product sales. This is explained in Figure 9.

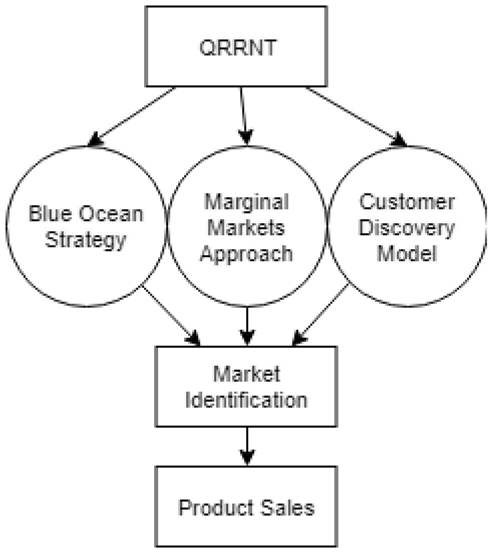

Figure 9: Blue Ocean Strategy and the route to sales for QRRNT

2.3.3 Ten Types of Innovation Approach

This theory makes one realize that the innovation and its successful diffusion depends on going beyond products. Products, as good as they may be, have a slim chance of being successful alone. It stresses empathically to 'go beyond products' since for products the 'unique effect is quickly eroded'(Keeley et al., 2013). They have proposed an ecosystem of various measurable attributes which in their view not only helps innovate, but in addition, serves as a useful tool to position one's innovation as well. The ten types are *Profit Model, Network, Structure, Process, Product performance, Product System, Service, Channel, Brand* & *Customer Engagement*. They have grouped the ten types into *Configuration, Offering* & *Experience* as shown in Figure 10. More explanation on each of the attributes is provided in section 1.3.1.

Figure 10: Grouping the ten types of innovation (extracted from https://www.doblin.com/dist/images/uploads/Doblin_TenTypesBrochure_Web.pdf)

It is their assertion that in order to maximize the innovation *diffusion* the *positioning* of the innovation must be done according to the above-mentioned guidelines. It is not necessary to purposely position the innovation in all the attributes although efficient use of multiple attributes increase the chances of a successful diffusion. For QRRNT's product, the following attributes have been identified and tabulated in Table 2.

Attributes									
Profit Model	Network	Structure	Process	Product Performance	Product System	Service	Channel	Brand	Customer Engagement
√	√	×	×	√	√	×	√	×	×

Table 2: Ten types attributes applicable to QRRNT

Profit Model: QRRNT has a profit model identified through its direct sales business model. More innovative profit models like 'power by the hour' is discussed in the Business plan section of this document and Appendix 2. In the 'power by the hour' business model, the intention is to sell the product as a service. Since legislation in countries like Norway allow for electricity to be sold back to the grid, this represents an innovation in the profit model.

Network: QRRNT has important partnerships. For example, it has a set of Investors as well as funding bodies like Innovasjon Norge, who provide financial stability to the start-up. For the development of prototype and engineering analysis they have partnered with EDR Medeso and IKM Electro. NTNU is also involved in the R&D and prototype testing. In the future, important partnerships will be formed with companies who will form a part of the value chain of QRRNT depending on its business model. These have been discussed in the business plan section 4.7.1 of this document and other value chains have been discussed in Appendix 2.

Figure 11: Important Partners in QRRNT

Product Performance: QRRNT's product USP's are discussed in the Market Study. But the product has an advantage in terms of ease of installation, not changing the direction of fluid flow and high efficiency of generating electricity. Thus, product features wise, QRRNT is comfortably placed in the micro turbine energy recovery market. However, QRRNT has to focus on the product development roadmap to formalize their product features and future versions of the product, in order to continue to fulfil its innovation potential in this particular attribute.

Product System: QRRNT's product is currently running on prototype stage. Later on, multiple iterations will lead to different product features. Although this is not a pressing need, but the scope is present to have a new and improved version of it down the line. In the 'System

Integrator' business model (explained in Appendix 2), QRRNT will form a part of the value chain of the system integrator thereby exhibiting an innovation in product system to create a robust and scalable system.

Channel: Channel innovation can be closely linked to the Network attribute in this case.

2.3.4 The Package approach to Innovation

This case-study in particular, is in many ways, beyond the 'Idea Evaluation' phase. However, this approach is still useful to analyse QRRNT's innovation positioning. Just like the The Ten Types of Innovation, the Package Approach (Alänge & Lundqvist, 2013) too stresses the need to look beyond products. It adopts an 'eco-system' approach to an idea. Thus, this entire treatise is to be considered as a variant of the same. Although this thesis does not follow the sample Idea Evaluation report format as shown in Figure 12, but the contents are essentially similar. This thesis, with its thorough analysis of commercialization issues combined with financial insights can also serve as a ready reference to investors the same as an Idea Evaluation report does. Important parts like Idea description is covered in this chapter and the previous one (Introduction). Most of the Value visions are covered in the next chapter (Market Study) with business model discussions being taken up in the final chapter (Business Plan)

Text box 1. A typical **Table of contents** for an idea evaluation

1. **Summary** (0.5 page)
2. **Idea description** (1-3 pages)
    a. Technical/functional description
    b. Idea providers – backgrounds and interests
    c. Novelty
    d. Freedom to operate (FTO) analysis
3. **Value visions** (1-4 pages)
    a. Identifying and prioritizing situations of use
    b. Temporal analysis for prioritized situation(s) of use
    c. Customer utilities for prioritized use
    d. Societal utilities for prioritized use
    e. Business utilities including indicative business model
    f. Market quantification
4. **Next steps** (1-3 pages)
    a. Further verification and development of idea
    b. Competence requirements
    c. Risk analysis
    d. Financial estimates
5. **Appendices**
    a. Log book (who did what when)
    b. Other important data

Figure 12: A Typical Idea Evaluation report (Extracted from source)

2.4 Techno Economic Evaluation (TEE)

Although not explicitly stated, but the TEE can be considered as a part of the package approach. TEE can be considered as a part of the Value visions and verification & development in the package approach. An innovation, however desirable, must be economically feasible in the present day to have a successful chance of diffusion.

The objective of the TEE is to collate the learnings gathered from similarly executed projects around the world. The TEE study helps to bring out factors that are crucial to the innovation diffusion, which might otherwise get missed. The TEE study helped understand the decision-making process of the prospective customer. The findings should not be taken as an inhibitor or a roadblock to innovation diffusion, but rather must be seen as discovery of issues on which serious discussion, management action & workarounds need to be considered. This also has a significant impact on marketing strategy and business plan.

In this case a lot of primary data is available to take a deep-dive into the factors which help in the TEE. Most of the primary data was gathered from experts in the water supply department in Australia and Canada. Their primary intention was use as a pressure reduction device with an additional benefit of energy recovery. Some of them had installed pilot projects as well. Thus, the feedback is from reliable and trustworthy sources. They have been attached in Appendix 3. An Investment Grade Audit, from the Covington Water District, U.S.A, has also been attached in Appendix 4. Covington Water District was in the process of installing a new intertie pipeline. The intention was to install an electric turbine generator in the pipeline to capture the energy that would be otherwise lost to the environment. The objective of the report was to undertake a complete investment grade audit in which all the necessary work and the resulting cost is analysed to arrive at a total cost of project. Access to such a report has the advantage to take into account all factors that are crucial to make this product successful considering from a Turnkey project perspective. Main findings from the primary data and the report have been summarized next, to present a snapshot of the TEE.

2.4.1 Minimum Business Case

Considering product performance alone, the change in flow rate and pressure of the water flow throughout the day/week/year will play the deciding role in determining the efficiency and viability of any solution.

This has an impact for QRRNT's positioning for water supply companies. Rate of water supply and pressure is not constant throughout a designated period. Any turbine, is designed to operate at an optimal flow and pressure to recover maximum energy. Variations in the design flow rate and pressure affects the efficiency and the turbine operates at sub-optimal conditions, thereby resulting in less energy and cost savings.

2.4.2 Asset Integrity

Since QRRNT is primarily targeting industrial customers, it is important to realize that a pipe with a turbine cannot be considered in isolation. A pipe section, on which QRRNT's product, is installed is a part of a much bigger and complex pipe network. The pipe section is also part of a process which has a certain function inside the factory or water supply system.

If considered as a pressure reduction valve, then it means that the system downstream needs water at lower pressure, thus if the turbine system fails, it has the potential to cause a lot of economic damage to the plant/installation. These will lead to repair costs as well as production loss due to downtime for repair. Thus, there should be a redundancy in design in case the turbine fails. This has implications for QRRNT as far as product development roadmap and capital costs are considered. For potential customers sufficiency of such conditions are critical before deciding to invest in a solution proposed by QRRNT.

Government policies and a conducive entrepreneurial atmosphere in respective geographies are crucial in this case. In this case the Miljøteknologi Project from Innovation Norway is helpful for reducing the risk on the start-up side as well as the customer side. More details of the Miljøteknologi project is given in the Business plan section 4.7.2.

2.4.3 Ancillary Costs

The Covington Water Distribution project gives an idea of the complete scope of work, if considered as a turnkey project. Costs associated with scope of work activities can be considered as ancillary costs, i.e., costs apart from the primary product, which in this is the energy recovery turbine. They are listed below and is not exhaustive.

- *Mechanical*: To provide piping
- *Controls*: Instrumentation to see the status of the turbine at any given instant.
- *Electrical*: Electrical wiring
- *Structural*: If any special structure is required to be constructed in relation to the installation of turbine, pipe support etc.
- *Civil*: Excavation costs for underground installations, creating a bypass channel etc.

- *Testing, Adjusting & Balancing*: Akin to Factory Acceptance Test, to fine tune the working of the turbine at the site so that it meets all desired objectives prior to first run.
- *Design*: Engineering work required to be done prior manufacturing
- *Removal and replacement*: If any old turbine/pressure reduction device is to be taken out before installing QRRNT's product.
- *Measurement & Verification*: To monitor and verify the performances vs claims.

2.4.3.1 Case-Study Summary

Important snapshots from the Covington Water District – Investment Grade Audit is given below in Table 3 and Table 4. Table 3 highlights the savings expected from the project whereas Table 4 gives up the breakup of expenses of the cost of the project as a whole. This project is also from a developed country (U.S.A) and therefore comparisons on the product and man-power costs can be made. Discussion on the findings follows. As can be seen that costs associated with the turbine is USD 313,957 whereas the total maximum project cost is USD 2.303,202. Thus, the product cost is barely 13% of the project cost. This has implications for QRRNT, since the ancillary costs as mentioned in 2.4.3 might become prohibitive for existing industries. A judicious approach is warranted wherein effort has to be made in positioning the energy saved and the environmental impact achieved vis-à-vis the costs involved. This has the potential to become the biggest inhibitor of the innovation.

Utility cost savings per year	USD 16,066
Guaranteed kWh savings per year	174,342 kWh
CO_2 emission reductions per year	275,298 lbs

Table 3: Project benefit snapshot - Covington Water District Project (extracted from source)

This also has implications in Business model selection. Collaborating with a 'Systems Integrator' is beneficial for QRRNT as it opens the market for new installations where ancillary costs as discussed in 2.4.3, are negated to a large degree as they are more applicable for industries already in operation. Collaborating with a systems integrator allows access to 'Greenfield' industries where the costs of incorporating an energy recovery mechanism is minuscule compared to the cost of setting up a new plant. More details are given in Appendix 2.

2.4.4 Alternative sources of Energy

Depending on the Kilowatt savings for a particular installation, the cost of installation of solar panels might be much cheaper than QRRNT's solution. Certain industries like Paper and Pulp produce Biomass as a waste product, which is an energy source in itself. Such companies sell this product to become more energy neutral. Some industries employ waste heat recovery systems to recovery energy and can recover energy to the tune of 60% of their energy input. Thus, QRRNT has to make significant efforts to differentiate and position itself in the market. QRRNT has to drive home the fact that theirs is a novel source of energy recovery which can be *complementary* to other energy recovery avenues and can be used simultaneously.

Project	Covington Water District
Scenario	C-4 Intertie Pipeline
Date	7/13/2017

Database ID	FIM Name	Mechanical	Electrical	EMCS	Lighting	General	Equipment	Other	Total
32495	10.03-CWD Provide Water Turbine at New Intertie	$ 69,733	$ 87,129	$ -	$ -	$ 70,560	$ 86,535	$ -	$ 313,957
33907	30.01-CWD Provide C-4 Intertie Pipeline	$ -	$ 150,725	$ -	$ -	$ 932,588	$ -	$ -	$ 1,083,313
	Total Base FIM Cost	$ 69,733	$ 237,854	$ -	$ -	$ 1,003,148	$ 86,535	$ -	$ 1,397,270

A. Construction Costs					
	Subtotal(FIM Cost and A)				*$ 1,397,270*
	Construction Bonds	%	1.00%	Percent of Subtotal (FIM Cost and A)	$ 13,973
				Total Construction Cost	$ 1,411,243
B. Professional Services Costs					
	Audit Fee	Lump	$34,055		$ 34,055
	Design	Lump	$207,800		$ 207,800
	Const. Management & Proj. Admin	%	6.00%	Percent of Total Base FIM Cost	$ 83,836
				Total Professional Services Cost	$ 325,691
C. Other Project Costs					
	Project Contingency	%	5.00%	Percent of Total Base FIM Cost	$ 69,864
	Performance Assurance (M&V) Yr 1	Lump	$1,500		$ 1,500
	Performance Assurance (M&V) Yr 2	Lump	$1,560		$ 1,560
	Performance Assurance (M&V) Yr 3	Lump	$1,682		$ 1,682
				Total Other Project Cost	$ 74,606
D. Overhead Costs & Fees					
	Overhead	%	10.00%	Percent of Total Construction Cost	$ 141,124
	Profit (Fee)	%	8.00%	Percent of Total Construction Cost	$ 112,899
				Total Overhead Cost & Fee	$ 254,024
E. Total Guaranteed Construction & ESCO Services (A + B + C + D)					$ 2,065,563
F. Non-Guaranteed Costs					
	Sales Tax	%	8.60%	Percent of Section E	$ 177,638
	WA DES Fee	Lump	$60,000		$ 60,000
				Total Non-Guaranteed Cost	$ 237,638
G. Total Maximum Project Cost (E + F)					$ 2,303,202

Table 4: Budget Summary - Covington Water District Project (extracted from source)

2.4.5 Expanding the Market

Since in theory the turbine solution can work with any fluid (liquid or gas), avenues must be searched for other applications of QRRNT's product. For example, wastewater.

2.4.6 Return on Investment (ROI)

Economic evaluation as an energy recovery device rests on its attractive Return on Investment proposition to the customer. Interviews with prospective clients have put the ROI as an energy recovery device to the tune of 5 to 7 years. Economic evaluation as a pressure reduction device (with an additional benefit of energy recovery) is to the tune of 10 to 12 years, since Pressure reduction devices *have* to be used in a system. Every pressure reduction device has a life cycle and has to be replaced eventually. This gives more room for QRRNT to introduce its solution.

Thus, the TEE has listed six factors that the potential customers can weigh and decide either for or against the product innovation adoption developed by QRRNT. This decision-making pivot is shown in Figure 13.

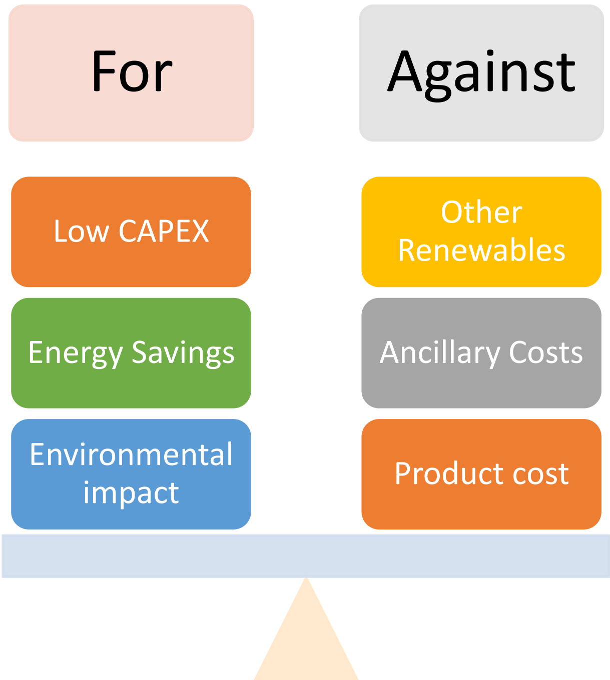

Figure 13: Decision making pivot for potential customers

2.5 Intellectual Property Considerations

The IPR strategy is currently being formulated. As on date, patent filing is at the draft stage. The draft patent is confidential and further information is not available. It is however known that the focus of the patent is going to be the process with some elements of product assembly.

Currently, QRRNT is working with ACAPO AS in formulating a IPR strategy and patent filing formalities. It is expected that the patent filing will take place in June 2018. However, QRRNT's primary focus is to be 'first-to-market'.

Using the search terms 'hydro electric pipe flow micro turbine' on the Google Patents website yielded approximately 4,175 results. This proves that this principle and concepts have been tried before. The search for prior art should be therefore done on the unique differentiators specific to QRRNT's product and processes. A preliminary search of the patent database was carried out and patents similar closest in principle to the one which QRRNT uses is listed in

Appendix 5. The top 5 patent classification categories for the search term on google patents were Y02E, E21B, F03B, Y02P & F05B. The CPC (Co-operative Patent Classification) categories for these 5 are elaborated in Table 5. The views expressed in this section are of a personal nature and must be corroborated with a qualified patent attorney.

Symbol	Classification and Description	Percentage of patents in search results
Y02E	Reduction of Greenhouse Gas (GHG) emissions, related to energy generation, transmission or distribution	44%
E21B	EARTH DRILLING, e.g. DEEP DRILLING (mining, quarrying E21C; making shafts, driving galleries or tunnels E21D); OBTAINING OIL, GAS, WATER, SOLUBLE OR MELTABLE MATERIALS OR A SLURRY OF MINERALS FROM WELLS	12.8%
F03B	MACHINES OR ENGINES FOR LIQUIDS (positive-displacement engines for liquid F03C; machines for liquids and gases F01; positive-displacement machines for liquids F04, rotary fluid gearing of the hydrokinetic type F16H41/00)	11.3%
Y02P	CLIMATE CHANGE MITIGATION TECHNOLOGIES IN THE PRODUCTION OR PROCESSING OF GOODS	11.1%
F05B	INDEXING SCHEME RELATING TO MACHINES OR ENGINES OTHER THAN NON-POSITIVE-DISPLACEMENT MACHINES OR ENGINES, TO WIND MOTORS, TO NON-POSITIVE DISPLACEMENT PUMPS, AND TO GENERATING COMBUSTION PRODUCTS OF HIGH PRESSURE OR HIGH VELOCITY	10.3%

Table 5: CPC classification details for patent search results

2.6 Conclusion

This section began with explaining the technology in brief. Thereafter, the invention was analysed through various innovation frameworks. The distinguishing criteria adopted was *diffusion* of the innovation since diffusion of the innovation alone will help realizing the maximum value out of the innovation. In many cases, using these criteria also helped connect the innovation with the type of market and the type of positioning, the product should have. Innovation was seen not only with a product development perspective but other factors as well which have a direct impact on the diffusion of the innovation. Important learnings were summarized through the real-life case studies and feedback received.

Thus, it can be said that QRRNT is well positioned to exploit the innovation in a broad sense. The Techno Economic Analysis shows that the ancillary costs have a high potential to become a roadblock in the diffusion of the innovation. Recommendation to QRRNT is that the Direct-Sales Business model (discussed in the Business plan) should be for initial customers only, as they primarily target existing industries. Collaborating with a 'System Integrator' (also discussed in the Business plan) will have advantages since the new construction of an industrial plant makes the ancillary costs irrelevant thereby giving a higher chance of diffusion of the innovation. This gives QRRNT an additional impetus to diversify business models urgently.

3 Market Study

3.1 Introduction

Feeding of from the Innovation study of the product, now the discussion naturally progresses to understand the market for it. This chapter will touch upon the following aspects, Customer Analysis, Competitor Analysis, Market Analysis, Macro Analysis & Market Strategy. Due to reasons, elaborated later in this chapter, a specific format is not followed where each item is discussed individually. First the Macro-economic analysis of the favourable policies are analysed to make a case for the commercialization of this innovation. Thereafter, the positioning of the product is discussed. Then, the need for a Marketing Strategy Model (MSM) is explained after which the MSM is explained in more detail. The customer analysis and the market analysis is discussed in the MSM itself, since it forms an integral part of it. After that, implications of the MSM model developed for QRRNT are discussed and certain recommendations are stated. Certain functional strategies are also discussed following that. Thereafter, the competitor analysis is presented and the chapter ends by lending a conclusion considering the chapter in its entirety.

3.2 Macro Analysis

It will be useful to conduct the macro analysis through the prism of *Policy & Regulatory, Economic* & *Environmental* factors.

3.2.1 Policy & Regulatory

The European Union's (EU's) climate change & energy policy objectives for the year 2020 stresses on strengthening and upgrading existing networks with the view point of including renewable energy generation, enhancing grid security & realising energy savings and efficiency (Giordano, Gangale, Fulli, & Sánchez Jiménez, 2011). In this comprehensive objective, energy efficiency and conservation will be the 'single largest prospective deliverer of greenhouse gas (GHG) reductions, both due to its potential and due to its low cost compared to other alternatives' (Pérez-Arriaga, 2010). The complex nature of the targets and the interconnected nature between various technologies brings out a need to harmonize several measures. The Smart-Grid (SG) technology has attracted considerable interest to build an open market as well as achieve targets regarding safety and lower emissions (Dric Clastres, 2011).

The solution provided by QRRNT can be seen as *micro-production* of electricity. One way to describe micro-production is, " *small scale generation of electricity and/or heat by individuals, small business and communities of which the main purpose is to meet the generators' own* *needs as it serves as an alternative or supplement to traditional centralized grid-connected power"* (Fredriksen, Jenssen, Wolst, & Rennesund, 2015).

Thus, it can be seen that the focus is on *de-centralizing* the power grid and encourage the local production and consumption of electricity by using SG technology as a possible alternative. Buying electricity from the grid will not be the only option, regulatory policies allow industries to transition from being passive *consumers* to active *prosumers*, wherein they will be producing and consuming locally generated electricity in addition to buying electricity from the grid. The European Union (EU) has no specific legislation on *prosumers* but some provisions can be found in the following EU directives from the European parliament to encourage micro-grid production.

- 2009, Renewable Energy Directive & Electricity Directive, requires member states to provide priority and/or guaranteed access to the gird system for all renewable electricity production, irrespective of its size (European Parliament, 2009; European Union, 2009)
- 2012, Energy Efficiency Directive introduces a similar requirement as listed in point no 1. For small scale and micro-combined heat and power (CHP). This additionally requires member states to encourage participation of demand response in wholesale and retail markets (European Parliament, 2012)
- 2013, European Parliament resolution on Microgeneration called for measures that would encourage prosumers to self-consume the electricity they produce as this can lead to lower costs for the system (European Parliament, 2013).

SG technology requires the installation of smart meters, which can measure the power supply *from* and *to* the grid. This enables effective billing and leads to actual realization of benefits of installed renewable energy. Policy incentives regarding the roll-out of smart meters is also encouraging in Norway (Fredriksen et al., 2015). The roll out of smart metres is to be concluded in all Nordic countries (except Iceland) by 2020. It is also expected that the role of demand response and micro-production technologies will increase in the Nordic power markets. Reduced grid tariffs, exemption on taxes and levies give additional impetus to favourable micro-production in the Nordics. A cursory glance on literature in academia documents favourable policies in other countries like USA and China as well (Ali et al., 2017).

3.2.2 Economic

Economic viability of the solution provided by QRRNT is mainly dependent on *Quantum of water usage, Quantum of pressure differential, pipe diameter* & *cost of electricity.* Thus, QRRNT is currently targeting potential industry verticals which have a combination of most of the factors listed above. As an example, for an individual plant, for every 3000 m^3/h flow rate and a pressure of 2.5 bar, the product developed by QRRNT has a monthly energy recovery of approximately 127,510 kWh (Kilo Watt hours) which translates into an annual savings of approx. 1,055,784 NOK per year at current electricity prices in Norway (0.69 øre/kWh). The unit cost of electricity in few places is significantly higher than that in Norway and thus in such places it becomes economically feasible at lower quantum of water usage and pressure. Please refer Appendix 6 and Appendix 7 respectively, for sample energy calculation and average industrial electricity pricing in the EU.

It must also be mentioned that since the source of energy recovery is novel, this can be used in parallel with other sources of renewable energy (wind, solar etc) and other energy recovery systems (heat & steam recovery). Initial capital investment is less, and electricity is generated at source, thereby cutting transmission losses of electricity. Surplus energy produced can also be sold to other consumers or be sent back to the electric grid.

A lot of processes also require reducing or increasing the pressure. Pressure reduction valves achieve such pressure regulation. For owners of such processes, the solution provided by QRRNT can also act as a pressure reduction device with an additional benefit of energy recovery.

3.2.3 Environmental

Environmental impact of any 'green' device is dependent on the geographical location and the primary source of commercially produced energy. Calculations of potential CO_2 savings are also quite technical and is dependent on many factors. The following example is just an illustration.

Since 96% of electricity generated in Norway is through hydropower, the primary source of electricity is much cleaner than Estonia as a point of comparison. Taking the example as shown in 3.2.2, it translates into an annual reduction of approx. 1 Ton of CO_2 emissions in Norway (7 kg/MWh) but a staggering 224 Tons of CO_2 in Estonia (1593 g/kWh) (Adapt Consulting AS, 2013)

A lot of environmental benefits are also intangible, for example effect of less CO_2 in atmosphere on health of plant and animal life, less expenditure on healthcare due to improved air quality for patients with allergies and respiratory conditions, etc.

Combining the concepts of 3.2.2 & 3.2.3, a comparative chart showing cost and environmental impact of 127,510 kWh of recovered electricity (as mentioned in the example), in different EU countries, is shown in Figure 14.

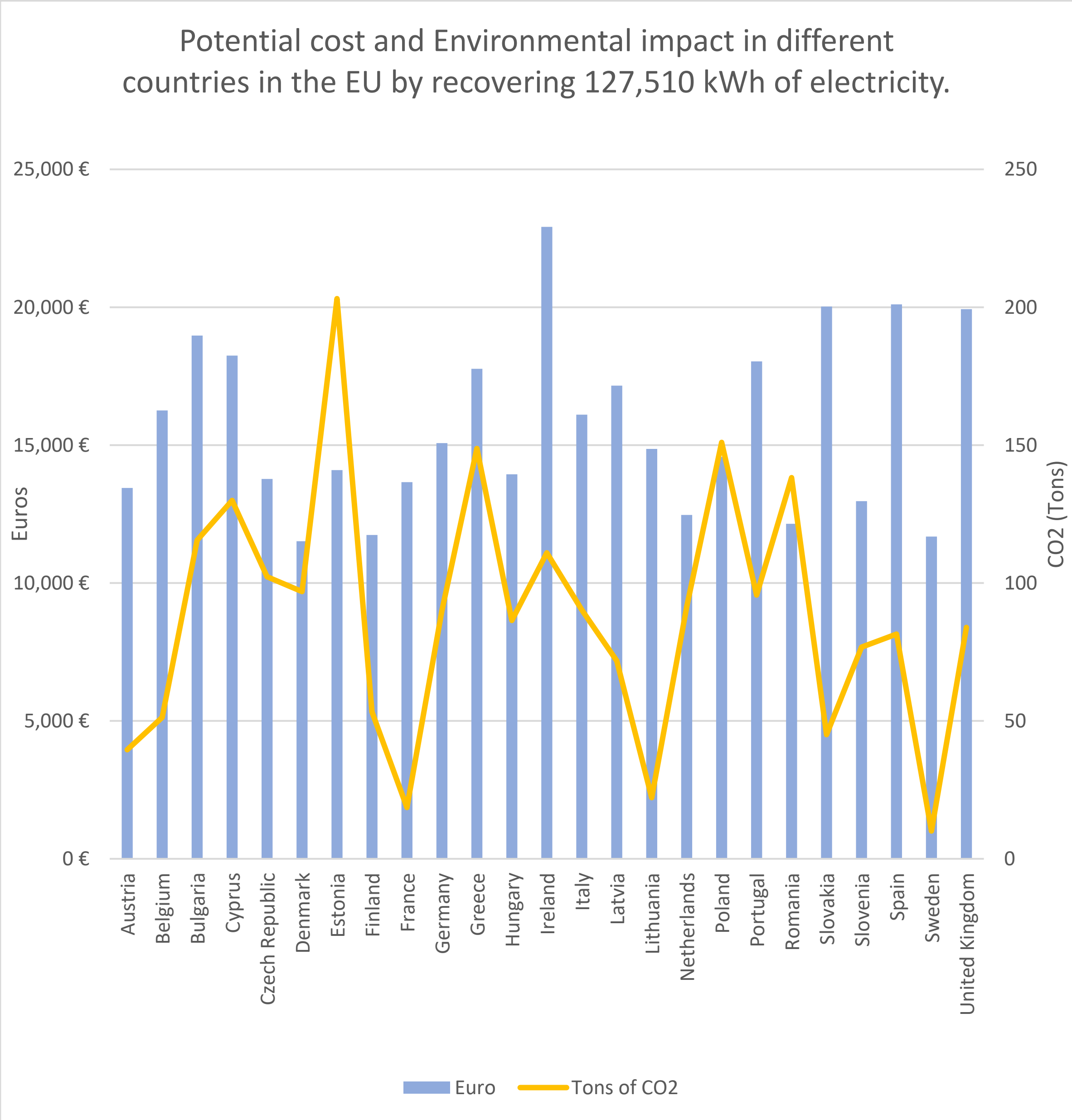

Figure 14: Chart comparing Cost Savings & Environmental impact by using QRRNT solution

3.3 Positioning Strategy

The QRRNT system can be viewed in two different capacities: as an energy recovery device and as a pressure reduction device. Through this dual approach, the market for QRRNT is opened to two thought processes, enabling the company to address two product segments. By viewing opportunity through two streams, the conversation with potential clients is broadened in its scope to help realize maximum value for QRRNT. The positioning strategy for QRRNT is shown in Figure 15.

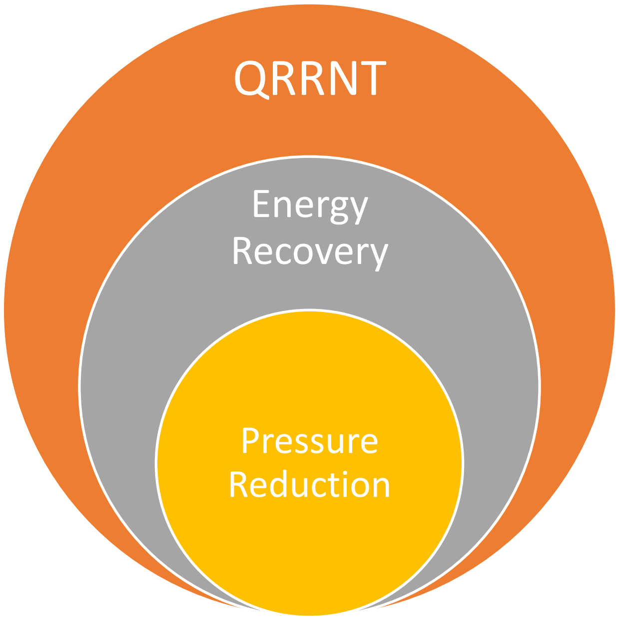

Figure 15: Positioning Strategy for QRRNT

3.4 The need for a Marketing Strategy Model for QRRNT

Literature available for successful marketing activities for a start-up, and that too which is into manufacture of *industrial* goods, is unfortunately very scarce (Abratt, 1993). This can be attributed to the fact that existing marketing theories are from 'old line' manufacturing industries like steel, auto & metals (Doyle & Saunders, 1985) and not start-ups. Multiple authors also point out to the fact that there is hardly any co-relation between the theories of marketing (esp. Marketing strategy) and developing an *operational* Marketing strategy for use in the real-world (Abratt, 1993; Backhaus & Muehlfeld, 2005; Dibb & Simkin, 1994; Doyle & Saunders, 1985; Wind & Cardozo, 1974). This conundrum is amplified for start-ups because there are many unknown variables in a new industrial product.

Since this treatise focuses on land based opportunities for the product developed by QRRNT, it can be considered that the market development needed to be developed from scratch. One therefore has a situation wherein the product is ready, but the markets are unsure. Thus, traditional marketing strategies are difficult to apply directly. There are many unknowns and managing this uncertainty will be a crucial component in any marketing strategy that QRRNT develops. Under these circumstances the target market segment appears undifferentiated, or, at the opposite extreme, every single customer appears as an individual segment, making it impossible to employ any reasonable marketing strategy (Wind & Cardozo, 1974).

The decision making of Entrepreneurs is different from a Marketing Manager. A Marketing manager often uses *predictive* approaches whereas the entrepreneur uses an *effectual* approach to decision making (Read, Dew, Sarasvathy, Song, & Wiltbank, 2009). *Effectual* approaches have its roots in cognitive sciences. For a start-up, incorporating the effectual lookout while designing marketing strategies has its own set of advantages. For example, a predictive approach considers the future as a simple continuation of the past, where prediction is considered necessary *and* useful. In contrast, in the effectual approach, the future is *co-created* by wilful agents which may include investors and partners. In the predictive approach, risk taking is always done under risk adjusted *expected value* whereas in the effectual approach, risk is measured in terms of *affordable loss* (Read et al., 2009). Thus, the marketing strategy model needs to factor in the *effectual* decision-making process of the Entrepreneur.

For a new industrial product, with a unclear market segmentation and consequent unclear target market, one must rely less on traditional planned approaches and allow for more intuitive understanding for handling complexity and ambiguity (Quinn, Hines, & Bennison, 2007). For start-ups, with new products and unclear marketing variables, marketing activities should be considered as incremental sequences and decisions forming a pattern retrospectively based on active networking (Harrison & Kjellberg, 2010).

3.5 The Marketing Strategy Model (MSM) for QRRNT

A conscious attempt must be made to stay away from traditional marketing strategies as explained for various reasons in 3.4. For an industrial product start-up, the marketing strategy should start from the most basic parameters. It should make use of the known and manage the unknown. In this respect an adapted MSM has been used, which has been derived from the ideal segmentation model from Wind & Cardozo (1974). From here onwards, important parameters of the model will be discussed individually and the whole model will be derived at the final stage.

3.5.1 Product

This is the fundamental parameter of the model. The entire strategy being formulated revolves around the product and its features. The functionality of the product requires significant amount of water and pressure differential. Only then can it produce electricity. Thus, these are necessary conditions for the product to work. Thus, industries prospected must have sufficient quantities of excess water flow and pressure differential.

3.5.2 External variables affecting the product

For this product, the following external variables have been identified. This list is not exhaustive.

- *Price of electricity*: Price of commercially available electricity in any geography has a direct bearing on the feasibility and attractiveness of QRRNT's product as a solution. For any industry, if the price of electricity is very low, the savings generated from the product will be low and thus QRRNT's product will have low attractiveness. The reverse scenario is also true.
- *Environmental impact (Tons of CO_2 saved)*: A good example to explain this concept is to consider Norway. In Norway, 95% of the electricity generation happens through hydro power, which is a clean source of energy. Thus, to make a sale in Norway saying that this product is environmentally beneficial, will be a hard-sell unless other factors are also attractive for a prospective customer. Conversely, in a country which uses fossil fuels for electricity generation (like India & China), QRRNT's product will be highly attractive as even at low thresholds of electricity price the environmental impact in terms of tonnes of CO_2 saved, will be significant.
- *Economic impact (Amount of money saved by utilizing QRRNT's product)*: This is directly proportional to the product features as explained in 3.5.1. The more the, water discharge and more the pressure differential, the more electricity can be generated, and more the quantum of money saved.
- *Sales price of product*: The price point of the solution should be attractive and feasible for the prospective customer.
- *Installation costs*: This insight has come through actual prospective talks with customers. For underground installations in a country like Norway, where manpower costs are very high, the cost of Installation is much higher than the sales price of the product itself.

3.5.3 Total Available Market (TAM)

This is the point where uncertainty begins. Technically, any industry with high water usage was a potential customer. But water usage statistics divided into industry verticals are very difficult to obtain if not impossible. Thus, using the *effectual approach* and *intuition* a preliminary list of industries was made (congruent to identifying macro-segments as outlined by Wind & Cardozo). The preliminary list consisted of the following industries. The TAM based on the such a segmentation comes to approximately USD 1.2 billion. The details are given below. It is to be noted that Table 6 is only indicative and not exhaustive.

Verticals	Locations per vertical	Potential Turbines per location	Total Turbines per vertical	Primary Interest of vertical	Revenue per Turbine for vertical	TAM for Vertical
Seawater Desalination plants	3685	1	3685	Energy Recovery	$ 150,000	$ 552,780,000
Offshore Production rigs	1332	1	1332	Energy Recovery	$ 150,000	$ 199,800,000
Metals mining	806	1	806	Energy Recovery	$ 150,000	$ 120,843,990
Shipping; scrubbers	600	2	1200	Energy / Pressure	$ 100,000	$ 120,000,000
Offshore drilling rigs	790	1	790		$ 150,000	$ 118,500,000
Paper mills	350	1	350	Energy Recovery	$ 100,000	$ 35,000,000
Municipalities (water supply) - Nordic and Germany	29	n/a	278	Pressure Control	$ 100,000	$ 27,795,883
Land based aquaculture - Norway	229	1	229	Energy Recovery	$ 100,000	$ 22,900,000
Ferro Silica Plants	41	1	41	Energy Recovery	$ 150,000	$ 6,150,000
Total						**$ 1,203,769,873**

Table 6: TAM based on water usage segmentation in different industry verticals (sources for all numbers are attached in appendix 8)

If one considers the global waste heat recovery market then it is expected to reach USD 56 billion by 2021, growing at a CAGR of almost 7% (Technavio, 2015). One can be fairly confident that the market for the product will be a significant percentage of the heat recovery market since most of the devices (boilers for ex.) which generate a lot of heat, usually require a lot of cooling water to keep the temperature regulated. Because the product can also be used as a pressure reduction device, one can proactively approach the control valve market. The control valve market is expected to reach USD 10.82 billion by 2020, growing at a CGR of 6.85% (Research & Markets, 2015).

3.5.4 Customer Analysis: Customer Discovery Model

The next step is to reduce uncertainty introduced in section 3.5.3 by matching the product benefits to the customer needs. For this the initial macro-segmentation were the industry verticals as shown in Table 6. It is important to note that the industry segmentation follows traditional market theory, but now aligning it to customer needs and benefits is a break from normative methods. Segments closely aligned to customer needs are often very powerful (Dibb & Simkin, 1994). For this, first – hand data was collected from major players in the industry verticals. Mainly from Norway and one from Sweden. A combination of Customer Discovery

Model and Customer Validation Model was taken up (Blank, 2013). A questionnaire was sent and a few telephone calls made to important players in each industry vertical to enquire data about their water usage details and gauge their interest in energy recovery products. The details of the Customer Discovery Exercise and status as of today are mentioned below.

Sr. No	Company Name	Location	Industry	Mode of Contact	Response received?
1	Norcem-Brevik	Norway	Cement	Email	No
2	Norcem-Kjøpsvik	Norway	Cement	Email	Yes
3	Yara	Norway	Chemicals	Email	No
4	Balsfjord Data Centre	Norway	Data Centres	Email	Yes
5	Green Mountain	Norway	Data Centres	Email	Yes
6	Nord-Trondelag Energi	Norway	Energy Companies	Email	Yes
7	Elkem Thamshavn	Norway	Ferro Silicon	Email	Yes
8	Finnfjord AS	Norway	Ferro Silicon	Email	Yes
9	Malvik Kommune	Norway	Municipalities	Email	No
10	Trondheim Kommune	Norway	Municipalities	Email	Yes
11	Norsk Hydro Holmestrand	Norway	Metals	Email	Yes
12	Holmen Energi	Sweden	Paper	Email	Yes
13	Norske Skog	Norway	Paper	Email	Yes
14	Ranheim Papir Fabrikk	Norway	Paper	Email	Yes
15	Mo Industri Park	Norway	Industry Park	Email	Yes

Table 7: Prospected Industries

In addition to this, information on mines and ships were also gathered by knowledgeable persons in their respective fields. Data gathered for companies mentioned in Table 7 as well as others have been attached in Appendix 9.

3.5.5 Selection of Acceptable Macro Segments

The replies received from the industry prospecting helped identify the following industries whose water and pressure differential appeared feasible for QRRNT as well as the industry vertical. Those were Ferro Silicon producers, Municipalities, Paper & Energy Companies. It must be noted that the customer discovery model outlined in 3.5.4, is a continuous process. This status is as on date and more acceptable Macro segments can be possibly found at a later date.

3.5.6 Selection of Target Segment

Further interviews/telecon were conducted with Norske Skog (Paper), Finnfjord AS (Ferro Silicon), Trondheim Kommune (Municipalities), TrønderEnergi (Energy Companies), to know about their expectations, price points & pains. A questionnaire to that effect was made (attached in Appendix 10). This lead to some interesting insights.

Paper production generates biomass, which is an energy resource in itself. They also recover up to 60% of the heat energy. Thus, QRRNT's product had low attractiveness for them, both in terms of energy recovery as well as a pressure reduction device. Therefore, that industry vertical was discarded. TrønderEnergi and Trondheim Kommune have shown interest in the product. TrønderEnergi as an Energy recovery device and Trondheim Kommune as a pressure reduction device. But for both of them installation costs are a cause for concern. Trondheim Kommune is also interested since the water supply in the city is through gravity (meaning that the water inlet is located at a higher altitude than the water outlet, so that water can flow by force of gravity and external energy need not be supplied to the system, thereby making the product redundant). Finnfjord AS is interested since they have a lot of cooling water going to waste and they see it as a good opportunity to save costs and energy.

Thus, the TAM in combination with the primary parameters and customer discovery model narrowed down a seemingly undifferentiated market into manageable industry verticals of Kommune and Ferro Silicon producers and they can be considered as the ideal customers for the pilot project. The entire process has been shown in a diagrammatic way in Figure 16 .

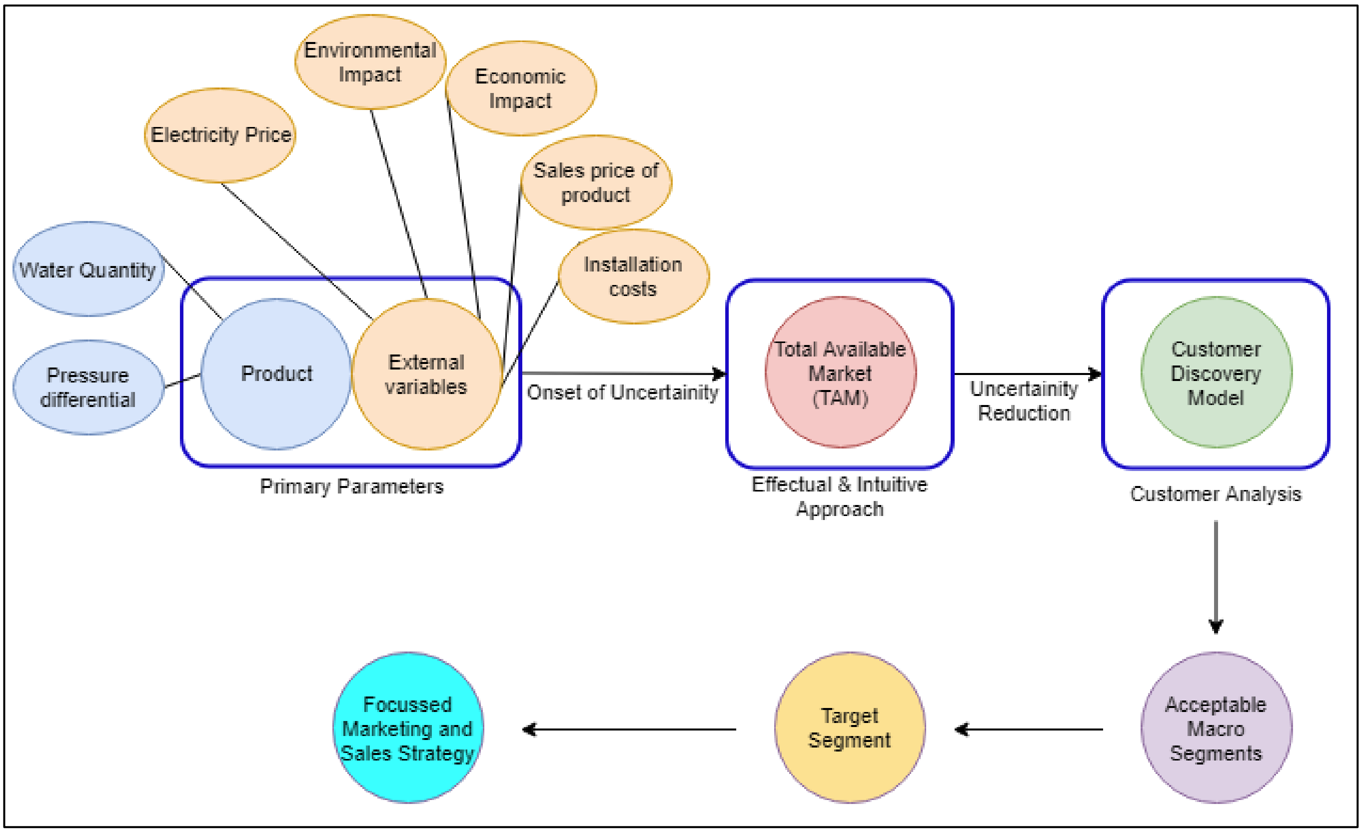

Figure 16: MSM model for QRRNT (adapted from Wind & Cardozo, 1974)

3.6 Implications of the MSM model for QRRNT

3.6.1 Repetitive use of the Customer Discovery Process

The MSM model derived above clearly shows the need repetitive use for Customer Discovery process because of the following reasons,

Size of a particular industry in different geographies: A case in point, is the cement industry in Norway. Cement is a water intensive industry, but the production volumes are too low in Norway for QRRNT to be commercially attractive. Other places in Europe and around the world, where the volumes are significantly larger, QRRNT's solution might still be attractive. Thus, each industry vertical must prospected across different geographies. One industry vertical which is unattractive in one geography might be attractive in another.

External variables: Through the customer discovery process only will one be able to find an industry with an acceptable combination of all the external variables in any particular geography.

3.6.2 Impact on Business Model Scenarios

QRRNT is a start-up with limited personnel and financial resources. The derived MSM model makes a clear link between uncertainty reduction in marketing variables and the customer discovery process, which has to be initiated according to *each* geographic segmentation. This has implications for QRRNT considering the *ex-ante* or pre-sales costs in making the match between the customer and them across different geographies. As with any strategy, this only increases the odds of a successful sale but comes with no guarantees.

Thus, commercialization of the solution will incur significant *ex-ante* costs and investment in time and resources if *only* the Direct-Sales business model is adopted. Several Business Plan scenarios and their value chains are discussed in Appendix 2, and although the Direct-Sales business model is adopted by QRRNT in the initial stages, it is recommended they branch out to use other business models in due course to maximize value and shorten commercialization time.

3.7 Other Functional Strategies

3.7.1 Product certifications

QRRNT over time should aspire for product certifications to satisfy the following.

Green / Energy Labelling: To have a pre-assigned credibility and to avoid the need for positioning again and again as an energy-efficient and environmentally product, it is beneficial if QRRNT forms a *Green Alliance* with a strategic partner (Mendleson & Polonsky, 1995). A strategic partner could be a certification agency. Having a green alliance will lead to increased reliability and provide positive publicity and reduce public criticism. A set of recommended energy efficiency product certification and Labelling for QRRNT could be as follows

- ErP (Energy-related Product) Directive - 2009/125/EC
- Energy Label Directive – 2010/30/EU
- Canada Energy Efficiency Regulation
- Australia/ New Zealand MEPS (Minimum Energy Performance Standards)
- Other National energy efficiency standards.

Industry specific standards: Certain certifications like ISO (International Organization for Standardization, https://www.iso.org/certification.html) are industry recognized standards which QRRNT should consider having. There are other specific standards that might be applicable per industry body. Companies like Statoil also have their own set of standards. Since getting a product certified involves significant investment of time and money, a careful Cost Benefit Analysis must be done before proceeding and investing time and resources in getting the product certified.

3.7.2 Participation in Expos

QRRNT had the opportunity to be invited to Technoport 2018 on behalf of Climate-KIC, in Trondheim. QRRNT had the opportunity to present its tech and product in front of a large section of industry experts and other start-ups. A lot of networking is possible in informal settings in Business Expos like Technoport and provide a suitable opportunity to generate leads, identify relevant partners etc. QRRNT hopes to increase its product awareness through outlets such as Business Expos once there is a confirmed acquisition of a pilot customer.

Figure 17: QRRNT at Technoport 2018 Business Expo

3.8 Competitor Analysis

Hydroelectric power generation is a very old concept. As a matter of fact, over 95% of the energy generated in Norway comes from Hydel sources. Thus, QRRNT and its competitors are separated based on the fact that the product or solution focuses on energy *recovery* and NOT on energy *generation.*

Price as a criterion for comparison is relevant only in a remote sense in this case. This is because, the price will depend on the size of the turbine, water usage, pressure differential, application and Return on Investment (ROI) expectation. The CDM (discussed in 4.8) has also confirmed that potential customers first make a match on their requirements and then ask about the price later. Thus, price is not compared of individual products in this case.

Several companies like Deep River AS, Sea-Lix, & Turbulent Hydro can be classified as geared towards hydro power generation on a 'Pico' scale. They are still localized power *generation* sources and their target market is run off from dams or to put units directly into river streams. Thus, they are not considered for further discussion. Direct competitors are Clean Power AS, Lucid Energy, Zeropex, & SoarHydro who focus their products on *industrial energy recovery.* Comparisons on specific parameters is done below.

It is important to note that none of these products have a 'mass-market' as of today and quite a few of them are still in the pilot-testing phase. Product descriptions/brochures for each have been attached in Appendix 11.

TURBINATOR® from CleanPower AS

Clean Power AS is a Norwegian company. Their product TURBINATOR®, is quite similar to the product QRRNT currently makes. They also have a combined turbine and generator installed. Their construction is also linear, meaning that their energy recovery solution also does not affect the direction of water flow. Their construction is also a simple flange bolted connection. The turbine efficiency is 80-85% as mentioned in their product brochure. Their solution is designed to work at low voltage systems. Patent search does not reveal any patents in the company's or the stakeholders' names, although their product brochure claim that they use 'patented technology'.

Product dimensions are not given, but based on the photographs on their product brochure, it can be concluded with relative confidence that, their product uses a higher footprint than QRRNT's. They also need additional bolting of their generator housing in addition to pipe flange bolting. QRRNT's solution does not require additional bolting apart from flange bolting under most circumstances.

Figure 18: CleanPower AS and their product

LucidPipe™ from Lucid Energy

Lucid Energy is an American company. Their product LucidPipe ™ is also similar to QRRNT's in principle. They too produce energy from pipe flow without changing the direction. In their product brochure it is mentioned specifically that they use spherical turbines inside large diameter gravity fed water transmission pipelines. Their pipe diameter range is 24" (600 mm) to 60" (1500 mm). It doesn't appear from the product brochure that they do any further customization of their product. Their generator housing lies outside the pipe, which occupies significant space in the vertical plane. Thus, their product has a larger footprint than QRRNT's.

This product is specifically geared towards installation in the water mains.

Figure 19: Lucid Energy and their product

Difgen® from Zeropex

Difgen® is a product developed by Zeropex, a U.K based company. This product is similar only in principle. It too has the generator housing outside the pipe but has a significantly large footprint. The generator is mounted on a separate skid frame. This product also comes with a separate control power module, thereby further increasing the required footprint for installation.

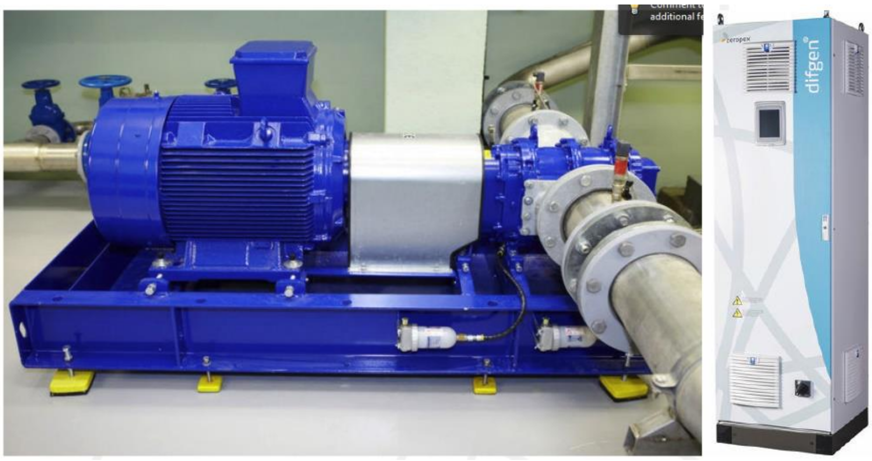

Figure 20: Zeropex and its product along with control power module

Inline Hydro Turbine from Soar Hydro

Soar Hydro is a company based in the U.S. Their Inline series is similar to QRRNT's product in principle. They recover energy from pipes without changing their direction of flow. They have a relatively small footprint in the horizontal plane but a significant one in the vertical plane. Their products are available for pipe diameters ranging from 4" (100 mm) to 24" (600 mm). From the brochure it appears that it requires additional construction of plinth/foundation to hold the turbine.

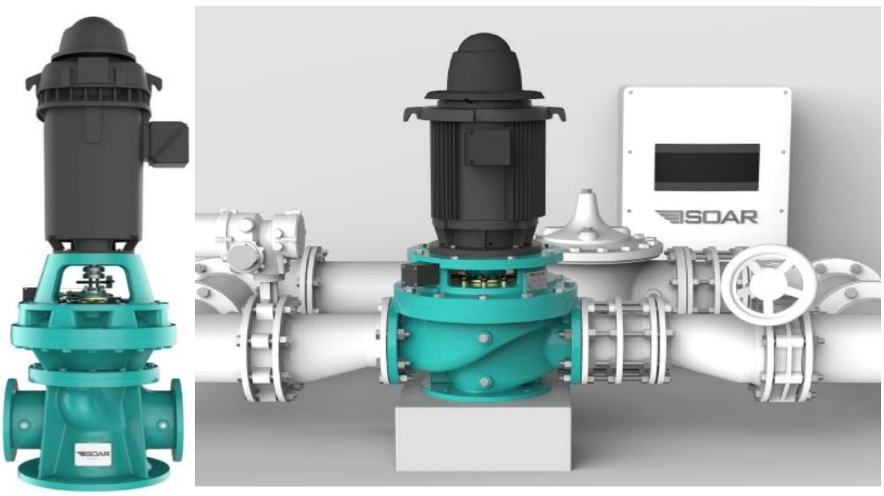

Figure 21: Soar Hydro and it's product

3.9 QRRNT’s Competitive Advantage

QRRNT’s USP (Unique Selling Proposition) is as follows

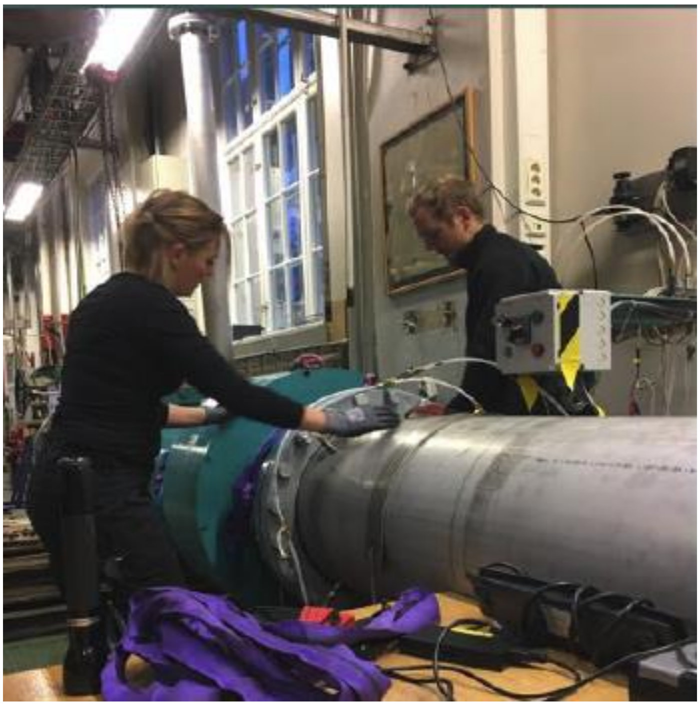

Figure 22: QRRNT's product footprint vis-a-vis competitors.

- Efficiency – Can recover 85% of the energy.
- Retrofittable nature – Can be easily incorporated into existing systems.
- Low CAPEX (Capital Expenditure) and OPEX (Operating Expenditure) costs.
- Small footprint
- Does not change direction of flow

Considering the features of the competitor products as discussed in section 3.8, QRRNT’s USP’s are largely intact. The turbine produced by QRRNT has a footprint which is considerably lower than its competitors, both in the horizontal as well as the vertical plane. This allows QRRNT’s turbine to be fit into very tight spaces in existing systems. The scale of QRRNT’s product vis-à-vis other products will be clear from. The in-built generator also has a small footprint compared to its competitors.

3.10 Conclusion

The Macro Analysis (section 3.2) represents the Quantitative data and the MSM variables (section 3.5) represent the Qualitative data collected for the Market Study. Thus, a mixed approach has been used in this Chapter. The Macro Analysis of the factors confirmed that the policies are quite susceptible to a company like QRRNT to exploit the opportunity presented.

The technical data analysed shows that the quantum of energy saved is significant, provided the initial conditions are right. Depending on the geography, the same amount of energy recovered will result in economic and environmental benefits in a varying degree. However, the external variables identified present the weakest link in the MSM and consequent successful commercialization of the solution. Thus, the MSM should be fine-tuned after each iteration of customer discovery exercise in every geography, by taking into account the Macro factors. Implications of the MSM model on the repetitive use of the customer discovery model and the business model scenarios were also discussed. It is recommended that QRRNT starts considering development of MSM strategies for other geographies as well for speedy commercialization of the product.

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4 Business Plan

4.1 Executive Summary

The product offered by QRRNT is an energy recovery device which recovers energy from excess flow and pressure in pipes. This is a novel source of energy recovery since the energy potential in pipes which have sufficient flow and pressure, usually go to waste. This is a business case for medium and large-scale water intensive industries. Quite a significant amount of water intensive industries are also significantly polluting industries. Thus, there is economic as well as environmental value to this product developed by QRRNT.

Apart from an energy recovery device, this device can also be positioned as a Pressure Reduction Device (PRD). The use of a Pressure Reduction device is ubiquitous and can be found in practically all spheres of life. This gives value to some industries (for e.g., Municipal Water Supply) for use of QRRNT's product as a PRD with an additional benefit of energy recovery.

This product has the potential to be marketed worldwide. It has high attractiveness in countries where the cost of purchased electricity is high and the source of commercial fuel generation is from fossil fuels or other unclean sources of energy. Policies are favourable for de-centralization of power generation in places such as the European Union which gives additional policy impetus in the commercialization of the solution.

Sales will be conducted through the Direct-Sales Business model in the initial phase. Revenue streams for this model are Direct Sales & repetitive earning streams are maintenance contracts. It is expected that additional business models will be effective in due course, either simultaneously with the Direct Sales business model, or completely replacing it. These are discussed later in this chapter.

4.2 The Pain

Countries are increasingly being pro-active on the effect of greenhouse gases in the environment. The EU has set carbon reduction targets for 2020 with an objective of low carbon economy by 2050. They have also set legislations which are beneficial to the use of micro-turbines. Industries are also under tremendous pressure to stay competitive with the rise of infrastructure, electricity costs and the pressure to reduce costs to sustain volume. Thus, the pain statement can be succinctly summarized as follows.

Industries need energy recovery systems to improve efficiency in energy usage due to economic, environmental & regulatory obligations.

4.3 The Solution

QRRNT's energy recovery turbine provides a solution to recover potential energy lost in pipe flow which meet certain thresholds of excess pressure and flow. This provides industries with a novel source of energy recovery which is not exploited yet. This will enable industries with new avenues for cost reduction while simultaneously affecting their carbon footprint in a positive way. The prototype solution which is currently being tested at NTNU's Water resources laboratory is shown in Figure 23.

Figure 23: Working prototype of QRRNT's product

As can be seen above, the QRRNT solution has the following advantages

1. This solution is provided flange-to-flange. This means, existing sections of the pipe (usually bolted, as seen in the figure) can be removed and the product put in place. This takes minimum time and in most cases, does not require suspension of operations.
2. This novel design does NOT change the direction of the fluid. Usually in other designs, the fluid flow direction is changed. Thus, it has minimum impact downstream of the pipe flow.

3. As can be seen in the figure, the footprint of the product is quite small, meaning it is quite small in size and can fit in tight places.
4. This product can be complementary to other energy recovery solutions already in place or planned in future.
5. Leads to reduced purchased energy costs.
6. Fits in line with ‘Green’ image of energy intensive and polluting industries.

The product is developed under able guidance of technical experts from NTNU. The product is also being currently tested at NTNU facilities. QRRNT is planning to file patent(s) for this technology and is currently at a draft stage. The patent is expected to be filed in June 2018.

4.4 Customer Value Proposition (CVP)

As of now, two potential type of customers have been identified in the land based market. This paper intentionally avoids the customers and CVP for the offshore market. The value proposition statement for land based customers is given below.

The solution developed by QRRNT can recover energy in the form of electricity from ***existing systems*** *in industries having sufficient water flow and pressure, thereby reducing fuel/electricity consumption resulting in improved efficiency and cost-savings.*

Two potential customers have been identified for the land based industries.

1. Customers who are interested in energy recovery.
2. Customers who need a pressure reduction device, where energy recovery is an additional benefit.

For Energy Recovery Customers, it gives them a new avenue of Energy Recovery and it fits in line with developing a ‘green’ image of energy intensive and polluting industries. For Pressure reduction customers this device gives them a chance to replace an ordinary pressure reduction device with QRRNT’s which has an additional benefit of energy recovery. There are a lot of other value propositions which are in common with both type of customers. For example, this product can be accommodated in existing systems thereby avoiding costly investment in new infrastructure, the equipment cost is low compared to other energy recovery systems, the turbine can recover 85% of the potential energy in the water flow & the installation is relatively easy (replacement of flange-to-flange pipe section). Osterwalder’s Value Proposition Canvas was employed to distil the value proposition statement for both types of customers and has been attached in Appendix 12.

4.5 The Market

Since this product is relatively 'new' in the market exact benchmarking to quantify the market is difficult. However energy recovery market is expected to reach USD 56 billion by 2021, growing at a CAGR of 7% ("TechNavio," 2015). The energy recovery market for our product can be a significant percentage of the same as wherever there is heat recovery, there is water requirement for its cooling. The Pressure Reduction control valve market is expected to reach USD 10.82 billion by 2020 growing at a CGR of 6.85% (Research & Markets, 2015).

Based on information available on industry verticals, the total available market comes to around USD 1.2 Billion. The details are given below in the table. This list is only indicative and not exhaustive. This is reproduced from Table 6 of the Market Study Chapter.

Verticals	Locations per vertical	Potential Turbines per location	Total Turbines per vertical	Primary Interest of vertical	Revenue per Turbine for vertical	TAM for Vertical
Seawater Desalination plants	3685	1	3685	Energy Recovery	$ 150,000	$ 552,780,000
Offshore Production rigs	1332	1	1332	Energy Recovery	$ 150,000	$ 199,800,000
Metals mining	806	1	806	Energy Recovery	$ 150,000	$ 120,843,990
Shipping; scrubbers	600	2	1200	Energy / Pressure	$ 100,000	$ 120,000,000
Offshore drilling rigs	790	1	790		$ 150,000	$ 118,500,000
Paper mills	350	1	350	Energy Recovery	$ 100,000	$ 35,000,000
Municipalities (water supply) - Nordic and Germany	29	n/a	278	Pressure Control	$ 100,000	$ 27,795,883
Land based aquaculture - Norway	229	1	229	Energy Recovery	$ 100,000	$ 22,900,000
Ferro Silica Plants	41	1	41	Energy Recovery	$ 150,000	$ 6,150,000
Total						**$ 1,203,769,873**

Table 6 (Reproduced): TAM based on water usage segmentation in different industry verticals

It must be noted that the details above are considering the Direct-Sales model. As the business model changes, additional changes would have to be considered to the market. Revenue streams for other Business models are mentioned in Appendix 2.

4.6 Competitors

Since the technology is not ubiquitous yet, it is difficult to derive the price point of competitors from the market. Therefore, comparisons are done on the product features and benefits. The focus of QRRNT is industries therefore solutions which are localized power generation units which use the run off from the river stream directly are not compared. Some companies which do this are Deep River AS, Sea-Lix & Turbulent Hydro. Direct competitors to QRRNT are Clean Power AS, Lucid Energy, Zeropex, & Solar Hydro which focus on *Industrial Energy Recovery*. A competitor matrix is shown in Table 8. One can see that a major advantage is that QRRNT's solution can fit in tight spaces as it's footprint is very low. Some pictures of competitor products have been attached in the Market study. Product description and brochures for each competitor have been attached in Appendix 11.

	QRRNT AS	**TURBINATOR** ® CleanPower AS	**LucidPipe** ™ Lucid Energy	**Difgen®** Zeropex	**Inline Hydro Turbine** Soar Hydro
Company Location?	Norway	Norway	U.S.A	U.K	U.S.A
Separate generator housing?	No	No	Yes	Yes	Yes
Construction?	Linear	Linear	Linear	Linear	Linear
Connection?	Flange-to-Flange / Bolted	Flange-to-Flange / Bolted	Flange-to-Flange / Bolted	Flange-to-Flange / Bolted	Flange-to-Flange / Bolted
Potential energy recovered / Efficiency?	85%	80-85%	-	-	-
Footprint (Space required to install the equipment)?	Low	Low	High	High	High
Customization?	Yes	Probably No	Probably No	Probably No	Set pipe sizes
Distinct Disadvantage compared to QRRNT	-	Bolting required for generator section	Technology verified for large pipes (in excess of 600 mm)	Separate housing as well as separate Instrument-ation control panel	Construction of additional plinth to support the generator mechanism

Table 8: Competitor Matrix

4.7 Business Model

For QRRNT a total of 3 business models were considered.

1. Direct Sales
2. Systems Integrator
3. Power by the hour.

After a thorough analysis of all the business models, it was decided that for the initial period a Direct-Sales Business Model will be followed. Contents and discussion on other business models have been attached in Appendix 2.

4.7.1 Direct Sales Business Model

This is the 'base' business model. The other two business models, which will be discussed in Appendix 2, are all based on the foundation of the Direct Sales business model with their own individual characteristics.

Here, QRRNT will sell the product as it is to the end user. The advantage lies in the fact that the *product positioning* of the solution either as an energy recovery or a pressure reduction device can be fully exploited. Since this is a very predictable business model, there is a high degree of control in all the elements comprising the business model.

In this business model, QRRNT can command a high degree of profit margin since the entire value chain is owned and controlled by QRRNT. For a start-up like QRRNT the obvious drawback is the high cost of customer acquisition and sales and marketing activities since each and every customer in the Industry verticals will have to be approached individually.

The Revenue Stream in this model will be through 3 main types

1. Product sales
2. SMLA (Service Maintenance Level agreements)
3. AMC (Annual Maintenance Contracts)

The key components of this Business model are show in Figure 24 and the Value chain of this business model is shown in Figure 25.

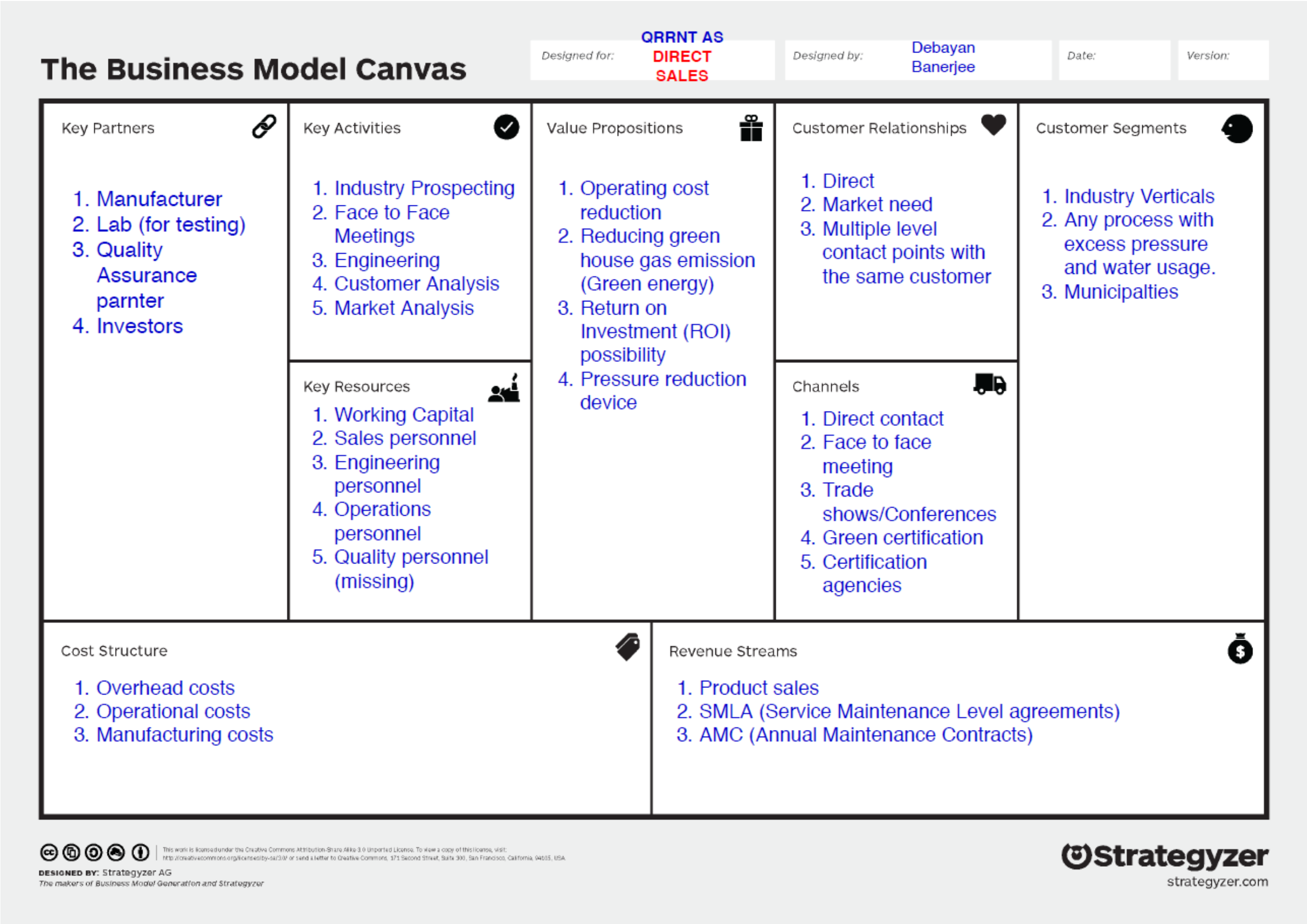

Figure 24: Business model canvas for the Direct-Sales model.

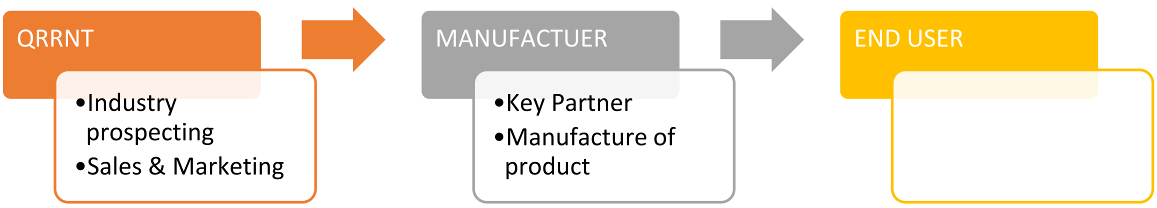

Figure 25: Value Chain: Direct-Sales Business Model

4.7.2 Why the Direct-Sales Model?

On comparing the direct-sales model and the ones discussed in Appendix 2, one can see that, each model has distinct advantages and disadvantages. But QRRNT has decided to follow the Direct Sales Business model in the beginning due to the following factors.

1. This Business model was adopted for the offshore and ship markets as well.
2. Innovasjon Norge is offering huge incentives for the pilot customer program under the Miljøteknologi project (Innovasjon Norge, 2016). Innovasjon Norge is reducing the risk for the customer by absorbing the sales price of the turbine to the customer produced by QRRNT. The customer only has to pay for the transportation and installation costs. Innovasjon Norge is reducing the risk for QRRNT by reimbursing 49% of the external cost incurred in the project.
3. Since the pilot program is for a few customers only, it is inevitable that Industry prospecting be done very carefully to select customers which are of high value in terms of Industry reputation, Industry vertical selected & potential returns to QRRNT in the form of data collected to re-iterate performance and design metrics of the turbine.

Thus, as QRRNT is doing the industry prospecting itself, it makes sense that QRRNT owns the value chain. This also gives QRRNT an opportunity to dive into the potential market and get to know their future customers personally and receive insights and feedback first hand. In the next stage the Business model might diversify into a combination of Direct Sales & System Integrator models. The financial projections have also been based on the Direct Sales business model.

4.8 Target Market & Go-to-Market Strategy

Any industry which has sufficient water usage and excess pressure is a target market in theory. Thus, the variables to define an attractive industry vertical, or any specific market, are relatively vague. It must also be kept in mind that QRRNT is a start-up with limited resources in terms of money and manpower, which hugely limits the market research and marketing ability.

If the circumstances are as mentioned in the above paragraph, it is useful to adopt lean strategies to efficiently scale up the business. One such lean start-up method is the 'Customer Discovery Model' (CDM) outlined by Steve Blank (Blank, 2013). As a result of this, the target market was immediately curtailed in terms of geographic reach. Customer discovery activities at the time of writing the thesis were limited mainly to the Nordic region, with a few instances of activities from European and other regions. More details on the Customer Discovery process have been outlined in the Market Study.

Through the CDM activities, it was found that there was a strong interest shown from Finnfjord AS and Trondheim Kommune. Finnfjord AS comes under Ferro Silicon production industry and the Kommune comes under Municipalities. QRRNT is hoping to get Finnfjord AS and Trondheim Kommune as pilot customers (as explained in section 3.5.4) first. Once they are on the pilot program project then it gives a lot of credibility to QRRNT to approach similar players in the industry for a sale as first paying customers, in this case other ferro silicon plants and other municipalities. Thus, these two verticals form the target market for the immediate future.

CDM also has low customer prospecting costs since mutual compatibility of QRRNT and potential customers is established before huge amounts of man-hours are spent on business development. This gives low turnaround time and quick response from interested parties.

QRRNT believes that CDM model will lead to a few pilot customers, which will then organically lead them to have first paying customers. After a reasonable corpus has been built, attention will then focus to core marketing and branding activities like Advertisements in magazines, Trade shows, exhibitions etc. Further down the line further diversification of the Business models (complete shift/addition/combination) is also expected.

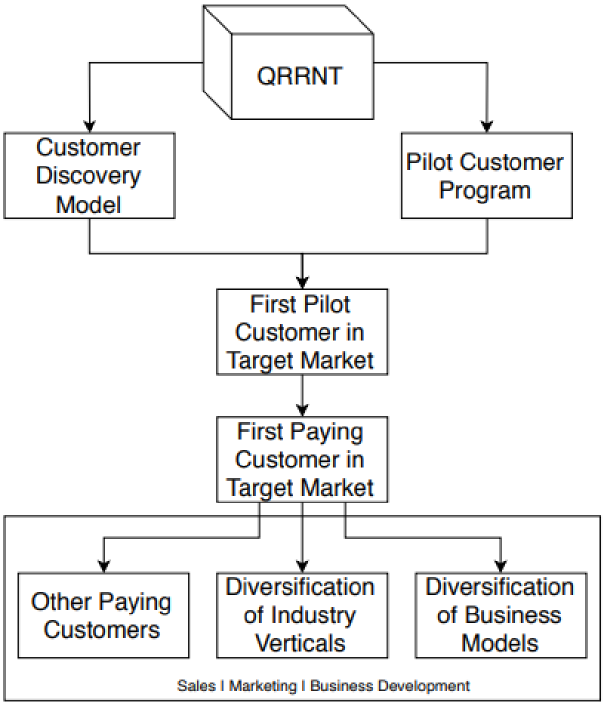

Figure 26: Progression from Identification of Target Market to Sales

4.9 Current Status & Future Plans

Current status, as of April 2018, is as follows

1. Pilot offers sent to two land based customers.
2. Advanced stages of negotiations with Trondheim Kommune.
3. Preliminary interest shown by Trønderenergi.

The main focus going forward will be to successfully end ongoing negotiations by converting offers into definite pilot customers. A tentative target would be to have sold at least 5 turbines (in the land based industries) by end of 2018. As QRRNT goes forward into 2019, planning for diversification in business models (mainly System Integrator business model as explained in Appendix 2). As the business will grow, the number of employees is expected to rise. A product development roadmap has to be initiated to diversify the product at a later stage in terms of new range or additional features.

Important milestones achieved till now are shown below.

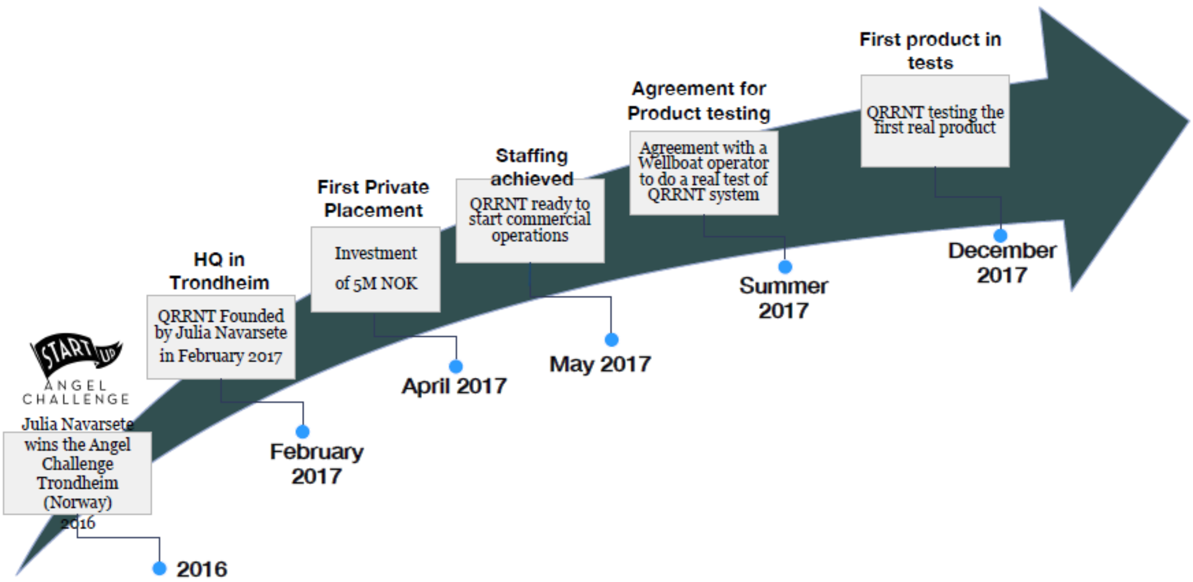

Figure 27: Important milestones achieved

A possible list of future milestones is mentioned below.

2018	• Secure pilot customers • Begin commercial sales • Target a sale of at least 5 turbines in the land based sector • Additional capital injection

2019	• Target a sale of at least 20 turbines in the land based sector • Start Diversification of Business model • Prepare a product development roadmap • Staff increase
2020	• Sales through different business models • Additional prototypes being developed as outlined by the product development roadmap • New Markets

4.10 Financial Evaluation

Below projections are QRRNT's best estimates. This thesis focusses on the land based business development activities. However, financial projections are prepared as a whole, for the company and includes both the land based and offshore verticals. The projections are based on a sale of 820 turbine units at a sales price of 1 MNOK each at the end of Q4-2020. This gives an EBIT of approx. 30 MNOK at the end of Q4-2020. Since this is an aggressive growth model it puts tremendous strain on the cash flow. As can be seen, this model requires a capital injection of approx. 30 MNOK, and QRRNT turns cash flow positive in Q3-2020. Head wise distribution is given in Figure 30. Detailed estimates have been attached in Appendix 13.

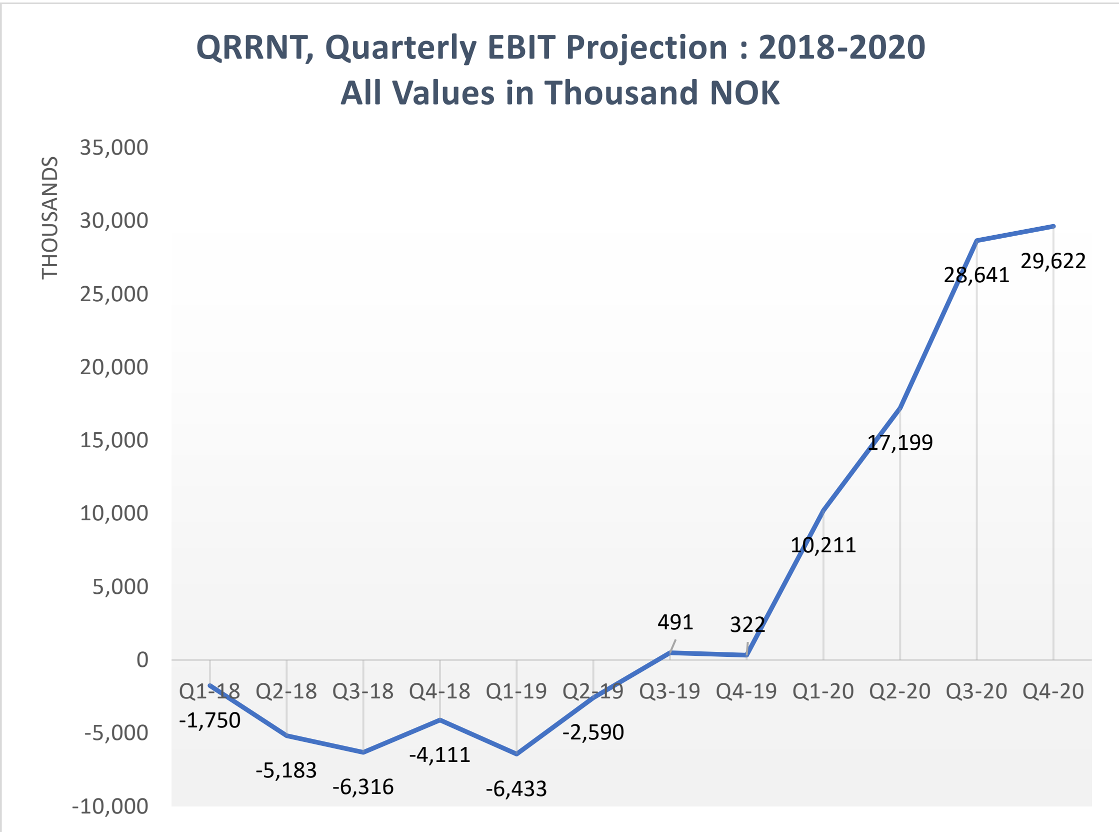

Figure 28: EBIT Projections for QRRNT

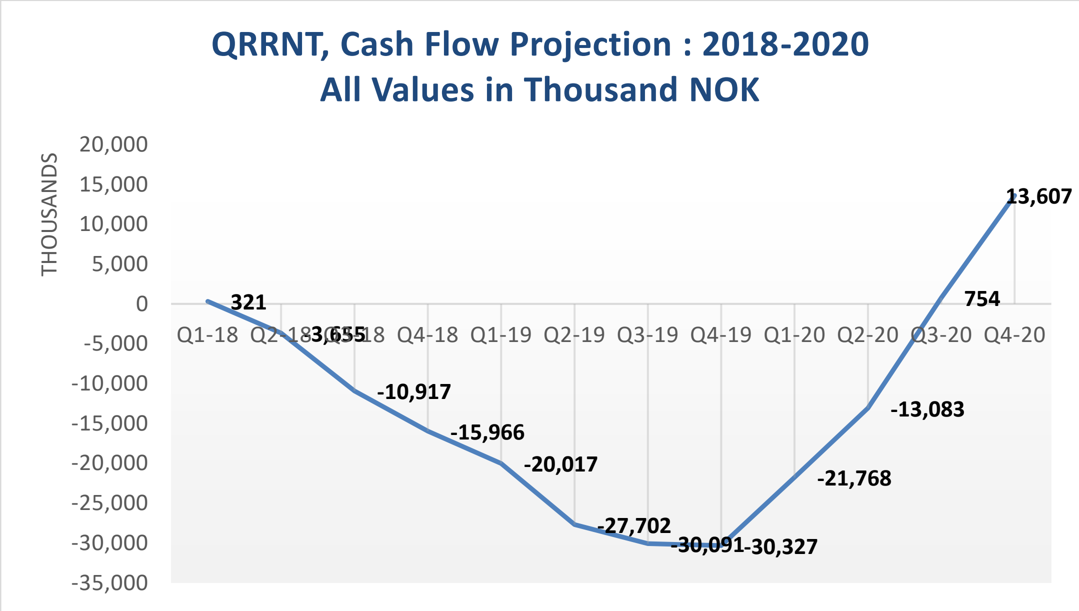

Figure 29: Free Cash Flow projection for QRRNT

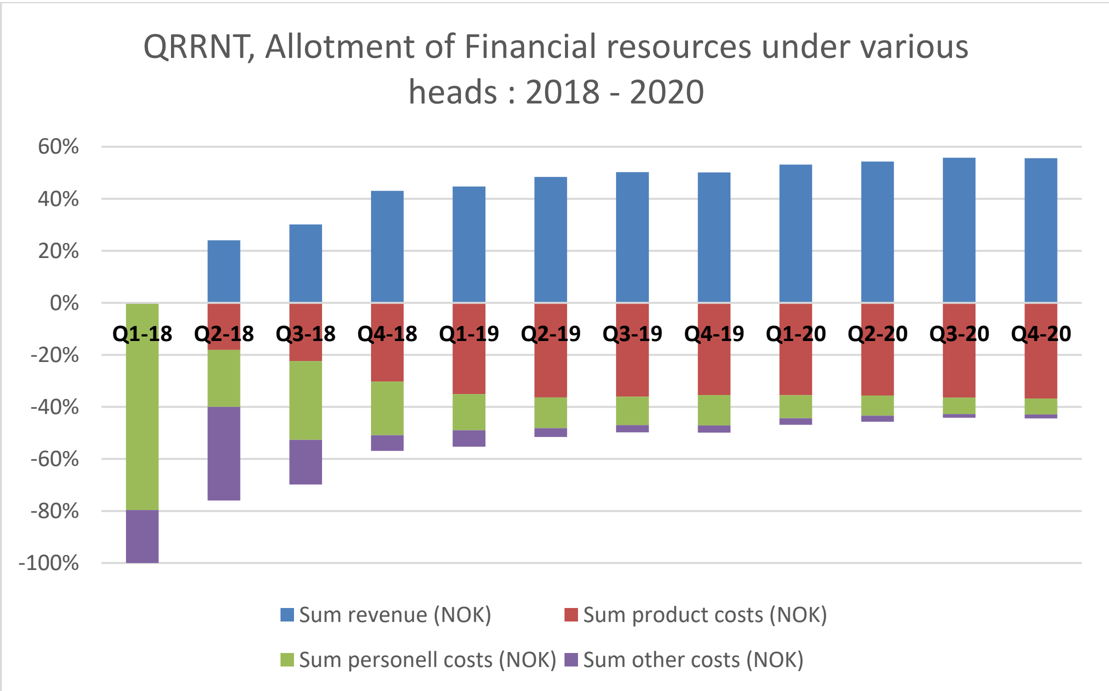

Figure 30: Distribution of resources for QRRNT

4.11 Critical Risks

The critical risks are elaborated below.

1. **Ancillary Costs**: This presents the biggest risk for QRRNT. In certain geographies the cost of civil & structural works is significantly high than the cost of the product itself. In a particular case study (not for QRRNT) the product cost was barely 13% of the total project cost. This has the potential to be a deal-breaker for potential customers. This

scenario is mostly applicable when the pipe, on which the QRRNT turbine is to be fixed, lies underground.

The mitigating measures for this risk requires actions on a policy level. For an untested technology like QRRNT's, it is important that bodies like Innovasjon Norway absorb a higher part of the risk for the first customer. At present Innovasjon Norway through its Miljøteknologi initiative reimburses only the product cost to the consumer. But when significant capital investment is required then Innovasjon Norway should be able to absorb more risk for the first pilot customer so that the product gets a chance to be tested in real life conditions. Quick internalization must also be considered in developing countries like India and China where manpower costs are less and environmental needs are more.

2. **Quantum of energy and environmental savings met through another renewable energy source**: If the solution provided by QRRNT saves a certain amount of energy leading to a certain amount of CO_2 reduction, then it is quite possible that another source of renewable energy like solar cells can provide the same amount of savings at a lower capital expense.

   The mitigating measures for this risk include educating the customer and de-linking the energy savings scenario as an 'either/or' case. Customers must be made aware of favourable legislations for energy producers or 'prosumers' and should be nudged towards a final goal of having an energy neutral establishment, which means that the customer produces (locally) all the energy it consumes.

3. **Replication of technology**: QRRNT, as on date, does not have any patent for its technology. Although patent application is expected to be filed in June 2018, but it has the chance of not being successful. Even if it is successful then the patent is granted country-wise, thus not giving it protection across all interested geographies. It also means a significant investment in time and resources for QRRNT to apply for the patent and to *enforce* patent infringements when discovered, if granted. The easiest mitigating measure for this is to be first to market and commercialize the energy recovery technology.
4. **Failure to secure required investment**: Failure to secure required investment will lead to unsustainable cash flows and might lead to closure of operations.

4.12 Organization Structure

QRRNT AS, is a start-up, located in Trondheim. Its headquarters are at Kongensgata 30, Trondheim-7012, Norway. At present QRRNT has 4 employees.

Julia Navarsete is the CEO of QRRNT AS, she describes herself as a ‘serial entrepreneur’ with her experience of building companies starting in 2008. Rupert Pearn is the Director of Sales & Business Development. He has extensive background in working in the boats and ship industries, primarily in the capacity of sales & business development. Kim Sedgwick is the Director of Operations. She has extensive background in Operations management in the roads and buildings sector. Fredrik Linge is the Optimization Engineer and is responsible for the technical aspects and turbine technology. He is a recent graduate from NTNU with an M.Sc. in Petroleum Engineering.

The Shareholding structure of QRRNT is given below.

Shareholders	Organisation Number	Number of Shares	Owner’s Share
QRRNT Holding AS	918 532 048	450 000	72.58%
18 Engler AS	918 658 750	40 000	6.452%
Angel Challenge AS	816 622 662	40 000	6.452%
Tidligfasefondet i Nord-Trøndelag AS	812 822 012	24 000	3.871%
Patchbox Ventures AS	818 883 692	6 000	0.968%
Ocular AS	991 650 407	1503	0.242%
Victrix AS	911 903 334	15 000	2.419%
Victrix Invest AS	917 116 083	7 500	1.210%
NTNU Accel AS	912 825 760	30 000	4.839%
Julia Sæther Larsen	20/7/88	1 500	0.242%
Lindbank AS	988 979 449	4 500	0.725%
Amount	-	620 003	100%

Table 9: Shareholding structure of QRRNT

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Appendix 1: QRRNT Company Structure

Qrrnt AS

proff.no/skriv-ut/qrrnt-as/trondheim/konsulenter/IF6X0J100NR

Consultants

- Org nr 918 610 669
- *Visiting address:* c / o Accel AS Kongens gate 30, 7012 Trondheim

Overview

Contact

Visiting address: c / o Accel AS Kongens gate 30, 7012 Trondheim

Categories:

- Consultants
- Technical consultants

Official company information

- *Legal Name:* QRRNT AS
- *Org nr:* 918 610 669
- *Company Type:* Limited Company
- *General Manager:* Julia Navarsete
- *NACE industry:* 71,129 Other engineering consultancy
- *Address:* c / o Accel AS Kongens gate 30, 7012 Trondheim
- *Postal Address:* c / o Accel AS Kongens gate 30, 7012 Trondheim
- *Registered in the enterprise register:* Yes
- *Registered in VAT:* Yes
- *Registered in the NAV aa register:* Yes
- *Registered in voluntary law:* No.
- *Date of Establishment:* 08.02.2017
- *Number of employees:* 4
- *Share capital:* 620 003

Source: Brønnøysund Registers

Roles

CEO	Julia Navarsete (born 1979)
Chairman	Tor Andersen (born 1954)
Board Member	Sverre Marvik (born 1971)
Accountant	Kpmg AS

Source: Brønnøysund Registers

shareholders

Name	Ant shares	Percentage in%
Qrrnt Holding AS	450000	100%

Last updated 08.02.2017

Appendix 2: Other possible Business Models for QRRNT

<u>Other Possible Business Models for QRRNT</u>

1 System Integrator Business Model

In our case a System Integrator is defined as someone who takes on a project from the client as a ‘one stop shop’ and then assumes the responsibility of delivering the ‘process’ or ‘system’ in its entirety. The System Integrator takes it upon themselves to arrange for various components in the system through various manufactures. Thus, there is a symbiotic relationship between QRRNT and a System Integrator.

Thus, the business model is similar to the Direct Sales Business model except for the fact that our point-of-sale is the System Integrator and our revenues are realized at that point. The end-user lies further down in the value chain. This business model allows QRRNT to focus on core engineering and business development activities whereas the need to prospect individual industries is taken away. This leads to cost savings in the sales & marketing activities.

Another significant advantage in collaborating with a System Integrator is that this gives access to ‘Greenfield’ projects, i.e. new plants and factories. The incentive to install an energy recovery system is high since the cost of the product plus the installation costs is miniscule when compared to the costs of setting up an entire new facility. This is especially true in a country like Norway where installation cost (post-operations) is significantly higher, in case of underground installations, than the cost of the product itself. However, this might lead to lower profit margins with the same amount of risk as the warranties associated with the product will still be on QRRNT’s shoulders

The revenue streams are same as in the Direct-Sales model explained in 4.7.1

The value chain of this business model is illustrated below

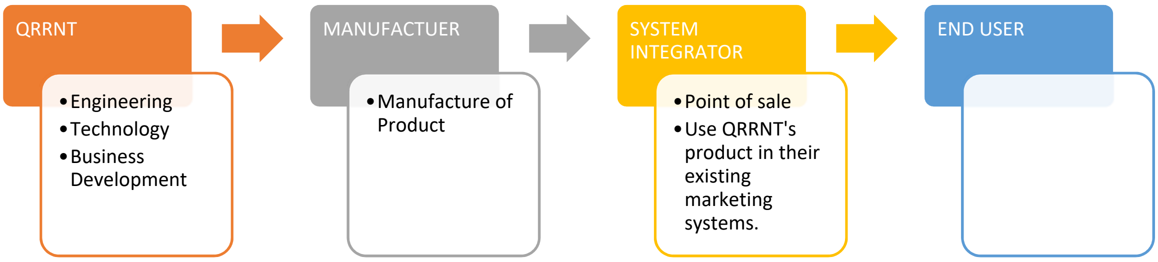

Figure 1: Value chain: System Integrator Business Model

The Business Model Canvas

Designed for: QRRNT AS SYSTEM INTEGRATOR

Designed by: Debayan Banerjee

Date:

Version:

Key Partners

1. Manufacturer
2. Lab (for testing)
3. Quality Assurance parnter
4. Investors
5. System Integrator

Key Activities

1. Face to Face Meetings
2. Engineering
3. Training of personnel from System integrator

Key Resources

1. Working Capital
2. Sales personnel
3. Engineering personnel
4. Operations personnel
5. Quality personnel (missing)

Value Propositions

1. Operating cost reduction
2. Reducing green house gas emission (Green energy)
3. Return on Investment (ROI) possibility
4. Pressure reduction device

Customer Relationships

1. Symbiotic relationship
2. Producer-Supplier

Channels

1. System Integrator

Customer Segments

1. System Integrator (can be manufacturing companies or engineering consultancies)
2. New Industrial projects.

Cost Structure

1. Overhead costs
2. Operational costs
3. Manufacturing costs

Revenue Streams

1. Product sales.
2. SMLA (Service Maintenance Level agreements)
3. AMC (Annual Maintenance Contracts)

2 Power by the Hour Business Model

This is similar to Rolls-Royce's 'Power by the Hour' business model, in which the concept used is 'Product-as-a-Service'. In this model, QRRNT would charge premium rates for the electricity recovered through its' solution. Thus, the customer would pay only for the kWh (Kilo Watt Hours) recovered and will be billed on a monthly or a quarterly basis. This model assumes that since all the risks will be on QRRNT's books, the customer will be incentivized to use this technology.

In all probability, this business model will be used at a later date, once the market is convinced of the value of the technology. Considering the capital costs involved, it will be nearly impossible for QRRNT to use this business model without building a significant amount of corpus through the Direct Sales and/or System Integrator Business model. In this model additional key elements in the cost structure are added. Those are Installation costs, Maintenance costs & Asset depreciation costs. The Value chain of this business model is illustrated below

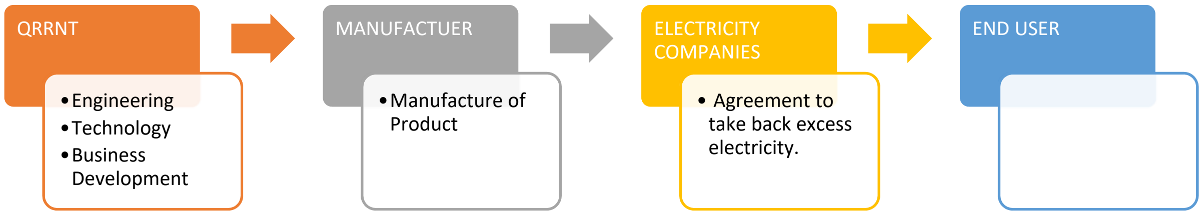

Figure 2: Value Chain: Power by the Hour Business model.

The Business Model Canvas

Designed for: QRRNT AS POWER BY THE HOUR

Designed by: Debayan Banerjee

Date:

Version:

Key Partners

1. Manufacturer
2. Lab (for testing)
3. Quality Assurance parnter
4. Investors
5. Energy companies
6. Installation partners
7. Institutional finance

Key Activities

1. Industry Prospecting
2. Face to Face Meetings
3. Engineering
4. Customer Analysis
5. Market Analysis
6. Record consumption data
7. Establish billing department

Key Resources

1. Working Capital with a long term outlook
2. Sales personnel
3. Engineering personnel
4. Operations personnel
5. Quality personnel (missing)

Value Propositions

1. Operating cost reduction
2. Reducing green house gas emission (Green energy)
3. Return on Investment (ROI) possibility
4. Pressure reduction device
5. Lower Capital Expenditure (CAPEX) costs.
6. Lower risks for customer.

Customer Relationships

1. Direct
2. Longer financial relationship

Channels

1. Direct contact
2. Face to face meeting
3. Trade shows/Conferences
4. Green certification
5. Certification agencies
6. Energy companies

Customer Segments

1. Industry Verticals
2. Any process with excess pressure and water usage.
3. Municipalties

Cost Structure

1. Overhead costs
2. Operational costs
3. Manufacturing costs
4. Installation costs
5. Maintenance costs
6. Depreciation costs

Revenue Streams

1. Recurring revenue through billing cycle

Appendix 3: Feedback from other energy recovery pilot projects

Feedback from Local Governments

Initial questions:

Hi everyone,

I am working for a company in Trondheim, Norway who are assessing the feasibility of a turbine that utilises the surplus pressure to create electricity from fluid flowing through a pipe. Essentially, it operates as a pressure reduction valve that also creates energy.
As an example, if you have a pipe with 2,000cubic metres flowing at 1 bar this would give us an effective energy recovery of 47kW. Over a year, that equates to 413 megawatt hours. The higher the pressure or flow, the higher the energy output. The minimum pipe size is 250mm-300mm with the current design.

My questions are:

1. *If you were to be offered such technology, what would be the first questions you ask regarding its functionality?*
2. *Is water pressure and the control of it a, an ongoing challenge within the water networks that you are managing?*
3. *Is there a need/want to recover energy from water flow when/where-ever possible?*
4. *How applicable would technology such like this be to your network?*
5. *Is there an expected ROI in such cases as replacing pressure reduction valves?*

I realise that those questions may be quite broad/simple, but I am hoping to create a discussion. Any assistance, risks or other information that you believe is relevant to us would also be appreciated.

Many thanks in advance,
Kim Sedgwick

Message From: Ben Wood

I would suggest speaking with some of the water authorities. Melbourne Water installed a number of mini-hydro plants around the bulk water supply system in Melbourne. Ian Royston was the project manager at MWC. I have a feeling other metro water corporations in Melbourne might have been looking at this as well - the scale of their infrastructure is likely to be closer.

Some of the key criteria and questions that should be asked would include:
- lowest NPV (business case). The change in flows and pressures throughout the day/week/year will play a very significant role in determining the efficiency and viability of any turbine/pump as turbine

- how do you maintain the core function of pressure reduction - i.e. protecting downstream assets
- you would need to look at capacity and requirements of the electrical network and what requirements in terms of the configuration of the generator
- what happens when the generator trips in terms of the turbine and management of flow and pressure - what sensitivity do you have to water hammer generated during a trip event - does this compromise either the upstream or downstream infrastructure?
- there are many turbine manufacturers as well as pump suppliers who might look at this. The civil and other associated works can be more significant in terms of the project delivery than the mechanical and electrical plant.
- there are some shonky people out there - I have sat in on tenders with people telling us stuff that was not possible.
- get references and talk about maintenance costs, availability of the system, and their real experience versus what they might have expected. was revenue a match for that predicted in the business case?

Is it worth while - I would say it is a great story - you are making something useful (electricity) where currently you waste that energy, but these systems can be maintenance intensive and expensive to design and construct "properly".

Good luck!
Ben.

Ben Wood
Manager Operations
Cardinia Shire
(former engineer and project manager with Melbourne Water)

Message From: Frederick Brillo

Hi,

Can I just ask what's the scale of this project? I'm thinking with 47Kw per day with how many turbines etc. it's quite an investment when a solar panel of a sample configuration can get up to 10Kw and 30Kw output. I'm going back to basics if it's worth considering but I'm assuming they have done this already to proceed in that avenue.

Regards,

Fred

Message From: Anne-Maree Burke

Hello Kim,

I'd initially suggest you indicate the flow in typical Australian units ie l/s and MPa.

Replying to your questions

1. Reliability, maintainability, mean time between service - what energy usage needs do I have near my PRVs. Can you use it in sewage pipes

2. Current PRVs are doing the job and would consider alternatives to improve carbon footprint if there is a positive business case, particularly as part of renewals or new capital

3. Yes when it provides a positive business case and sometimes a neutral business case if a community benefit can be gained

4. Likely to be applicable but would need more information to confirm this.

5. Not ROI on PRV replacement, more service consistency and risk management for PRV replacement. ROI for new/alternative justification though.

Anne-Maree Burke

Manager Water Strategy

Kempsey Shire Council

Response from Jeff Knapp – author of the paper from Halifax Water (Canada).

1. Have you installed further turbines as PRVs since the pilot project? JK: No. not yet, but we are considering at least two additional sites for future installations.
2. Are continuing to have success with the pilot program? JK: Yes. The one turbine we have in operation has been working almost flawlessly since the fall of 2014. The one problem we experienced with the unit was caused by a broken speed sensor collar, and was due to improper installation by the mechanical contractor. Other than that, it is working very well, with only normal, minimal maintenance.
3. Were there any limitations that you found from the design of the turbine you installed which would prevent you from installing the same type in other situations? JK: The main limitations are really the cost of the units versus the energy revenue, which affects the financial returns (e.g. payback, IRR, O&M costs, etc.), and the technical/performance specs such as flow, pressure reduction, availability, etc. With any of these turbine projects, the first and most important consideration is the flow and pressure reduction, since both determine the available power of the turbine. Next is availability, which determines the energy production rate. Finally, the energy revenue rate and project cost determines the financial performance. Inadequacy in any one of

these can mean the difference between and successful and unsuccessful project. Proper site selection based on adequate flows, heads, and turbine selection is very important.

The inlet pipe size was 8” nominal (200 mm). Design flow was ~ 370 m3/h at a head of ~ 40 m

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Message From: Leon

G'day Kim,

there are a lot of variables here.

Is the discharge to a reservoir?

Is the flow continuous or intermittent?

An inline Pelton Wheel connected to a generator will achieve pressure reduction during flow but not under static head.

Break pressure structures are usually used to dissipate potential energy and elimiate water hammer.

Elimination of water hammer may return benefits in reduced materials cost depending on the risk level that is acceptable.

Appendix 4: Covington Water District – Investment Grade Audit

Covington Water District

Investment Grade Audit – C-4 Turbine
WA DES #2016-085 A (1)
Energy Services Proposal
Revision 1

COVINGTON, WA
13 JULY 2017

FOR THE LIFE OF YOUR BUILDING

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Project Contacts

AREA OF RESPONSIBILITY	NAME	CONTACT NUMBER	EMAIL
Primary Client Contact	Tom Malphrus	253.867.0906	Tom.Malphrus@covingtonwater.com
CWD General Manager	Thomas Keown	253.867.0900	Thomas.Keown@covingtonwater.com
WA DES Representative	Doug Kilpatrick	360.407.9380	Doug.Kilpatrick@des.wa.gov
Account Executive	Andrew Williamson	206.832.8489	andrewwi@mckinstry.com
Program Manager	Mark Nieman, P.E., CEM	206.832.8152	markn@mckinstry.com
Energy Engineer	Mark Nieman, P.E., CEM	206.832.8152	markn@mckinstry.com
Performance Assurance Specialist	Michael Lubbering	206.832.8128	michaellu@mckinstry.com
Construction Manager	Heather Helgen	206.832.8099	heatherh@mckinstry.com
Civil Engineer	Lance Stevens, P.E.	206.284.0860	lstevens@g-o.com
Canyon Hydro (Turbine Vendor)	Eric Melander	360.592.5552	Eric.melander@canyonhydro.com

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Contents

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Executive Summary

OUTCOME SNAPSHOT

This project represents an excellent opportunity to significantly improve facilities while saving energy and trimming utility spending. McKinstry looks forward to making this project a success.

McKinstry estimates these **savings** if proposed facility improvement measures (FIMs) are installed:

$16,066
Utility cost savings/year

174,342
Guaranteed kWh/year

Carbon dioxide emissions reductions would equal:

Reduction of **275,298** lbs eCO_2 / year

24
Vehicles removed from roads

34 Acres
of trees planted

1.1 Overview

Through the Washington State Department of Enterprise Services (DES) Energy Savings Performance Contracting (ESPC) program, McKinstry has completed an extensive study and investigation of energy upgrades for Covington Water District. Our Directed Engineering Study presents a targeted solution for improving the overall facility efficiency and operation. Our proposed solutions will result in lower utility use and cost.

1.2 Current Situation

CHALLENGES

Currently, Covington Water District is in the process of designing and installing a new intertie pipeline between the Tacoma Water system and the 660 pressure zone of the Covington Water District. It is gravity fed from the source at the Howard Hanson Dam. Conventional design would install a PRV (pressure reducing valve) station before the 660 zone to prevent over-pressurization, but the energy dissipated would be lost to the environment and provide no additional benefit to the District.

GOALS

The District would like to have an electric generation water turbine installed in the new C-4 intertie to generate electricity and capture energy that would otherwise be lost to the environment. Since the anticipated water flow at this location is expected to have a base-line flow over 800 gpm, 24 hours a day, year-round, this intertie is a great location to locate an electric turbine generator.

2017 COMMERCE GRANT AWARD & PIPELINE PROJECT COMBINATION

In March, 2017, Covington Water District submitted an ESP to Washington State Commerce that only contained the energy savings portion of the entire project. This ESP includes both, portions of the entire ESP, adding the C-4 Intertie Pipeline described below. The pipeline itself does not save energy on its own, but is necessary to keep incremental costs down to provide a turbine, which does provide energy savings to the District and the State. In the original Turbine ESP, costs and savings were lower, but subsequently, a larger, better turbine selection was discovered. This larger turbine fits the flow and pressure profile of the new intertie and provides more energy savings to the project. Table 4.1 shows the detailed cost breakouts of both the pipeline as well as the incremental Turbine project costs with the larger turbine selection. Audit and design fees shown now include both the turbine and pipeline projects, including the full Design fee that includes the Civil Engineer, Surveying and Engineering Construction Administration for the entire project. The DES fee is also included in this ESP as the Turbine project would not have added to the base DES fee associated with the total ESP package shown here.

Executive Summary

1.3 Solutions

This project includes:

FIM ID: 10.03-CWD PROVIDE WATER TURBINE AT NEW INTERTIE

This measure would provide an electric generation water turbine at the new C-4 intertie to generate electricity. This location is the new, planned intertie between the Tacoma Water system and the 660 pressure zone of the Covington Water District. It is gravity fed from the source at the Howard Hanson Dam. Design flow for the turbine will be an average 865 gpm for approximately 11.5 months out of the year, allowing for service down-time. Differential pressure is expected to be 170 to 220 feet of head (830 to 880 feet above sea level at the source down to 660 feet above sea level). The initial turbine size has a 28 to 47 kW output, using a 55.9 kW, 1800 rpm, 208 VAC, 60 Hz, 3 phase motor to produce electricity. Power from the turbine will be fed back to the Administration Building and would be net-metered with the PSE electrical service.

FIM ID: 30.01-CWD PROVIDE C-4 INTERTIE PIPELINE

This measure provides a new transmission main between the Tacoma Utilities C-4 tap and the 660 pressure zone in the Covington Water District water system per the Gray & Osborne Permit drawings, dated June 19, 2017.

1.4 Summary of Benefits

FINANCIAL BENEFITS

Section 4 of this document provides a detailed look at the project financials. Including sales tax and prior to any utility incentives, the final project cost is $2,303,202. The turbine portion of the project cost is $376,749 with the annual energy savings at $16,066 per year. The Washington Department of Commerce also awarded the Turbine Project $79,447.

ENVIRONMENTAL BENEFITS

By taking the necessary steps to reduce energy consumption through the implementation of the facility improvement measure detailed in this report, Covington Water District will attain the savings outlined in the outcome snapshot on the left. This is equivalent to:

- 12 average-sized homes being removed from the power grid; or
- 12,914 light bulbs (13.5 Watt LED) not energized; or
- 466,607 miles not driven by an average size vehicle.

NEXT STEPS

An earlier version of this Energy Service Proposal was submitted for the March 9, 2017 Department of Commerce Grant Application and was subsequently awarded $79,447. Once acceptance of this ESP is complete, final design and construction of the turbine system will be incorporated into the existing pipeline intertie project, slated to be fully installed and operational by February 28, 2018.

Executive Summary

1.5 McKinstry Differentiators

COMPANY AT-A-GLANCE

- Established 1960
- Over 1,700 employees
- 23 offices
- 55+ Professional Engineers
- 80+ LEED Accredited Professionals

MCKINSTRY EXPERIENCE

$20 million	Customer utility savings guaranteed
$100 million	Grants & rebates secured for clients
636 million	Kilowatt hours saved
453 thousand	Metric tons of CO_2 saved
91 million	Gas Therms saved

CO_2 emission reductions resulting from McKinstry projects have environmental impacts equal to:

3,167 acres	Forest acres saved from destruction
51.5 million	Gallons of gas not used
83+ thousand	Cars taken off the road
40+ thousand	Homes taken off the power grid

COMPANY OVERVIEW

McKinstry has over 50 years of experience assessing and improving facilities in the Pacific Northwest. With more than 1,500 successful energy and facility improvement projects completed in the past 15 years, McKinstry has the expertise to offer comprehensive solutions to Covington Water District. McKinstry is more than just another energy services company, we believe in serving as your trusted advisor "*For the Life of Your Building.*"

MCKINSTRY APPROACH ADVANTAGES

- Vendor- and product-neutral for truly consultative role
- Transparent pricing
- Total cost of ownership consideration
- No "shared savings" model

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Scope of Work

2.1 Facility Improvement Measure (FIM) List

For full descriptions of the scope of work of each measure, please refer to Section 2 - Detailed Scope of Work.

FIM # 10.03-CWD PROVIDE WATER TURBINE AT NEW INTERTIE

FIM # 30.01-CWD PROVIDE C-4 INTERTIE PIPELINE

2.2 McKinstry Services

McKinstry will include the following services related to this project:

1. *Energy Audit:*
   The energy audit is complete and is submitted under Section 5 – Directed Engineering Study.
2. *Design Services:*
   McKinstry will provide a detailed engineering design as needed to obtain permitting, Owner review, and approval of the proposed systems. In addition, McKinstry will also provide construction support services, start-up, testing, as-built drawings of systems installed, and provide operations and maintenance manuals.
3. *Construction:*
   Provide, or cause to be provided, all material, labor, and equipment, including paying for permits, fees, bonds, and insurance, required for the complete and working installation of McKinstry's equipment.
   a. McKinstry will provide a site superintendent who will be responsible for the onsite supervision and coordination of trades and subcontractors. This individual's responsibilities will also include regular work observations, quality control, site security, enforcement of the site-specific safety plan, as well as coordinating any impact upon building tenants with the Owner.
   b. McKinstry may perform portions of the construction work or may subcontract portions to qualified firms. In either case, McKinstry will share information regarding actual costs of the work with the Owner and DES.
   c. When McKinstry has completed the installation of the equipment, including start-up, operations verification, and training in accordance with the Proposal, McKinstry will provide to Owner and DES a "Notice of Commencement of Energy Savings."
   d. At the conclusion of the project, McKinstry will submit a "Notice of Substantial Completion" to the Owner and DES.
4. *Construction Management:*
   McKinstry will provide a dedicated construction manager who will provide contract administration services for the project. The owner is expected to coordinate day-to-day communications with tenants and any scheduling of tenant relocations in and around occupied areas.
5. *Operation Training:*
   McKinstry will provide relevant training of building staff during construction as agreed to by the Owner and DES.
6. *Performance Maintenance:*
   McKinstry will provide ongoing monitoring and support services to help ensure that guaranteed savings are achieved throughout the term of the agreement. Ongoing services shall be under separate agreement. Ongoing services shall be at the discretion of the Owner and DES to terminate. Specific tasks associated with proposed ongoing Measurement and Verification (M&V) can be found in Table 3.2 - M&V Plan Outline.

   For this project, McKinstry has included an M&V term of three year to the Owner and DES per Department of Commerce requirements for Commerce Grant Projects.

7. *Equipment Maintenance:*
McKinstry will provide no equipment maintenance or repairs after the warranty period. Following the completion of the installation and Owner acceptance of the equipment, the Owner shall provide all necessary service, repairs, and adjustments to the equipment so that the equipment will perform in the manner and to the extent set forth in the Proposal. McKinstry shall have no obligation to service or maintain the equipment after the warranty period.

8. *Warranty:*
McKinstry will warrant equipment for one year following Notice of Commencement of Energy Savings. Specific information regarding equipment warranty will be passed on to owner.

9. *Hazardous Waste (other than PCB lighting ballasts):*
Should the project require removal or disposal of hazardous material, McKinstry may have the hazardous material or substances removed and disposed of at the request of the Owner. McKinstry typically does not assume ownership of the material but may act on behalf of the Owner to properly remove and dispose of the material. The Owner agrees and acknowledges that it has not relied on or employed McKinstry to analyze or identify the presence of any hazardous substance on the Owner's premises. Unless specifically identified, the cost of non-PCB hazardous material abatement and disposal is not included in this proposal.

10. *Hazardous Waste (associated with PCB lighting ballasts):*
Where PCB ballasts are discovered as part of lighting retrofit work, McKinstry shall dispose of PCB ballasts through an approved hazardous waste vendor. The cost of hazardous material abatement and disposal associated with PCB ballasts is included in this proposal.

2.3 Extent of Subcontracting

McKinstry may subcontract the energy audit, design, construction management, start-up, and training portions of this Contract to qualified firms upon review and approval by owner. Construction subcontracts will be awarded competitively. McKinstry will endeavor to satisfy the Diverse Business Enterprise utilization goals of the Owner and DES.

2.4 Project Schedule

The following information lists several milestone dates for the project. McKinstry will develop a detailed schedule outlining all of the various design, pre-construction, construction, and closeout tasks associated with the project and that interfaces with other construction work not under this proposal.

	START	**FINISH**
ESP Review and Approval Process	7/17/2017	8/11/2017
Final Design and Pre-Construction	7/13/2017	9/2017
C-4 Intertie Pipeline Construction	9/2017	2/28/2018
Delivery of Turbine	9/2017	3/2018
Construction of Turbine	4/2018	5/2018

Detailed Scope of Work

FIM ID # 32495
10.03-CWD Provide Water Turbine at New Intertie
Admin Gas and Electric

GENERAL

Provide an electric generation water turbine at the new C-4 intertie to generate electricity. This location is the new, planned intertie between the Tacoma Water system and the 660 pressure zone of the Covington Water District. It is gravity fed from the source at the Howard Hanson Dam. Design flow for the turbine will be an average 865 gpm for approximately 11.5 months out of the year, allowing for service down-time. Differential pressure is expected to be 170 to 220 feet of head (830 to 880 feet above sea level at the source down to 660 feet above sea level). The initial turbine size has a 28 to 47 kW output, using a 55.9 kW, 1800 rpm, 208 VAC, 60 Hz, 3 phase motor to produce electricity. Power from the turbine will be fed back to the Administration Building and would be net-metered with the PSE electrical service.

SCOPE OF WORK INCLUDES

1. Civil
   A. See Drawings and Responsibility Matrix
2. Mechanical
   A. Provide a Cornell pump turbine. Basis of design is a 4TR2, operating at 1800 rpm
      1) Turbine will pass 2.60 cfs (1,165 gpm) at an available head of 170 feet and 3.29 cfs (1,474 gpm) at an available head of 220 feet
      2) Production range will be 28 kW to 47 kW
      3) Fixed flow turbine, cast iron and lead free bronze fitted, horizontal, direct drive
      4) Induction generator basis of design is a US Motors, 55.9 kW, 1800 rpm, 208 VAC, 60 Hz, 3 ph
   B. Provide 10” lug-style butterfly valve with hydraulic actuator
   C. Provide (1) custom 10” x 4” inlet piping, flanged and epoxy coated with pressure gauge
   D. Provide (1) custom 6” x 10” outlet piping, flanged and epoxy coated with pressure gauge
   E. Provide (1) custom hydraulic power unit for actuation of turbine inlet valve
   F. Provide (1) custom structural steel equipment mounting skid
   G. Provide (1) direct drive couplings and flexible coupling element with steel drive guard
   H. Furnish (1) Switchgear/controls panel to parallel the generator with the utility grid and provide protective relays to North American utility grid standards for a project of this size. Specific utility requirements may change the scope of the switchgear/controls package offered and pricing may be affected. A one line diagram and equipment list will be submitted for local electrical utility review and approval prior to proceeding with panel manufacturing. The proposed switchgear and controls package includes the following options: Power factor correction capacitor bank, UL508A labeling of the switchgear/controls panel.
   I. Provide micro PLC to controls for auto restart and annunciation
   J. Provide PLC programming software and communication cables
   K. Provide kW transducer with 4-20mA signal to terminal blocks
   L. Provide RS485 Modbus RTU communication to DMM, signal to terminal blocks
   M. Provide bench test of the multi-function protective relay
   N. Set the turbine/generator skid on the concrete pad mounting fasteners (pad and fasteners by others), level and plumb the skid, then install the inlet cone, inlet valve and outlet cone to allow upstream and downstream flange connections to the turbine/generator equipment (by others). coordinate flange connection procedures with pipe installation contractor.
   O. Following completion of vault piping, check flange connections, perform final alignment of the turbine and generator drive shafts and grout the turbine/generator skid bases.
   P. Provide mechanical and electrical startup, commissioning and training services.
   Q. Provide Plumbing and drain to sewer per Drawings C-4 (sanitary sewer) and P-1.
   R. Provide HVAC equipment per Drawings H-1 & H-2.
3. Controls
   A. Provide Turbine Control Panel.
4. Electrical
   A. Electrical permits
   B. Provide 200 amp, 208 V, 3 phase meter base
   C. Provide utility disconnect
   D. Provide 200 amp, 208 V, 3 phase panel
   E. Provide 200 amp, 3 phase feeder from Admin Building to turbine building
   F. Installation of FBO new Turbine control panel
   G. Provide 100 amp, 3 phase feeders from turbine through control panel to 200 amp panel

Detailed Scope of Work

   H. Provide 1" conduit from control panel to Turbine panel for control wires
   I. Allowance of $1,000 for new control wire and terminations
   J. Provide underground conduits in PVC with RGS 90's
   K. Provide above ground conduits in RGS
   L. Provide core drill for conduit routing into Administration Building electrical room
5. Structural
   A. See Drawings S-1 through S1-3.
6. Architectural
   A. Provide slab on grade turbine building (see Drawings A1-1 and A1-2)
   B. This FIM includes the cost of the building as described less the cost of what a PRV vault associated with the new intertie pipeline would cost (estimated to be $85,000)
7. Acoustical
   A. Not applicable
8. Commissioning
   A. See item 2.R above
9. Demolition and Removal
   A. Not applicable
10. Allotments
   A. None
11. Design
   A. Provide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
12. Measurement and Verification (M&V)
   A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
13. Training
   A. Provide training as required for this FIM. See item 2.R above.

CLARIFICATIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should contract directly with qualified abatement specialists.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above
3. All areas of work will be accessible with prior notice
4. This proposal assumes all work will be performed on regular shift after 6:00am, Monday through Friday at regular shift rates
5. Pricing provided is based on code approved industry standard material and practices
6. This proposal assumes all 120/208V breakers are rated at 10kAIC and all 277/480V breakers are rated at 14kAIC
7. We have assumed the existing service and panels can accommodate any additional loads
8. Scope of work substitutes underground PVC conduit vs. rigid specified on the plans.
9. Light fixtures based on vapor tight fixtures, not Holophane brand.

EXCLUSIONS

1. Work on energized systems
2. Arc Flash or Coordination studies
3. Revisions to panels or gear except as noted above
4. Overtime and shift premiums to recover schedule delays caused by others
5. Revisions to fire alarm systems

COVINGTON WATER DISTRICT C-4 TURBINE RESPONSIBILITY MATRIX

10.03-CWD Provide Water Turbine at New Intertie

EQUIPMENT	FURNISH	RECEIVE	INSTALL	WIRE	CONTROLS	START-UP
(01 CP 02) CONTROL PANEL, HYDROELECTRIC EQUIPMENT PACKAGE	CANYON HYDRO	CANYON HYDRO	CANYON HYDRO	CANYON HYDRO	CANYON HYDRO	CANYON HYDRO
ONE LINE POWER DIAGRAM FOR TURBINE PACKAGE	CANYON HYDRO	CANYON HYDRO	ELECTRICAL	ELECTRICAL	-	CANYON HYDRO
(01 HEIG 01) INDUCTION GENERATOR, HYDROELECTRIC EQUIPMENT PACKAGE	CANYON HYDRO	CANYON HYDRO	CANYON HYDRO	ELECTRICAL	CANYON HYDRO	CANYON HYDRO
(01 HEP 01) HYDROELECTRIC EQUIPMENT PACKAGE	CANYON HYDRO	CANYON HYDRO	CANYON HYDRO	ELECTRICAL	CANYON HYDRO	CANYON HYDRO
(01 HHPU 01) HYDRAULIC POWER UNIT, HYDROELECTRIC EQUIPMENT PACKAGE	CANYON HYDRO	CANYON HYDRO	CANYON HYDRO	ELECTRICAL	CANYON HYDRO	CANYON HYDRO
(01 LS 01) LIMIT SWITCH, HYDROELECTRIC EQUIPMENT PACKAGE	CANYON HYDRO	CANYON HYDRO	CANYON HYDRO	ELECTRICAL	CANYON HYDRO	CANYON HYDRO
(01 LS 02) LIMIT SWITCH, HYDROELECTRIC EQUIPMENT PACKAGE	CANYON HYDRO	CANYON HYDRO	CANYON HYDRO	ELECTRICAL	CANYON HYDRO	CANYON HYDRO
(01 MB 01) METER BASE	ELECTRICAL	ELECTRICAL	ELECTRICAL	ELECTRICAL	-	ELECTRICAL
COORDINATE REMOVAL OF EXISTING METER WITH PSE	ELECTRICAL	ELECTRICAL	ELECTRICAL	ELECTRICAL	-	ELECTRICAL
(01 MDP 01) PANELBOARD, MAIN DISTRIBUTION, 208/120 VAC, 600A, 3-PHASE (EXISTING)	EXISTING	EXISTING	EXISTING	ELECTRICAL	-	ELECTRICAL
(01 PB 01) PANELBOARD, 208/120 VAC, 200A	ELECTRICAL	ELECTRICAL	ELECTRICAL	ELECTRICAL	ELECTRICAL	ELECTRICAL
(01 SDS 01) SIFTER DISCONNECT SWITCH	ELECTRICAL	ELECTRICAL	ELECTRICAL	ELECTRICAL	ELECTRICAL	ELECTRICAL
(01 SPD 01) 160 KA PER PHASE/80 KA PER MODE, FULL MODE, WITH NEUTRAL WITH FILTER AND OVERLOAD PROTECTION MOUNTED INSIDE (01 PB 01)	ELECTRICAL	ELECTRICAL	ELECTRICAL	ELECTRICAL	ELECTRICAL	ELECTRICAL
CONDUIT & CONDUCTOR (P0101, P0102, P0103 & P0104) FROM PANELBOARD (01 MDP 01) TO TURBINE	ELECTRICAL	ELECTRICAL	ELECTRICAL	ELECTRICAL	ELECTRICAL	ELECTRICAL
COMMISSIONING TURBINE CONTROLS	-	-	-	-	CANYON HYDRO	CANYON HYDRO
(01 BLDG 01) TURBINE BUILDING	CIVIL CONTR.	CIVIL CONTR.	CIVIL CONTR.	ELECTRICAL	ELECTRICAL	CIVIL CONTR.

30.01-CWD Provide C-4 Intertie Pipeline

EQUIPMENT	FURNISH	RECEIVE	INSTALL	WIRE	CONTROLS	START-UP
(01 CB 01) CIRCUIT BREAKER, 200A, 3-POLE, 65 KAIC, MAIN DISTRIBUTION, 208/120 VAC, 600A, 3-PHASE PANELBOARD	ELECTRICAL	ELECTRICAL	ELECTRICAL	ELECTRICAL	-	ELECTRICAL
(01 CP 01) CONTROL PANEL	ELECTRICAL	ELECTRICAL	ELECTRICAL	ELECTRICAL	SCADA CONTR.	ELECTRICAL
(01 EF 01) EXHAUST FAN	MECHANICAL	MECHANICAL	MECHANICAL	ELECTRICAL	MECHANICAL	MECHANICAL
(01 T 01) THERMOSTAT, UNIT HEATER	MECHANICAL	MECHANICAL	MECHANICAL	ELECTRICAL	MECHANICAL	MECHANICAL
(01 T 02) THERMOSTAT, EXHAUST FAN	MECHANICAL	MECHANICAL	MECHANICAL	ELECTRICAL	MECHANICAL	MECHANICAL
(01 UH 01) UNIT HEATER	MECHANICAL	MECHANICAL	MECHANICAL	ELECTRICAL	MECHANICAL	MECHANICAL
EQUIPMENT NAMEPLATES, LABELS AND SIGNAGE	CIVIL CONTR.	CIVIL CONTR.	CIVIL CONTR.	ELECTRICAL	MECHANICAL	-
FLOW METER	CIVIL CONTR.	CIVIL CONTR.	CIVIL CONTR.	ELECTRICAL	SCADA CONTR.	CIVIL CONTR.
PRV SCADA CONTROLS	CIVIL CONTR.	CIVIL CONTR.	CIVIL CONTR.	ELECTRICAL	SCADA CONTR.	CIVIL CONTR.

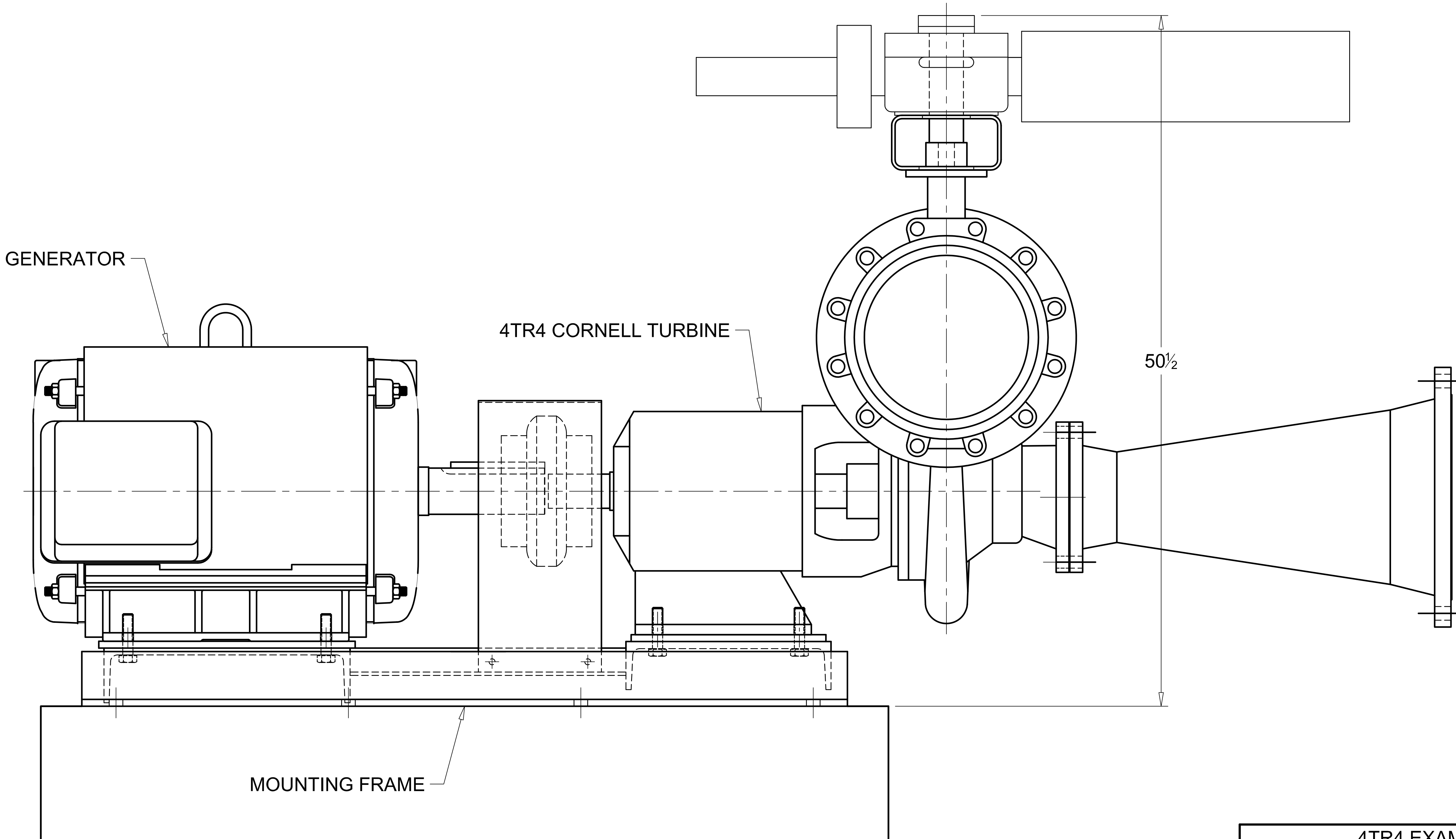
EQUIPMENT	FURNISH	RECEIVE	INSTALL	WIRE	CONTROLS	START-UP
TRENCHING, FILL & PATCHING TO MATCH EXISTING	CIVIL CONTR.	CIVIL CONTR.	CIVIL CONTR.	ELECTRICAL	-	CIVIL CONTR.
C-4 PIPELINE	CIVIL CONTR.	CIVIL CONTR.	CIVIL CONTR.	ELECTRICAL	-	CIVIL CONTR.
COMMISSIONING CONTROLS	CIVIL CONTR.	CIVIL CONTR.	CIVIL CONTR.	ELECTRICAL	SCADA CONTR.	CIVIL CONTR.

NOTES:

1. CIVIL CONTRACTOR RESPONSIBLE FOR SETTING UP AND TESTING PIPELINE VALVES AND CONTROLS. CIVIL CONTRACTOR TO HIR DISTRICT'S INTEGRATOR TO TIE ALL OF THE CONTROLS INTO THE DISTRICT'S SCADA SYSTEM.
2. CIVIL CONTRACTOR TO HIRE VALVE REPRESENTATIVE TO TEST AND SET THE PRV'S.
3. SEE CIVIL, ELECTRICAL, STRUCTURAL AND MECHANICAL DRAWINGS FOR SCOPE OF WORK.

REVISION: 7/13/2017

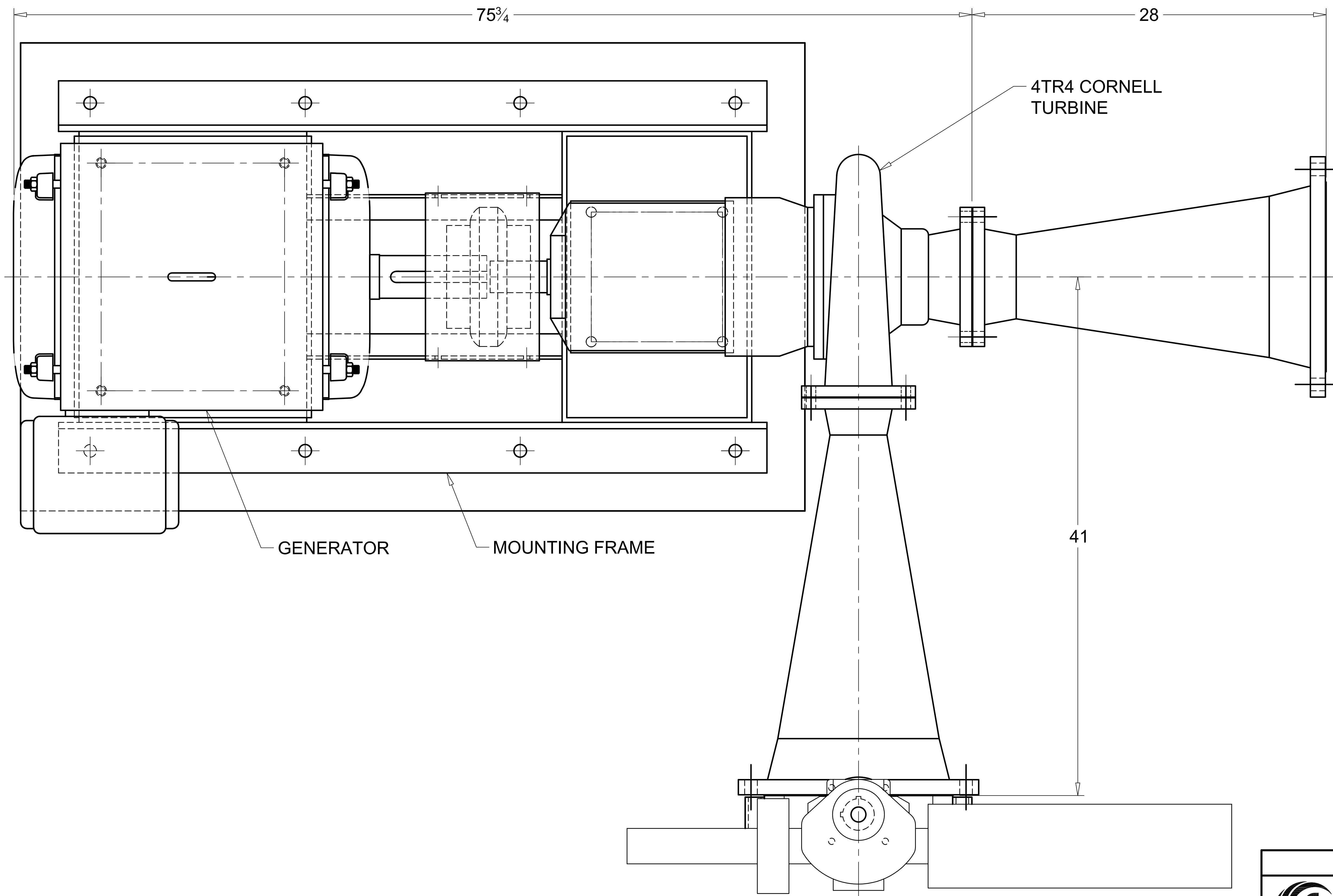
TYPICAL TURBINE INSTALLATION EXAMPLE



4TR4 EXAMPLE

Canyon Hydro
5500 Blue Heron Lane
Deming, Washington 98244
(360) 592-5552
the water power division of Canyon Industries, Inc

FILE: ELEVATION VIEW | DATE: 2011-06-02



4TR4 EXAMPLE

Canyon Hydro
5500 Blue Heron Lane
Deming, Washington 98244
(360) 592-5552
the water power division of Canyon Industries, Inc

FILE: PLAN VIEW | DATE: 2011-06-02

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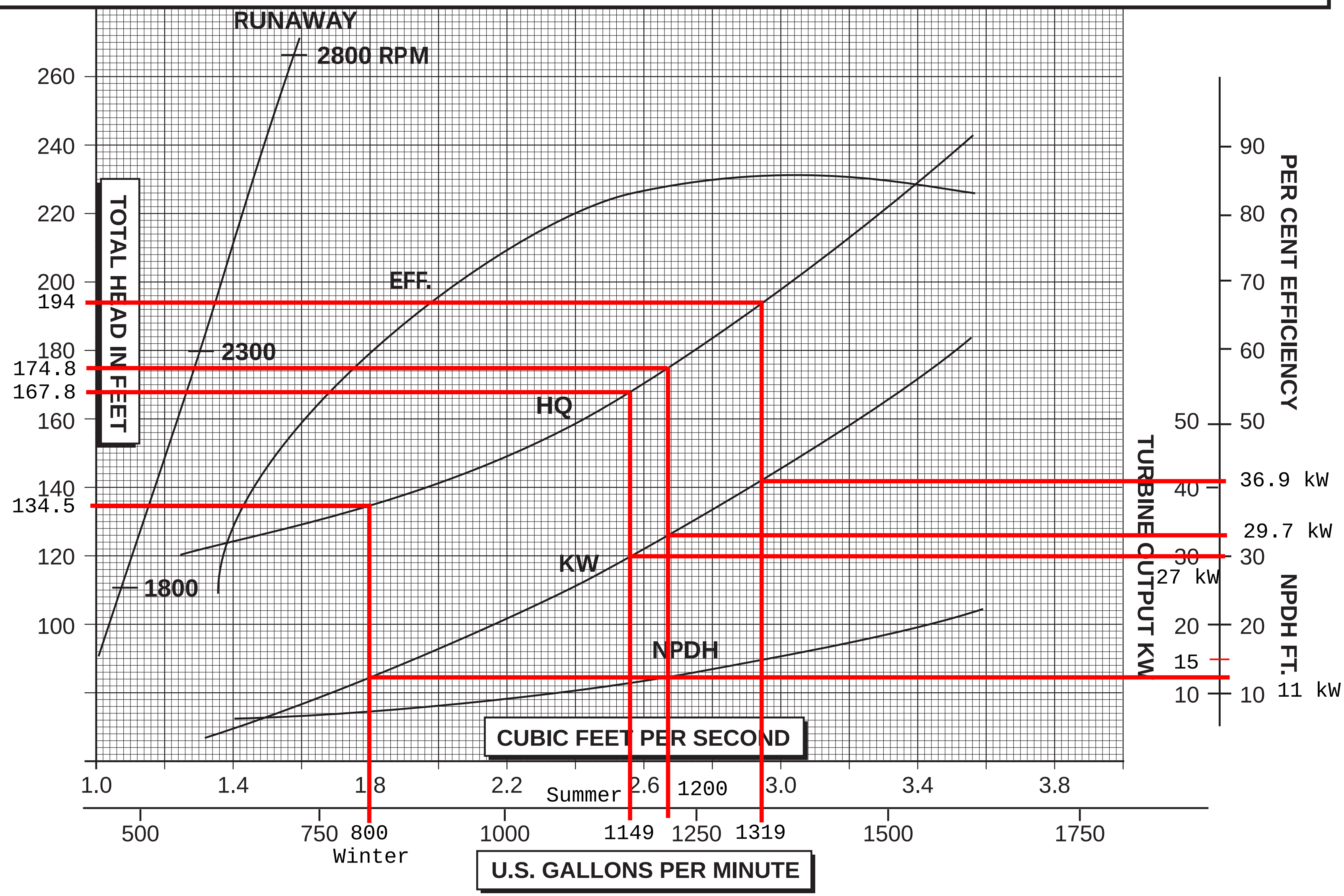
INLET = 4.0 IN. / EXHAUST = 6.0 IN.	N_S = 1290	SPEED = 1830 RPM	TURBINE MODEL — 4 TR2



4 TR2	CORNELL PUMP COMPANY • PORTLAND, OREGON	CORNELL

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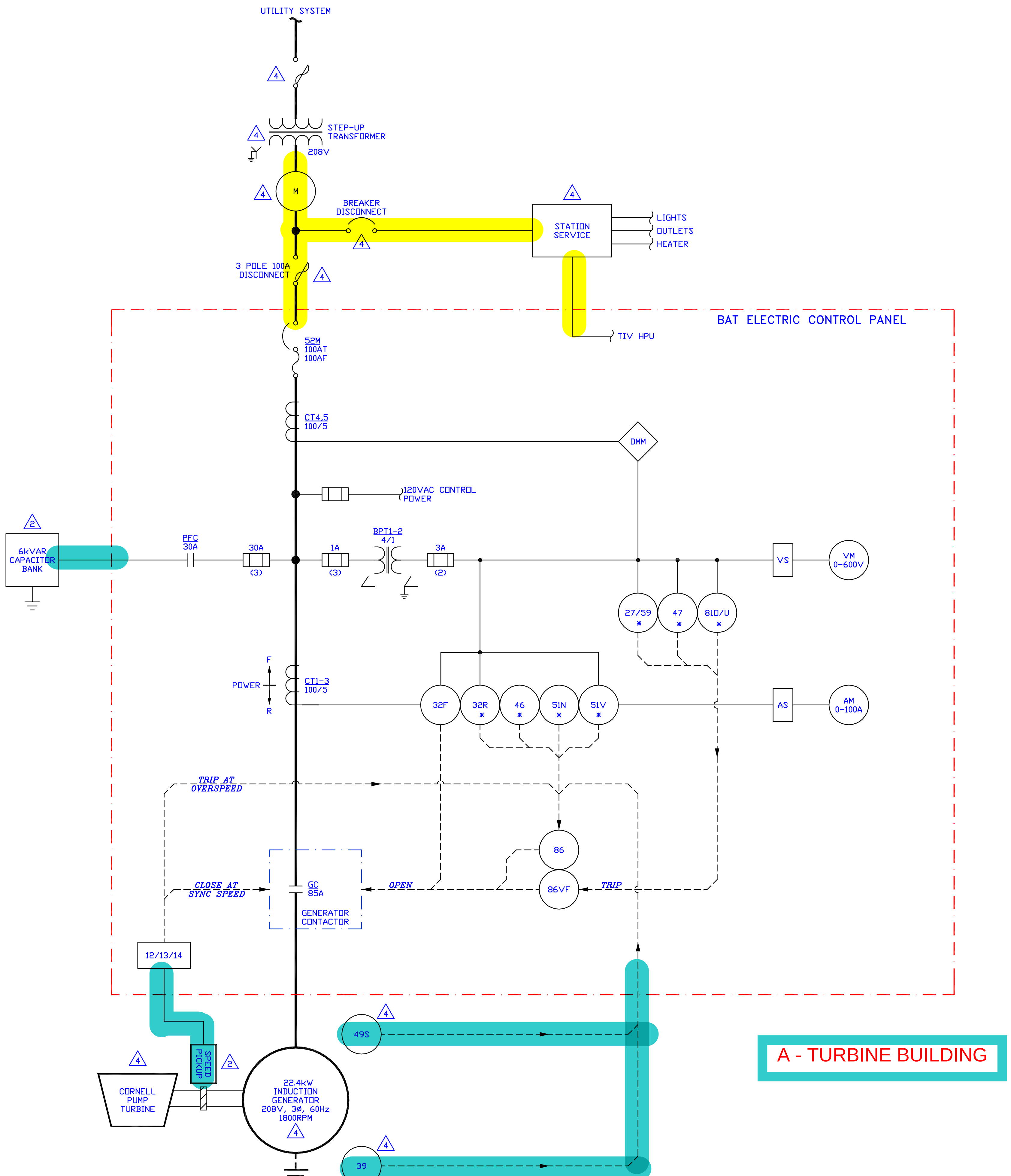

ELECTRICAL RELAY AND EQUIPMENT LIST

STYLE	FUNCTION	DESCRIPTION	SETTING	MFG.	PART No.
12/13/14	SPEED RELAY/ TACHOMETER	24VDC, 4 RELAY	12=OVER=21600RPM 13=SYNC=1800RPM 14=UNDER=360RPM	RED LION	PAXR0030
27/59	UNDER/OVER VOLTAGE	120VAC, 3Ø	27-1 88%, 2SEC. 27-2 50%, 10CYCLES 59-1 110%, 1SEC. 59-2 120%, 10CYCLES	BECKWITH	PART OF MFR
32F	FORWARD POWER RELAY	120VAC, 5A, 3Ø	5% FWD POWER, 1SEC	MULTITEK	M200-RP3
32R	REVERSE POWER	120VAC, 5A, 3Ø	2% REV PWR 10sec. DELAY	BECKWITH	PART OF MFR
46	CURRENT BALANCE	5A, 3Ø	10% FLA, 10SEC	BECKWITH	PART OF MFR
47	PHASE SEQUENCE VOLTAGE BALANCE	120VAC, 3Ø	47-10%, 10SEC	BECKWITH	PART OF MFR
51N	NEUTRAL OVERCURRENT	5A, 3Ø	10A, 1SEC	BECKWITH	PART OF MFR
51V	OVERCURRENT W/VOLT RESTRAINED	5A, 3Ø	90A, TD1	BECKWITH	PART OF MFR
52M	MAIN BREAKER	480V, 100A, 18kAIC, 3 POLE	100A FRAME 100A TRIP	GENERAL ELECTRIC	SEDA36AT0100 SRPE100A100
81O/U	OVER/UNDER FREQUENCY	120VAC, 1Ø	81O-60.5Hz, 10CYCLES 81U-1 59.0Hz, 60CYCLES 81U-2 57.0Hz, 10CYCLES	BECKWITH	PART OF MFR
86	LOCKOUT RELAY	24VDC	NO SETTINGS	SHALLCO	7602B
86VF	VOLT/FREQ LOCKOUT RELAY	4-POLE, 24VDC	NO SETTINGS	SQUARE D	8501XDO80V53
DMM	DIGITAL MULTI METER	120VAC, 5A, 3Ø, 3W 24VDC AUX PWR	NO SETTINGS	MULTITEK	M842-SB4-PE
GC	GENERATOR CONTACTOR	480V, 3Ø, 85A, 120VAC CONTROL	NO SETTINGS	SPRECHER & SCHUH	CA7-85-00-120
MFR	MULTI FUNCTION RELAY	120VAC, 5A, 3Ø, 3W 24VDC AUX POWER	SEE 27/32R/46/47 51N/51V/59/81O/81U	BECKWITH	M3410A-1B1P10
PFC	POWER FACTOR CONTACTOR	480V, 3Ø, 30A, 120VAC CONTROL	NO SETTINGS	SPRECHER & SCHUH	CA7-30-10-120

NOTES

BAT ELECTRIC SWITCHGEAR/CONTROL PANEL TO BE UL508A LABELED.

EXAMPLE DRAWING, FINAL DRAWING PENDING DESIGN

SYMBOLS

- 2 SUPPLIED BY BAT ELECTRIC INSTALLED BY OTHERS
- 4 NOT BY BAT ELECTRIC
- * RELAY FUNCTIONS PART OF MFR

DEVICE LEGEND

39	- OVER VIBRATION
49S	- STATOR TEMP SWITCH
AM	- AMMETER
AS	- AMMETER SWITCH
BPT	- BUS POTENTIAL TRANSFORMER
CT	- CURRENT TRANSFORMER
HPT	- HOUSE POWER TRANSFORMER
M	- METERING
TIV	- TURBINE INLET VALVE
VM	- VOLTMETER
VS	- VOLTMETER SWITCH

BAT ELECTRIC, INC.
20410 MARTINEZ LANE
REDDING, CA 96002
TEL: (530) 221-1336
FAX: (530) 221-3496

CANYON HYDRO
CONVINGTON WATER HYDRO PROJECT
ONE LINE DIAGRAM

TEXT REV B

DWG No.: 17Q0503-01

ENGR: D.BATDORF DRFT: PT DATE: 2-14-17

REV	BY	DATE

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Detailed Scope of Work

FIM ID # 33907
30.01-CWD Provide C-4 Intertie Pipeline
Admin Gas and Electric

GENERAL

Provide a new transmission main between the Tacoma Utilities C-4 tap and the 660 pressure zone in the Covington Water District water system per the Gray & Osborne Permit drawings, dated June 19, 2017.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Provide piping per Drawings M-1, M-2, M1-1.
2. Controls
   A. Not applicable.
3. Electrical
   A. Provide Pipeline Electrical per Drawings E-1 through E-8 and EC-1, ED-1 and ED-2.
4. Structural
   A. See Drawings S-1 through S1-3.
5. Architectural
   A. Not applicable.
6. Civil
   A. Provide intertie pipeline per Drawings C-1 through C-9.
7. Specialty
   A. Not applicable.
8. Testing, Adjusting and Balancing (TAB)
   A. Not applicable
9. Commissioning
   A. Not applicable.
10. Demolition and Removal
   A. Not applicable.
11. Allotments
   A. Not applicable.
12. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
13. Measurement and Verification (M&V)
   A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training
   A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should contract directly with qualified abatement specialists.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.
3. Includes providing EMT conduit in lieu of rigid conduit noted in the drawings.
4. Includes connecting to Tacoma Water Turnout, outside of the turnout, per Drawing C-7. Excludes work within the Tacoma Water Turnout.

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COVINGTON WATER DISTRICT

KING COUNTY

WASHINGTON

C4 TAP & TRANSMISSION MAIN

FOR PERMIT

DISTRICT OFFICIALS

JEFF CLARK

ALAN EADES

KEVIN FUHRER

DAVID ROSELLE

TAL WEBERG

COMMISSIONERS

THOMAS KEOWN

GENERAL MANAGER

CONTACTS:

ENGINEER	LANCE STEVENS P.E.	206-284-0860
OWNER	TOM MALPHRUS	253-867-0906
PUGET SOUND ENERGY		800-321-4123
ESCO	MARK NIEMAN	206-762-3311

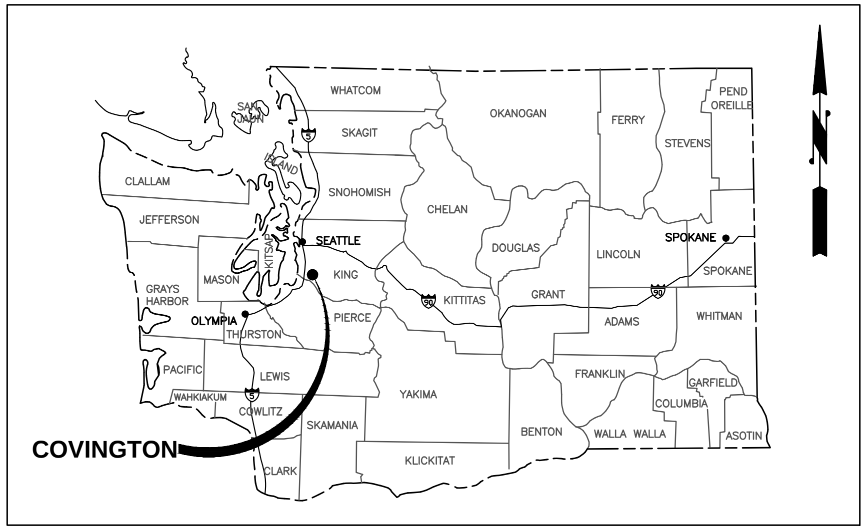
APPROVED FOR CONSTRUCTION

DISTRICT ENGINEER

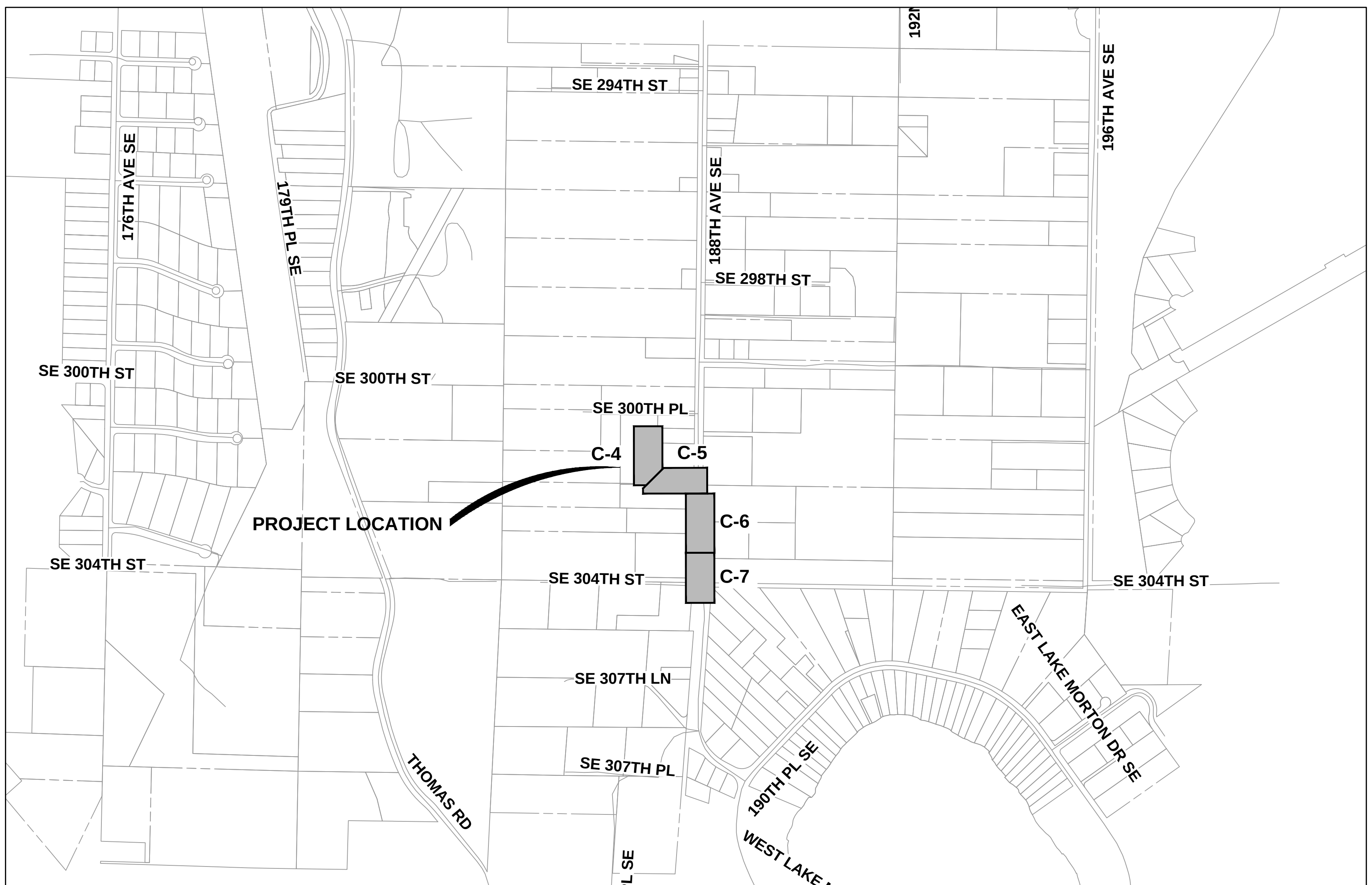
DATE

Gray & Osborne, Inc.
CONSULTING ENGINEERS
701 DEXTER AVENUE NORTH SUITE 200
SEATTLE, WASHINGTON 98109 (206) 284-0860

JUNE 2017
G&O JOB #16608



LOCATION MAP
NTS



VICINITY MAP
NTS

SHEET INDEX

SHEET NO.	SHEET DESCRIPTION
–	COVER
C–SHEETS	
C–1	LOCATION MAP, VICINITY MAP, AND SHEET INDEX
C–2	ABBREVIATIONS, LINETYPES, SYMBOLS, VICINITY MAP, AND SHEET INDEX
C–3	SURVEY CONTROL PLAN AND KEY MAP
C–4	PLAN & PROFILE 0+00 TO 4+00
C–5	PLAN & PROFILE 4+00 TO 8+00
C–6	PLAN & PROFILE 8+00 TO 12+00
C–7	PLAN & PROFILE 12+00 TO 14+65
C–8	DETAILS
C–9	COVINGTON WATER DISTRICT TYPICAL DETAILS
M–SHEETS	
M–1	PIPE SYMBOLS, PROCESS PIPING/EQUIPMENT IDENTIFICATIONS, & DETAILS
M–2	MISCELLANEOUS DETAILS
M1–1	TURBINE BUILDING MECHANICAL PLAN
HVAC	
H–1	HVAC SCHEDULE AND DETAILS
H–2	HVAC PLAN
P–SHEETS	
P–1	PLUMBING PLAN
E SHEETS	
E–1	ELECTRICAL SYMBOLS, ABBREVIATIONS, AND NOTES
E–2	TAG LIST AND LIGHTING SCHEDULE
E–3	ONE LINE DIAGRAM
E–4	PANEL BOARD [01 PB 01] SCHEDULE
E–5	CONTROL PANEL [01 CP 01] ELEMENTARY WIRING DIAGRAM
E–6	CONTROL PANEL [01 CP 01] ELEMENTARY WIRING DIAGRAM
E–7	BUILDING POWER, CONTROL, AND INSTRUMENTATION PLAN
E–8	BUILDING LIGHTING, RECEPTACLE, AND HVAC PLAN
EC–1	CABLE AND CONDUIT SCHEDULE
ED–1	DETAILS
ED–2	DETAILS
S–SHEETS	
S–1	STRUCTURAL NOTES
S–2	TYPICAL STRUCTURAL DETAILS
S1–1	FOUNDATION AND FLOOR PLANS
S1–2	ROOF FRAMING PLAN AND BUILDING SECTION
S1–3	TYPICAL STRUCTURE DETAILS
A–SHEETS	
A1–1	BUILDING ELEVATIONS, SECTION, AND DOOR SCHEDULE AND DETAILS
A1–2	ARCHITECTURAL DETAILS

0 1" 2"
TWO INCHES AT FULL SCALE
IF NOT, SCALE ACCORDINGLY

Gray & Osborne, Inc.
CONSULTING ENGINEERS
701 DEXTER AVENUE NORTH SUITE 200
SEATTLE, WASHINGTON 98109 • (206) 284-0860

DATE: JUNE 2017
SCALE: NOTED
DRAWN: JWS
CHECKED: RJW
APPROVED: LDS

No.	REVISION	DATE	APP'D

FOR PERMIT

LANCE D. STEVENS
STATE OF WASHINGTON
45274
REGISTERED PROFESSIONAL ENGINEER

COVINGTON WATER DISTRICT
KING COUNTY WASHINGTON

C4 TAP & TRANSMISSION MAIN

LOCATION MAP, VICINITY MAP, AND SHEET INDEX

SHEET: C-1
OF: 29

JOB NO.: 16608
DWG: VICINITY MAP

I:\covington water district\16608.00 tacoma tap and transmission main\Design\Planset\General\VICINITY MAP.dwg, 6/14/2017 1:29 PM, JON SPURLIN

ABBREVIATIONS

AVE	AVENUE
AC	ASBESTOS CEMENT PIPE
ADJ	ADJUST
ALT	ALTERNATE
ALUM	ALUMINUM
ANSI	AMERICAN NATIONAL STANDARDS INSTITUTE
AP	ANGLE POINT
ASPH	ASPHALT
ASTM	AMERICAN SOCIETY OF TESTING AND MATERIALS
ASSY	ASSEMBLY
BF	BLIND FLANGE
BLDG	BUILDING
BLK	BLOCK
BO	BLOW OFF
BOP	BEGINNING OF PROJECT
BVCE	BEGIN VERTICAL CURVE ELEVATION
BVCS	BEGIN VERTICAL CURVE STATION
CTR	CENTER
CAP	CORRUGATED ALUMINUM PIPE
CB	CATCH BASIN
CI	CAST IRON
℄	CENTER LINE
CLR	CLEARANCE
CMP	CORRUGATED METAL PIPE
CO	CLEANOUT
CONC	CONCRETE
C	CONDUIT
CONN	CONNECTION
CONT	CONTINUOUS
CPEP	CORRUGATED POLYETHYLENE PIPE
CPLG	COUPLING
CY	CUBIC YARD
CONT	CONTINUED
CL	CLASS
CF	CUBIC FEET
CFS	CUBIC FEET PER SECOND
DC	DEGREE OF CURVATURE
DI	DUCTILE IRON
DIA	DIAMETER
DOT	DEPARTMENT OF TRANSPORTATION
DIM	DIMENSION
DWGS	DRAWING(S)
D	DRAIN
E	EAST
EA	EACH
EL	ELEVATION
ELEC	ELECTRICAL
EOA	EDGE OF ASPHALT
EOP	END OF PROJECT
EVCE	END VERTICAL CURVE ELEVATION
EVCS	END VERTICAL CURVE STATION
EXIST	EXISTING
FIG	FIGURE
FIN	FINISHED
FL	FLANGE
FT	FEET
GA	GAUGE
GALV	GALVANIZED
GI	GALVANIZED IRON
GV	GATE VALVE
HDPE	HIGH DENSITY POLYETHYLENE PIPE
ID	INSIDE DIAMETER
IE	INVERT ELEVATION
INV	INVERT
IN	INCH
L	LENGTH
LB	POUND
LF	LINEAR FEET
MAX	MAXIMUM
MFR	MANUFACTURER
MH	MANHOLE
MIN	MINIMUM
MJ	MECHANICAL JOINT
MISC	MISCELLANEOUS
N	NORTH
NO	NUMBER
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
PI	POINT OF INTERSECTION
PP	POWER POLE
PVI	POINT OF VERTICAL INTERSECTION
PE	PLAIN END
PERF	PERFORATED
PVC	POLYVINYL CHLORIDE
PVMT	PAVEMENT
PVT	POINT OF VERTICAL TANGENT
PC	POINT OF CURVATURE
PT	POINT OF TANGENCY
QTY	QUANTITY
RET	RETAINING
RR	RAILROAD
R	RADIUS
RED	REDUCER
REINF	REINFORCE
REQD	REQUIRED
R/W	RIGHT-OF-WAY
SL	SLOPE
S	SOUTH
SCH	SCHEDULE
SF	SQUARE FEET
SHT	SHEET
SPECS	SPECIFICATIONS
SQ	SQUARE
STA	STATION
STD	STANDARD
TB	THRUST BLOCK
TC	TOP OF CURB
TEL	TELEPHONE
TESC	TEMPORARY EROSION AND SEDIMENT CONTROL
THRD	THREADED
THRU	THROUGH
TYP	TYPICAL
VERT	VERTICAL
W	WEST
WSDOT	WASHINGTON STATE DEPARTMENT OF TRANSPORTATION
W/	WITH
W/O	WITHOUT

LINETYPES

EXISTING | PROPOSED | DESCRIPTION

SURFACE FEATURES

- CURB (TYPE AS NOTED)
- CURB & GUTTER
- ASPHALT PAVEMENT
- GRAVEL SURFACING
- CONCRETE SURFACING
- CEMENT CONC. SIDEWALK
- FENCE/RAILING (TYPE AS NOTED)
- FENCE WITH GATE
- SHRUB/TREE/VEGETATION LINE
- EDGE OF LANDSCAPING

SURVEY

- RIGHT-OF-WAY LINE
- CENTERLINE OF RIGHT-OF-WAY
- CENTERLINE OF CONSTRUCTION
- PROPERTY LINE
- PERMANENT EASEMENT LINE
- TCE TCE — TEMPORARY CONSTRUCTION EASEMENT
- 10 — CONTOUR LINE

UTILITIES

- E — BURIED ELECTRICAL
- T — BURIED TELEPHONE/COMMUNICATIONS
- G — GAS MAIN (SIZE AS NOTED)
- W — WATER MAIN (SIZE AS NOTED)
- S — SANITARY SEWER MAIN (SIZE AS NOTED)
- D — STORM DRAIN (SIZE AS NOTED)
- D — CULVERT (SIZE & TYPE AS NOTED)
- DITCH CENTERLINE

WATER SYMBOLS

EXISTING | PROPOSED | DESCRIPTION

- CAP/PLUG
- COUPLING/ADAPTER
- REDUCER
- THRUST BLOCK
- TEMPORARY THRUST BLOCK
- WATER METER
- WELL
- WATER VAULT (SIZE VARIES)

FIRE HYDRANT

- FIRE HYDRANT (2-NOZZLE)
- FIRE HYDRANT (3-NOZZLE)

JOINTS

- FLANGE/BLIND FLANGE
- MECHANICAL JOINT

VALVES

- AIR RELIEF VALVE
- BLOW-OFF VALVE
- GATE VALVE
- BUTTERFLY VALVE

GAS/POWER/TELEPHONE SYMBOLS

EXISTING | PROPOSED | DESCRIPTION

- GAS METER
- GAS VALVE
- PAD MOUNT TRANSFORMER
- TRANSMISSION TOWER
- UTILITY POLE
- UTILITY POLE ANCHOR
- UTILITY PEDESTAL

SIGNALIZATION/ILLUMINATION SYMBOLS

EXISTING | PROPOSED | DESCRIPTION

- STREET LIGHT ASSEMBLY/LUMINAIRE
- POST MOUNTED LIGHT

SANITARY/STORM SEWER SYMBOLS

EXISTING | PROPOSED | DESCRIPTION

- STORM DRAIN MANHOLE/TYPE 2 CATCH BASIN (ACTUAL DIMENSION SHOWN FOR PROPOSED)
- STORM DRAIN CATCH BASIN, CONCRETE INLET, OR YARD/AREA DRAIN (ACTUAL DIMENSION SHOWN FOR PROPOSED)
- SANITARY SEWER MANHOLE (ACTUAL DIMENSION SHOWN FOR PROPOSED)
- CLEAN OUT (SAN. SEWER OR STORM)

SURFACE FEATURES/LANDSCAPING

EXISTING | PROPOSED | DESCRIPTION

- BUILDING
- MAIL BOX (NOTED)
- SIGN
- TREE STUMP
- RIP RAP
- SHRUB
- NOTED — TREE (CONIFER)
- NOTED — TREE (DECIDUOUS)

SURVEY SYMBOLS

EXISTING | PROPOSED | DESCRIPTION

- CONTROL POINT
- MONUMENT (IN CASE)
- MONUMENT (SURFACE)

0 1" 2"

TWO INCHES AT FULL SCALE. IF NOT, SCALE ACCORDINGLY

Gray & Osborne, Inc.
CONSULTING ENGINEERS
701 DEXTER AVENUE NORTH SUITE 200
SEATTLE, WASHINGTON 98109 • (206) 284-0860

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LANCE D. STEVENS — STATE OF WASHINGTON — 45274 — REGISTERED PROFESSIONAL ENGINEER

COVINGTON WATER DISTRICT
KING COUNTY WASHINGTON

C4 TAP & TRANSMISSION MAIN

ABBREVIATIONS, LINETYPES, SYMBOLS, VICINITY MAP, AND SHEET INDEX

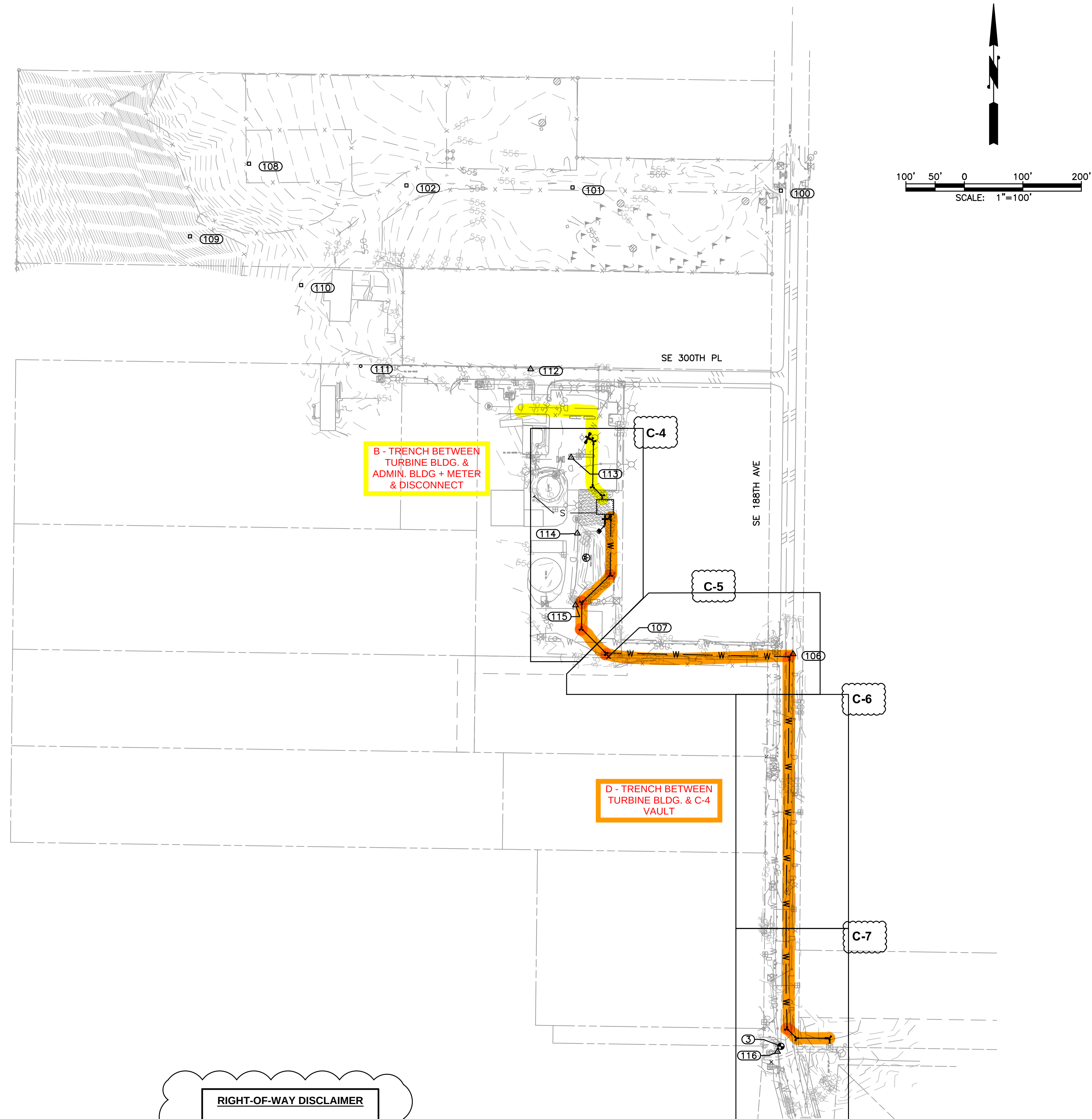
SHEET: C-2
OF: 29

JOB NO.: 16608
DWG: LEGEND

HORIZONTAL DATUM: NAD83[91]

VERTICAL DATUM: NAVD88

POINT	NORTHING	EASTING	Elev.	DESCRIPTION
2	127131.12	1328527.47	480.13	SFMC= FOUND MONUMENT IN CASE, 1 3/4" BRASSY W/ PUNCH. SET IN CONC 0.70' DOWN IN CASE. INTX OF 188TH AVE SE & SE COVINGTON-SAWYER RD
3	122624.80	1328476.92	548.79	SFMC, BRASSY WITH PUNCH. DOWN 0.90' IN CASE. IN S. BOUND LANE OF 188TH AVE SE. AT INTX W/ SE 304 ST. "T21N R6E 6/7 1/4 LS 21673 2002"
100	124086.93	1328476.78	558.33	SSHT= SET HUB AND TACK, 8' W OF W EDGE OF ASPHALT. ALONG 188TH AVE SE. +/- 8' SE OF SE WATER VAULT COR AT S SIDE OF DRIVEWAY TO LOT. AT SE 299TH PL
101	124092.35	1328120.61	555.75	SSHT, 5' N OF WOOD FENCE OF SE HORSE AREA. 11' W/NW FROM W SIDE OF GATE. 11' S OF EDGE OF GRAVEL
102	124095.82	1327836.63	552.20	SSHT, 8' N OF N SIDE OF GRAVEL DRIVEWAY. 19' S OF WOOD FENCE. N OF N SIDE OF GRAVEL DRIVEWAY. 8' E OF METAL FENCE POST THAT SITS 8' N OF N SIDE GRAVEL DRIVEWAY
103	126093.65	1328503.92	470.75	SSNT=SET MAG NAIL WITH TAG STAMPED "G&O CONTROL," S SIDE OF DRIVEWAY TO HOUSE #29245. W SIDE OF 188TH AVE SE IN PAVEMENT BREAK
104	125246.03	1328525.71	526.69	SSN=SET 60D NAIL W/ WHISKERS, 3' E OF E EDGE OF ASPHALT. ALONG 188TH AVE SE. +/- 19.5' S/SW FROM SW COR OF DRIVEWAY TO HOUSE #29524
105	124494.28	1328513.92	554.98	SSNT, 0.50' W OF E EDGE OF ASPHALT. ALONG 188TH AVE SE. 8' W OF FENCE LINE COR OF HOUSE #29816
106	123295.21	1328497.69	556.70	SSNT, AT E. EDGE OF ASPHALT ALONG 188TH AVE SE. ACROSS FROM S. ENTRANCE TO COVINGTON WATER DISTRICT
107	123290.71	1328182.22	557.46	SSN, 2' S OF CHAIN FENCE. 1' N OF EDGE OF GRAVEL. +/- 20' W OF GATE ENTRANCE
108	124132.99	1327567.47	548.84	SSHT, W END OF GRAVEL RIDING AREA
109	124008.81	1327466.54	530.00	SSHT, ON GRASS HILLSIDE
110	123925.48	1327656.56	546.81	SSHT, IN GRASS W OF BARN. SE OF RHODODENDRON
111	123787.04	1327758.36	552.22	SSS=SURVEY SET 60D NAIL W/ WHISKERS, 3' S OF CHAIN LINK 6TH FENCE POST COUNTING E TO W. N SIDE GRAVEL PARKING LOT
112	123782.06	1328048.97	557.99	SSNT, 2' S OF N EDGE ASPHALT, W SIDE OF E ENTRANCE. N OF COVINGTON WD SIGN. 1.2' E OF PAVEMENT GRADE BREAK
113	123631.12	1328118.19	559.63	SSNT, 1' S OF S SIDE ISLAND W/ HOT BOX. SW ISLAND IN MAIN GATED PARKING LOT.
114	123501.42	1328128.80	557.39	SSNT, E SIDE ASPHALT DRIVE NW OF POND
115	123378.74	1328125.69	555.41	SSNT, 2' S OF N EDGE ASPHALT, S OF DRAIN MH @ SW CORNER OF POND. 7' NE OF CATCH BASIN.
116	122615.87	1328471.12	549.18	SSNT, N SIDE OF DRIVEWAY ON SE 304TH ST. 10' E OF POWER POLE, 1' SE OF EDGE OF ASPHALT.



RIGHT-OF-WAY DISCLAIMER

THE RIGHT-OF-WAY AND/OR PROPERTY LINES SHOWN HEREON ARE BASED ON AVAILABLE INFORMATION, NOT ON A SURVEYED LOCATION AND ARE ONLY APPROXIMATE.

0 1" 2"

TWO INCHES AT FULL SCALE. IF NOT, SCALE ACCORDINGLY

Gray & Osborne, Inc.
CONSULTING ENGINEERS
701 DEXTER AVENUE NORTH SUITE 200
SEATTLE, WASHINGTON 98109 • (206) 284-0860

DATE: JUNE 2017
SCALE: NOTED
DRAWN: JWS
CHECKED: RAB
APPROVED: LDS

No.	REVISION	DATE	APPD
	FOR PERMIT		

RICHARD A. BOND — STATE OF WASHINGTON — REGISTERED PROFESSIONAL LAND SURVEYOR — 40097

LANCE D. STEVENS — STATE OF WASHINGTON — REGISTERED PROFESSIONAL ENGINEER — 45274

COVINGTON WATER DISTRICT
KING COUNTY WASHINGTON

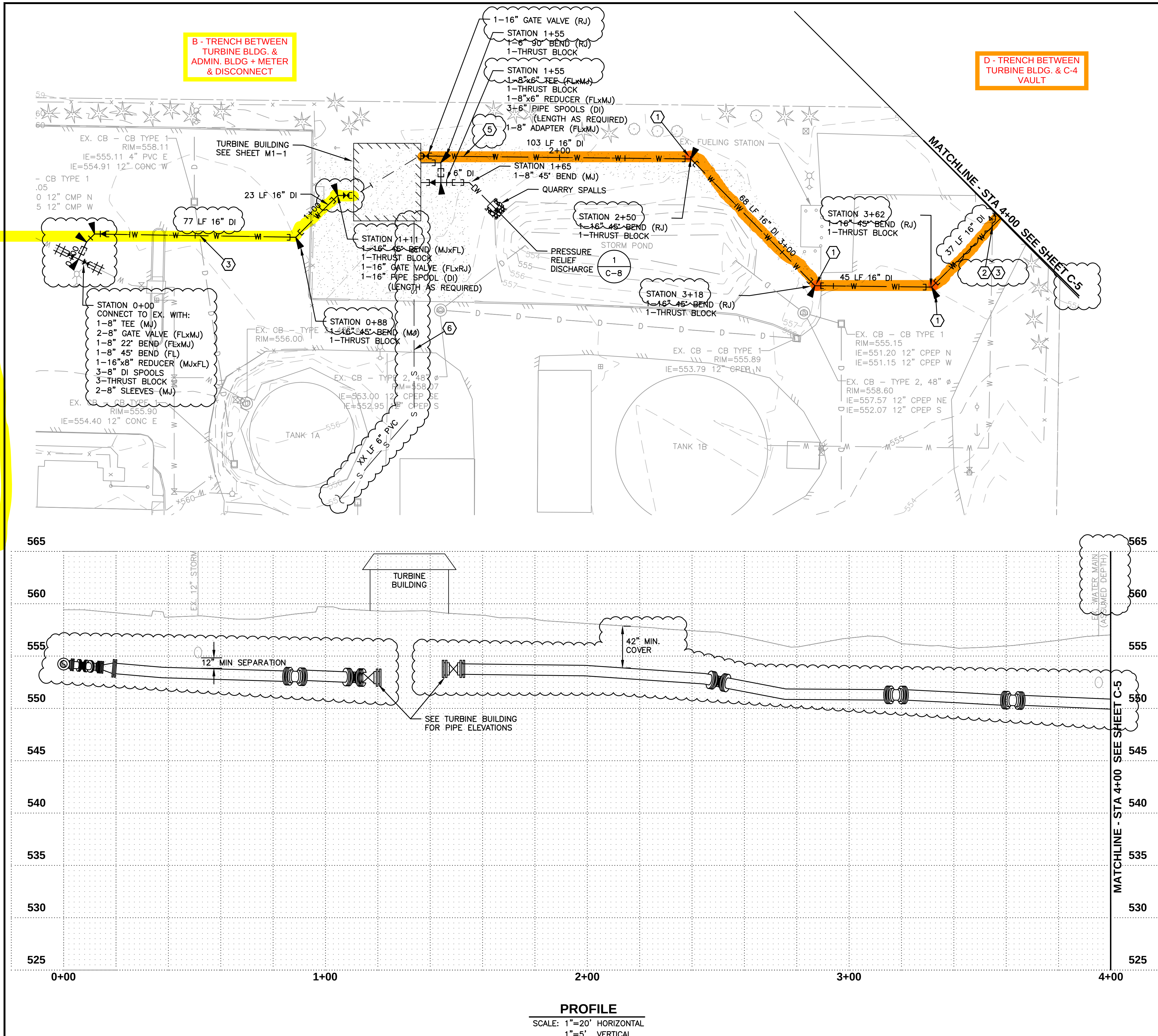
C4 TAP & TRANSMISSION MAIN

SURVEY CONTROL PLAN AND KEY MAP

SHEET: C-3
OF: 29

JOB NO.: 16608
DWG:SURVEY CTRL PLAN

i:\covington water district\16608.00 tacoma tap and transmission main\Design\Planset\Civil\SURVEY CTRL PLAN.dwg, 6/14/2017 1:30 PM, JON SPURLIN



PROFILE

SCALE: 1"=20' HORIZONTAL
1"=5' VERTICAL

CONSTRUCTION NOTES

1. CONTRACTOR SHALL RESTRAIN FIRST TWO JOINTS BEFORE AND AFTER EACH FITTING.
2. CONTRACTOR SHALL HOLD UTILITY POLE.
3. POSSIBLE UTILITY CONFLICT.
4. CONTRACTOR SHALL REMOVE AND REINSTALL EX. FENCE AS REQUIRED. COORDINATE WITH PROPERTY OWNER AND ENGINEER.
5. ALL LINES SHALL BE PIGGED PRIOR TO ACCEPTANCE. SEE STANDARD DETAIL_____, SHEET __-__
6. 6" PVC SANITARY SEWER AT 2% MINIMUM SLOPE. CONNECT TO EXISTING SANITARY SEWER PER DETAIL_____, SHEET__-__

Gray & Osborne, Inc.
CONSULTING ENGINEERS
701 DEXTER AVENUE NORTH SUITE 200
SEATTLE, WASHINGTON 98109 • (206) 284-0860

DATE: JUNE 2017	SCALE: NOTED	DRAWN: JWS	CHECKED: RJW	APPROVED: LDS

FOR PERMIT

No.	REVISION	DATE	APP'D

COVINGTON WATER DISTRICT
KING COUNTY WASHINGTON
C4 TAP & TRANSMISSION MAIN
PLAN & PROFILE 0+00 TO 4+00

SHEET: C-4
OF: 29
JOB NO.: 16608
DWG:PLAN

TWO INCHES AT FULL SCALE. IF NOT, SCALE ACCORDINGLY.

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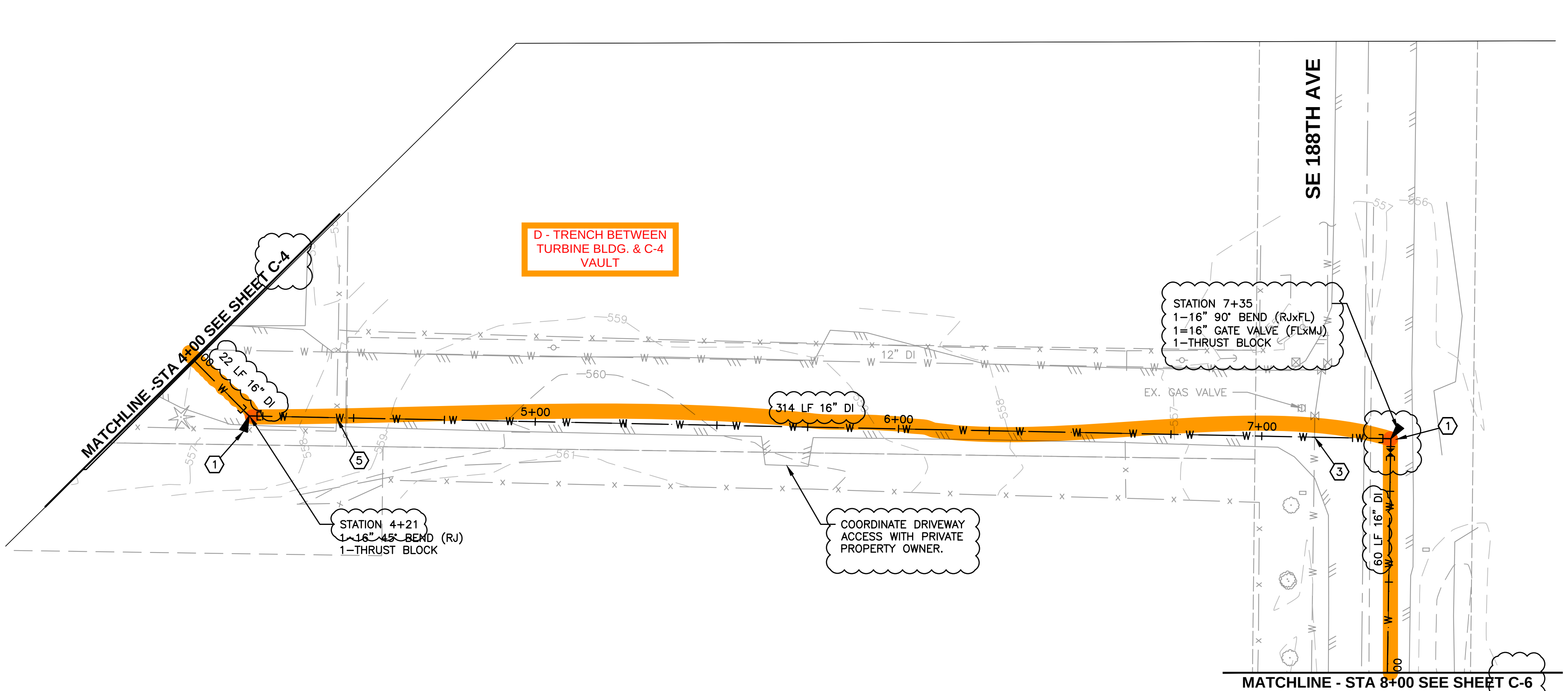

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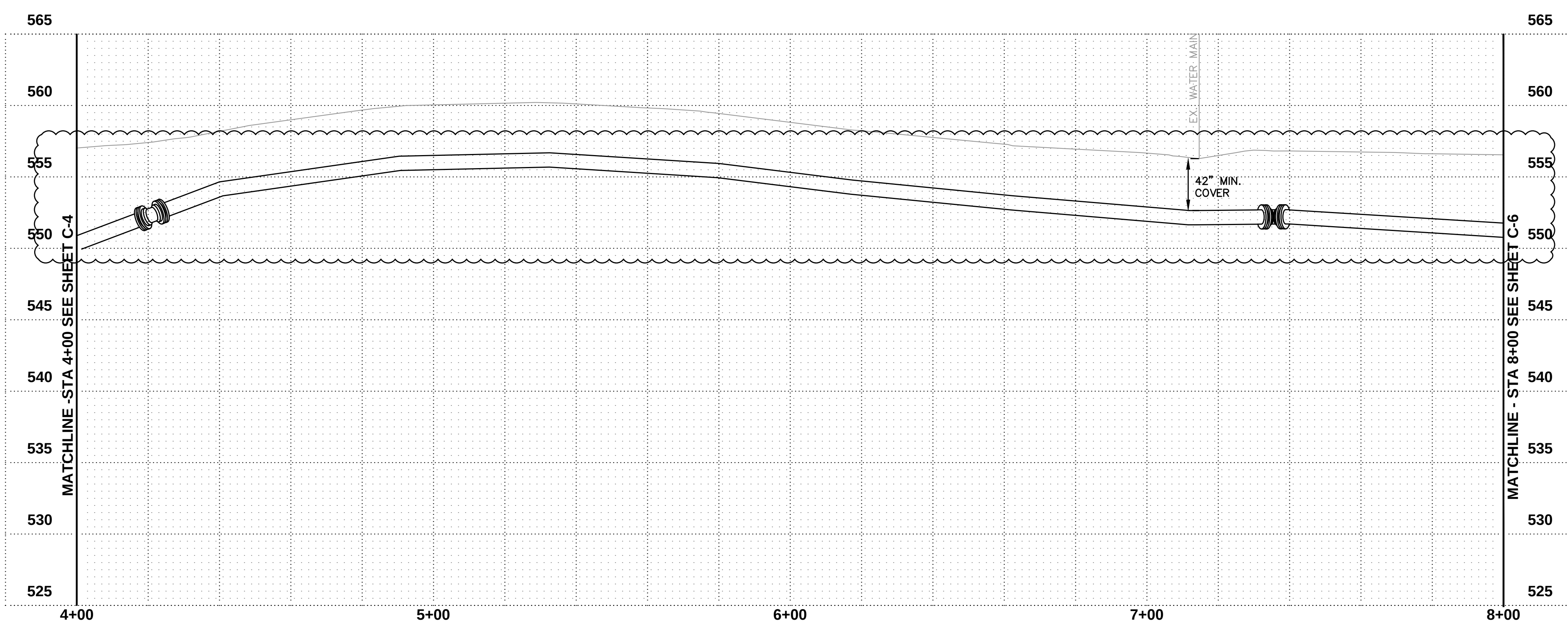


PROFILE

SCALE: 1"=20' HORIZONTAL
1"=5' VERTICAL

0 1" 2"
TWO INCHES AT FULL SCALE. IF NOT, SCALE ACCORDINGLY

Gray & Osborne, Inc.
CONSULTING ENGINEERS
701 DEXTER AVENUE NORTH SUITE 200
SEATTLE, WASHINGTON 98109 • (206) 284-0860

DATE: JUNE 2017
SCALE: NOTED
DRAWN: JWS
CHECKED: RJW
APPROVED: LDS

No.	REVISION	DATE	APPD

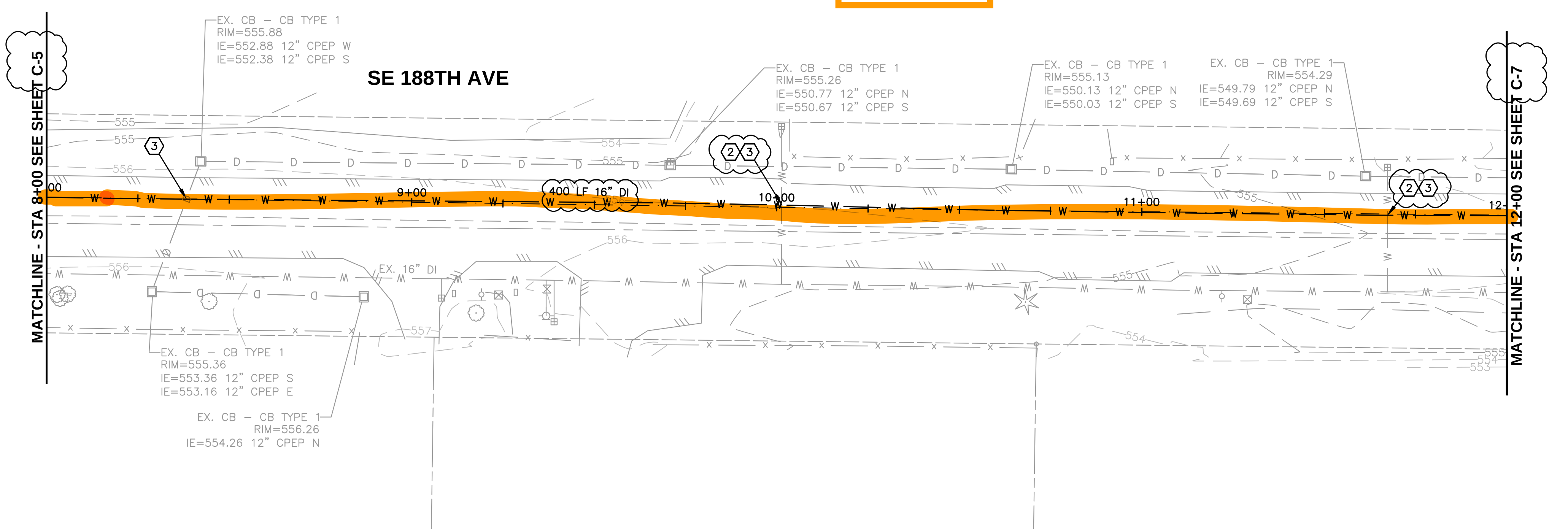
FOR PERMIT

LANCE D. STEVENS, STATE OF WASHINGTON, REGISTERED PROFESSIONAL ENGINEER, 45274

COVINGTON WATER DISTRICT
KING COUNTY WASHINGTON
C4 TAP & TRANSMISSION MAIN
PLAN & PROFILE 4+00 TO 8+00

SHEET: C-5
OF: 29
JOB NO.: 16608
DWG: PLAN

D - TRENCH BETWEEN TURBINE BLDG. & C-4 VAULT



SCALE: 1"=20'

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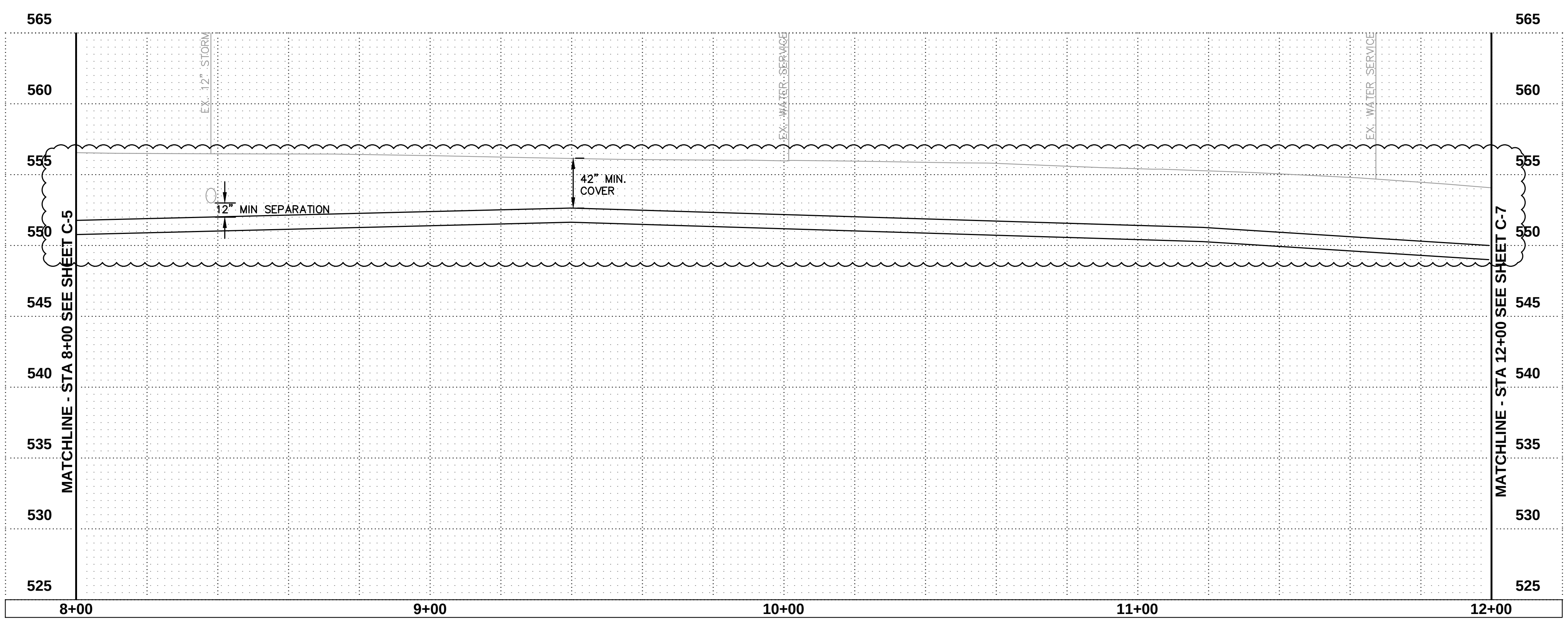


PROFILE

SCALE: 1"=20' HORIZONTAL
1"=5' VERTICAL

Gray & Osborne, Inc.
CONSULTING ENGINEERS
701 DEXTER AVENUE NORTH SUITE 200
SEATTLE, WASHINGTON 98109 • (206) 284-0860

DATE: JUNE 2017
SCALE: NOTED
DRAWN: JWS
CHECKED: RJW
APPROVED: LDS

FOR PERMIT

No.	REVISION	DATE	APP'D

LANCE D. STEVENS — STATE OF WASHINGTON — 45274 — REGISTERED PROFESSIONAL ENGINEER

COVINGTON WATER DISTRICT
KING COUNTY WASHINGTON

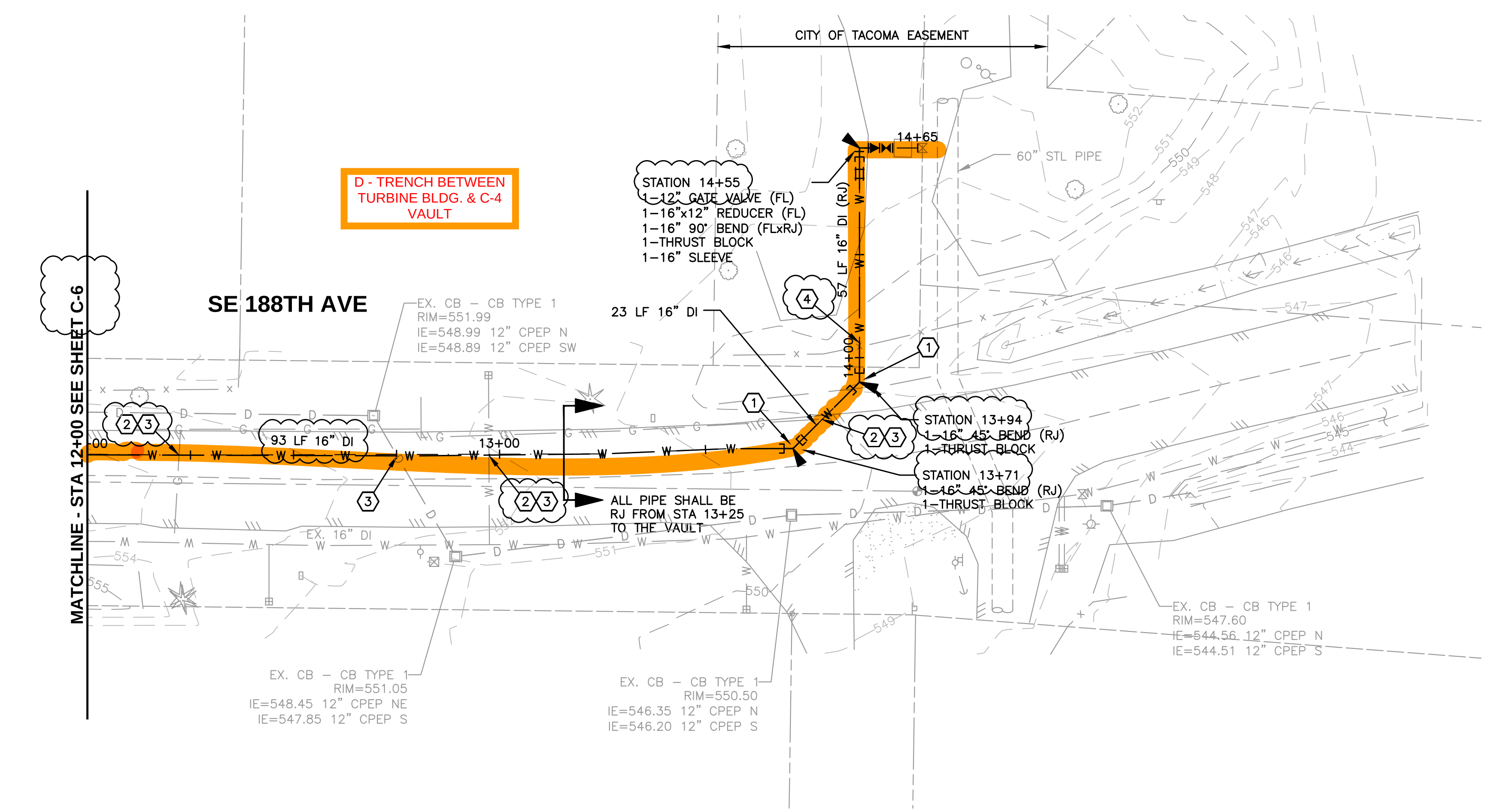
C4 TAP & TRANSMISSION MAIN

PLAN & PROFILE 8+00 TO 12+00

SHEET: C-6
OF: 29

TWO INCHES AT FULL SCALE. IF NOT, SCALE ACCORDINGLY

JOB NO.: 16608
DWG:PLAN



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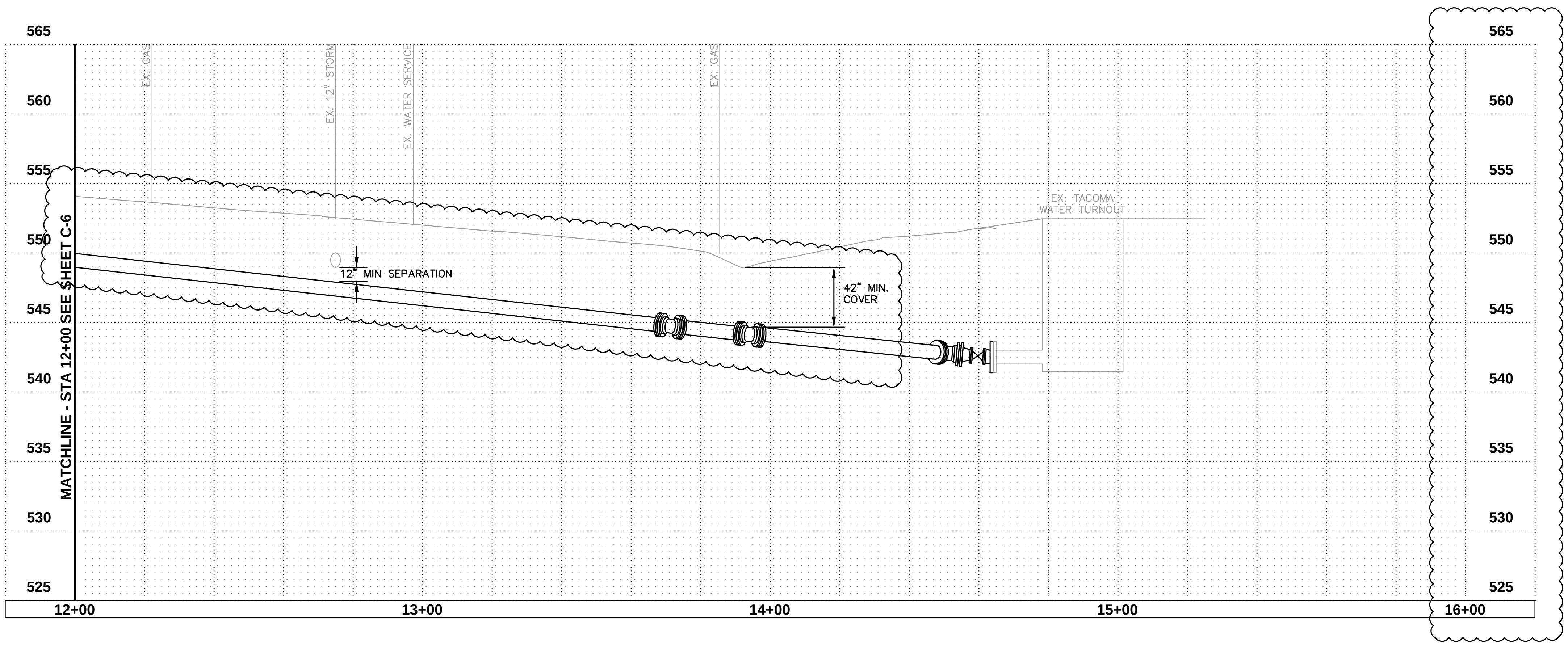


PROFILE

SCALE: 1"=20' HORIZONTAL
1"=5' VERTICAL

0 1" 2"
TWO INCHES AT FULL SCALE IF NOT, SCALE ACCORDINGLY

Gray & Osborne, Inc.
CONSULTING ENGINEERS
701 DEXTER AVENUE NORTH SUITE 200
SEATTLE, WASHINGTON 98109 • (206) 284-0860

DATE: JUNE 2017
SCALE: NOTED
DRAWN: JWS
CHECKED: RJW
APPROVED: LDS

No.	REVISION	DATE	APP'D

FOR PERMIT

LANCE D. STEVENS — STATE OF WASHINGTON — REGISTERED PROFESSIONAL ENGINEER — 45274

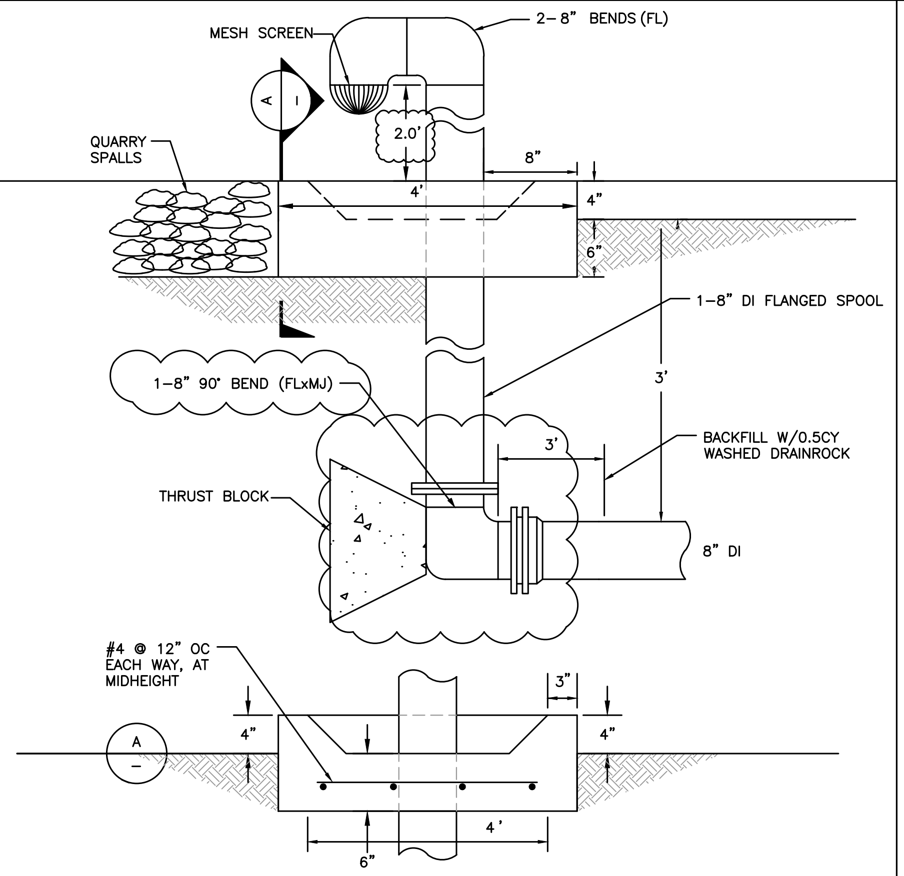
COVINGTON WATER DISTRICT
KING COUNTY WASHINGTON

C4 TAP & TRANSMISSION MAIN

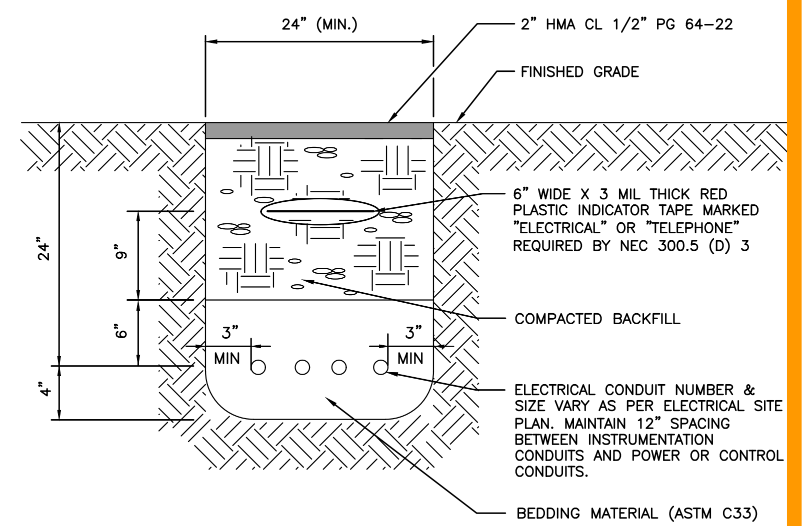
PLAN & PROFILE 12+00 TO 14+65

SHEET: C-7
OF: 29

JOB NO.: 16608
DWG: PLAN



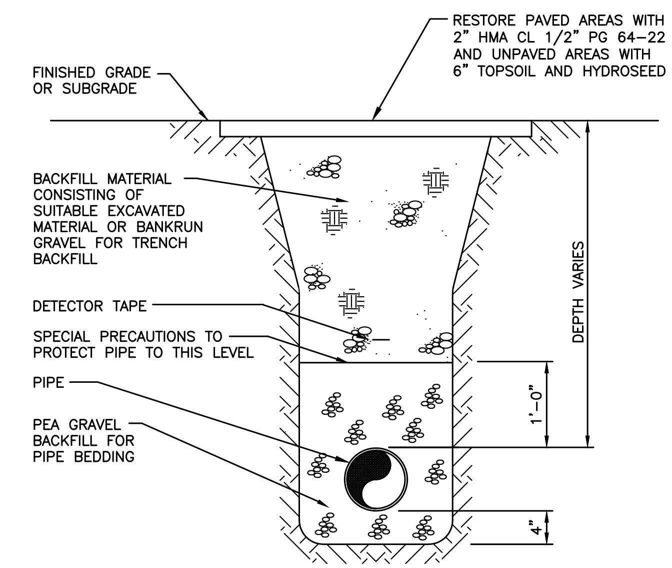
1 TYP **PRESSURE RELIEF DISCHARGE AND SPLASH PAD**
NOT TO SCALE



NOTE:

1. SPACING BETWEEN CONDUITS AND OTHER UTILITIES SHALL BE IN COMPLIANCE WITH THE UTILITIES OR 24 INCHES MINIMUM, WHICHEVER IS THE GREATER.

2 TYP **ELECTRICAL TRENCHING DETAIL**
NOT TO SCALE



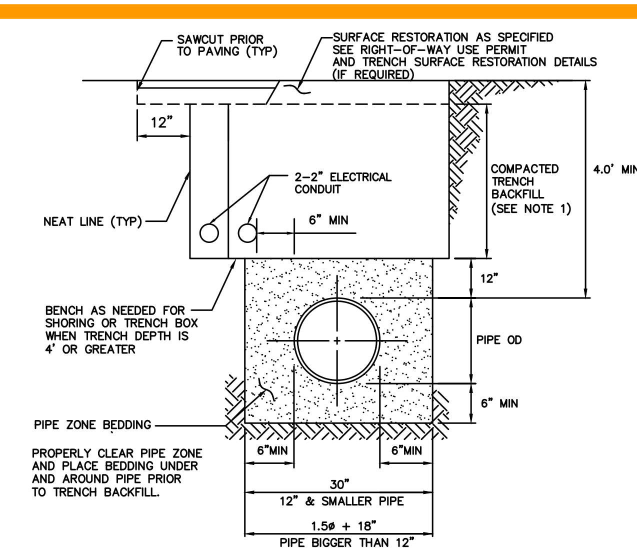
3 TYP **SEWER TRENCH SECTION**
NOT TO SCALE

TRENCH SURFACE RESTORATION

WITHIN PAVED AREAS OUTSIDE OF KING COUNTY RIGHT OF WAY:
2" HMA CL 1/2" PG 64-22.

WITHIN PAVED AREAS WITHIN KING COUNTY RIGHT OF WAY:
4" HMA CL 1/2" PG 64-22.

WITHIN UNPAVED AREAS:
4" TOPSOIL W/ HYDROSEED.



NOTES:

1. TRENCH BACKFILL AND PIPE ZONE BEDDING SHALL BE 100% IMPORTED CRUSHED SURFACING TOP COURSE COMPACTED TO 95% MODIFIED PROCTOR PER ASTM S1557 IN PAVED AREAS AND 90% IN UNPAVED AREAS.
2. EXCAVATE FOR THE PIPE BELL TO ENSURE UNIFORM SUPPORT FOR THE PIPE BARREL.
3. TRENCH AND PAVEMENT RESTORATION SHALL BE DONE PER RIGHT-OF-WAY USE PERMIT.

*WSDOT: CURRENT REVISION OF STANDARD SPECIFICATIONS FOR ROAD, BRIDGE, AND MUNICIPAL CONSTRUCTION, WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

LAST REVISED	05/12	Covington Water District — TYPICAL TRENCH DETAIL — 5
APPROVED BY		
STEVE LEE	12/16	
ENGINEER		

B - TRENCH BETWEEN TURBINE BLDG. & ADMIN. BLDG + METER & DISCONNECT

D - TRENCH BETWEEN TURBINE BLDG. & C-4 VAULT

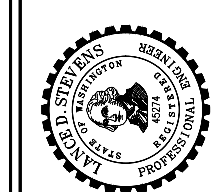
0 1" 2"
TWO INCHES AT FULL SCALE IF NOT, SCALE ACCORDINGLY

Gray & Osborne, Inc.
CONSULTING ENGINEERS
2102 CARRIAGE DRIVE SW, BLDG. I
OLYMPIA, WA 98502 • (360) 292-7481

DATE: JUNE 2017
SCALE: NOTED
DRAWN: JWS
CHECKED: RJW
APPROVED: LDS

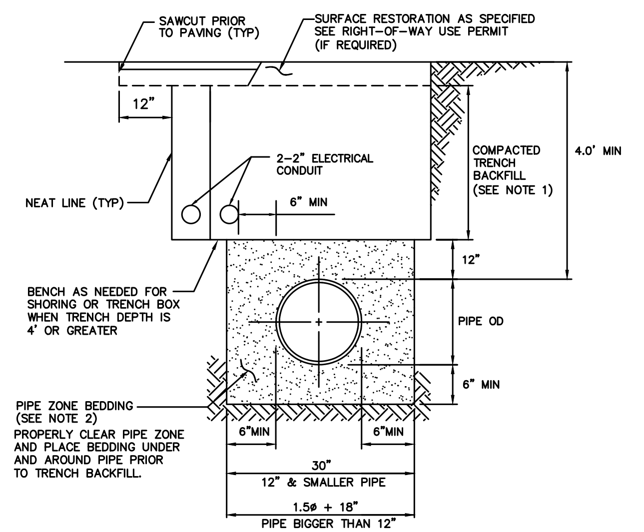
No. | REVISION | DATE | APP'D

FOR PERMIT



COVINGTON WATER DISTRICT
KING COUNTY WASHINGTON
C4 TAP & TRANSMISSION MAIN
DETAILS

SHEET: C-8
OF: 29
JOB NO.: 16608
DWG:DETAILS

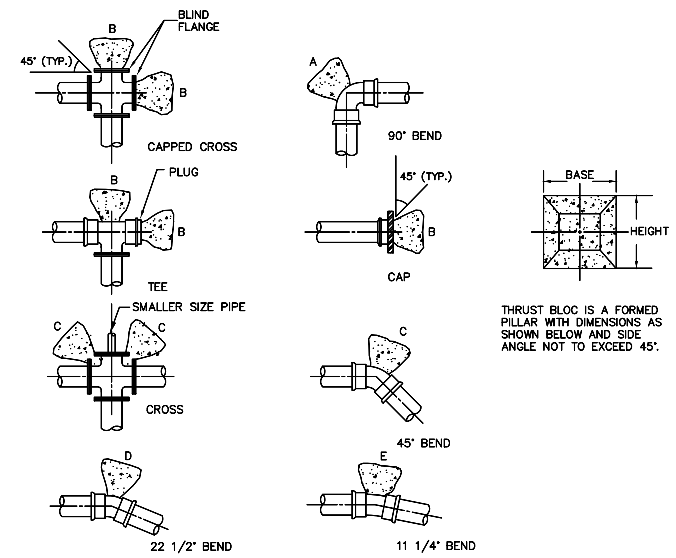


NOTES:

1. TRENCH BACKFILL SHALL BE
   - PAVED AREA: GRANULAR BACKFILL AS APPROVED BY LOCAL AGENCY, OR PER WSDOT* 9-03.12(3), CDF WHEN SPECIFIED, OR APPROVED NATIVE MATERIAL FREE OF ORGANTIC MATERIAL COMPACTED TO 95% OF MAXIMUM DENSITY. APPROVED NATIVE MATERIAL WILL GENERALLY MEET WSDOT 9-03.19
   - UNIMPROVED AREA: SELECT GRANULAR MATERIAL WITH MAXIMUM DIMENSION OF 2-1/2" PER WSDOT 9-03.19, COMPACTED TO 90% OF MAXIMUM DENSITY.
2. GRAVEL BACKFILL FOR PIPE ZONE BEDDING SHALL BE SELECT GRANULAR MATERIAL PER WSDOT 9-03.12(3), WITH MAXIMUM DIMENSIONOF OF 1-1/4" COMPACTED TO 95% OF MAXIMUM DENSITY BY APPROVED HAND-HELD TOOLS.
3. EXCAVATE FOR THE PIPE BELL TO ENSURE UNIFORM SUPPORT FOR THE PIPE BARREL.
4. TRENCH AND PAVEMENT RESTORATION SHALL BE DONE PER RIGHT-OF-WAY USE PERMIT.

*WSDOT: CURRENT REVISION OF STANDARD SPECIFICATIONS FOR ROAD, BRIDGE, AND MUNICIPAL CONSTRUCTION, WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

LAST REVISED	05/12	Covington Water District	TYPICAL TRENCH DETAIL	5
APPROVED BY				
STEVE LEE	12/16			
ENGINEER				



HORIZONTAL THRUST BLOCKING - TABLE

MIN. BEARING AREA AGAINST UNDISTURBED SOIL (SQUARE FEET)

PIPE SIZE	DEAD END (CONDITION B)				90° BEND (CONDITION A)				45° BEND (CONDITION C)				22.5° BEND (CONDITION D)				11.25° BEND (CONDITION E)			
	A (FT.2)	B (FT.)	H (FT.)	D (FT.)	A (FT.2)	B (FT.)	H (FT.)	D (FT.)	A (FT.2)	B (FT.)	H (FT.)	D (FT.)	A (FT.2)	B (FT.)	H (FT.)	D (FT.)	A (FT.2)	B (FT.)	H (FT.)	D (FT.)
4"	3.00	2.00	1.50	1.50		2.50	1.50	1.50	2.19	1.75	1.25	1.50	1.25	1.25	1.00	1.50	0.50	1.00	0.50	1.50
6"	6.00	3.00	2.00	1.50	7.88	3.50	2.25	1.50	4.38	2.50	1.75	1.50	2.19	1.75	1.25	1.50	1.25	1.25	1.00	1.50
8"	9.38	3.75	2.50	1.50	13.50	4.50	3.00	2.00	7.88	3.50	2.25	1.50	3.75	2.50	1.50	1.50	2.19	1.75	1.25	1.50
10"	14.25	4.75	3.00	2.00	20.63	5.50	3.75	2.50	11.00	4.00	2.75	2.00	6.00	3.00	2.00	1.50	3.00	2.00	1.50	1.50
12"	20.63	5.50	3.75	2.50	29.25	6.50	4.50	2.75	15.44	4.75	3.25	2.00	7.88	3.50	2.25	1.50	3.75	2.50	1.50	1.50
16"	36.25	7.25	5.00	3.00	50.31	8.75	5.75	3.50	27.63	6.50	4.25	2.50	13.50	4.50	3.00	2.00	7.31	3.25	2.25	1.50

A=AREA B=BASE H=HEIGHT D=DEPTH

LAST REVISED	05/12	Covington Water District	HORIZONTAL CONCRETE THRUST BLOCKING	4
APPROVED BY				
STEVE LEE	12/16			
ENGINEER				

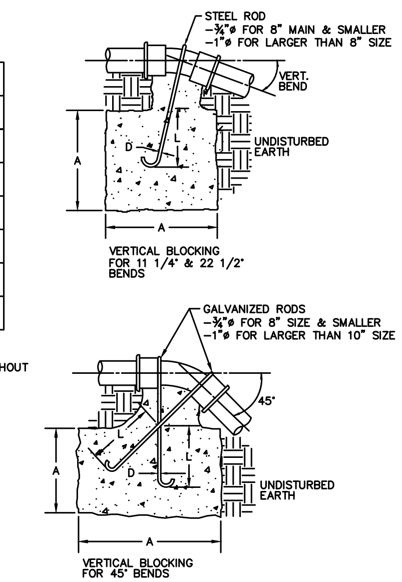
NOTES:

1. BEARING AREA OF CONC. THRUST BLOCKING BASED ON 200 PSI WATER PRESSURE, SOIL BEARING CAPACITY OF 2,000 LBS/FT2 AND 1.5 FACTOR OF SAFTY. THE DESIGN ENGINEER IS TO VERIFY BLOCK SIZING IS ADEQUATE FOR SPECIFIC SITE CONDITIONS
2. AREAS MUST BE ADJUSTED FOR OTHER PIPE SIZES, PRESSURES AND SOIL CONDITIONS.
3. CONCRETE BLOCKING SHALL BE CAST IN PLACE AND HAVE A MINIMUM OF 1/4 SQUARE FOOT BEARING AGAINST THE FITTING.
4. BLOCKING SHALL BEAR AGAINST FITTINGS ONLY AND SHALL BE CLEAR OF JOINTS TO PERMIT REMOVING OR DISMANTLING OF JOINT.
5. CONTRACTOR SHALL INSTALL BLOCKING ADEQUATE TO WITHSTAND FULL TEST PRESSURE AS WELL AS TO CONTINUOUSLY WITHSTAND OPERATION PRESSURE UNDER ALL CONDITIONS OF SERVICE.
6. CONCRETE SHALL BE 2500 PSI MIN.
7. INSTALL PLASTIC TYPE SHEETING (MIN. 6 MIL.) AROUND THE FITTING ALL BOLTS, NUTS, AND GLANDS FOR FUTURE DISMANTLING.
8. THRUST BLOCKING FOR PIPE LARGER THAN 16" WILL REQUIRE ENGINEERED DESIGN FOR SPECIFIC CONDITIONS.
9. DIMENSION "A" IN THE VERTICAL THRUST BLOCK DETAIL IS THE DIMENSION FOR ALL SIDES OF BLOCK.

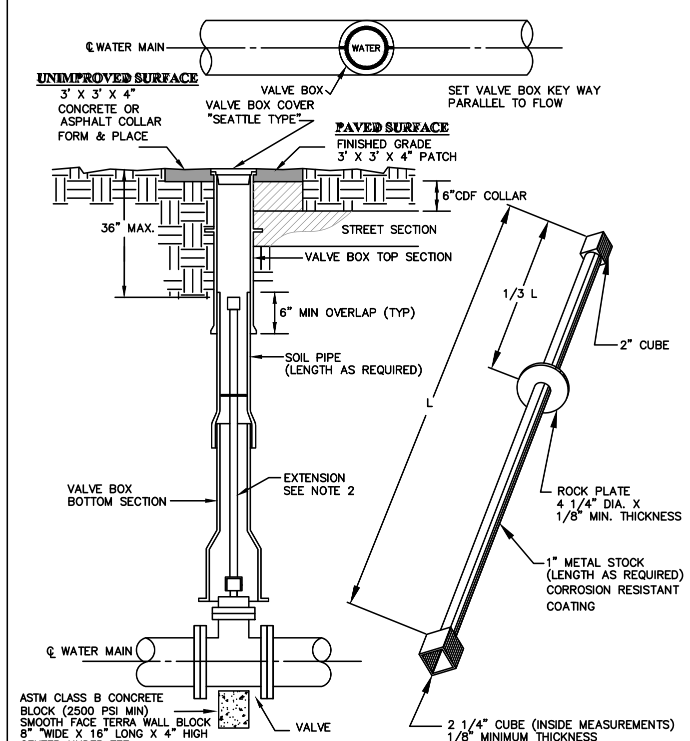
VERTICAL THRUST BLOCKING FOR 11 1/4°, 22 1/2°, 45° BENDS

PIPE SIZE	V B	CU FT	A	D	L
4"	11 1/4°	8	2.00'	3/4"	1.5'
	22 1/2°	16	2.50'	3/4"	2.0'
	45°	27	3.00'	3/4"	2.0'
6"	11 1/4°	16	2.50'	3/4"	2.0'
	22 1/2°	27	3.00'	3/4"	2.5'
	45°	53	3.75'	3/4"	2.5'
8"	11 1/4°	27	3.00'	3/4"	2.5'
	22 1/2°	53	3.75'	3/4"	3.0'
	45°	91	4.50'	3/4"	3.5'
10"	11 1/4°	43	3.50'	1"	3.0'
	22 1/2°	77	4.25'	1"	3.5'
	45°	145	5.25'	1"	4.0'
12"	11 1/4°	53	3.75'	1"	3.0'
	22 1/2°	107	4.75'	1"	4.0'
	45°	190	5.75'	1"	4.5'
16"	11 1/4°	91	4.50'	1 1/8"	3.5'
	22 1/2°	190	5.75'	1 1/8"	4.5'
	45°	343	7.00'	1 1/8"	4.5'

90° VERTICAL BENDS ARE NOT ALLOWED WITHOUT DISTRICT APROVAL OF ENGINEERED DESIGN SUBMITTAL

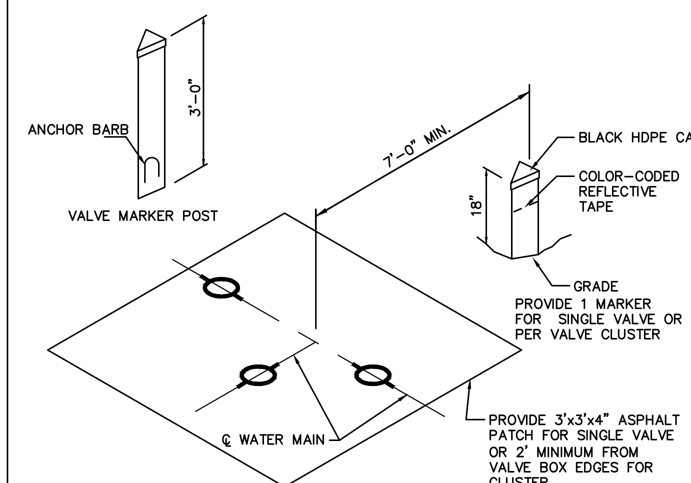


LAST REVISED	05/12	Covington Water District	HORIZONTAL & VERTICAL THRUST BLOCKING TABLE	4A
APPROVED BY				
STEVE LEE	12/16			
ENGINEER				



NOTES:
1. EXTENSION IS REQUIRED WHEN THE VALVE NUT IS MORE THAN THREE (3) FEET BELOW FINISHED GRADE (MIN. = 1').
2. ONE EXTENSION, IF REQUIRED, IS TO BE USED PER VALVE.
3. ALL EXTENSIONS ARE TO BE MADE OF STEEL, SIZED AS NOTED, AND PAINTED WITH TWO (2) COATS OF ENAMEL PAINT.
4. VALVE BOX AND LID - H20 LOADING; MARKED "WATER".

LAST REVISED	09/16	Covington Water District	VALVE BOX AND NUT EXTENSION DETAIL	9
APPROVED BY				
STEVE LEE	12/16			
ENGINEER				



NOTES:

1. VALVE MARKER POST SHALL BE TRIVIEW MANUFACTURED BY RHINO MARKING AND PROTECTION SYSTEMS, ITEM #TVF36BB. MARKER SHALL INCLUDE TRIGRIP ANCHOR SYSTEM CONSISTING OF ANCHOR BARBS THAT FOLD OUT FROM POST. THE POST SHALL BE SUPPLIED WITHOUT ANY WARNING OR IDENTIFICATION STICKERS.
2. VALVE MARKER SHALL BE INSTALLED WHERE DIRECTED BY DISTRICT ENGINEER.
3. VALVE MARKER POST SHALL BE A MINIMUM 36" LONG AND SHALL BE INSTALLED AS DIRECTED BY DISTRICT ENGINEER. THE EXPOSED LENGTH SHALL ALWAYS BE 18", REGARDLESS OF OVERALL LENGTH.
4. THE POST SHALL BE SET TO POINT CORNER AT THE VALVE OR CENTER OF CLUSTER AND SHALL BE SITUATED IN A SAFE AND REASONABLY CONSPICUOUS LOCATION.
5. THE SOILS SUPPORTING POST SHALL BE TIGHTLY COMPACTED AROUND ANCHOR BARBS TO SECURE POST IN THE GROUND.
6. DISTRICT WILL PROVIDE STENCILING AND REFLECTIVE TAPE.

LAST REVISED	05/12	Covington Water District	VALVE MARKER POST	8
APPROVED BY				
STEVE LEE	12/16			
ENGINEER				

Gray & Osborne, Inc.
CONSULTING ENGINEERS
2102 CARRIAGE DRIVE SW, BLDG. I
OLYMPIA, WA 98502 • (360) 292-7481

DATE: JUNE 2017
SCALE: NOTED
DRAWN: JWS
CHECKED: RJW
APPROVED: LDS

FOR PERMIT

No.	REVISION	DATE	APP'D

LANCE D. STEVENS
STATE OF WASHINGTON
45274
REGISTERED PROFESSIONAL ENGINEER

COVINGTON WATER DISTRICT
KING COUNTY
WASHINGTON

C4 TAP & TRANSMISSION MAIN

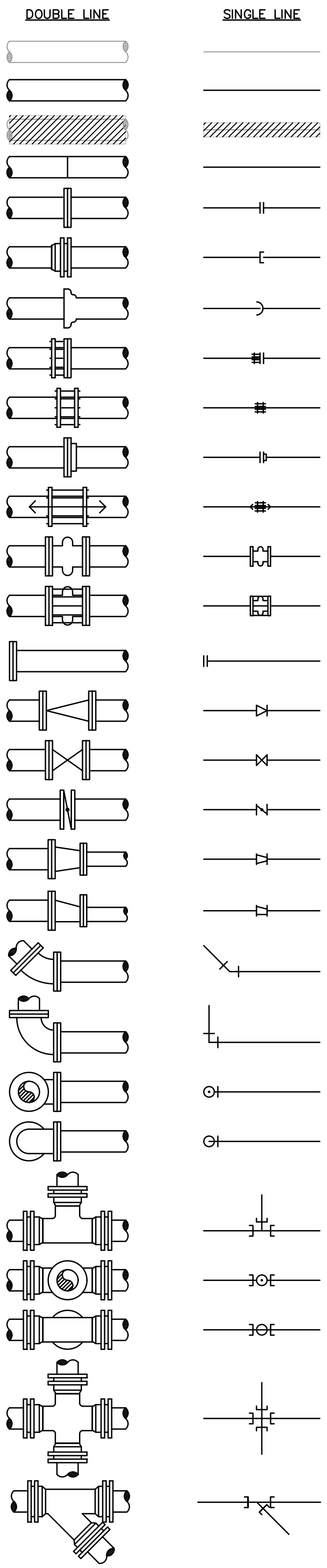
COVINGTON WATER DISTRICT TYPICAL DETAILS

SHEET: C-9
OF: 29

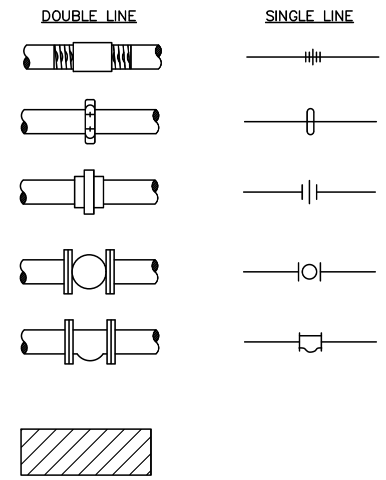
0 1" 2"
TWO INCHES AT FULL SCALE IF NOT, SCALE ACCORDINGLY

JOB NO.: 16608
DWG:DETAILS

PIPING SYMBOLS



- EXISTING PIPE
- NEW PIPE
- EXISTING PIPE TO BE REMOVED
- WELDED
- FLANGED
- MECHANICAL JOINT
- SOLVENT WELDED JOINT
- FLANGED COUPLING ADAPTER
- FLEXIBLE COUPLING
- ADAPTER FLANGE
- RESTRAINED FLEXIBLE COUPLING
- RUBBER EXPANSION JOINT
- RESTRAINED RUBBER EXPANSION JOINT
- BLIND FLANGE
- CHECK VALVE
- GATE VALVE
- BUTTERFLY VALVE
- CONCENTRIC REDUCER
- ECCENTRIC REDUCER
- ELBOW, 45°
- ELBOW, 90°
- ELBOW UP
- ELBOW DOWN
- TEE
- TEE UP
- TEE DOWN
- CROSS
- WYE



- SCREWED JOINT
- GROOVED COUPLING
- UNION
- BALL VALVE
- DIAPHRAGM VALVE

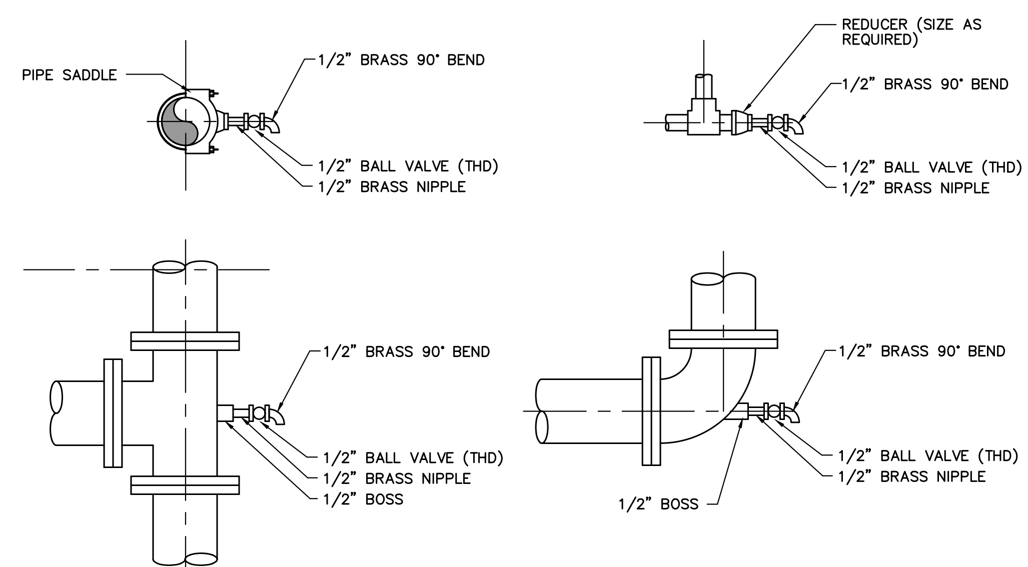
DENOTES ITEMS TO BE REMOVED AND DISPOSED OF BY CONTRACTOR IN ACCORDANCE WITH THE SPECIFICATIONS

PIPING MATERIAL AND JOINTING SCHEDULE

(EXCEPT WHERE SHOWN DIFFERENTLY ON THE DRAWINGS)

PROCESS PIPING CODE (SEE THIS SHEET)	INSIDE STRUCTURES	BURIED
W	FLANGED OR GROOVED DUCTILE IRON	RESTRAINED MECHANICAL JOINT DUCTILE IRON
D $\geq$ 4"	FLANGED OR GROOVED DUCTILE IRON	MECHANICAL JOINT DUCTILE IRON

NOTE:
DRAIN PIPE FOR DISCHARGE TO WASTE MANHOLES AND TRANSMISSION MAIN DRAIN SHALL BE PROVIDED WITH RESTRAINED JOINTS.



1 TYP **TYPICAL SAMPLING CONNECTION DETAILS**
NOT TO SCALE

PROCESS PIPING / EQUIPMENT IDENTIFICATIONS

PROCESS PIPING

LINE SIZE — 24" SC — PROCESS TYPE SEE LIST BELOW

PROCESS

D	DRAIN
W	WATER
(S)	WATER SAMPLE TAP
(P)	PRESSURE GAUGE
(PT)	PRESSURE TRANSDUCER

EQUIPMENT

EQUIPMENT TYPE (SEE LIST BELOW) — XX POL 999 — EQUIPMENT NUMBER (SEQUENTIAL LISTING)
AREA

EQUIPMENT

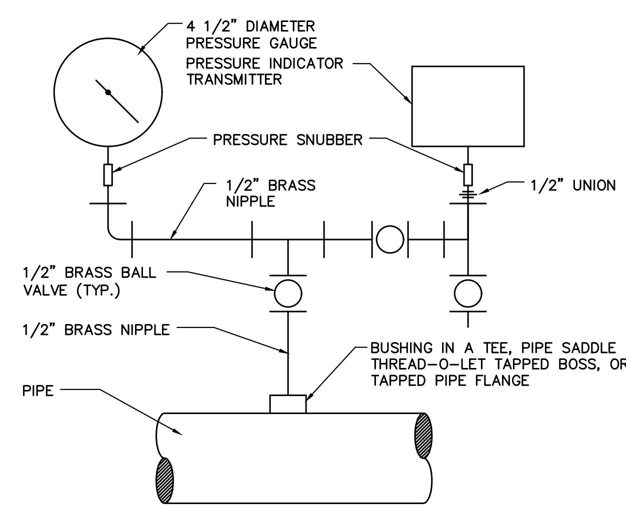
MTR	TURBINE MOTOR
STR	H-STRAINER

VALVES

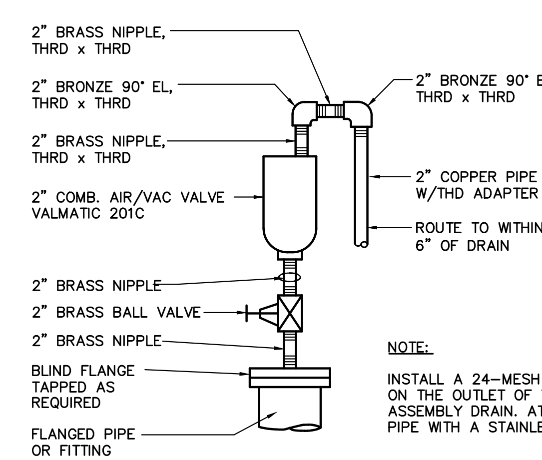
AV	COMBINATION AIR VALVE
CV	CONTROL VALVE
PRV	PRESSURE REDUCING VALVE
PRFV	PRESSURE RELIEF VALVE

INSTRUMENTS / ANALYZERS

FE	FLOW METER
FIT	FLOW INDICATOR/TRANSMITTER
PT	PRESSURE TRANSDUCER
P	PRESSURE GAUGE



2 TYP **PRESSURE TRANSDUCER**
NOT TO SCALE



NOTE:
INSTALL A 24-MESH STAINLESS STEEL SCREEN ON THE OUTLET OF THE AIR AND VACUUM ASSEMBLY DRAIN. ATTACH THE SCREEN TO THE PIPE WITH A STAINLESS STEEL BAND.

3 M1-1 **COMBINATION AIR AND VACUUM ASSEMBLY**
NOT TO SCALE

0 1" 2"
TWO INCHES AT FULL SCALE IF NOT, SCALE ACCORDINGLY

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CONSULTING ENGINEERS
2102 CARRIAGE DRIVE SW, BLDG. I
OLYMPIA, WA 98502 • (360) 292-7481

DATE: JUNE 2017
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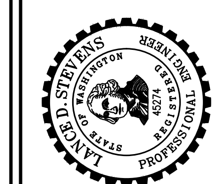
DRAWN: EH
CHECKED: SLG
APPROVED: LDS

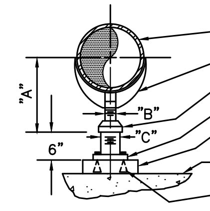
No.	REVISION	DATE	APPD

FOR PERMIT



COVINGTON WATER DISTRICT
KING COUNTY WASHINGTON
C4 TAP & TRANSMISSION MAIN
PIPE SYMBOLS, PROCESS PIPING & EQUIP IDENTIFICATIONS, & DETAILS

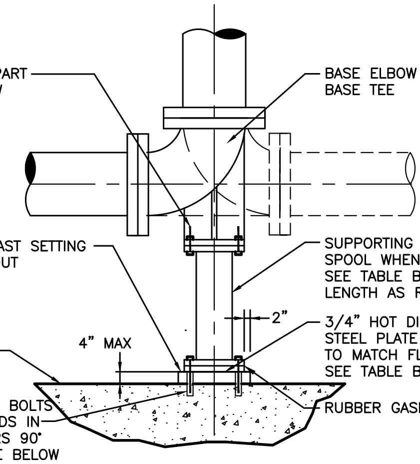
SHEET: M-1
OF: 2
JOB NO.: 16608
DWG: PIPE SYMB



PIPE SIZE "X"	MIN. LENGTH "A"	MAX. LENGTH "A"	PIPE DIAM. "B"	PIPE DIAM. "C"
4"	9 1/4"	1'-2"	2 1/2"	3"
6"	10 1/2"	1'-3 1/4"	2 1/2"	3"
8"	11 3/4"	1'-4 1/2"	2 1/2"	3"
10"	1'-1 1/2"	1'-6 1/1"	2 1/2"	3"
12"	1'-3"	1'-7 3/4"	2 1/2"	3"
16"	1'-7 1/2"	2'-0"	3 1/2"	6"

NOTES :
1. PIPE SUPPORT SHALL BE "ANVIL" FIG. 264 OR EQUAL
2. PIPE "C" TO BE SET IN THREADED FLANGE BASE AND WELDED ALL AROUND.
3. ALL STEEL NOT STAINLESS SHALL BE HOT DIPPED GALVANIZED AFTER FABRICATION.

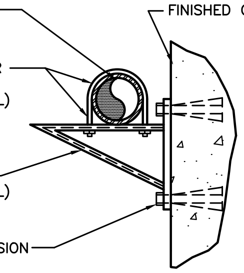
1 TYP **PIPE SUPPORT TYPE C**
NOT TO SCALE



BASE TEE OR ELBOW DIA.	BOLT OR ROD DIA.	SUPPORTING PIPE SPOOL DIA.	STEEL PLATE DIMENSIONS
4"	5/8"	2"	6" X 6"
6"	5/8"	2 1/2"	7" X 7"
8"	5/8"	4"	8" X 8"
10"	5/8"	4"	8" X 8"
12"	3/4"	6"	10" X 10"
16"	3/4"	8"	14" X 14"

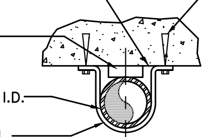
NOTES :
1. SUPPORTING PIPE SPOOL NOT REQUIRED WHEN CONCRETE PAD HAS TO BE LESS THAN 4" HIGH IN ORDER TO INSTALL A SUPPORTING PIPE SPOOL
2. ALL STEEL NOT STAINLESS SHALL BE HOT DIPPED GALVANIZED AFTER FABRICATION.

2 TYP **PIPE SUPPORT TYPE D**
NOT TO SCALE



NOTE:
1. ALL STEEL NOT STAINLESS SHALL BE HOT DIPPED GALVANIZED AFTER FABRICATION.

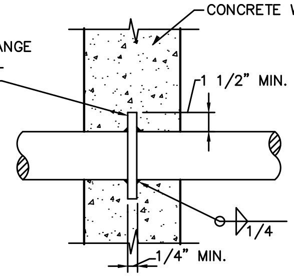
3 TYP **PIPE SUPPORT TYPE G**
NOT TO SCALE



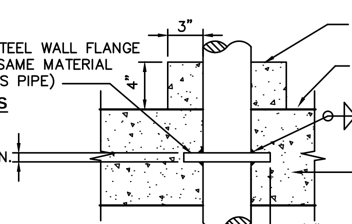
4 TYP **PIPE SUPPORT TYPE K**
NOT TO SCALE

STEEL PIPE

WALLS

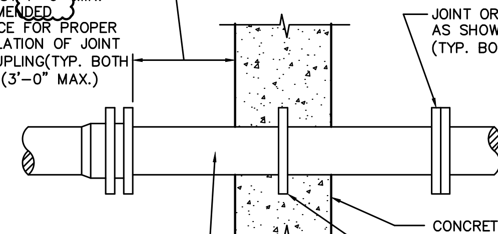


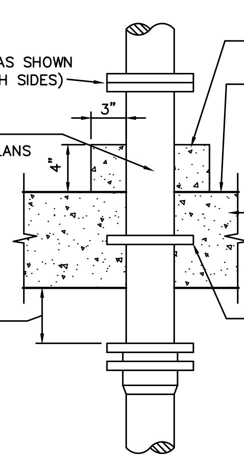
FLOORS



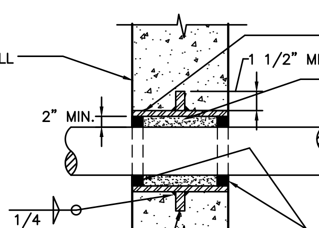
NOTES:
1. FOR EXISTING CONCRETE CORE DRILL AN OPENING OF ADEQUATE SIZE TO ALLOW FOR INSTALLATION OF PENETRATION SHOWN ON THIS DETAIL. THE OPENING SHALL BE FILLED WITH NON-SHRINK GROUT AFTER PIPE INSTALLATION. CONCRETE SURFACES SHALL BE ROUGHENED BEFORE FILLING WITH GROUT.
2. FOR ADDITIONAL REINFORCEMENT AROUND PIPE PENETRATIONS SEE DETAIL 3 S-2
3. FOR CMU WALLS, CORE DRILL HOLE. PROVIDE MIN. 2" THICK NON-SHRINK GROUT ENCASEMENT ALL AROUND PIPE IN WALL.
4. A MECHANICAL JOINT SHALL BE INSTALLED WITHIN 3 FEET OF ALL WALL PENETRATIONS INTO STRUCTURES.
5. FOR PRE-CAST WALLS, CORE DRILL AN OPENING OF ADEQUATE SIZE AND INSTALL AN EXPANDING RUBBER SEAL, KOR-N-SEAL BOOT, OR EQUAL.

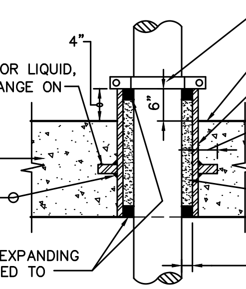
CAST OR DUCTILE IRON PIPE



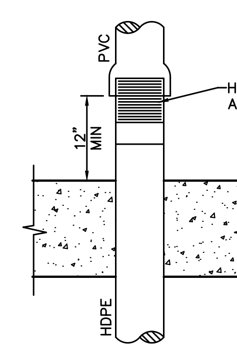


PVC OR FRP PIPE





5 TYP **PIPE PENETRATIONS THROUGH CONCRETE WALLS AND FLOORS DETAILS**
NOT TO SCALE



6 TYP **HDPE TRANSITION ADAPTER**
NOT TO SCALE

LANCE D. STEVENS STATE OF WASHINGTON 45274 REGISTERED PROFESSIONAL ENGINEER

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OLYMPIA, WA 98502 • (360) 292-7481

DATE: JUNE 2017
SCALE: NOTED
DRAWN: EH
CHECKED: SLG
APPROVED: LDS

FOR PERMIT

No.	REVISION	DATE	APP'D

COVINGTON WATER DISTRICT
KING COUNTY WASHINGTON

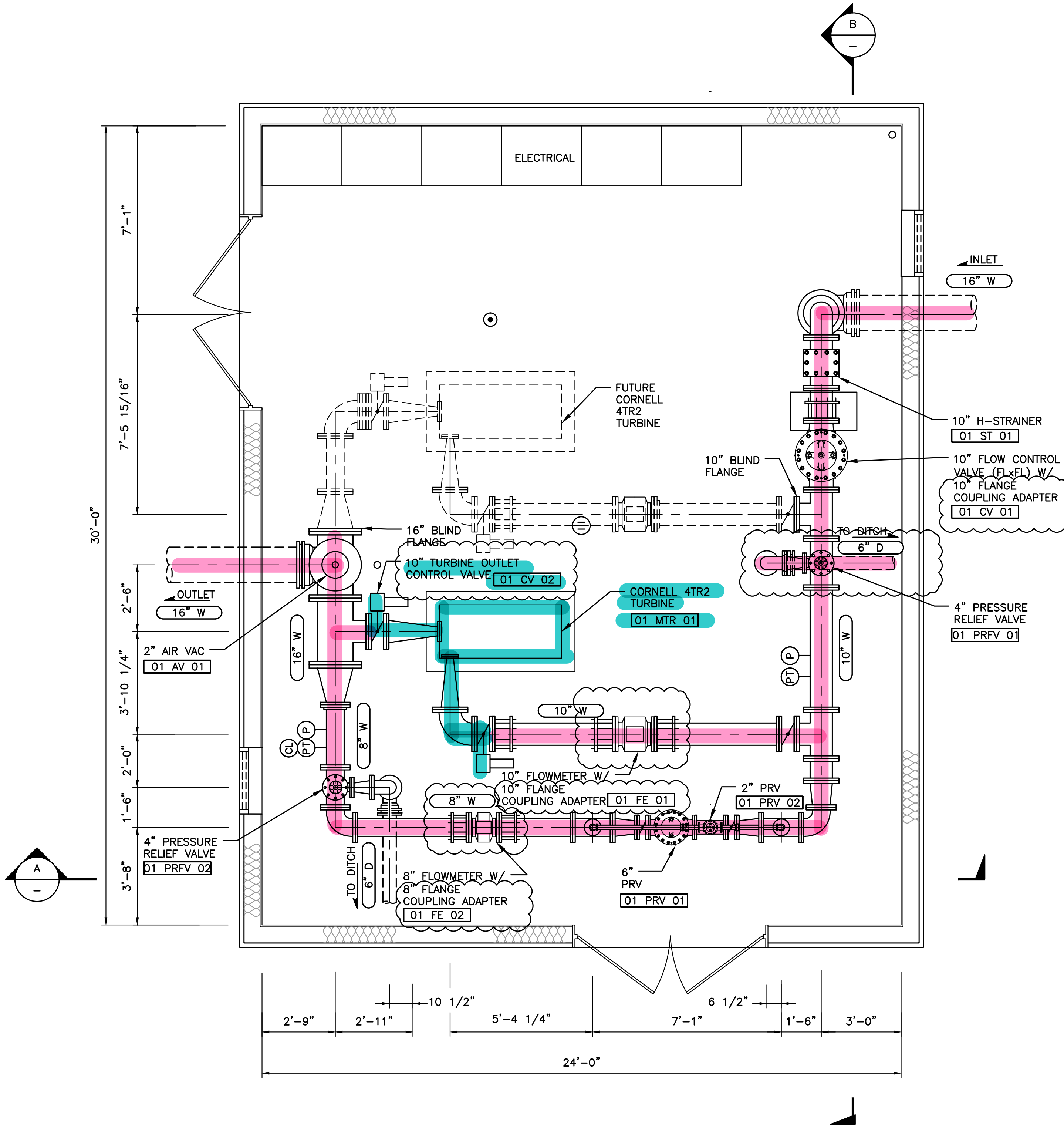
C4 TAP & TRANSMISSION MAIN

MISCELLANEOUS DETAILS

SHEET: M-2
OF: 2

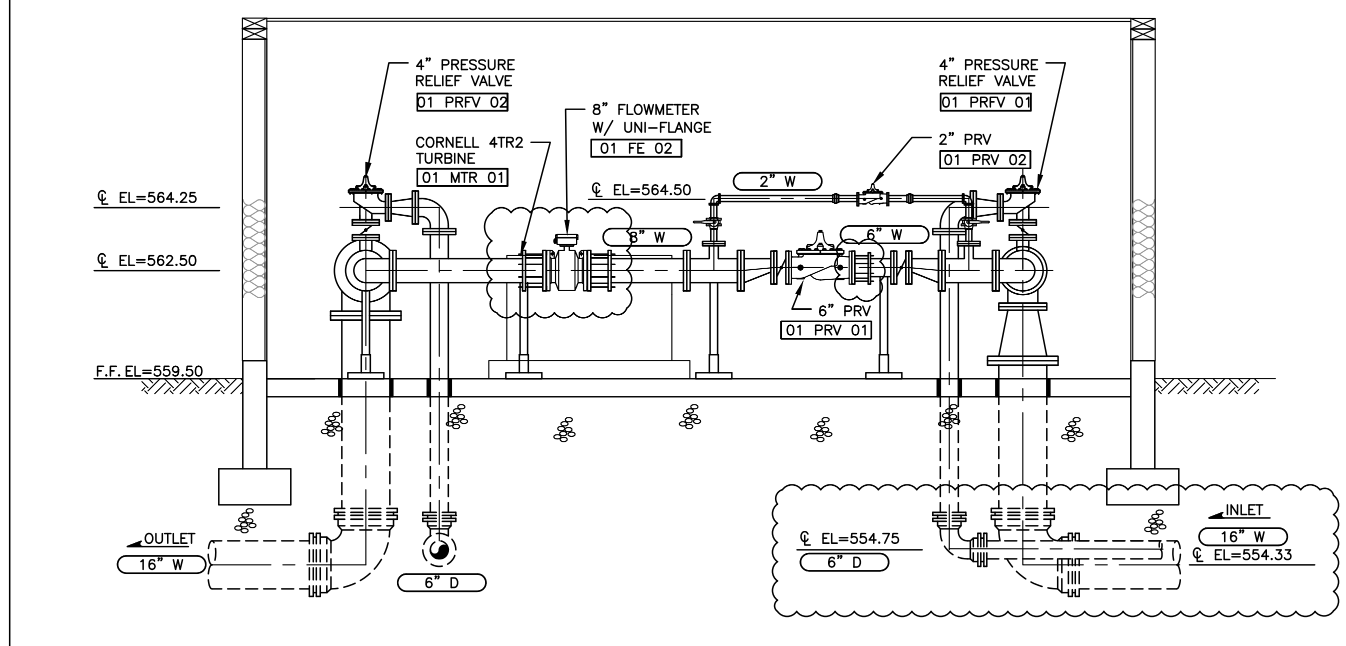
JOB NO.: 16608
DWG: PIPE_SUPT_DET

A - TURBINE SCOPE
C - PIPELINE SCOPE

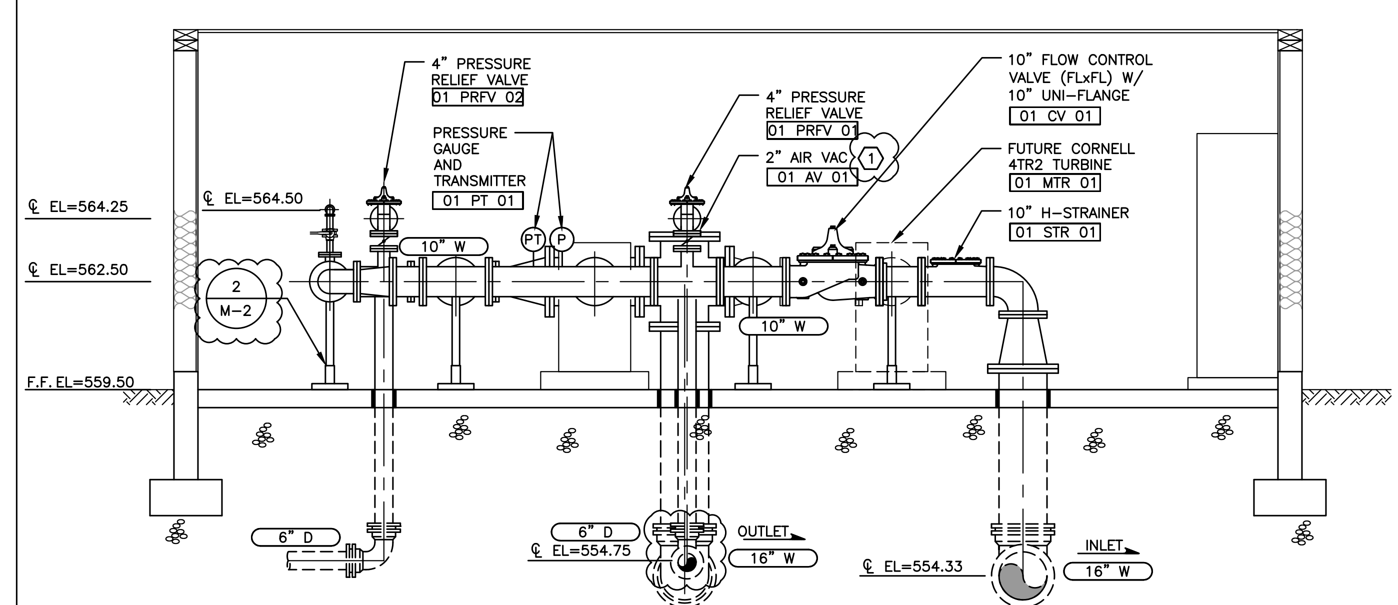


NOTE: INLET AND OUTLET PIPING ELEVATIONS TO THE TURBINE WILL VARY DEPENDING UPON INLET/OUTLET ELEVATIONS TO BE PROVIDED BY CANYON HYDRO.

TURBINE BUILDING MECHANICAL PLAN
SCALE: 3/8"=1'-0"



SECTION A
SCALE: 3/8"=1'-0"



SECTION B
SCALE: 3/8"=1'-0"

1 DRAIN TO FLOOR. SEE SHEET P-1 FOR FLOOR DRAIN LOCATION

0 1" 2"
TWO INCHES AT FULL SCALE IF NOT, SCALE ACCORDINGLY

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LANCE D. STEVENS, STATE OF WASHINGTON, REGISTERED PROFESSIONAL ENGINEER 45274

COVINGTON WATER DISTRICT
KING COUNTY WASHINGTON
C4 TAP & TRANSMISSION MAIN
TURBINE BUILDING MECHANICAL PLAN

SHEET: M1-1
OF:
JOB NO.: 16608
DWG: TRBNE BLDG PLN SECS

HVAC DESIGN CRITERIA

OA VENTILATION

NONE: TURBINE ROOM IS CONSIDERED A NON–OCCUPIED EQUIPMENT ROOM.

HEATING

WINTER DESIGN DB TEMP: 18°F
DESIGN HEATING SETPOINT: 45°F
TOTAL REQ'D HEATING LOAD: 6,500 BTU/HR
TYPE: ELECTRIC RESISTANCE
MIN. DESIGN CAPACITY: 2 kW

COOLING

SUMMER DESIGN DB TEMP: 86°F
DESIGN COOLING SETPOINT: 95°F
TOTAL REQ'D COOLING LOAD: 19,000 BTU/HR
TYPE: SUPPLY FAN
MIN. DESIGN CAPACITY: 2,000 CFM

DEHUMIDIFICATION

EFFECTIVE VOLUME: 7,200 CUBIC FEET
MIN. DESIGN CAPACITY: 290 CFM

GENERAL NOTES:

1. DUCT CONSTRUCTION AND EQUIPMENT SUPPORTS SHALL COMPLY WITH THE LATEST INTERNATIONAL MECHANICAL CODE AND WITH CURRENT SMACNA DUCT CONSTRUCTION STANDARDS.
2. PROVIDE ADEQUATE EQUIPMENT SERVICE CLEARANCE AROUND EQUIPMENT ACCORDING TO MFG'S RECOMMENDATIONS.

CONTROL DESCRIPTION:

[01 SF 01] WALL MOUNTED SUPPLY FAN PROVIDES COOLING VENTILATION FOR THE TURBINE ROOM AND IS SPEED CONTROLLED BY A REMOTE THERMOSTAT [01 T 01].

[01 HT 01] WALL MOUNTED ELECTRIC HEATER PROVIDES HEAT FOR THE TURBINE ROOM AND IS CONTROLLED BY AN INTEGRAL THERMOSTAT.

FAN SCHEDULE

BUILDING	ROOM NAME	UNIT NO.	TYPE	MANUFACTURER & MODEL NO.	VOLTAGE, PHASE, AND MCA	CONTROLS	STANDARD CFM	REMARKS
TURBINE	TURBINE ROOM	01 SF 01	SIDEWALL SUPPLY FAN	GREENHECK SS1–16–428–AVG/7 OR EQUAL	3/4 HP 120V 1ø	01 T 01	2,000 CFM @ 0.5" S.P.	PROVIDE SHORT WALL HOUSING W/ GUARDS, GRAVITY DAMPER, VARI–GREEN MOTOR W/ THERMAL OVERLOAD, ALUMINUM PROPELLER, AND NEMA 4 DISCONNECT.

CONTROL SCHEDULE

BUILDING	ROOM NAME	TYPE	EQUIPMENT NO.	CONTROLLED EQUIPMENT	HEATING SET PT.	COOLING SET PT.	RH% SET PT	MANUFACTURER & MODEL NO.	VOLTAGE	MOUNTING HEIGHT	REMARKS
TURBINE	TURBINE ROOM	CONTROL VOLTAGE	01 T 01	01 SF 01	N/A	90°F	N/A	GREENHECK V.G. TEMP/HUMID CONTROLLER	24v	48" AFF	

LOUVER SCHEDULE

BUILDING	ROOM NAME	LOUVER NO.	TYPE	MANUFACTURER & MODEL NO.	ROUGH OPENING SIZE (WxH)	REMARKS
TURBINE	TURBINE ROOM	01 LVR 01	INTAKE LOUVER	GREENHECK ESD–403 OR EQUAL	30" X 30"	PROVIDE INSECT SCREEN, KYNAR FINISH, CUSTOM COLOR, AND EXTENDED SILL. BOTTOM OF LOUVER OPENING @ 7' AFF.
		01 LVR 02	EXHAUST LOUVER	GREENHECK ESD–403 OR EQUAL	30" X 30"	PROVIDE BIRD SCREEN, GRAVITY DAMPER, KYNAR FINISH, CUSTOM COLOR, AND EXTENDED SILL. BOTTOM OF LOUVER OPENING @ 7' AFF.

HEATER SCHEDULE

BUILDING	ROOM NAME	HEATER NO.	TYPE	MANUFACTURER & MODEL NO.	VOLTAGE, AND PHASE	CONTROLS	KW OR BTU/H OUTPUT	MOUNTING	REMARKS
TURBINE	TURBINE ROOM	01 HT 01	UNIT HEATER	QMARK MUH0581 OR EQUAL	208V 3ø	INTEGRAL THERMOSTAT	5 KW	WALL BRACKET	PROVIDE INTEGRAL DISCONNECT, MOUNTING PLATE @ 9'–6" AFF.

DEHUMIDIFIER SCHEDULE

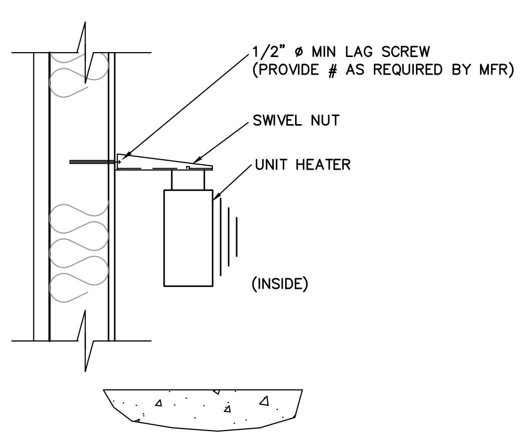
BUILDING	ROOM NAME	UNIT NO.	MANUFACTURER & MODEL NO.	VOLTAGE, PHASE AND MCA	CONTROLS	RELATIVE HUMIDITY SET POINT	MOUNTING	REMARKS
TURBINE	TURBINE ROOM	01 DH 01	EBAC WM80 OR EQUAL	110 V 1ø 8 A	INTEGRAL	45%	WALL BRACKET	MOUNT BOTTOM OF UNIT @ 4' AFF. ROUTE CONDENSATE DRAIN DOWN TO EQUIPMENT DRAIN.

HVAC ABBREVIATIONS

SYMBOL	DESCRIPTION
AFG	ABOVE FINISHED GRADE
AFF	ABOVE FINISHED FLOOR
BTU	BRITISH TERMAL UNIT
CFM	CUBIC FEET PER MINUTE
CU	CONDENSING UNIT
DN	DOWN
EF	EXHAUST FAN
ERV	ENERGY RECOVERY VENTILATOR
HWH	HEX WASHER HEAD
MCA	MINIMUM CIRCUIT AMPS
OA	OUTISDE AIR
SF	SUPPLY FAN
SP	STATIC PRESSURE
SS	STAINLESS STEEL
TYP	TYPICAL
WC	WATER COLUMN
WP	WALL PENETRATION

HVAC LEGEND

SYMBOL	DESCRIPTION
X YY ##	EQUIPMENT TAG (X–AREA; YY–EQUIPMENT ABBREVATION; ##–SEQUENTIAL NUMBER)
T	THERMOSTAT/TEMPERATURE TRANSMITTER
ø	DIAMETER OR PHASE SIGN



0 1" 2"
TWO INCHES AT FULL SCALE. IF NOT, SCALE ACCORDINGLY

Gray & Osborne, Inc.
CONSULTING ENGINEERS
701 DEXTER AVENUE NORTH SUITE 200
SEATTLE, WASHINGTON 98109 • (206) 284–0860

DATE: JUNE 2017
SCALE: NOTED
DRAWN: ASD
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APPROVED: AMP

No.	REVISION	DATE	APPD
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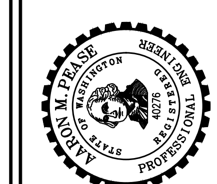


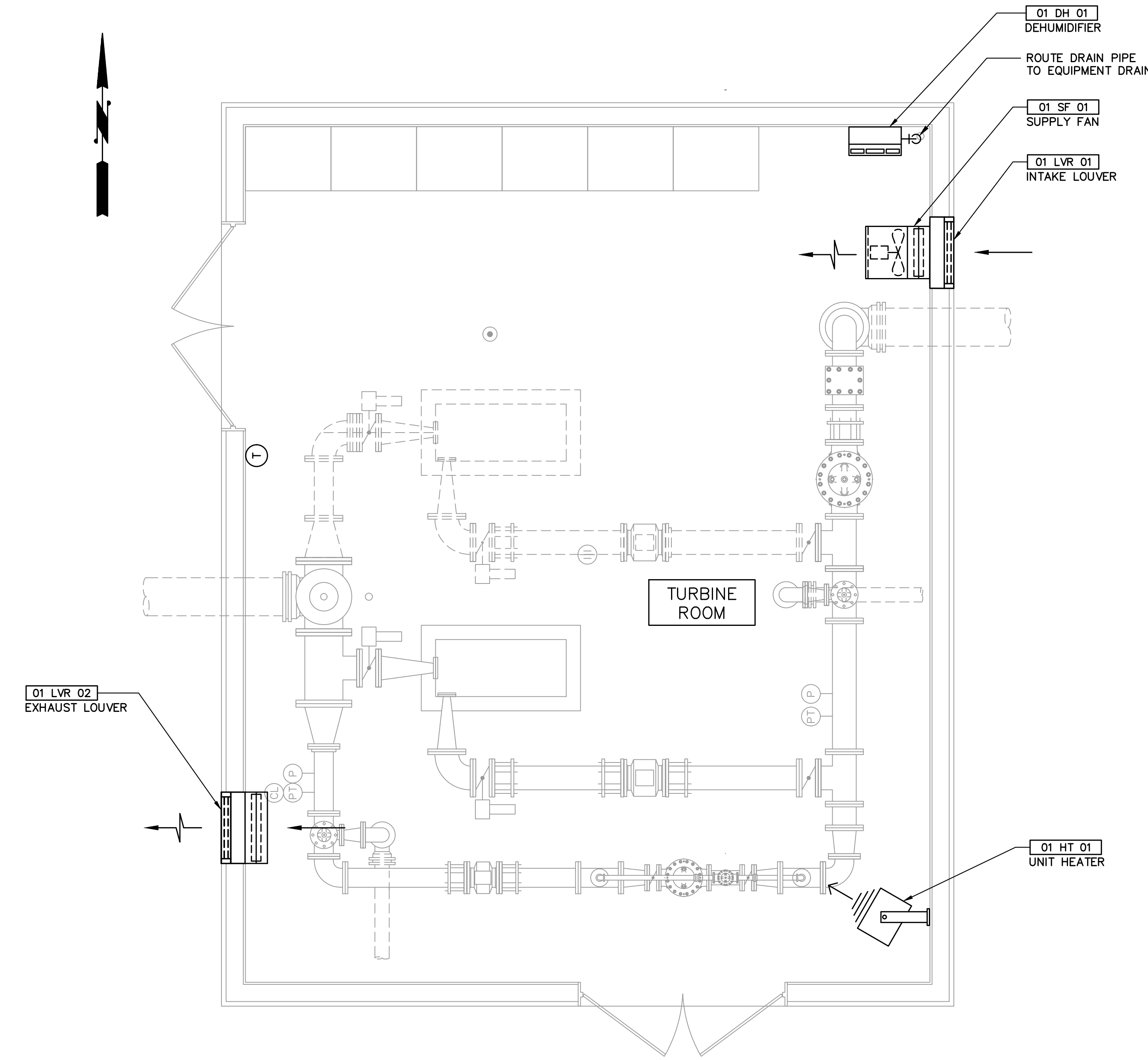
COVINGTON WATER DISTRICT
KING COUNTY WASHINGTON

C4 TAP & TRANSMISSION MAIN

HVAC SCHEDULE AND DETAILS

SHEET: H-1
OF: 2

JOB NO.: 16608
DWG:H_TRBN_BLDG



HVAC PLAN

SCALE: 3/8"=1'-0"

0 1" 2"

TWO INCHES AT FULL SCALE.
IF NOT, SCALE ACCORDINGLY

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701 DEXTER AVENUE NORTH SUITE 200
SEATTLE, WASHINGTON 98109 • (206) 284-0860

DATE: JUNE 2017
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DRAWN: ASD
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APPROVED: AMP

No.	REVISION	DATE	APP'D

FOR PERMIT

AARON M. PEASE — STATE OF WASHINGTON — 40276 — REGISTERED PROFESSIONAL ENGINEER

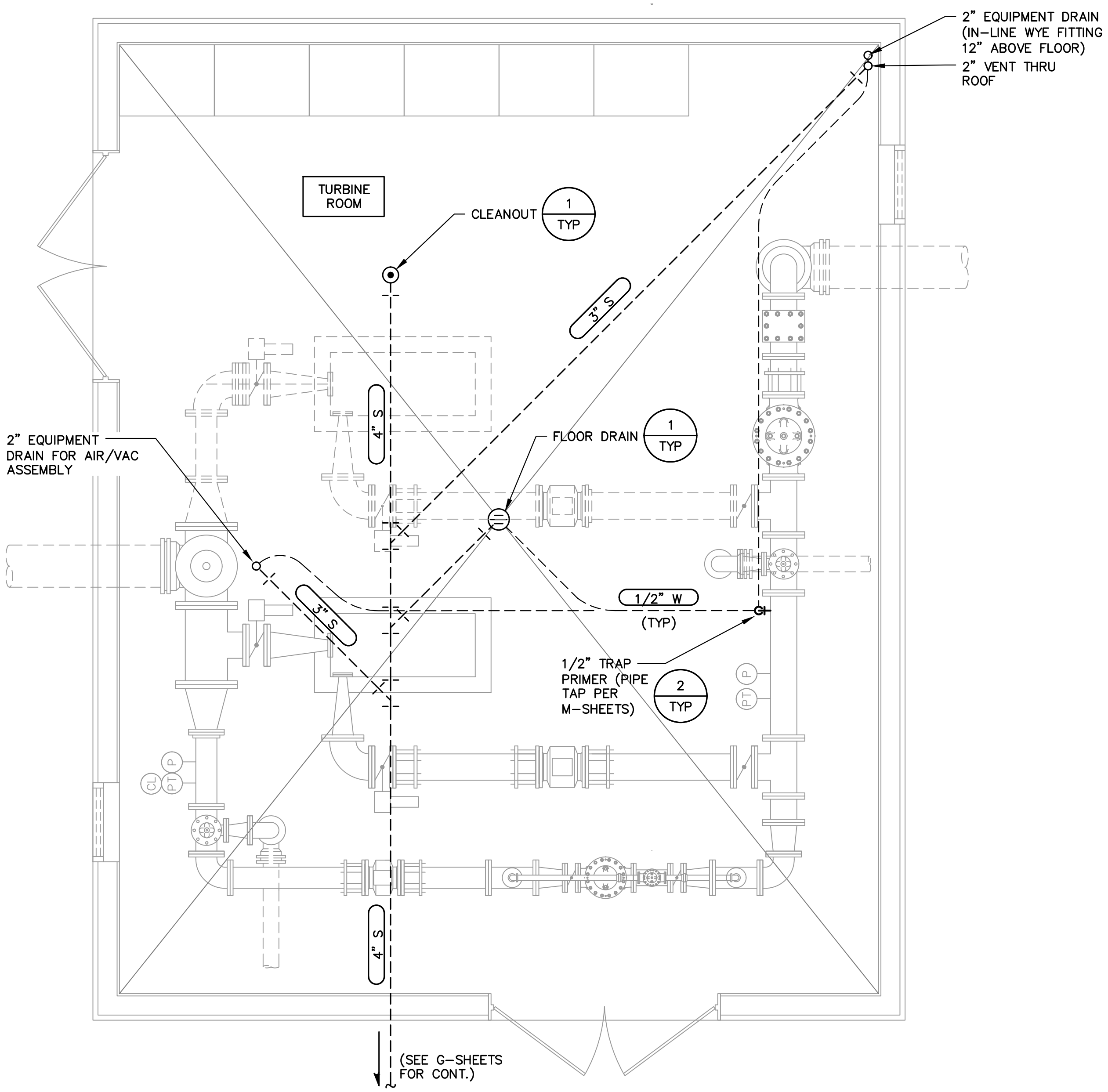
COVINGTON WATER DISTRICT
KING COUNTY WASHINGTON

C4 TAP & TRANSMISSION MAIN

HVAC PLAN

SHEET: H-2
OF: 2

JOB NO.: 16608
DWG: H_TRBN_BLDG



TURBINE BUILDING PLUMBING PLAN

SCALE: 3/8"=1'-0"

WATER PIPING NOTES

1. ALL PLUMBING WORK SHALL CONFORM WITH THE SPECIFICATIONS AND WITH THE CURRENT EDITION PLUMBING CODE OR SHALL BE APPROVED BY THE LOCAL BUILDING OFFICIAL.

DRAINAGE PIPING NOTES

1. ALL PLUMBING WORK SHALL CONFORM WITH THE SPECIFICATIONS AND WITH THE CURRENT EDITION PLUMBING CODE OR SHALL BE APPROVED BY THE LOCAL BUILDING OFFICIAL.
2. ALL BURIED DRAINS SERVING FLOOR DRAINS AND OTHER PLUMBING FIXTURES UNDER SLAB SHALL BE CAST IRON SOIL PIPE. MINIMUM SLOPE SHALL BE 1/4"/FT.
3. ALL BENDS UNDER FLOOR TO BE 45° FITTINGS MAXIMUM.

PLUMBING SYMBOLS & ABBREVIATIONS

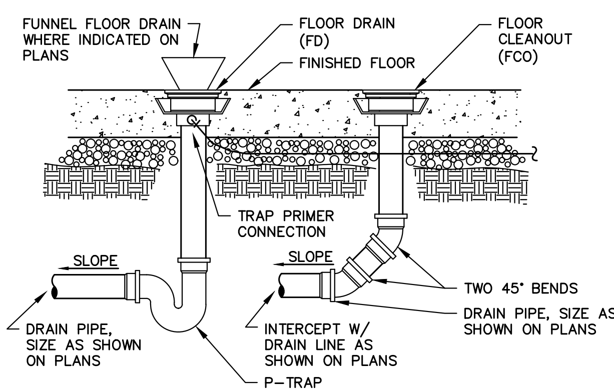
SHUT OFF VALVE
UTILITY STATION
TEE UP
TEE DOWN
90° BEND UP
90° BEND DOWN AND UP

DRAINAGE PIPING LEGEND

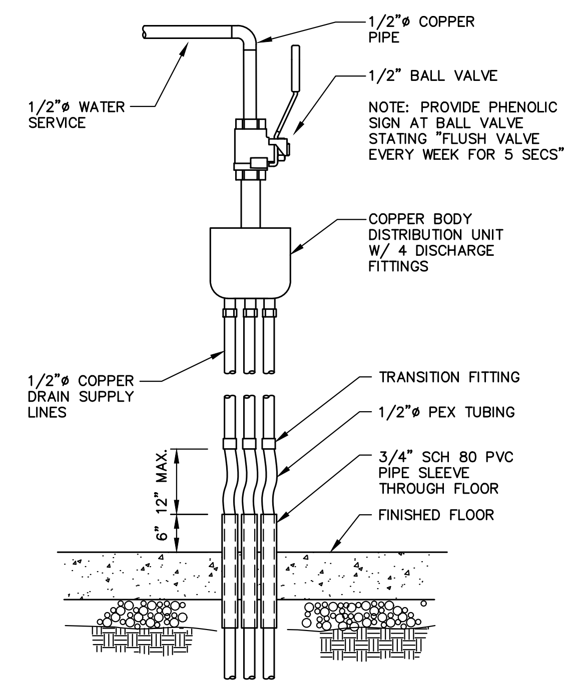
S	SEWER PIPE OR DRAIN PIPE
CO	CLEAN OUT
FD	FLOOR DRAIN
ED	EQUIPMENT DRAIN

NOTE:

FOR ADDITIONAL ABBREVIATIONS & SYMBOLS SEE CORRESPONDING ELECTRICAL, STRUCTURAL, HVAC, ARCHITECTURAL, & MECHANICAL SHEETS.



1 TYP **FLOOR DRAIN AND CLEANOUT DETAIL**
NOT TO SCALE



2 TYP **TRAP PRIMER AND SLAB PENETRATION DETAIL**
NOT TO SCALE

0 1" 2"
TWO INCHES AT FULL SCALE IF NOT, SCALE ACCORDINGLY

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CONSULTING ENGINEERS
2102 CARRIAGE DRIVE SW, BLDG. I
OLYMPIA, WA 98502 • (360) 292-7481

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AARON M. PEASE, STATE OF WASHINGTON, 40276, REGISTERED PROFESSIONAL ENGINEER

COVINGTON WATER DISTRICT
KING COUNTY WASHINGTON
C4 TAP & TRANSMISSION MAIN
PLUMBING PLAN

SHEET: P-1
OF: 1
JOB NO.: 16608
DWG: P_TRBN_BLDG

i:\covington water district\16608.00 tacoma tap and transmission main\Design\Planset\Plumbing\P_TRBN_BLDG.dwg, 6/14/2017 1:34 PM, JON SPURLIN

ABBREVIATIONS

A	AMPERE (AMP)
AC	ALTERNATING CURRENT
AF	BREAKER FRAME SIZE (IN AMPS)
AI	ANALOG INPUT
AIC	AMPERS–INTERRUPTING CAPACITY
AL	ALUMINUM
AM	AMMETER
AO	ANALOG OUTPUT
AT	BREAKER TRIP (SETTING IN AMPS)
ATS	AUTOMATIC TRANSFER SWITCH
AWG	AMERICAN WIRE GAUGE
BATT	BATTERY
BKR	BREAKER
CP	CONTROL PANEL
CPT	CONTROL POWER TRANSFORMER
CST	CONTROL STATION
CT	CURRENT TRANSFORMER
CU	COPPER
DC	DIRECT CURRENT
DI	DISCRETE INPUT
DIST	DISTRIBUTION
DO	DISCRETE OUTPUT
DTWV	DISCHARGE–TO–WASTE VALVE
EIOM	EXTENDED I/O MODULE
ETC	ELAPSED TIME/COUNTER METER
ETM	ELAPSED TIME METER
ENCL	ENCLOSURE
EXIST	EXISTING
FDR	FEEDER
FLA	FULL LOAD AMPS
FU	FUSE
FVNR	FULL VOLTAGE NON REVERSING
FVR	FULL VOLTAGE REVERSING
FY	FLOW COMPUTATION
G	GROUND CONDUCTOR
GEC	GROUNDING ELECTRODE CONDUCTOR
GFCI	GROUND FAULT CIRCUIT INTERRUPTER
GND	GROUND
H	HORN
HA	HAND–AUTO
HIM	HUMAN INTERFACE MODULE
HMI	HUMAN MACHINE INTERFACE
HOA	HAND–OFF–AUTO
HOR	HAND–OFF–REMOTE
HP	HORSEPOWER
JCXXX	JUNCTION BOX, CONTROL
JPXXX	JUNCTION BOX, POWER
JSXXX	JUNCTION BOX, SIGNAL
kA	KILOAMPERES
kAIC	KILOAMPERES–INTERRUPTING CAPACITY
KCM	THOUSAND CIRCULAR MILLS
kV	KILOVOLT
kVA	KILOVOLT–AMPERE
kVAh	KILOVOLT–AMPERE HOUR
kVAR	KILOVAR (REACTIVE KILOVOLT–AMPERE)
KVARh	KILOVAR–HOUR
kW	KILOWATT
kWh	KILOWATT–HOUR
LA	LIGHTNING ARRESTOR
LAN	LOCAL AREA NETWORK
LFMC	LIQUIDTIGHT FLEXIBLE METAL CONDUIT
LINE	POWER LINE/POWER BLOCK
LV	LOW VOLTAGE
M	MAGNETIC CONTACTOR
mA	MILLIAMPERES
MCC	MOTOR CONTROL CENTER
MCM	THOUSAND CIRCULAR MILLS
MCP	MOTOR CIRCUIT PROTECTOR
MOV	METAL OXIDE VARISTOR
MS	MOTOR STARTER
MSDS	MOTOR SAFETY DISCONNECT SWITCH
MTS	MANUAL TRANSFER SWITCH
MTU	MASTER TELEMETRY UNIT
mV	MILLIVOLT
MW	MEGAWATT
N	NEUTRAL CONDUCTOR
NEC	NATIONAL ELECTRICAL CODE
NEMA	NATIONAL ELECTRIC MANUFACTURERS ASSOC.
NESC	NATIONAL ELECTRICAL SAFETY CODE
NFPA	NATIONAL FIRE PROTECTION AGENCY
OCPD	OVERCURRENT PROTECTION DEVICE
OE	OVERHEAD ELECTRIC
OIU	OPERATOR INTERFACE UNIT
OL	OVERLOAD, THERMAL
OLR	OVERLOAD RELAY
P	POLE
PF	POWER FACTOR
PH	PHASE
PLC	PROGRAMMABLE LOGIC CONTROL
PMR	PHASE MONITOR RELAY
PMU	POWER MONITOR UNIT
POT	POTENTIOMETER
PVC	POLYVINYL CHLORIDE CONDUIT
RGS	RIGID GALVANIZED STEEL CONDUIT
RVSS	REDUCED–VOLTAGE SOFT START
RMC	RIGID METALLIC CONDUIT
RNC	RIGID NONMETALLIC CONDUIT
RTU	REMOTE TELEMETRY UNIT
s	SECOND
SHD	SHIELDED
SPD	SURGE PROTECTION DEVICE
SS	STAINLESS STEEL
SUSE	SUITABLE FOR USE AS A SERVICE ENTRANCE
TB	TERMINAL BLOCK
TDAD	TIME DELAY AFTER DE–ENERGIZATION
TDAE	TIME DELAY AFTER ENERGIZATION
TQS	TORQUE SWITCH
TSP	TWISTED SHIELDED PAIR
TST	TWISTED SHIELDED TRIAD
T/M	THERMAL MAGNETIC
UPS	UNINTERRUPTIBLE POWER SUPPLY
V	VOLT
VA	VOLT–AMPERE
VFD	VARIABLE FREQUENCY DRIVE
VMR	VOLTAGE MONITORING RELAY
W	WATT
WAN	WIDE AREA NETWORK
Wh	WATT–HOUR
WP	WEATHER PROOF
XFMR	POWER TRANSFORMER

SYMBOL LEGEND

PLAN SYMBOLS

CONDUIT DOWN
CONDUIT UP
CONDUIT STUB UP/END CAP
DISCONNECT SWITCH
FUSED DISCONNECT SWITCH
COMMUNICATION OUTLET
TELEPHONE OUTLET
SPECIAL OUTLET
DUPLEX RECEPTACLE
DUPLEX RECEPTACLE (HIDDEN)
QUAD RECEPTACLE
QUAD RECEPTACLE (HIDDEN)
FLOOR MOUNTED RECEPTACLE
OR LIGHT POLES
SINGLE DUAL
#12 AWG GROUND CONDUCTOR
#12 AWG NEUTRAL CONDUCTOR
#12 AWG BRANCH CONDUCTOR
CROSSMARKS INDICATE QUANTITY AND USE OF CONDUCTORS

S_X SWITCH, X =
3 = 3–WAY K = KEY
4 = 4–WAY M = MOTION

SEAL OFF

(X) MOTOR X = HORSE POWER

(XX) XX= CV CHECK VALVE
FE FLOW ELEMENT
FI FLOW INDICATOR
FIT FLOW INDICATOR/TRANSMITTER
FS FLOW SWITCH
FT FLOW TRANSMITTER
HD HEAT DETECTOR
IS INFLUENT SAMPLER
ISW INTRUSION SWITCH
J JUNCTION BOX
L LIMIT SWITCH
LE LEVEL ELEMENT
LI LEVEL INDICATOR
LIT LEVEL INDICATOR/TRANSMITTER
LS LEVEL SWITCH/FLOAT
LT LEVEL TRANSDUCER
MDT MOTION DETECTOR
MFM MAGNETIC FLOW METER
PC PHOTO CELL
PE PRESSURE ELEMENT
PI PRESSURE INDICATOR
PIT PRESSURE INDICATOR TRANSMITTER
PS PRESSURE SWITCH
PT PRESSURE TRANSMITTER
SD SMOKE DETECTOR
SV SOLENOID VALVE
T THERMOSTAT

ELEMENTARY WIRING DIAGRAM SYMBOLS

WIRE CONNECTION
TERMINAL POINT
MOUNTED ON OUTER DOOR
MOUNTED ON INNER DOOR
NC CONTACT
NC CONTACTOR
NO CONTACT
NO CONTACTOR
SS SOLID STATE CONTACTOR
(ALT) ALTERNATING RELAY
(CR) CONTROL RELAY
(C) CONTACTOR
(C) BP "BYPASS" CONTACTOR
(C) IC "ISOLATION" CONTACTOR
(C) SS SOLID STATE CONTACT RELAY
(M) MOTOR RELAY
(TR) TIME DELAY RELAY
LIGHT EMITTING DIODE
DIODE
(X) INDICATING LIGHT
A = AMBER R = RED
B = BLUE W = WHITE
G = GREEN
(X) "PUSH TO TEST" LIGHT

HAND OFF AUTO XOO OXO OOX OR RESET OFF ON OOX XOO 3–POSITION HOA/RESET SWITCH

A B XO OX OR ON OFF OX XO 2–POSITION SELECTOR SWITCH

GFCI DUPLEX OUTLET
DUPLEX OUTLET
FUSE
FUSE W/ LED
8888 DIGITAL READOUT

LOCKABLE DEVICE
N.O. TOGGLE SPST SWITCH
N.C. TOGGLE SPST SWITCH
N.C. TEMPERATURE SWITCH
N.O. TEMPERATURE SWITCH
N.O. PUSHBUTTON
N.C. PUSHBUTTON
N.O. MUSHROOM PUSHBUTTON
N.C. MUSHROOM PUSHBUTTON
N.O. PRESSURE SWITCH
N.C. PRESSURE SWITCH
N.C. LIMIT SWITCH
N.O. LIMIT SWITCH
N.C. FLOW SWITCH
N.O. FLOW SWITCH
N.O. FLOAT SWITCH
N.C. FLOAT SWITCH
N.C. DIFFERENTIAL PRESSURE SWITCH
N.O. DIFFERENTIAL PRESSURE SWITCH
TDAE, N.O., TIME DELAY CLOSE, INSTANTANEOUS RE–OPEN
TDAE, N.C., TIME DELAY OPEN, INSTANTANEOUS RE–CLOSE
TDAD, N.O., INSTANTANEOUS CLOSE, TIME DELAY RE–OPEN
TDAD, N.C., INSTANTANEOUS OPEN, TIME DELAY RE–CLOSE
GROUND EQUIPMENT/CHASSIS
GROUND, ISOLATED
RESISTOR
POTENTIOMETER
SOLENOID VALVE COIL
TRANSFORMER WINDING/ REACTOR/CHOKE

ONE LINE SYMBOLS

CAPACITOR
M CIRCUIT BREAKER, MAGNETIC ONLY
T/M CIRCUIT BREAKER, THERMAL–MAGNETIC
CIRCUIT CONNECTION
CONTACTOR
CURRENT TRANSFORMER
FUSE
FUSIBLE DISCONNECT
GROUND EQUIPMENT/CHASSIS
(G) GENERATOR
S N SOLID NEUTRAL
AM ANALOG AMMETER
REACTOR/CHOKE
THERMAL OVERLOAD RELAY
POTENTIAL TRANSFORMER

GENERAL SYMBOLS

XXXXX CONDUIT
XX XXXX XX TAG LABEL
GFCI GFCI PANELBOARD CIRCUIT
X AREA ID TAG
DEMOLITION (DEMO)
INTRINSICALLY SAFE AREA
CLEARANCE AREA

LINETYPES

EXPOSED CONDUIT
UNDERGROUND (BURIED) CONDUIT
GROUNDING ELECTRODE CONDUCTORS
EMBEDDED CONDUIT (WALLS, CONCRETE, ETC.)

NOTE: UNLESS NOTED OTHERWISE.

NOTE:
THIS IS A GENERAL LEDGER SHEET. ALL SYMBOLS MAY NOT APPLY.

GENERAL ELECTRICAL NOTES:

SITE AND BUILDING PLANS:

1. CONDUIT ROUTING IS SHOWN FOR SCHEMATICALLY. ACTUAL ROUTING MAY BE MORE DIRECT AND IS LEFT TO THE CONTRACTOR FOLLOWING SPECIFICATIONS 16130. NON–ELECTRICAL BURIED PIPING HAS ROUTING PRIORITY OVER ELECTRICAL BURIALS.
2. ALL TRENCHING SHALL BE PER ELECTRICAL TRENCHING DETAIL, REFERENCE ED–SHEETS.
3. THE CONTRACTOR SHALL TAKE ALL STEPS NECESSARY TO PROTECT EXISTING UTILITIES.
4. THROUGHOUT THIS DOCUMENT, THE TERM "DEMO" MEANS TO REMOVE, THEN WASTEHAUL OR RETURN TO THE OWNER, PER THE OWNER'S DIRECTION.

GENERAL CONTROL PANEL NOTES:

1. UNLESS SPECIFICALLY NOTED OTHERWISE ON THE CONTROL PANEL DETAILS, THE FOLLOWING NOTES APPLY.

1.1 ALL ENCLOSURES SHALL BE PROVIDED WITH AN ENGRAVED NAMEPLATE CORRESPONDING TO THE ASSOCIATED TAG ID NUMBER AND TAG DESCRIPTION.

TAG DESCRIPTION ← 1/4" TEXT
[TAG NUMBER] ← 3/16" TEXT

NOTE: MOTOR STARTER NAMEPLATES SHALL BE BLACK WITH WHITE LETTERING, REFERENCE MCC PANEL DOOR NAMEPLATE SCHEDULE.

1.2 WHERE PANELS CONTAIN POWER FROM MULTIPLE SOURCES, PROVIDE A YELLOW SAFETY STICKER, APPROXIMATELY 2" x 3", AS SHOWN BELOW.

CAUTION
THIS DEVICE IS POWERED FROM SEVERAL SOURCES
THE DISCONNECT SWITCH WILL NOT SHUT OFF ALL SOURCES OF ELECTRICAL ENERGY

INDOOR INSTALLATIONS:

1. ALL EXPOSED PORTIONS OF CONDUITS FROM UNDERGROUND SHALL BE RGS. ALL OVERHEAD CONDUITS SHALL BE EMT.
2. EXCEPT FOR INSTRUMENTATION, NON LINEAR CIRCUITS, AND INTRINSICALLY SAFE CIRCUITS ALL PORTIONS OF CONDUITS IN THE ATTIC SHALL BE EMT.
3. PANELS MOUNTED ON INTERIOR WALLS SHALL BE SUPPORTED TO THE WALL WITH 1/2–INCH (MINIMUM) GALVANIZED UNISTRUT.

PULLBOX AND VAULT INSTALLATIONS:

1. ALL MOUNTING FASTENERS (NUTS, BOLTS SCREWS, WASHERS, ETC.) SHALL BE 316 STAINLESS STEEL.
2. ALL MOUNTING BRACKETS AND BRACING SHALL BE 316L STAINLESS STEEL.
3. ALL EXPOSED PORTIONS OF CONDUITS SHALL BE PVC–COATED RGS UNLESS SPECIFICALLY NOTED OTHERWISE.
4. ALL CONNECTIONS INTO ENCLOSURES SHALL BE WATERTIGHT, MADE INTO THE BOTTOM OF THE PANELS, USING MYER–TYPE HUBS. REFERENCE SPECIFICATION 16130.
5. PANELS MOUNTED ON VERTICAL WALLS SHALL BE SUPPORTED TO THE WALL WITH 1/2–INCH (MINIMUM) 316L STAINLESS STEEL UNISTRUT.
6. ENCLOSURE SHALL INCLUDE WELDED MOUNTING TABS. HOLES SHALL NOT BE DRILLED THROUGH ENCLOSURE SURFACES FOR MOUNTING PURPOSE.

CABLE AND CONDUIT NOTES:

1. REFERENCE SPECIFICATION 16120 FOR CONDUCTORS, INSTRUMENTATION, COMMUNICATION, AND OTHER SPECIAL CABLES AND CONDUCTORS.
2. REFERENCE SPECIFICATION 16130 FOR RACEWAYS, BOXES, AND JUNCTION BOX TYPES, AND HANDHOLE, PULLBOX, AND VAULT CONDUIT INSTALLATION METHODS.
3. CONDUIT NUMBERS ARE FORMATTED AS:

TAANN(S) WHERE: T = TYPE (P=POWER; C=CONTROL; S=SIGNAL/INSTRUMENTATION)
AA= AREA NUMBER (01–99)
NN= CONDUIT NUMBER WITHIN THE AREA (01–99)
S = SPARE CONDUIT (~ "TILDE") (IF APPLICABLE)

P0319~ = AREA 03 POWER CONDUIT NO. 19, SPARE
C0112 = AREA 01 CONTROL CONDUIT NO. 12
S0521~ = AREA 05 INSTRUMENTATION CONDUIT NO. 21, SPARE

4. CABLE AND CONDUIT SCHEDULES:

4.1. THE CABLE AND CONDUIT SCHEDULE PROVIDES CONDUIT NUMBER, SOURCE, DESTINATION, AND SIZE AS WELL AS CONDUCTOR AND CABLE REQUIREMENTS. REFERENCE SPECIFICATION 16130 FOR CONDUIT COMPOSITION AND COATING.

4.2. CONDUITS MARKED WITH "* n" (WHERE n = 1, 2, OR 3) SHALL BE 100% CONTINUOUS PER SPECIFICATION 16130.

SPECIFICALLY, CONDUITS MARKED WITH:

"* 1" DENOTE NON LINEAR POWER CIRCUITS. IF THESE CONDUITS ENTER A PULLBOX, THEN THEY MUST CONNECT TO A "TYPE 1" J–BOX INSIDE THE PULLBOX.

"* 2" DENOTE INTRINSICALLY SAFE CIRCUITS, EITHER CONTROL OR INSTRUMENTATION. IF THESE CONDUITS ENTER A PULLBOX, THEN THEY MUST CONNECT TO A "TYPE 2" J–BOX INSIDE THE PULLBOX.

"* 3" DENOTE INSTRUMENTATION CIRCUITS THAT ARE NOT INTRINSICALLY SAFE. IF THESE CONDUITS ENTER A PULLBOX, THEN THEY MUST CONNECT TO A "TYPE 3" J–BOX INSIDE THE PULLBOX.

5. REGARDLESS OF THE TYPE OF CONDUIT BEING ROUTED TO A MOTOR, THE LAST 18 INCHES OF THE CONDUIT CONNECTING TO THE MOTOR SHALL BE LFMC.

READING ELECTRICAL SHEETS:

ELEMENTARY DIAGRAMS:

1. ELEMENTARY DIAGRAMS ARE SHOWN IN LADDER LOGIC FORM WITH LINE NUMBERS FORMATTED AS:

SS.LL WHERE SS = SHEET NUMBER AND
LL = LINE NUMBER

2. RELAY COIL "TYPES" ARE INDICATED INSIDE THE COIL SYMBOL AS PER THE SYMBOL SCHEDULE ON THIS SHEET. THE COIL NUMBER IS OF THE FORMAT:

TTSS.LL.AA WHERE TT = RELAY TYPE (PER SYMBOL SCHEDULE)
SS.LL = AS DESCRIBED ABOVE
AA = ASSOCIATION WITH A DRIVE, CONTROLLER, CONTROL PANEL, ETC.

3. RELAY CONTACTS ARE NUMBERED IN ASSOCIATION WITH THEIR COILS FOLLOWED BY "–X" WHERE X IS THE CONTACT POLE NUMBER.

EXAMPLE: RELAY CONTACTS FOR A DPDT RELAY

POLE NUMBER	N.O. CONTACT REFERENCE	N.C. CONTACT REFERENCE
1:	12.40	NA\
2:	13.04	13.05\

LINE NUMBER
SHEET NUMBER

N.O. = NORMALLY OPEN CONTACT
N.C. = NORMALLY CLOSED CONTACT.

4. CONTACTS AND ANALOG SIGNALS CONNECTED TO PLC I/O ARE FORMATTED AS:

*RR.SS.CC WHERE * DENOTES A PLC I/O CONNECTION
RR = PLC RACK NUMBER
SS = RACK SLOT NUMBER
CC = SLOT CHANNEL NUMBER

PANELBOARD CIRCUIT ASSIGNMENTS:

1. LIGHTING FIXTURES AND RECEPTACLES ARE SHOWN WITH THEIR PANELBOARD CIRCUIT BREAKER NUMBER FOLLOWING THE FORMAT BELOW:

PANELBOARD TAG
(EX: [01 PB 02]
CKT 02–02, 04, 06 ← 3rd CIRCUIT BREAKER POSITION NUMBER (3 POLE)
2nd CIRCUIT BREAKER POSITION NUMBER (2 POLE)
1st CIRCUIT BREAKER POSITION NUMBER

PLCS:

1. REFERENCE CONTROL PANEL SPECIFICATION 16940.
2. WIRE ALL PLC ANALOG AND DIGITAL INPUTS AND OUTPUTS, WHETHER ASSIGNED OR SPARE, TO TERMINAL GROUPS PER SPECIFICATION.
3. ALL PLC DIGITAL OUTPUTS SHALL BE BUFFERED THROUGH INTERPOSING RELAYS. SPARE OUTPUTS, AND OUTPUTS ASSIGNED OUTSIDE THE PANEL, SHALL BE CONNECTED TO A FUSED TERMINAL PAIR.
4. N.O. OR N.C. CONTACTS FORMATTED AS *RR:SS:CC ARE DERIVED FROM PLC DIGITAL OUTPUT BUFFER RELAYS. THE RELAY CONTACT INDICATOR *RR:SS:CC INDICATES THE RELAY'S ASSOCIATED PLC DIGITAL OUTPUT RACK, SLOT, AND CHANNEL.

CONNECTIONS TO ELECTRICAL DEVICES IN VAULTS:

(XX) DEVICE — 316L S.S. CGB CONNECTOR — PVC–COATED RGS CONDUIT — MNFR'S CABLE

(XX) DEVICE — COUPLING — PVC–COATED RGS CONDUIT — LFMC CONDUIT

1. REFERENCE SPECIFICATION 16130.

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JOHN P. GALLUCCI
STATE OF WASHINGTON
40552
REGISTERED PROFESSIONAL ENGINEER

COVINGTON WATER DISTRICT
KING COUNTY WASHINGTON
C4 TAP & TRANSMISSION MAIN
ELECTRICAL SYMBOLS, ABBREVIATIONS, AND NOTES

SHEET: E-1
OF: 8

JOB NO.: 16608
DWG:E_SYM_ABBR

AREA 01 - DEVICE TAG LIST

TAG ID#	TAG DESCRIPTION	VINTAGE
01 BLDG 01	TURBINE BUILDING	NEW
01 CB 01	CIRCUIT BREAKER, 200A, 3-POLE, 65 KAIC, MAIN DESTRUCTION, 208/120 VAC, 600A, 3-PHASE PANELBOARD	NEW
01 CLA 01	CHLORINE ANALYZER, OUTLET	NEW
01 CP 01	CONTROL PANEL, TURBINE BUILDING	NEW
01 CP 02	CONTROL PANEL, HYDROELECTRIC EQUIPMENT PACKAGE NO. 1	NEW
01 CP 03	CONTROL PANEL, HYDROELECTRIC EQUIPMENT PACKAGE NO. 2	FUTURE
01 DREC 01	DEDICATED RECEPTACLE, DEHUMIDIFIER, TURBINE BUILDING	NEW
01 DSP 01	DISTRICT SCADA PANEL	EXISTING
01 EF 01	EXHAUST FAN	NEW
01 FCV 01	FLOW CONTROL VALVE, INLET	NEW
01 FIT 01	FLOW INDICATING TRANSMITTER, HYDROELECTRIC EQUIPMENT PACKAGE NO. 1 INDUCTION GENERATOR	NEW
01 FIT 02	FLOW INDICATING TRANSMITTER, HYDROELECTRIC EQUIPMENT PACKAGE NO. 2 INDUCTION GENERATOR	FUTURE
01 FIT 03	FLOW INDICATING TRANSMITTER, HIGH FLOW, FLOW	NEW
01 HEIG 01	INDUCTION GENERATOR, HYDROELECTRIC EQUIPMENT PACKAGE NO. 1	NEW
01 HEIG 02	INDUCTION GENERATOR, HYDROELECTRIC EQUIPMENT PACKAGE NO. 2	FUTURE
01 HEP 01	HYDROELECTRIC EQUIPMENT PACKAGE NO. 1	NEW
01 HEP 02	HYDROELECTRIC EQUIPMENT PACKAGE NO. 2	FUTURE
01 HHPU 01	HYDRAULIC POWER UNIT, HYDROELECTRIC EQUIPMENT PACKAGE NO. 1	NEW
01 HHPU 02	HYDRAULIC POWER UNIT, HYDROELECTRIC EQUIPMENT PACKAGE NO. 2	FUTURE
01 HT 01	UNIT HEATER, TURBINE BUILDING	NEW
01 IS 01	INTRUSION SWITCH, WEST DOOR	NEW
01 IS 02	INTRUSION SWITCH, SOUTH DOOR	NEW
01 L 01	LIMIT SWITCH, HYDROELECTRIC EQUIPMENT PACKAGE NO. 1	NEW
01 L 02	LIMIT SWITCH, HYDROELECTRIC EQUIPMENT PACKAGE NO. 1	NEW
01 L 03	LIMIT SWITCH, CLOSED, INLET FLOW CONTROL VALVE	NEW
01 L 04	LIMIT SWITCH, CLOSED, OUTLET PRESSURE REDUCING VALVE NO. 1	NEW
01 L 05	LIMIT SWITCH, BYPASS PRESSURE REDUCING VALVE NO. 2	NEW
01 L 06	LIMIT SWITCH, HYDROELECTRIC EQUIPMENT PACKAGE NO. 2 HYDRAULIC POWER UNIT	FUTURE
01 L 07	LIMIT SWITCH, HYDROELECTRIC EQUIPMENT PACKAGE NO. 2 HYDRAULIC POWER UNIT	FUTURE
01 MB 01	METER BASE	NEW
01 MDP 01	PANELBOARD, MAIN DESTRUCTION, 208/120 VAC, 600A, 3-PHASE	EXISTING
01 PB 01	PANELBOARD, 208/120 VAC, 200A	NEW
01 PBOX 01	PULL BOX	NEW
01 PIT 01	PRESSURE INDICATION TRANSMITTER, INLET	NEW
01 PIT 02	PRESSURE INDICATION TRANSMITTER, OUTLET	NEW
01 PRV 01	PRESSURE REDUCING VALVE NO. 1, OUTLET	NEW
01 PRV 02	PRESSURE REDUCING VALVE NO. 2, BYPASS	NEW
01 SDS 01	SIFTER DISCONNECT SWITCH, TURBINE BUILDING SUPPLY FAN	NEW
01 SF 01	SUPPLY FAN, TURBINE BUILDING	NEW
01 SHD 01	SMOKE HEAT DETECTOR	NEW
01 SHD 02	SMOKE HEAT DETECTOR	NEW
01 SV 01	SOLENOID VALVE, OPEN, INLET FLOW CONTROL VALVE	NEW
01 SV 02	SOLENOID VALVE, CLOSED, INLET FLOW CONTROL VALVE	NEW
01 SV 03	SOLENOID VALVE, OPEN, OUTLET PRESSURE REDUCING VALVE NO. 1	NEW
01 SV 04	SOLENOID VALVE, OPEN, BYPASS PRESSURE REDUCING VALVE NO. 2	NEW
01 T 01	THERMOSTAT, TURBINE BUILDING SUPPLY FAN	NEW
01 USDS 01	UTILITY SAFETY DISCONNECT SWITCH	NEW

A - TURBINE BUILDING

B - TRENCH BETWEEN TURBINE BLDG. & ADMIN. BLDG + METER & DISCONNECT

ELECTRICAL WORK SUMMARY:

THIS SUMMARY OF ELECTRICAL WORK IS INCLUDED AS A COURTESY AND IS INTENDED TO PROVIDE A GENERAL UNDERSTANDING OF ELECTRICAL DESIGN INTENT AND MAJOR ELECTRICAL CONSTRUCTION TASKS. IT IS NOT PROVIDED AS A COMPLETE LIST OF WORK AND SHALL NOT BE USED FOR BIDDING PURPOSES. REFER TO ALL PLANS AND SPECIFICATIONS.

1. NEW TURBINE BUILDING WITH HYDROELECTRIC EQUIPMENT PACKAGE.
2. CONDUITS FOR FUTURE HYDROELECTRIC EQUIPMENT PACKAGE.
3. POWER WILL COME FROM/BE DELIVERED TO THE EXISTING POWER DISTRIBUTION IN THE DISTRICT HEADQUARTERS BUILDING.
4. THE TURBINE BUILDING WILL BE CONNECTED TO THE EXISTING TELEMETRY SYSTEM LOCATED IN THE DISTRICT HEADQUARTERS BUILDING.

A - TURBINE BUILDING

LIGHTING SCHEDULE

MNUEMONIC	TECHNOLOGY	APPLICATION	BB *	DESCRIPTION	MANUFACTURER NAME	MANUFACTURER SERIES NO.	INPUT (VA)	VOLTAGE	COMMENTS
L1	LED	WET, CEILING/OVERHEAD	NO	8" X 48", RECTANGULAR.	HOLOPHANE	EVT4	43	120 VAC, 1 PH	6000 LUMENS, 4000 K COLOR, MEDIUM DISTRIBUTION,FROSTED LENS, WET APPLICATION
L2	LED	WET, CEILING/OVERHEAD	YES	8" X 48", RECTANGULAR, BATTERY-BACKED.	HOLOPHANE	EVT4	43	120 VAC, 1 PH	6000 LUMENS, 4000 K COLOR, MEDIUM DISTRIBUTION,FROSTED LENS, WET APPLICATION
L3	LED	WET, WALL-MOUNT, BUILDING	NO	EXTERIOR BUILDING LIGHT.	LITHONIA	DSXW1 LED	40	120 VAC, 1 PH	3059 LUMENS, 4000 K, 10 LEDS (ONE ENGINE), 1000 MA DRIVE CURRENT, AND VANDAL GUARD. 13-3/4" W X 10" D X 6-3/8" H.

* = BATTERY BACKED

Gray & Osborne, Inc.
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FOR PERMIT

COVINGTON WATER DISTRICT
KING COUNTY WASHINGTON

C4 TAP & TRANSMISSION MAIN

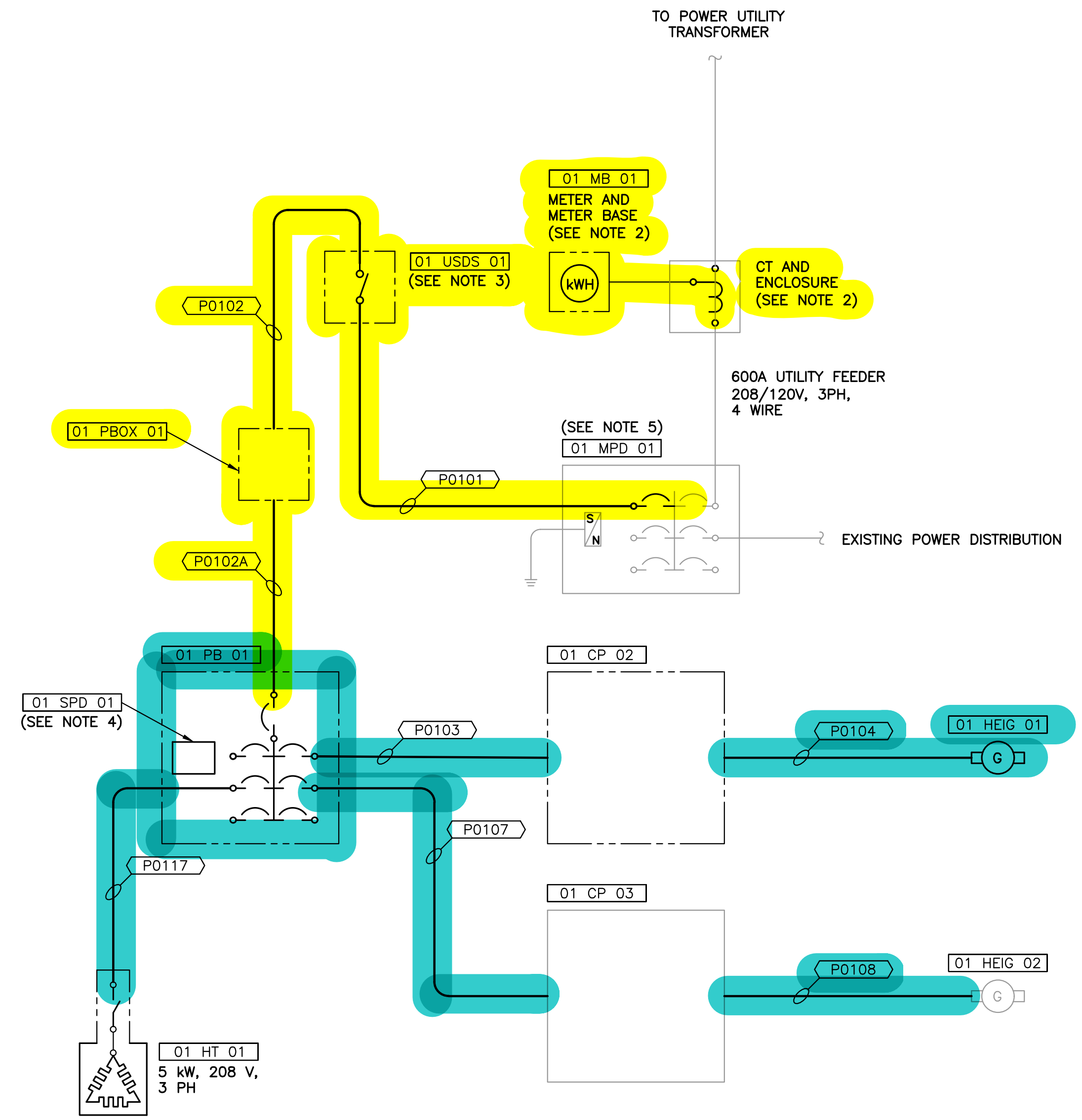
TAGS AND LIGHTING SCHEDULE

SHEET: E-2
OF: 8

JOB NO.: 16608
DWG: E_SYM_ABBR

A - TURBINE BUILDING

B - TRENCH BETWEEN TURBINE BLDG. & ADMIN. BLDG + METER & DISCONNECT



ONE LINE DIAGRAM

1 / –

NOT TOSCALE

NOTES:

1. SEE NOTES ON – / E-1 .
2. THE POWER UTILITY COMPANY IS PUGET SOUND ENERGY. COORDINATE REMOVAL OF EXISTING POWER METER AND INSTALLATION OF NET–METERING POWER METER WITH PSE. PROVIDE NEW CTS, WIRING, AND METER BASE IF REQUIRED BY PSE.
3. MOUNT [01 SDS 01] ON THE ADMINISTRATION BUILDING EXTERIOR WALL NEXT TO [01 MB 01]. PROVIDE A PLACARD LABELED "HYDROELECTRIC TURBINE BUILDING POWER DISCONNECT SWITCH."
4. [01 SPD 01] SHALL BE PROVIDED AS A COMPLETE 160 kA PER PHASE/80 kA PER MODE, FULL MODE, WITH NEUTRAL WITH FILTER, AND WITH OVERLOAD PROTECTION. MOUNT [01 SPD 01] INSIDE OF [01 PB 01].
5. PANELBOARD [01 MDP 01] IS A SQUARE–D I–LINE SERIES E1. [01 MDP 01] IS LOCATED IN THE BASEMENT OF THE ADMINISTRATION BUILDING. CORE–DRILL THROUGH THE BASEMENT WALL AND ROUTE CONDUIT P0101 TO [01 MDP 01]. INSTALL CIRCUIT BREAKER [01 CB 01] IN SPACES 32, 34, AND 36 AND UPDATE THE PANELBOARD SCHEDULE.

Gray & Osborne, Inc.
CONSULTING ENGINEERS
701 DEXTER AVENUE NORTH SUITE 200
SEATTLE, WASHINGTON 98109 • (206) 284-0860

DATE: JUNE 2017
SCALE: NOTED
DRAWN: TMR
CHECKED: PAM
APPROVED: JPG

No.	REVISION	DATE	APPD

FOR PERMIT

JOHN P. GALLUCCI – STATE OF WASHINGTON – 40552 – REGISTERED PROFESSIONAL ENGINEER

COVINGTON WATER DISTRICT
KING COUNTY WASHINGTON

C4 TAP & TRANSMISSION MAIN

ONE LINE DIAGRAM

SHEET: E-3
OF: 8
JOB NO.: 16608
DWG: E_OLD

PANELBOARD [01 PB 01] SCHEDULE

CKT. NO.	DIRECTORY	PHASE A VA	PHASE A A	PHASE B VA	PHASE B A	PHASE C VA	PHASE C A	LOAD TYPE	BKR AMPS	BUS	BKR AMPS	LOAD TYPE	PHASE A VA	PHASE A A	PHASE B VA	PHASE B A	PHASE C VA	PHASE C A	DIRECTORY	CKT. NO.
1	[01 CP 02], CONTROL PANEL, HYDROELECTRIC EQUIPMENT PACKAGE	400	3.3					Z	3/100	A	3/100	Z	–	–					[01 CP 03], CONTROL PANEL, HYDROELECTRIC EQUIPMENT PACKAGE NO. 2	2
3	[01 CP 02], CONTROL PANEL, HYDROELECTRIC EQUIPMENT PACKAGE			400	3.3			Z	|	B	|	Z			–	–			[01 CP 03], CONTROL PANEL, HYDROELECTRIC EQUIPMENT PACKAGE NO. 2	4
5	[01 CP 02], CONTROL PANEL, HYDROELECTRIC EQUIPMENT PACKAGE					400	3.3	Z	|	C	|	Z					–	–	[01 CP 03], CONTROL PANEL, HYDROELECTRIC EQUIPMENT PACKAGE NO. 2	6
7	[01 DREC 01], DEDICATED RECEPTACLE, DEHUMIDIFIER, TURBINE BUILDING	960	8.0					R	1/20	A	3/20	H	1,667	13.9					[01 HT 01], UNIT HEATER, TURBINE BUILDING	8
9	[01 SF 01], SUPPLY FAN, TURBINE BUILDING			1,656	13.8			H	1/20	B	|	H			1,667	13.9			[01 HT 01], UNIT HEATER, TURBINE BUILDING	10
11	[01 CP 01], CONTROL PANEL, TURBINE BUILDING					600	5.0	Z	1/20	C	|	H					1,667	13.9	[01 HT 01], UNIT HEATER, TURBINE BUILDING	12
13	[01 CP 01], CONTROL PANEL, TURBINE BUILDING	450	3.8					Z	1/20	A	1/20	R	900	7.5					[01 DREC 01], DEDICATED RECEPTACLE, DEHUMIDIFIER, TURBINE BUILDING	14
15	BUILDING RECEPTACLES			540	4.5			R	1/20	B	1/20	L			467	3.9			BUILDING LIGHTING	16
17	BUILDING RECEPTACLES					540	4.5	R	1/20	C	1/20	Z					–	–	SPARE	18
19	SPARE	–	–					Z	1/20	A	1/20	Z	–	–					SPARE	20
21	SPARE			–	–			Z	1/20	B	1/20	Z			–	–			SPARE	22
23	SPARE					–	–	Z	1/20	C	1/20	Z					–	–	SPARE	24
	SUM OF PHASE VA, AMPS	1,810	15.1	2,596	21.6	1,540	12.8						2,567	21.4	2,134	17.8	1,667	13.9	SUM OF PHASE VA, AMPS	

[01 PB 01] ELECTRICAL AND CONSTRUCTION SPECIFICATIONS:

CONFIGURATION:	208/120 VAC, 3 PH, 60 Hz
POWER BUS:	225 A, COPPER
NEUTRAL BUS:	225 A (100% OF POWER BUS), ISOLATED FROM GROUND, SOLDERLESS CONNECTIONS
GROUND BUS:	PROVIDE PER UL 67
BUS BRACING:	35 kAIC, MINIMUM
MAIN BREAKER:	200 AT, 225 AF, 3 PH, 3 P, 35 kAIC, MOLDED CASE, VERTICAL MOUNTING
DISTRIBUTION BREAKERS:	BOLT–ON, MOLDED CASE, 35 kAIC, MINIMUM
GROUND BONDING:	GROUND AND NEUTRAL SEPARATED
ENCLOSURE:	NEMA 1 GASKETED
NUMBER OF CIRCUITS:	24
UNCOMMITTED CIRCUITS:	FILL WITH SPARE 20 A, 1 P, 35 kAIC BREAKERS
POWER DERIVED FROM:	[01 MDP 01], PANELBOARD, MAIN DESTRUCTION, 208/120 VAC, 600A, 3–PHASE
BUS BREAKERS:	3 POLE, 2x 100 A, 35 kAIC
	3 POLE, 1x 20 A, 35 kAIC
	1 POLE, 15x 20 A, 35 kAIC

A - TURBINE BUILDING

C - PIPELINE PANELS

LOAD DISTRIBUTION:

LOAD DISTRIBUTION:	AMPS	VA	%
BY PHASE:			
TOTAL LOAD, PHASE A:	36.5 A	4,377 VA	35.5%
TOTAL LOAD, PHASE B:	39.4 A	4,730 VA	38.4%
TOTAL LOAD, PHASE C:	26.7 A	3,207 VA	26.0%
BY LOAD TYPE:			
TOTAL LIGHTING (L):		467 VA	3.8%
TOTAL MOTOR (M):		0 VA	0.0%
TOTAL HVAC (H):		6,656 VA	54.1%
TOTAL RECEPTACLE (R):		2,940 VA	23.9%
TOTAL OTHER (Z):		2,250 VA	18.3%
TOTAL CONNECTED LOAD:		12.31 kVA	100.0%

NOTES:

1. THE CONTRACTOR SHALL PROVIDE A TYPED PANELBOARD SCHEDULE FOR ALL ACTUAL LOAD ASSIGNMENTS.

LEGEND:

GFCI DENOTES GFCI PANELBOARD CURCUIT BREAKER.

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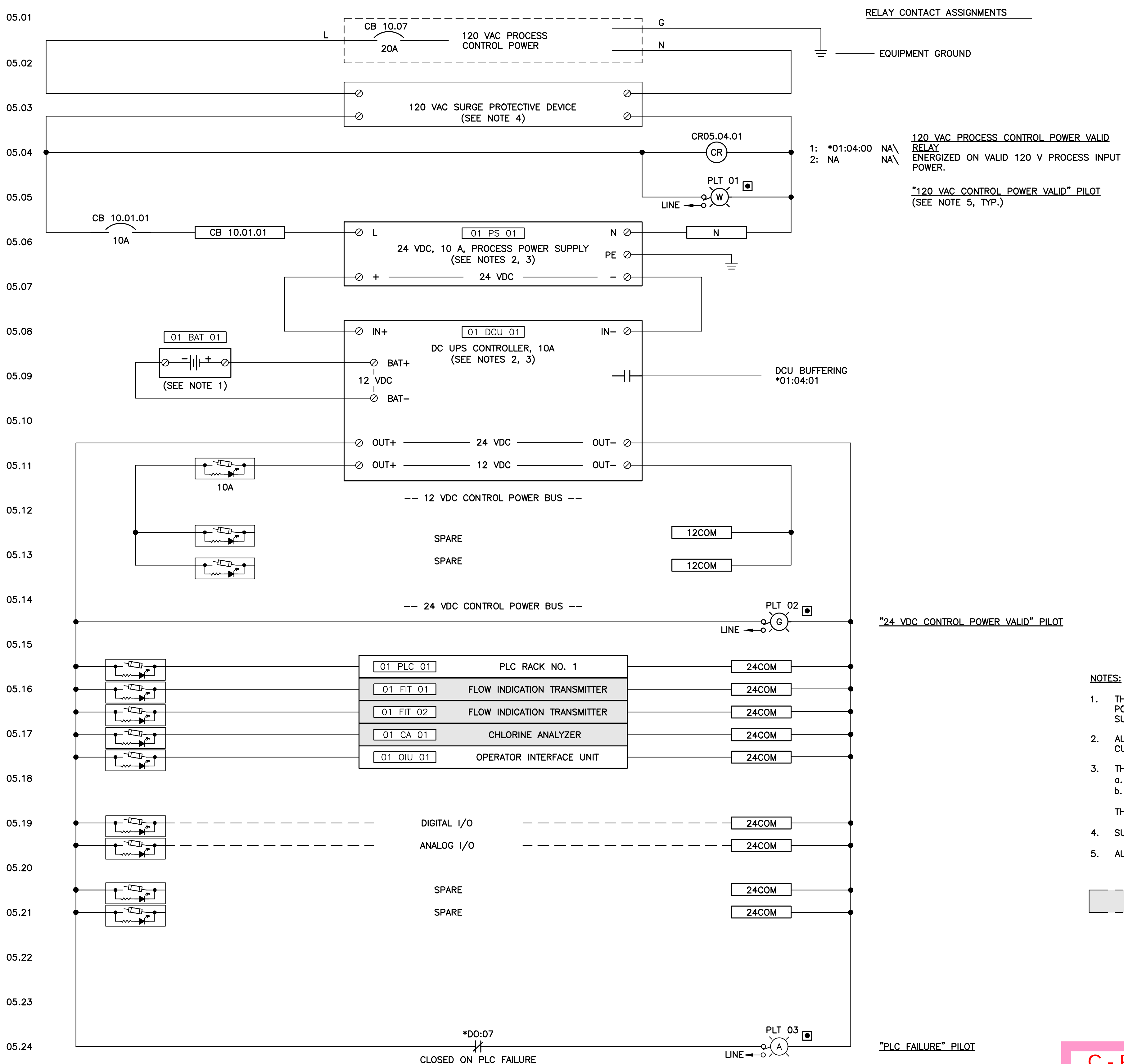
COVINGTON WATER DISTRICT
KING COUNTY WASHINGTON

C4 TAP & TRANSMISSION MAIN

PANEL BOARD [01 PB 01] SCHEDULE

SHEET: E-4
OF: 8

JOB NO.: 16608
DWG:E_OLD



NOTES:

1. THE INTEGRATOR SHALL CALCULATE AND SIZE BACK-UP BATTERY [01 BAT 01] FOR 6 HOURS (MINIMUM) OF 24 VDC POWER, WITH ALL CONNECTED LOADS ACTIVE. THESE CALCULATIONS SHALL BE PRESENTED TO ENGINEERING DURING SUBMITTAL.
2. ALL POWER SUPPLIES, CONVERTERS, AND UPS DEVICES SHALL BE INDUSTRIAL, PACKAGED, UL-LISTED, DIN-RAIL DEVICES. CUSTOM-BUILT CIRCUIT BOARDS AND LOOSE ELECTRONIC DEVICES SHALL NOT BE ALLOWED.
3. THIS 24 VDC POWER SYSTEM IS DESIGNED AROUND THE FOLLOWING DEVICES:
   a. [01 PS 01] SINGLE PHASE, 120 VAC/24 VDC, 10A, POWER SUPPLY — PULS #QS10.241
   b. [01 DCU 01] 24 VDC IN, 24/12 VDC OUT, 10A, DC-UPS CONTROLLER — PULS #UB10.245

   THESE UNITS MAY BE REPLACED WITH "OR EQUAL" DEVICES.
4. SURGE PROTECTIVE DEVICE IS 120 VAC, 40 kA; 1" WIDE, DIN-RAIL; BUSSMANN #BSPM1120S2G OR EQUIVALENT.
5. ALL PILOT LIGHTS IN [01 CP 01B] SHALL BE PUSH-TO-TEST, LED TYPE.

SHADED DEVICES ON THIS SHEET ARE REMOTE FROM [01 CP 01].

C - PIPELINE PANELS

PLC CONTROL PANEL [01 CP 01] ELEMENTARY WIRING DIAGRAM
1 / –
NOT TO SCALE

Gray & Osborne, Inc.
CONSULTING ENGINEERS

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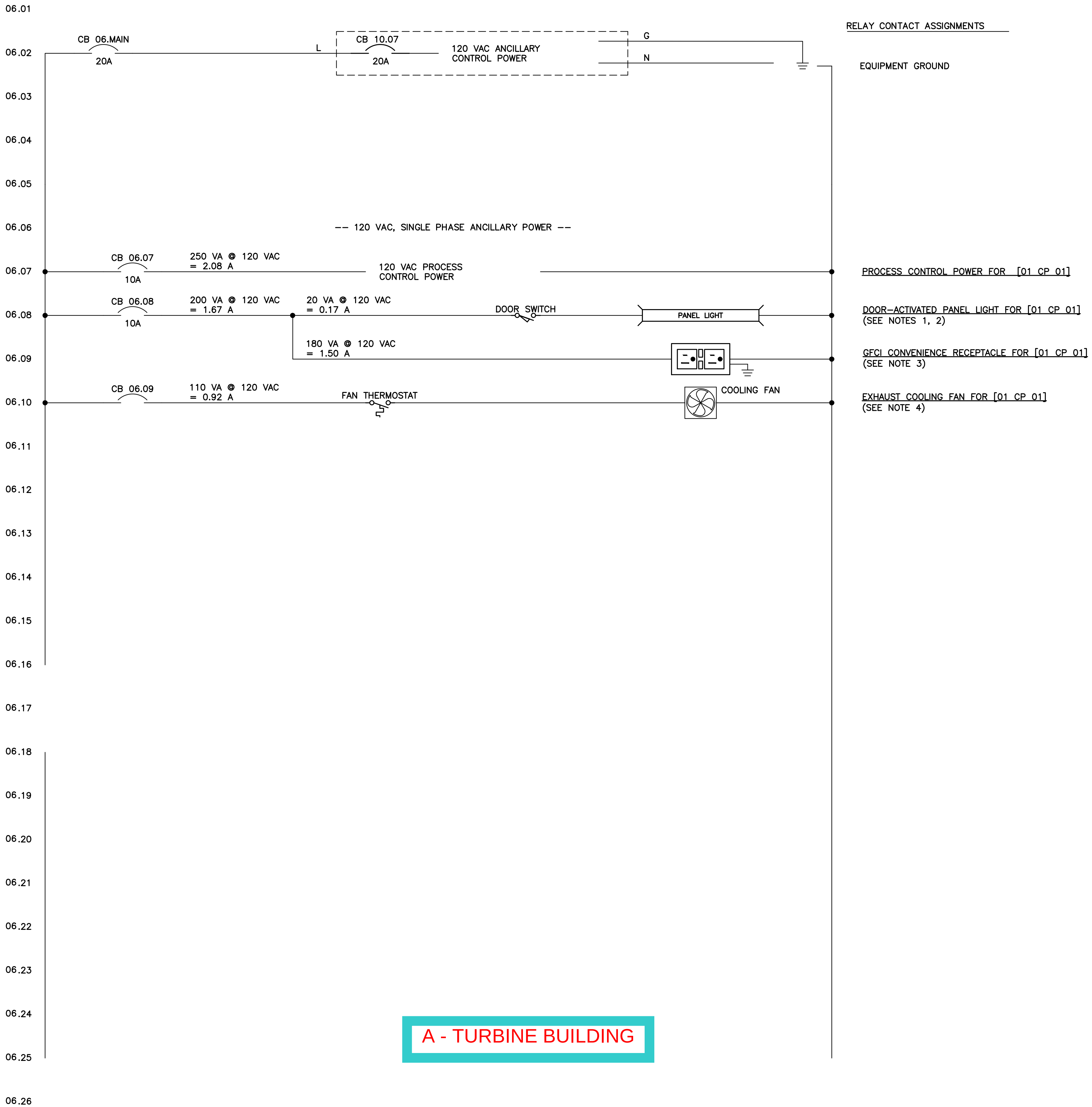
COVINGTON WATER DISTRICT
KING COUNTY — WASHINGTON
C4 TAP & TRANSMISSION MAIN
CONTROL PANEL [01 CP 01] ELEMENTARY WIRING DIAGRAM

SHEET: E-5
OF: 8
JOB NO.: 16608
DWG: E_CPEWD



A - TURBINE BUILDING

NOTES:

1. DOOR SWITCHES SHALL CLOSE WHEN THE DOOR IS OPENED.
2. PANEL LIGHTS SHALL BE 120 VAC, LED.
3. RECEPTACLE SHALL BE 15A, WHITE, GFCI, DIN-RAIL MOUNTED.
4. COOLING FANS SHALL BE EXHAUSTING TYPE, MOUNTED NEAR THE TOP OF THE PANELS. THERMOSTATS SHALL BE COOLING TYPE, ON WITH HIGH TEMP.
5. ADJUST CIRCUITS TO THE GENERATOR ACCESSORIES AS REQUIRED BY THE MANUFACTURER.

PLC CONTROL PANEL [01 CP 01]
1 – 120 VAC POWER DISTRIBUTION ELEMENTARY WIRING DIAGRAM
NOT TO SCALE

Gray & Osborne, Inc.
CONSULTING ENGINEERS

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COVINGTON WATER DISTRICT
KING COUNTY WASHINGTON
C4 TAP & TRANSMISSION MAIN
CONTROL PANEL [01 CP 01] ELEMENTARY WIRING DIAGRAM

SHEET: E-6
OF: 8
JOB NO.: 16608
DWG: E_CPEWD

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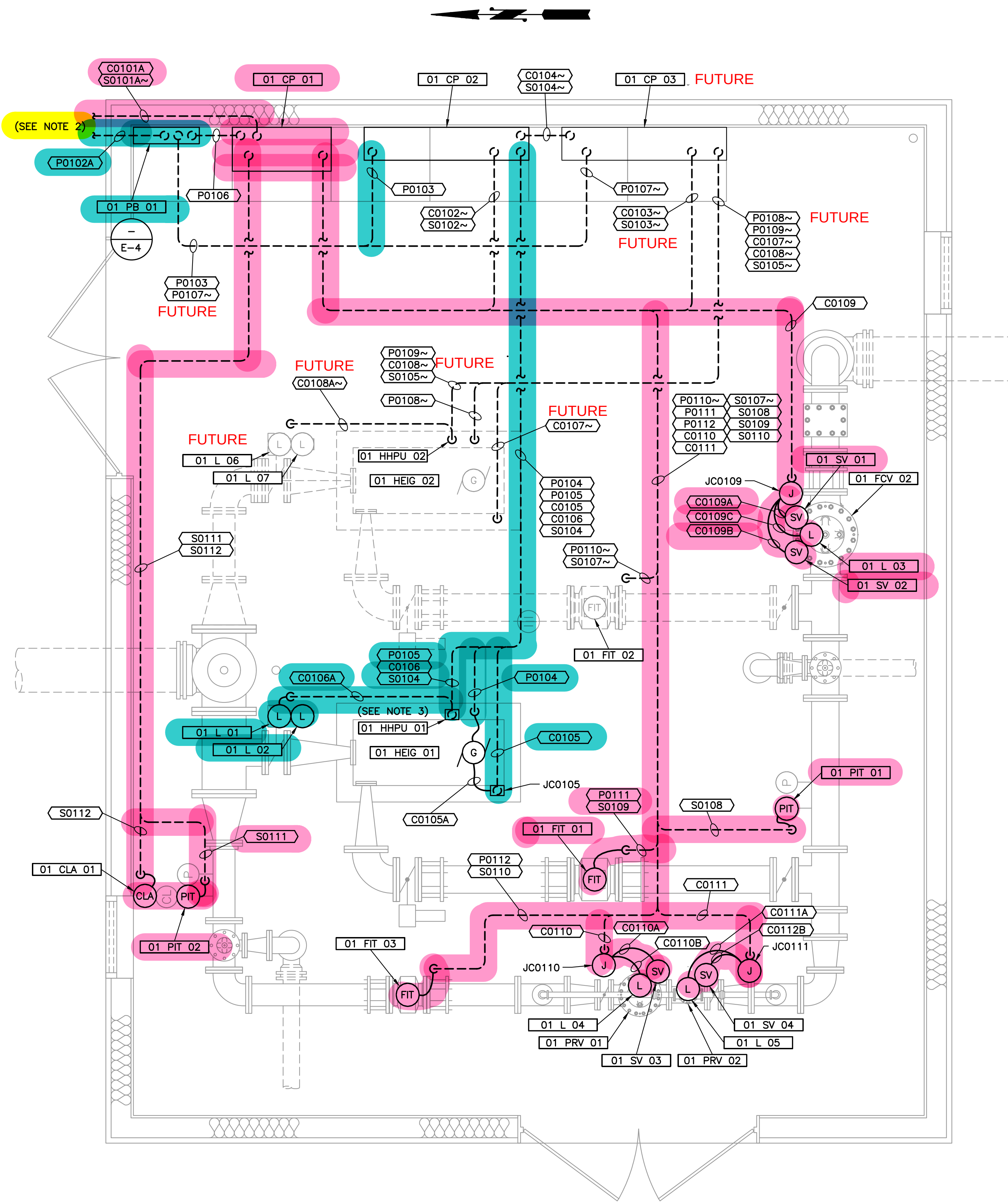

NOTES:

1. SEE NOTES ON E-1.
2. TO PULL BOX [01 PBOX 01] APPROXIMATELY 200 FEET TO THE NORTH.
3. CONNECTIONS AT [01 HHPU 01] ARE NOT SHOWN OR INCLUDED IN THE CABLE AND CONDUIT SCHEDULE. CONNECT PER MANUFACTURER'S RECOMMENDATION. PROVIDE POWER/CONTROL JUNCTION BOX AND SIGNAL JUNCTION BOX AT [01 HHPU 01].

A - TURBINE BUILDING

B - TRENCH BETWEEN TURBINE BLDG. & ADMIN. BLDG + METER & DISCONNECT

C - PIPELINE PANELS

1 / – **BUILDING POWER, CONTROL, AND INSTRUMENTAITON PLAN**
SCALE: 1/2"=1'-0"

0 1" 2"
TWO INCHES AT FULL SCALE IF NOT, SCALE ACCORDINGLY

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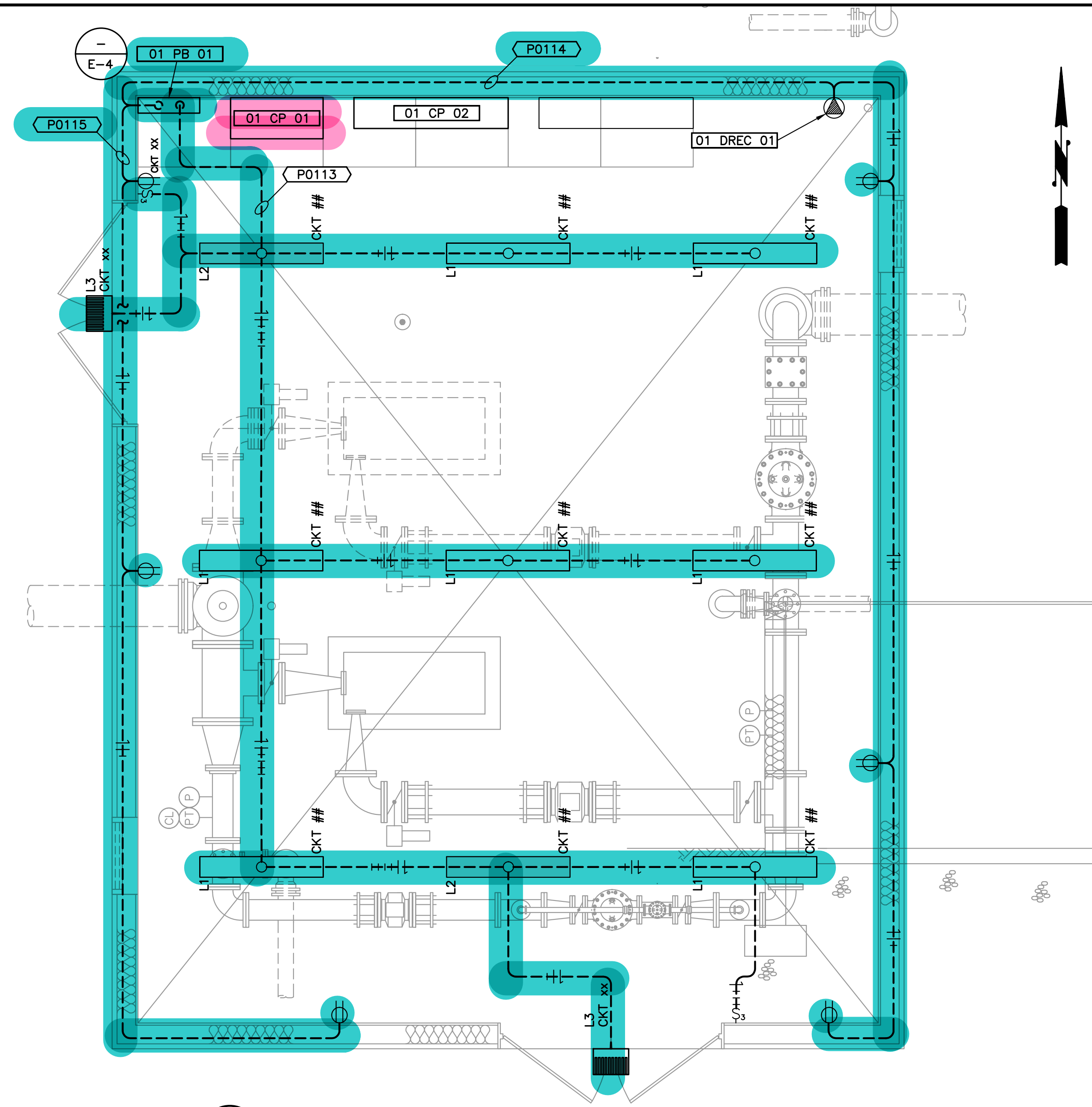
JOHN P. GALLUCCI
STATE OF WASHINGTON
40552
REGISTERED PROFESSIONAL ENGINEER

COVINGTON WATER DISTRICT
KING COUNTY WASHINGTON

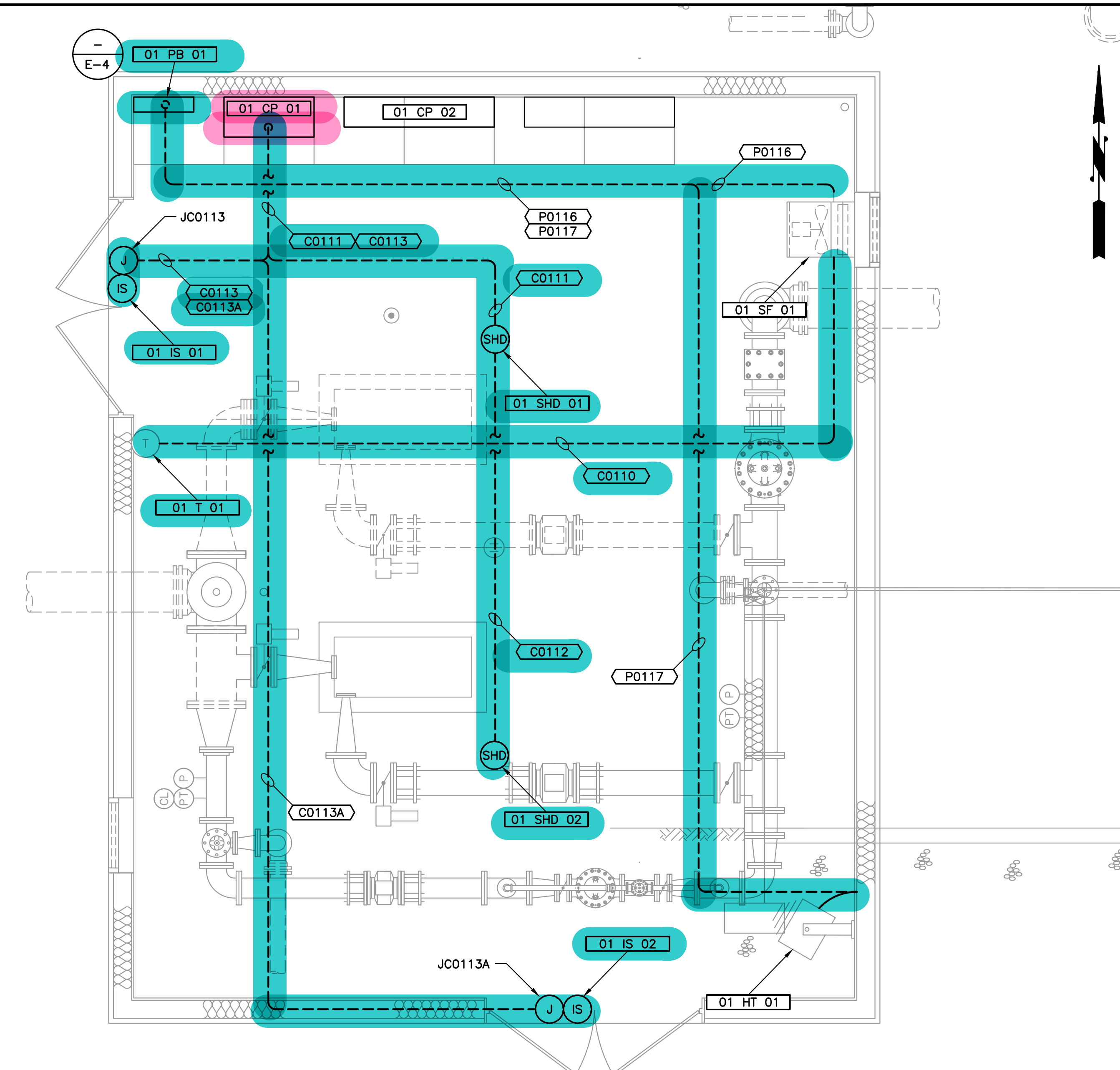
C4 TAP & TRANSMISSION MAIN

BUILDING POWER, CONTROL, AND INSTRUMENTATION PLAN

SHEET: E-7
OF: 8
JOB NO.: 16608
DWG: E_BLDG



1 BUILDING LIGHTING AND RECEPTACLE PLAN
SCALE: 3/8"=1'-0"



2 BUILDING HVAC AND FIRE PLAN
SCALE: 3/8"=1'-0"

A - TURBINE BUILDING

C - PIPELINE PANELS

NOTES:

1. SEE NOTES ON E-1.
2. SEE LIGHTING SCHEDULE ON E-2.
3. ALL EXPOSED CONDUITS SHALL BE RGS. CONDUIT IN ATTIC CAN BE SCHEDULE EMT OR 40 PVC.
4. CONDUIT NUMBERS FOR CONVENIENCE RECEPTACLE AND LIGHTING CIRCUITS ARE ONLY APPLIED TO THE CONDUIT LEAVING THE POWER SOURCE. CONDUITS BETWEEN DEVICES ARE REQUIRED AND ARE NOT SHOWN IN THE CABLE AND CONDUIT SCHEDULE.
5. RECEPTACLES SHALL BE SURFACE MOUNTED TO THE INTERIOR AND EXTERIOR WALLS.
6. ALL INTERIOR CONVENIENCE RECEPTACLES SHALL BE 20A, WHITE, GFCI, DUPLEX, IN CAST ALUMINUM BOXES WITH WEATHERPROOF COVERS. RECEPTACLES MOUNTED TO CONCRETE OR CMU WALLS SHALL BE SURFACE-MOUNTED.
7. ALL EXTERIOR RECEPTACLES SHALL BE 20A, WHITE, GFCI, DUPLEX, IN CAST ALUMINUM BOXES WITH FULL IN SERVICE COVERS, AND SURFACE-MOUNTED.
8. ALL DEDICATED RECEPTACLES SHALL BE 20A, GRAY, SIMPLEX, NON-GFCI, IN CAST ALUMINUM BOXES WITH WEATHERPROOF COVERS. THEY SHALL BE LABELED FOLLOWING SPECIFICATION 16140.
9. ALL INTERIOR RECEPTACLES SHALL BE MOUNTED 42 INCHES ABOVE THE FLOOR. EXTERIOR RECEPTACLES SHALL BE MOUNTED AT 24 INCHES ABOVE GRADE AND ALIGNED WITH SMOOTH BLOCK.
10. THE ROUTING OF CONDUITS FOR LIGHTING AND RECEPTACLES ARE SHOWN FOR CLARITY ONLY. THE CONTRACTOR MAY USE MORE DIRECT ROUTING WHERE APPROPRIATE ROUTE CONDUITS IN THE ATTIC.
11. EXPOSED CONDUITS TO CONVENIENCE RECEPTACLES AND LIGHT SWITCHES MAY BE 1/2-INCH TRADE SIZE WHERE ALLOWED BY CODE.
12. THE POWER CONDUCTORS TO EMERGENCY LIGHTS SHALL NOT BE SWITCHED.
13. THE CONTRACTOR MAY USE MORE DIRECT ROUTING WHERE APPROPRIATE FOLLOWING SPECIFICATION 16130.
14. INTRUSION SWITCH CIRCUITS SHALL BE 24 VDC, EACH WIRED SEPARATELY TO THE MAIN CONTROL PANEL.
15. INTRUSION SWITCHES SHALL BE WIRED SUCH THAT THEY ARE OPEN-CIRCUITED WHEN THE DOOR IS OPEN, CLOSED WHEN THE DOOR IS CLOSED.
16. SMOKE DETECTORS SHALL BE 24 VDC POWERED WITH FORM C (DRY) CONTACTS. WIRE THE CONTACTS TO BE OPEN WHEN IN THE ALARM CONDITION, CLOSED UNDER NORMAL CONDITIONS.
17. HEATERS AND EXHAUST FANS SHALL INCLUDE INTEGRAL SAFETY DISCONNECT SWITCHES.

0 1" 2"
TWO INCHES AT FULL SCALE
IF NOT, SCALE ACCORDINGLY

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COVINGTON WATER DISTRICT
KING COUNTY WASHINGTON
C4 TAP & TRANSMISSION MAIN
BUILDING LR

SHEET: E-8
OF: 8
JOB NO.: 16608
DWG: E_BLDG

POWER CABLE AND CONDUIT SCHEDULE

	NUMBER	SOURCE	DESTINATION	SIZE	CONDUCTORS		NOTES
	P0101	[01 MDP 01], PANELBOARD, MAIN DESTRUCTION, 208/120 VAC, 600A, 3-PHASE	[01 SDS 01], SIFTER DISCONNECT SWITCH, TURBINE BUILDING SUPPLY FAN	2-1/2"	3X 250 KCM XHHW-2; 1X #3 AWG XHHW-2 N; 1X #6 AWG XHHW-2 G		CONDUCTORS ARE OVERSIZED
	P0102	[01 SDS 01], SIFTER DISCONNECT SWITCH, TURBINE BUILDING SUPPLY FAN	[01 PBOX 01], PULL BOX	2-1/2"	3X 250 KCM XHHW-2; 1X #3 AWG XHHW-2 N; 1X #6 AWG XHHW-2 G		CONDUCTORS ARE OVERSIZED
	P102A	[01 PBOX 01], PULL BOX	[01 PB 01], PANELBOARD, 208/120 VAC, 200A	2-1/2"	3X 250 KCM XHHW-2; 1X #3 AWG XHHW-2 N; 1X #6 AWG XHHW-2 G		CONDUCTORS ARE OVERSIZED
	P0103	[01 PB 01], PANELBOARD, 208/120 VAC, 200A	[01 CP 02], CONTROL PANEL, HYDROELECTRIC EQUIPMENT PACKAGE NO. 1	1-1/4"	3X #3 AWG XHHW-2; 1X #8 AWG XHHW-2 N; 1X #8 AWG XHHW-2 G		
	P0104	[01 CP 02], CONTROL PANEL, HYDROELECTRIC EQUIPMENT PACKAGE NO. 1	[01 HEIG 01], INDUCTION GENERATOR, HYDROELECTRIC EQUIPMENT PACKAGE NO. 1	1-1/4"	3X #3 AWG XHHW-2; 1X #8 AWG XHHW-2 N; 1X #8 AWG XHHW-2 G		
	P0105	[01 CP 02], CONTROL PANEL, HYDROELECTRIC EQUIPMENT PACKAGE NO. 1	[01 HHPU 01], HYDRAULIC POWER UNIT, HYDROELECTRIC EQUIPMENT PACKAGE NO. 1	3/4"	3X #12 AWG XHHW-2; 1X #12 AWG XHHW-2 G		
	P0106	[01 PB 01], PANELBOARD, 208/120 VAC, 200A	[01 CP 01], CONTROL PANEL, TURBINE BUILDING	3/4"	2X #12 AWG XHHW-2; 2X #12 AWG XHHW-2 N; 1X #10 AWG XHHW-2 G; 1X #12 AWG XHHW-2 G		
	P0107~	[01 PB 01], PANELBOARD, 208/120 VAC, 200A	[01 CP 03], CONTROL PANEL, HYDROELECTRIC EQUIPMENT PACKAGE NO. 2	1-1/4"	PULL WIRE		SPARE CONDUIT.
FUTURE	P0108~	[01 CP 03], CONTROL PANEL, HYDROELECTRIC EQUIPMENT PACKAGE NO. 2	[01 HEIG 01], INDUCTION GENERATOR, HYDROELECTRIC EQUIPMENT PACKAGE NO. 1	1-1/4"	PULL WIRE		SPARE CONDUIT.
FUTURE	P0109~	[01 CP 03], CONTROL PANEL, HYDROELECTRIC EQUIPMENT PACKAGE NO. 2	[01 HHPU 02], HYDRAULIC POWER UNIT, HYDROELECTRIC EQUIPMENT PACKAGE NO. 2	3/4"	PULL WIRE		SPARE CONDUIT.
FUTURE	P0110~	[01 CP 01], CONTROL PANEL, TURBINE BUILDING	[01 FIT 02], FLOW INDICATING TRANSMITTER, HYDROELECTRIC EQUIPMENT PACKAGE NO. 2 INDUCTION GENERATOR	3/4"	PULL WIRE		SPARE CONDUIT.
	P0111	[01 CP 01], CONTROL PANEL, TURBINE BUILDING	[01 FIT 01], FLOW INDICATING TRANSMITTER, HYDROELECTRIC EQUIPMENT PACKAGE NO. 1 INDUCTION GENERATOR	3/4"	1X #12 AWG XHHW-2; 1X #12 AWG XHHW-2 N; 1X #12 AWG XHHW-2 G		
	P0112	[01 CP 01], CONTROL PANEL, TURBINE BUILDING	[01 FIT 03], FLOW INDICATING TRANSMITTER, HIGH FLOW, FLOW	3/4"	1X #12 AWG XHHW-2; 1X #12 AWG XHHW-2 N; 1X #12 AWG XHHW-2 G		
	P0113	[01 PB 01], PANELBOARD, 208/120 VAC, 200A	BUILDING LIGHTING	3/4"	1X #12 AWG XHHW-2; 1X #12 AWG XHHW-2 N; 1X #12 AWG XHHW-2 G		
	P0114	[01 PB 01], PANELBOARD, 208/120 VAC, 200A	[01 DREC 01], DEDICATED RECEPTACLE, DEHUMIDIFIER, TURBINE BUILDING	3/4"	2X #12 AWG XHHW-2; 2X #12 AWG XHHW-2 N; 1X #12 AWG XHHW-2 G		
	P0115	[01 PB 01], PANELBOARD, 208/120 VAC, 200A	BUILDING RECEPTACLES	3/4"	1X #12 AWG XHHW-2; 1X #12 AWG XHHW-2 N; 1X #12 AWG XHHW-2 G		
	P0116	[01 PB 01], PANELBOARD, 208/120 VAC, 200A	[01 SF 01], SUPPLY FAN, TURBINE BUILDING	3/4"	1X #12 AWG XHHW-2; 1X #12 AWG XHHW-2 N; 1X #12 AWG XHHW-2 G		
	P0117	[01 PB 01], PANELBOARD, 208/120 VAC, 200A	[01 HT 01], UNIT HEATER, TURBINE BUILDING	3/4"	3X #12 AWG XHHW-2; 1X #12 AWG XHHW-2 G		

CONTROL CABLE AND CONDUIT SCHEDULE

	NUMBER	SOURCE	DESTINATION	SIZE	CONDUCTORS		NOTES
	C0101	[01 DSP 01], DISTRICT SCADA PANEL	[01 PB 01], PANELBOARD, 208/120 VAC, 200A	2"	2X 8-C, 4-TP, #23 AWG, CAT6		1X VCAT6 IS SPARE
	C0101A	[01 PB 01], PANELBOARD, 208/120 VAC, 200A	[01 CP 01], CONTROL PANEL, TURBINE BUILDING	2"	2X 8-C, 4-TP, #23 AWG, CAT6		
	C0102~	[01 CP 01], CONTROL PANEL, TURBINE BUILDING	[01 CP 02], CONTROL PANEL, HYDROELECTRIC EQUIPMENT PACKAGE NO. 1	3/4"	PULL WIRE		SPARE CONDUIT.
FUTURE	C0103~	[01 CP 01], CONTROL PANEL, TURBINE BUILDING	[01 CP 03], CONTROL PANEL, HYDROELECTRIC EQUIPMENT PACKAGE NO. 2	3/4"	PULL WIRE		SPARE CONDUIT.
	C0104~	[01 CP 02], CONTROL PANEL, HYDROELECTRIC EQUIPMENT PACKAGE NO. 1	[01 CP 03], CONTROL PANEL, HYDROELECTRIC EQUIPMENT PACKAGE NO. 2	3/4"	PULL WIRE		SPARE CONDUIT.
	C0105	[01 CP 02], CONTROL PANEL, HYDROELECTRIC EQUIPMENT PACKAGE NO. 1	JUNCTION BOX, JC0105	3/4"	6X #14 AWG XHHW-2; 1X #12 AWG XHHW-2 G		2X #14 ARE SPARE
	C0105A	JUNCTION BOX, JC0105	[01 HEIG 01], INDUCTION GENERATOR, HYDROELECTRIC EQUIPMENT PACKAGE NO. 1	3/4"	4X #14 AWG XHHW-2		
	C0106	[01 CP 02], CONTROL PANEL, HYDROELECTRIC EQUIPMENT PACKAGE NO. 1	[01 HHPU 01], HYDRAULIC POWER UNIT, HYDROELECTRIC EQUIPMENT PACKAGE NO. 1	3/4"	6X #14 AWG XHHW-2; 1X #12 AWG XHHW-2 G		2X #14 ARE SPARE
	C0106A	[01 HHPU 01], HYDRAULIC POWER UNIT, HYDROELECTRIC EQUIPMENT PACKAGE NO. 1	[01 L 01], LIMIT SWITCH, HYDROELECTRIC EQUIPMENT PACKAGE NO. 1	3/4"	4X #14 AWG XHHW-2		INCLUDES [01 L 02]
FUTURE	C0107~	[01 CP 03], CONTROL PANEL, HYDROELECTRIC EQUIPMENT PACKAGE NO. 2	[01 HEIG 02], INDUCTION GENERATOR, HYDROELECTRIC EQUIPMENT PACKAGE NO. 2	3/4"	PULL WIRE		SPARE CONDUIT.
FUTURE	C0108~	[01 CP 03], CONTROL PANEL, HYDROELECTRIC EQUIPMENT PACKAGE NO. 2	[01 HHPU 02], HYDRAULIC POWER UNIT, HYDROELECTRIC EQUIPMENT PACKAGE NO. 2	3/4"	PULL WIRE		SPARE CONDUIT.

CONTROL CABLE AND CONDUIT SCHEDULE

NUMBER	SOURCE	DESTINATION	SIZE	CONDUCTORS		NOTES
C0108A~	[01 HHPU 02], HYDRAULIC POWER UNIT, HYDROELECTRIC EQUIPMENT PACKAGE NO. 2	[01 L 03], LIMIT SWITCH, CLOSED, INLET FLOW CONTROL VALVE	3/4"	PULL WIRE		SPARE CONDUIT. FUTURE
C0109	[01 CP 01], CONTROL PANEL, TURBINE BUILDING	JUNCTION BOX JC0109	3/4"	6X #14 AWG XHHW-2; 1X #12 AWG XHHW-2 G		
C0109A	JUNCTION BOX JC0109	[01 SV 01], SOLENOID VALVE, OPEN, INLET FLOW CONTROL VALVE	3/4"	2X #14 AWG XHHW-2		
C0109B	JUNCTION BOX JC0109	[01 SV 02], SOLENOID VALVE, CLOSED, INLET FLOW CONTROL VALVE	3/4"	2X #14 AWG XHHW-2		
C0109C	JUNCTION BOX JC0109	[01 L 03], LIMIT SWITCH, CLOSED, INLET FLOW CONTROL VALVE	3/4"	2X #14 AWG XHHW-2		
C0110	[01 SF 01], SUPPLY FAN, TURBINE BUILDING	[01 T 01], THERMOSTAT, TURBINE BUILDING SUPPLY FAN	3/4"	1X 9-C, #16 AWG		
C0111	[01 CP 01], CONTROL PANEL, TURBINE BUILDING	[01 SHD 01], SMOKE HEAT DETECTOR	3/4"	6X #14 AWG XHHW-2; 1X #12 AWG XHHW-2 G		
C0112	[01 SHD 01], SMOKE HEAT DETECTOR	[01 SHD 02], SMOKE HEAT DETECTOR	3/4"	4X #14 AWG XHHW-2; 1X #12 AWG XHHW-2 G		
C0113	[01 CP 01], CONTROL PANEL, TURBINE BUILDING	JUNCTION BOX JC0113, [01 IS 01], INTRUSION SWITCH, WEST DOOR	3/4"	4X #14 AWG XHHW-2; 1X #12 AWG XHHW-2 G		
C0113A	[01 IS 01], INTRUSION SWITCH, WEST DOOR	JUNCTION BOX JC0113A, [01 IS 02], INTRUSION SWITCH, SOUTH DOOR	3/4"	2X #14 AWG XHHW-2; 1X #12 AWG XHHW-2 G		

INSTRUMENTATION CABLE AND CONDUIT SCHEDULE

NUMBER	SOURCE	DESTINATION	SIZE	CONDUCTORS		NOTES
S0101~	[01 DSP 01], DISTRICT SCADA PANEL	[01 PB 01], PANELBOARD, 208/120 VAC, 200A	1"	PULL WIRE	* 3	SPARE CONDUIT.
S0101A~	[01 PB 01], PANELBOARD, 208/120 VAC, 200A	[01 CP 01], CONTROL PANEL, TURBINE BUILDING	1"	PULL WIRE	* 3	SPARE CONDUIT.
S0102~	[01 CP 01], CONTROL PANEL, TURBINE BUILDING	[01 CP 02], CONTROL PANEL, HYDROELECTRIC EQUIPMENT PACKAGE NO. 1	1"	PULL WIRE	* 3	SPARE CONDUIT.
S0103~	[01 CP 01], CONTROL PANEL, TURBINE BUILDING	[01 CP 03], CONTROL PANEL, HYDROELECTRIC EQUIPMENT PACKAGE NO. 2	1"	PULL WIRE	* 3	SPARE CONDUIT. FUTURE
S0104~	[01 CP 02], CONTROL PANEL, HYDROELECTRIC EQUIPMENT PACKAGE NO. 1	[01 CP 03], CONTROL PANEL, HYDROELECTRIC EQUIPMENT PACKAGE NO. 2	1"	PULL WIRE	* 3	SPARE CONDUIT. FUTURE
S0105	[01 CP 02], CONTROL PANEL, HYDROELECTRIC EQUIPMENT PACKAGE NO. 1	[01 HHPU 01], HYDRAULIC POWER UNIT, HYDROELECTRIC EQUIPMENT PACKAGE NO. 1	1"	4X 2-C, 1-TP, #18 AWG, OS	* 3	
S0106~	[01 CP 03], CONTROL PANEL, HYDROELECTRIC EQUIPMENT PACKAGE NO. 2	[01 HHPU 02], HYDRAULIC POWER UNIT, HYDROELECTRIC EQUIPMENT PACKAGE NO. 2	1"	PULL WIRE	* 3	SPARE CONDUIT. FUTURE
S0107~	[01 CP 01], CONTROL PANEL, TURBINE BUILDING	[01 FIT 02], FLOW INDICATING TRANSMITTER, HYDROELECTRIC EQUIPMENT PACKAGE NO. 2 INDUCTION GENERATOR	3/4"	PULL WIRE	* 3	SPARE CONDUIT. FUTURE
S0108	[01 CP 01], CONTROL PANEL, TURBINE BUILDING	[01 PIT 02], PRESSURE INDICATION TRANSMITTER, OUTLET	3/4"	1X 2-C, 1-TP, #18 AWG, OS	* 3	
S0109	[01 CP 01], CONTROL PANEL, TURBINE BUILDING	[01 FIT 01], FLOW INDICATING TRANSMITTER, HYDROELECTRIC EQUIPMENT PACKAGE NO. 1 INDUCTION GENERATOR	3/4"	2X 2-C, 1-TP, #18 AWG, OS	* 3	
S0110	[01 CP 01], CONTROL PANEL, TURBINE BUILDING	[01 FIT 03], FLOW INDICATING TRANSMITTER, HIGH FLOW, FLOW	3/4"	2X 2-C, 1-TP, #18 AWG, OS	* 3	
S0111	[01 CP 01], CONTROL PANEL, TURBINE BUILDING	[01 PIT 02], PRESSURE INDICATION TRANSMITTER, OUTLET	3/4"	1X 2-C, 1-TP, #18 AWG, OS	* 3	
S0112	[01 CP 01], CONTROL PANEL, TURBINE BUILDING	[01 CLA 01], CHLORINE ANALYZER, OUTLET	1"	3X 2-C, 1-TP, #18 AWG, OS	* 3	

0 1" 2"
TWO INCHES AT FULL SCALE
IF NOT, SCALE ACCORDINGLY

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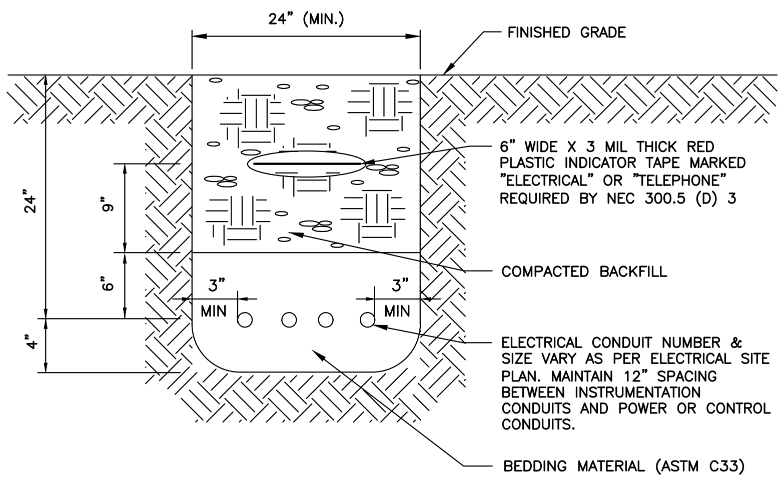
JOHN P. GALLUCCI
STATE OF WASHINGTON
40552
REGISTERED PROFESSIONAL ENGINEER

COVINGTON WATER DISTRICT
KING COUNTY WASHINGTON
C4 TAP & TRANSMISSION MAIN
CABLE AND CONDUIT SCHEDULE

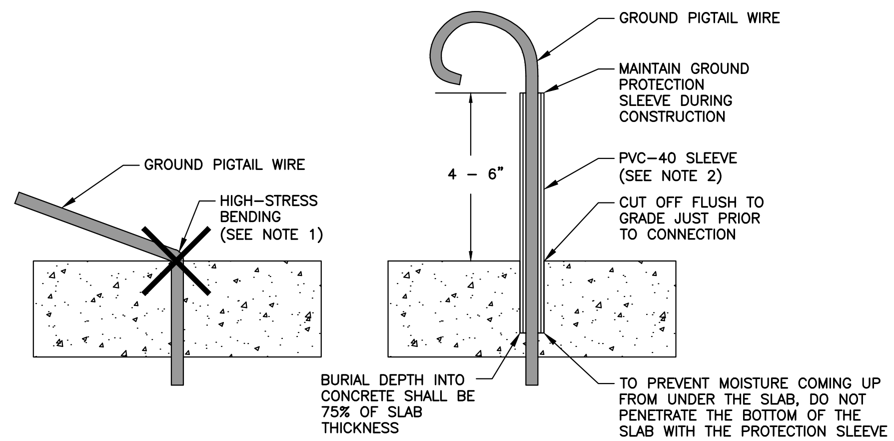
SHEET: EC-1
OF: 1
JOB NO.: 16608
DWG:E_CCS



NOTE:

1. SPACING BETWEEN CONDUITS AND OTHER UTILITIES SHALL BE IN COMPLIANCE WITH THE UTILITIES OR 24 INCHES MINIMUM, WHICHEVER IS THE GREATER.

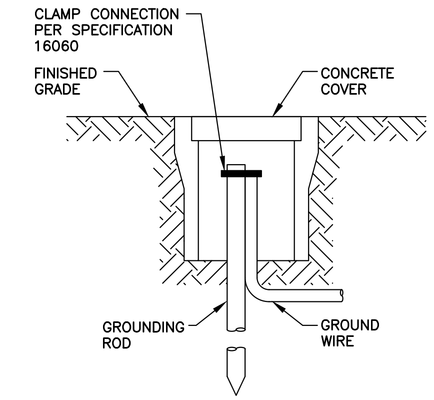
1 TYP ELECTRICAL TRENCHING DETAIL
NOT TO SCALE



NOTES:

1. BARE COPPER GROUND WIRES SHALL NOT PENETRATE DIRECTLY OUT OF CONCRETE FLOORS. CONSTRUCTION ACTIVITIES CAN CAUSE TIGHT WIRE BENDING AND POSSIBLE GROUND WIRE DEGRADATION. DETAIL "A" IS NOT ACCEPTABLE.
2. PROTECT THE GROUND PIGTAIL DURING CONSTRUCTION WITH A PVC-40 SLEEVE INSTALLED AS DESCRIBED IN DETAIL "B".
3. JUST PRIOR TO SETTING EQUIPMENT OVER, OR MAKING THE FINAL CONNECTION OF THE GROUND WIRE, CUT OFF THE SLEEVE FLUSH TO THE FLOOR TAKING CARE NOT TO CUT INTO THE GROUND WIRE.

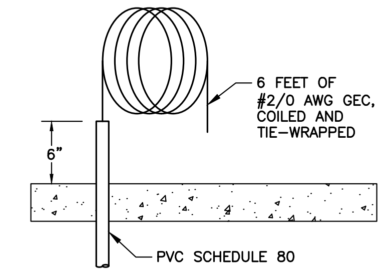
2 TYP GROUND PIGTAIL CONTRUCTION PROTECTION SLEEVE DETAIL
NOT TO SCALE



NOTES:

1. GROUND ROD BOX SHALL BE FOGTITE GROUND ROD BOX WITH ROAD RATING EQUAL TO THE DEVICE OR STRUCTURE IT SUPPORTS (H20 MINIMUM).

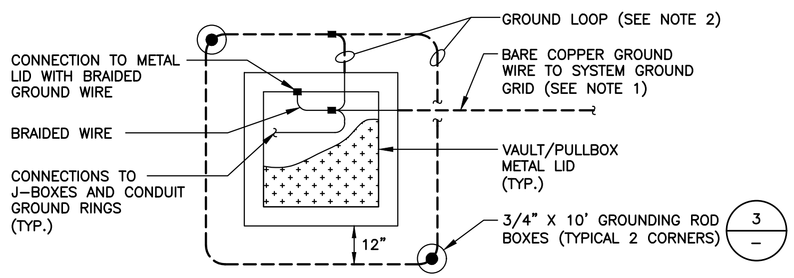
3 TYP GROUND ROD BOX DETAIL
NOT TO SCALE



NOTES:

1. BARE COPPER GROUND WIRES TO FUTURE EQUIPMENT [01 SDS 01A] AND [01 MCC 01A] SHALL BE CONNECTED FROM THE GROUND GRID TO 6-FOOT COILS THROUGH 6-INCH CONDUIT STUB-UPS ALIGNED WITH FUTURE EQUIPMENT.
2. TIE-WRAP THE COILS AND NEATLY SET THEM NEAR THE WALL.

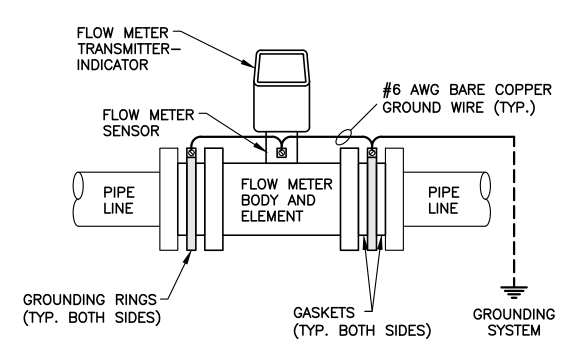
4 TYP GEC INSTALLATIONS FOR FUTURE EQUIPMENT
NOT TO SCALE



NOTES:

1. PROVIDE AND SIZE GROUND CONDUCTOR FROM SYSTEM GROUND DISTRIBUTION PER – E-12 .
2. PROVIDE BARE COPPER GROUND LOOP AROUND THE VAULT/PULLBOX 12-INCHES OUT AND 12-INCHES DEEP.
3. GROUND ALL METAL COMPONENTS AS PER "VAULT AND PULLBOX GROUNDING" IN SPECIFICATION 16060.
4. ALL GROUND CONDUCTORS SHALL BE STRANDED WITH THE EXCEPTION OF THE FLEXIBLE BRAIDED GROUND CONDUCTOR TO THE METAL HATCH LIDS.

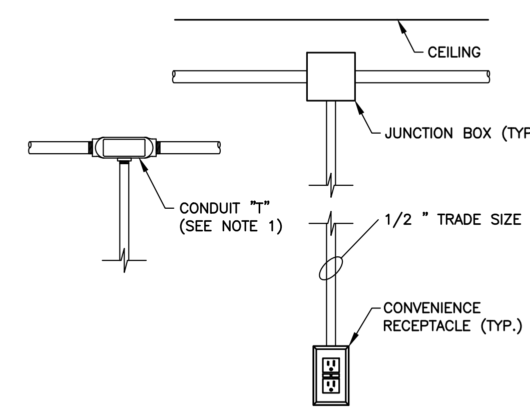
5 TYP METAL LID GROUNDING DETAIL
NOT TO SCALE



NOTES:

1. CONTRACTOR SHALL PROVIDE AND INSTALL INSULATING GASKETS AND MANUFACTURER'S GROUND RINGS TO EACH SIDE OF THE FLOW METER BODY. THE GROUND RINGS AND FLOW METER SENSOR SHALL BE TIED TO THE SYSTEM GROUND WITH A #6 AWG GROUNDING WIRE. CONNECT AS SHOWN OR PER MANUFACTURER'S REQUIREMENTS.

6 TYP FLOW METER GROUNDING DETAIL
NOT TO SCALE



NOTES:

1. WHERE SPLICING FOR CONVENIENCE RECEPTACLE IS PERFORMED IN A CONDUIT BODY THE CONDUIT BODY SHALL BE SIZED PER THE NEC AND HAVE ITS VOLUME MARKED BY THE MANUFACTURER COMPLIANT TO NEC 314.16(C).

7 TYP JUNCTION BOX AND RECEPTACLE DETAIL
NOT TO SCALE

0 1" 2"
TWO INCHES AT FULL SCALE IF NOT, SCALE ACCORDINGLY

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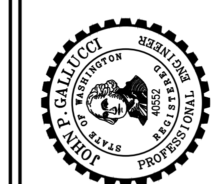

COVINGTON WATER DISTRICT
KING COUNTY WASHINGTON

C4 TAP & TRANSMISSION MAIN

DETAILS

SHEET: ED-1
OF: 2
JOB NO.: 16608
DWG: E_DET

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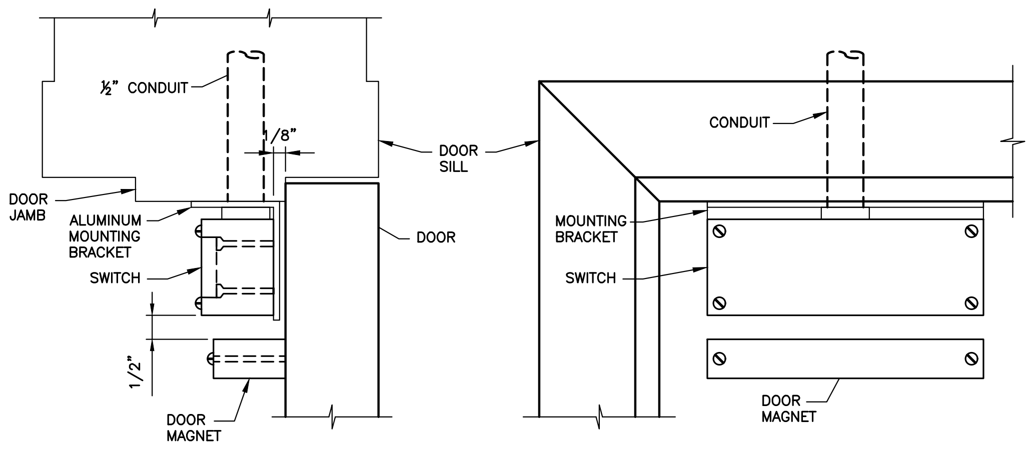
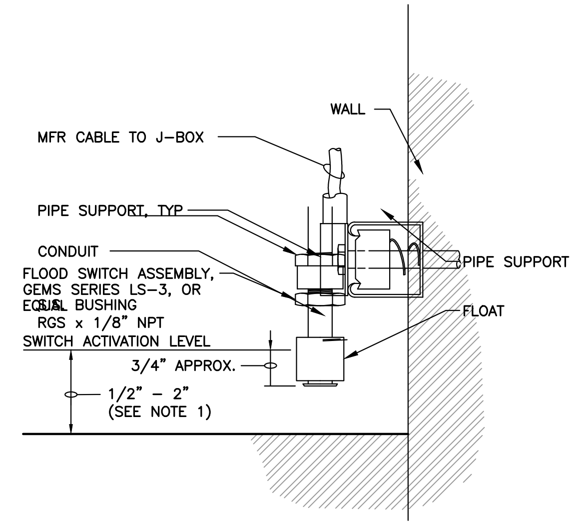


NOTES:

1. DOOR INTRUSION SWITCH SHALL BE MAGNETIC TYPE, TRIPLE BIASED, TAMPER PROOF, SENTROL 2800T SERIES OR EQUAL.
2. CONTRACTOR SHALL FABRICATE ALUMINUM MOUNTING BRACKET FOR SWITCH.

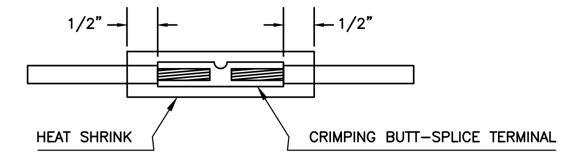
2 TYP — MAN DOOR INTRUSION SWITCH DETAIL

NOT TO SCALE



NOTES:

1. SET THE FLOOD TRIP LEVEL WITH THE OWNER.
2. FLOOD SWITCH MANUFACTURE'S CABLE SHALL BE SPLICED TO CONDUCTOR WIRES IN AN ADJACENT CONTROL J-BOX. (2 / –)

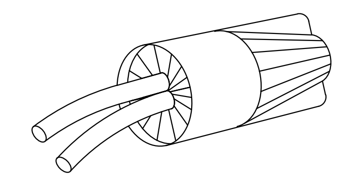


NOTES:

1. TRIMMED PORTION OF WIRES SHALL PENETRATE TO THE FULL DEPTH SPLICE TERMINAL AND BE CRIMPED PER MANUFACTURER'S RECOMMENDATIONS.
2. HEAT SHRINK OVERLAY SHALL BE 1/2" MINIMUM, THEN WRAPPED WITH ELECTRICAL TAPE TO PROVIDE INSULATION LEVEL TO CODE.

3 TYP — BUTT-SPLICE TERMINATING DETAIL

NOT TO SCALE



NOTES:

1. PROVIDE WATER-TIGHT CONNECTOR FOR CONTROL AND INSTRUMENTATION CONDUCTOR SPLICING. INCLUDE A STRAIN RELIEF ON CONTROL CONDUCTOR SPLICE CONNECTORS. REFERENCE SPECIFICATION 16120 FOR SPECIFIC REQUIREMENTS.
2. SUBMERGE THE SPLICE AND TEST FOR WATER-TIGHT INTEGRITY.

4 TYP — CONTROL AND INSTRUMENTATION CONDUCTOR WATER-TIGHT SPLICE DETAIL

NOT TO SCALE

0 1" 2"
TWO INCHES AT FULL SCALE. IF NOT, SCALE ACCORDINGLY

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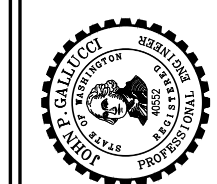


COVINGTON WATER DISTRICT
KING COUNTY WASHINGTON
C4 TAP & TRANSMISSION MAIN
E_DET

SHEET: ED-2
OF: 2
JOB NO.: 16608
DWG: E_DET

GENERAL STRUCTURAL NOTES

GENERAL

THE GENERAL CONTRACTOR SHALL VERIFY ALL DIMENSIONS AND SITE CONDITIONS BEFORE STARTING WORK. THE ENGINEER SHALL BE NOTIFIED OF ANY DISCREPANCY. USE DETAIL MARKED "TYPICAL" WHEREVER APPLICABLE. CHANGES, OMISSIONS OR SUBSTITUTIONS ARE NOT PERMITTED WITHOUT WRITTEN APPROVAL OF THE ENGINEER. REFER TO THE SPECIFICATIONS FOR FURTHER REQUIREMENTS. DO NOT SCALE THE DRAWINGS.

ALL MATERIALS AND WORKMANSHIP SHALL CONFORM TO THE 2015 EDITION OF THE INTERNATIONAL BUILDING CODE.

THE DESIGN, ADEQUACY AND SAFETY OF ERECTION BRACING, SHORING, TEMPORARY SUPPORTS, ETC., IS THE SOLE RESPONSIBILITY OF THE CONTRACTOR, AND HAS NOT BEEN CONSIDERED BY THE ENGINEER OF RECORD. THE CONTRACTOR IS RESPONSIBLE FOR THE STABILITY OF THE STRUCTURE PRIOR TO THE COMPLETION OF ALL SHEAR WALLS, ROOF AND FLOOR DIAPHRAGMS AND FINISH MATERIALS. THE CONTRACTOR SHALL PROVIDE THE NECESSARY BRACING TO PROVIDE STABILITY PRIOR TO THE APPLICATION OF THE ABOVE MENTIONED COMPONENTS.

THE GENERAL NOTES APPLY TO ALL STRUCTURES UNLESS NOTED OTHERWISE (U.N.O.). LOCATION AND SIZE OF ANCHOR BOLTS FOR SPECIFIC EQUIPMENT SHALL BE SPECIFIED BY THE VENDOR. CONTRACTOR SHALL COORDINATE LOCATIONS OF STRUCTURAL OPENINGS, PENETRATIONS AND EMBEDDED ITEMS WITH THE MECHANICAL, ARCHITECTURAL, ELECTRICAL, PLUMBING AND VENTILATION SECTIONS OF THE DRAWINGS AND WITH SUPPLIERS AND SUBCONTRACTORS AS MAY BE REQUIRED.

SPECIAL INSPECTION & TESTING

SPECIAL INSPECTIONS SHALL MEET THE REQUIREMENTS OF IBC CHAPTER 17.
OBSERVE THE WORK ASSIGNED FOR CONFORMANCE WITH APPROVED DRAWINGS AND SPECIFICATIONS.

FURNISH INSPECTION REPORTS TO THE BUILDING OFFICIAL AND ENGINEER. DISCREPANCIES SHALL BE BROUGHT TO THE IMMEDIATE ATTENTION OF THE CONTRACTOR FOR CORRECTION; THEN, IF NOT CORRECTED, TO THE BUILDING OFFICIAL AND ENGINEER. SUBMIT A FINAL REPORT STATING THE WORK WAS IN CONFORMANCE WITH THE APPROVED DRAWINGS AND SPECIFICATIONS AND THE APPLICABLE WORKMANSHIP PROVISIONS OF IBC.

SPECIAL INSPECTION REQUIRED:
CONCRETE: IN ACCORDANCE WITH SECTION 1705.3 AND TABLE 1705.3
WOOD: IN ACCORDANCE WITH SECTION 1705.5
SOIL: IN ACCORDANCE WITH SECTION 1705.6 AND TABLE 1705.6

SHOP DRAWINGS

SHOP DRAWINGS, WHERE REQUIRED, SHALL BE CHECKED AND APPROVED BY THE GENERAL CONTRACTOR PRIOR TO SUBMITTING FOR ENGINEER REVIEW. SHOP DRAWINGS SHALL BE SUBMITTED TO THE ENGINEER FOR REVIEW OF DESIGN INTENT, PRIOR TO FABRICATION. GENERAL CONTRACTOR IS RESPONSIBLE FOR VERIFICATION AND COORDINATION OF DIMENSIONS AND DETAILS FOR EACH SUBCONTRACTOR.

DESIGN LOADS

ROOF SNOW LOAD:
DESIGN SNOW LOAD,Ps....................16 PSF
GROUND SNOW LOAD,Pg....................20 PSF
SNOW EXPOSURE FACTOR, Ce....................1.0
SNOW LOAD IMPORTANCE FACTOR, Is....................1.2
THERMAL FACTOR, Ct....................1.1

WIND DESIGN DATA:
ULTIMATE WIND SPEED (3-SECOND GUST), Vult....................115 MPH
NOMINAL WIND SPEED, Vasd....................89.1MPH
RISK CATEGORY....................IV
WIND EXPOSURE....................C

EARTHQUAKE DESIGN DATA
MAPPED SPECTRAL RESPONSE ACCELERATIONS
Ss....................1.228g
S1....................0.464g
SITE CLASS....................D
SPECTRAL RESPONSE COEFFICIENTS
Sds....................0.826
Sdl....................0.475
SEISMIC IMPORTANCE FACTOR, Ie.................... 1.5
RISK CATEGORY....................IV
SEISMIC DESIGN CATEGORY....................D
BASIC SEISMIC-FORCE-RESISTING SYSTEM(S)........LIGHT FRAME WOOD WALLS W/ STRUCTURAL WOOD SHEAR PANELS
DESIGN BASE SHEAR....................0.191W
SEISMIC RESPONSE COEFFICIENT(S), Cs....................0.191
RESPONSE MODIFICATION FACTOR(S), R....................6.5
ANALYSIS PROCEDURE USED....................EQUIVALENT LATERAL FORCE ANALYSIS

ALLOWABLE BEARING PRESSURE:....................2000 PSF

EXTEND ALL EXTERIOR FOOTINGS 2'-0" MINIMUM BELOW FINISHED GRADE. UNO (UNLESS NOTED OTHERWISE), BOTTOM OF ALL FOOTINGS TO BEAR ON NATIVE, INORGANIC, UNDISTURBED SOIL. NO FOOTING SHALL BEAR HIGHER THAN 1 VERTICAL TO 1.5 HORIZONTAL SLOPE ABOVE ANY EXCAVATION, EXISTING OR PLANNED. CONTRACTOR SHALL PROVIDE TEMPORARY SHORING TO PREVENT MOVEMENT OF WALLS IF BACKFILL IS PLACED BEFORE FLOOR SYSTEM IS IN PLACE. THERE SHALL BE 95% COMPACTION (ASTM D1557 MODIFIED PROCTOR DENSITY) OF ALL BACKFILL SOIL UNDER SLABS ON GRADE.

CAST-IN-PLACE CONCRETE

CONCRETE SHALL HAVE THE FOLLOWING PROPERTIES:
28-DAY STRENGTH f'c=3,500 PSI
AIR ENTRAINMENT: 5%-7%
MAXIMUM SLUMP: 3" FOR SLABS FOOTINGS, 4" FOR WALLS, COLUMNS AND BEAMS. CONSTRUCTION TO BE IN ACCORDANCE WITH ACI 318.

SUBMIT MIX DESIGN FOR REVIEW AND PROVIDE NOT LESS THAN 6 SACKS OF CEMENT PER CUBIC YARD FOR ALL CONCRETE WITH MAXIMUM W/C=0.45.

REINFORCING STEEL

WELDED WIRE FABRIC (W.W.F.): ASTM A82 AND A185
DEFORMED BARS: ASTM A615, GRADE 60 (GRADE 40 FOR #3).
UNLESS OTHERWISE NOTED ON THESE DRAWINGS, MINIMUM CONCRETE COVER FOR REINFORCING BARS SHALL BE AS FOLLOWS:
- CONCRETE CAST AGAINST SOIL=3".
- FORMED CONCRETE AGAINST SOIL=2".
- WALLS, COLUMNS AND BEAMS EXPOSED TO WATER, SEWAGE & WEATHER=2".
- WALLS, COLUMNS AND BEAMS DRY CONDITION=1 1/2".

PROVIDE 2-#5 MIN. U.N.O. TRIM BARS AROUND ALL OPENINGS IN CONCRETE WALLS OR SLAB EXTENDING 2'-6" PAST CORNERS, TYP. AT TIME OF CONCRETE PLACEMENT, REINFORCING SHALL BE FREE OF MUD, OIL, OR OTHER NONMETALLIC COATINGS THAT MAY DECREASE BOND.

WELDING OF REINFORCING BARS SHALL CONFORM TO ANSI/AWS D1.4.
WHERE PERMITTED, LOW HYDROGEN WELDING RODS SHALL BE USED FOR ALL WELDING OF REINFORCING BARS. SPECIAL INSPECTION IS REQUIRED FOR ALL FIELD WELDING.

SUBMIT SHOP DRAWINGS OF REINFORCING STEEL FOR REVIEW BY THE ENGINEER PRIOR TO FABRICATION. REINFORCING SHALL BE DETAILED IN ACCORDANCE WITH ACI 315 AND 318 (LATEST EDITION).

STRUCTURAL STEEL AND MISCELLANEOUS METALS

"W" SHAPES: ASTM A992, Fy=50 KSI.
"HP" SHAPES: ASTM A572, Fy=50, KSI.
PLATES AND BARS: ASTM A36, Fy=36 KSI.
PIPE: ASTM A53 OR A501, Fy=35 KSI MINIMUM.
TUBING: ASTM A500, GRADE B, Fy=46 KSI.

ALL BOLTS FOR CONNECTIONS IN SUBMERGED CONDITION SHALL BE: ASTM F593C OR F593D STAINLESS STEEL (SS) BOLTS. ALL OTHERS SHALL BE GALVANIZED ASTM A325-N BOLTS HIGH STRENGTH BOLTS (H.S.B.), U.N.O. AS ASTM A307 MACHINE BOLTS (M.B.). WHERE HIGH STRENGTH BOLTS ARE USED, THEY SHALL BE INSTALLED WITH LOAD INDICATOR DEVICES (LOAD INDICATOR WASHERS OR SNAP-OFF HEADS).
ADHESIVE ANCHORS: HILTI HIT-150 OR APPROVED EQUAL, U.N.O. INSTALL PER MANUFACTURER'S RECOMMENDATIONS.

HEADED ANCHOR STUDS (H.A.S.): ASTM A108, Fy=50 KSI, END WELDED PER MANUFACTURER'S RECOMMENDATIONS.
ALL ANCHOR BOLTS AND THREADED RODS: ASTM F1554, U.N.O. ALL ANCHOR BOLTS MUST BE ACCURATELY PLACED IN THEIR FINAL LOCATION PRIOR TO POURING CONCRETE, "WET STICKING" OF ANCHOR BOLTS IS NOT ALLOWED.

WELDING ELECTRODES OR WIRES: AWS A5.1 OR A5.5, E70XX; AWS A5.17, E70S-X; AWS A5.20, E7XT-X.
FOR ALL SHOP WELDS AND FIELD WELDS OF ALL LATERAL RESISTING ELEMENTS, ELECTRODES SHALL BE E70 WITH A MINIMUM SPECIFIED CVN OF 20 FT-LBS AT -20 DEGREES FAHRENHEIT. ALL WELDS SHALL BE 3/16" MINIMUM U.N.O.

ERECTION AND FABRICATION IN ACCORDANCE WITH AISC "SPECIFICATION FOR STRUCTURAL STEEL BUILDINGS." WELDING SHALL CONFORM TO AWS "STRUCTURAL WELDING CODE – STEEL". ALL WELDING SHALL BE PERFORMED BY AWS/WABO CERTIFIED WELDERS.

ALL COLUMNS AND BEAMS TO BE FROM UNSPLICED LENGTHS U.N.O. ON THE DRAWINGS. SUBMIT SHOP DRAWINGS SHOWING SIZES, DIMENSIONS AND REQUIRED CONNECTION DETAILS FOR REVIEW BY THE ENGINEER PRIOR TO FABRICATION.

WOOD

ROOF SHEATHING SHALL BE 1/2" (NOMINAL) MIN. U.N.O. APA RATED SHEATHING 24/0, EXPOSURE 1, SIZED FOR SPACING. INSTALL PANELS WITH 1/4" SPACING AT END JOINTS AND 1/8" SPACING AT EDGE JOINTS MIN. INSTALL PLYWOOD SHEATHING WITH FACE GRAIN PERPENDICULAR TO SUPPORTS.

SAWN LUMBER: HEM-FIR #1 OR BETTER, U.N.O. WWPA GRADING RULES. ALL DIMENSIONS NOTED ARE NOMINAL. WOOD BEARING ON OR WITHIN 1" OF CONCRETE OR CMU OR WITHIN 6" OF EARTH SHALL BE TREATED WITH AN APPROVED PRESERVATIVE. ALL NAILS ARE TO BE "COMMON." ALL NAILS IN TREATED TIMBER SHALL BE GALVANIZED. ALL FRAMING CONNECTORS NOTED ARE PER SIMPSON STRONG TIE COMPANY INC. OR ENGINEER APPROVED EQUAL. SEE MANUFACTURER'S REQUIREMENTS.

TREATED LUMBER SHALL BE BRANDED WITH A QUALITY CONTROL AGENCY MARK BY AMERICAN WOOD PROTECTION ASSOCIATION.

GLUE-LAMINATED MEMBERS:
- SIMPLE SPAN BEAMS: 24F-V4.
- CONTINUOUS OR CANTILEVER BEAMS: 24F-V8.
- COMPRESSION MEMBERS: 2.
- TENSION MEMBERS: 3.

GLUE-LAMINATED MEMBERS SHALL CONFORM TO THE LATEST EDITION OF AITC 117, "DESIGN STANDARD SPECIFICATIONS FOR STRUCTURAL GLUED LAMINATED TIMBER OF SOFTWOOD SPECIES." SHOP DRAWINGS OF GLUE-LAMINATED MEMBERS TO BE SUBMITTED FOR REVIEW BY THE ENGINEER PRIOR TO FABRICATION. FRAMING ANCHORS AND CONNECTORS: SIMPSON OR APPROVED EQUAL AS INDICATED ON DRAWINGS. INSTALL PER MANUFACTURER'S RECOMMENDATIONS. FOR NAILING NOT SHOWN ON DRAWINGS, USE IBC NAILING SCHEDULE, TABLE NO. 2304.9.1. ALL WOOD BEARING ON CONCRETE OR MASONRY, IF LESS THAN 4'-0" ABOVE GRADE, SHALL BE PRESSURE TREATED DOUGLAS FIR. STRUCTURAL MEMBERS SHALL NOT BE CUT FOR PIPES, ETC., UNLESS SPECIFICALLY NOTED OR DETAILED.

PREFABRICATED WOOD TRUSSES

ROOF TRUSSES SHALL BE DESIGNED BY THE CERTIFIED MANUFACTURER FOR THE SPANS AND CONDITIONS SHOWN ON THE DRAWINGS AND THE LOADS LISTED BELOW.
MAXIMUM TRUSS SPACING: 24" O.C.

TRUSS LOADING UNLESS NOTED OTHERWISE ON DRAWINGS:
TOP CHORD LIVE LOAD=25 PSF.
TOP CHORD DEAD LOAD=5 PSF.
TOP CHORD WIND UPLIFT=17.1 PSF
BOTTOM CHORD LIVE LOAD=0 PSF.
BOTTOM CHORD DEAD LOAD=10 PSF.
ADDITIONAL LIVE LOAD: SNOW LOAD DUE TO DRIFTING SHALL BE INCLUDED AS SPECIFIED ON THE DRAWINGS.

TRUSSES TO BE FABRICATED BY A CERTIFIED MEMBER OF THE TRUSS PLATE INSTITUTE. DESIGN, FABRICATION AND ERECTION TO CONFORM TO THE TRUSS PLATE INSTITUTE STANDARDS. CONNECTOR PLATES SHALL BE ICC APPROVED WITH A MINIMUM SIZE OF 3"x5". ALL CHORD MEMBERS SHALL HAVE LUMBER GRADE STAMPS; ALL WEB MEMBERS SHALL HAVE GRADE STAMPS OR ALL WEB MEMBERS, FOR A GIVEN TRUSS, SHALL BE MADE FORM THE SAME LUMBER GRADE WITH AT LEAST 50% OF THE WEB MEMBERS BEARING A GRADE STAMP. TRUSS DESIGNS AND ERECTION PLANS SHALL BE BY A PROFESSIONAL ENGINEER REGISTERED IN THE STATE OF WASHINGTON. ERECTION PLANS SHALL SHOW TRUSS SPACING, TRUSS MARK NUMBERS (CORRESPONDING TO THE DESIGN CALCULATIONS), CONCENTRATED LOADS, PERMANENT INDIVIDUAL TRUSS MEMBER RESTRAINT PER IBC SECTION 2303.4.1.2 AS REQUIRED BY THE TRUSS DESIGN AND ERECTION BRACING. SHOP DRAWING SHALL INCLUDE, FOR EACH TYPE OF TRUSS, DIMENSIONS AND CONFIGURATIONS, NOMINAL LUMBER SIZE AND GRADE, SPECIFICATIONS FOR CONNECTOR PLATE USED, SIZE AND LOCATION OF EACH CONNECTOR AT EACH JOINT AND AMOUNT OF CAMBER IF REQUIRED. DESIGN CALCULATIONS, SHOP DRAWINGS AND ERECTION PLANS SHALL BE SUBMITTED FOR REVIEW BY THE ENGINEER PRIOR TO FABRICATION.

SUPPLEMENTAL STRUCTURAL ABBREVIATIONS:

ABV	ABOVE	FRM'G	FRAMING	STIRR	STIRRUP
AFF	ABOVE FINISH FLOOR	FS	FAR SIDE	STRUC	STRUCTURE(AL)
ADD'L	ADDITIONAL	FTG	FOOTING	SYM	SYMMETRICAL
ADJ	ADJACENT	GA	GAUGE	T	TOP
AL	ALUMINUM	GB	GRADE BEAM	T&G	TONGUE AND GROOVE
APPRX	APPROXIMATE	GLB	GLUE-LAMINATED BEAM	TMPRY	TEMPORARY
ARCH	ARCHITECTURAL	HAS	HEADER ANCHOR STUDS	TN	TOE NAIL
@	AT	HDR	HEADER	TO	TOP OF
BEL	BELOW	HF	HEM-FIR	TRANS	TRANSVERSE
BF	BRACED FRAME	HGR	HANGER	TOS	TOP OF SLAB
BM	BEAM	HSB	HIGH STRENGTH BOLT (A325 UNO)	TYP	TYPICAL
BN	BOUNDRY NAIL	HSS	HOLLOW STRUCTURAL STEEL	UNO	UNLESS NOTED OTHERWISE
BNDRY	BOUNDRY	IBC	INTERNATIONAL BUILDING CODE	VFY	VERIFY
BO	BOTTOM OF	IF	INSIDE FACE	WHS	WELDED HEADED STUD
BOS	BOTTOM OF SLAB	INT	INTERIOR	WP	WORK POINT
BOT	BOTTOM	JST	JOIST	WS	WESTERN SPECIES
BRDG	BRIDGE(ING)	K	KIPS (1000 POUNDS)	WTS	WELDED THREADED STUD
BRG	BEARING	LAT	LATERAL	X-STG	EXTRA STRONG
CAM	CAMBER(ED)	LDGR	LEDGER	XX-STG	DOUBLE EXTRA STRONG
CANT	CANTILEVER(ED)	LLH	LONG LEG HORIZONTAL		
CDF	CONTROLLED DENSITY FILL	LLV	LONG LEG VERTICAL		
CG	CENTER OF GRAVITY	LS	LAG SCREW		
CIP	CAST IN PLACE	LSL	LAMINATED STRAND LUMBER		
CJ	CONTROL JOINT	LT WT	LIGHT WEIGHT		
CJP	COMPLETE JOINT PENETRATION	LVL	LAMINATED VENEER LUMBER		
COL	COLUMN	MAS	MASONRY		
CONST	CONSTRUCTION	MAT'L	MATERIAL		
CONT	CONTINUOUS	MB	MACHINE BOLT (A307)		
CTSK	COUNTERSINK	MFR	MANUFACTURER		
DBL	DOUBLE	MRF	MOMENT RESISTING FRAME		
D	DEPTH	MTL	METAL		
d	PENNY (NAILS)	(N)	NEW MEMBER		
DF	DOUGLAS FIR	NS	NEAR SIDE		
DIAG	DIAGONAL	OH	OVERHANG		
DIAPH	DIAPHRAGM	ORNT	ORIENTATE (ION)		
do	DITTO (DO OVER)	PAR	PARALLEL		
DWG	DRAWING	P/C	PRECAST CONCRETE		
DWL	DOWEL	PERP	PERPENDICULAR		
EA	EACH	PSL	PARALLEL STRAND LUMBER		
EXIST	EXISTING MEMBER	PT	PRESSURE TREAT(ED)		
EF	EACH FACE	P/T	POST TENSIONED		
EJ	EXPANSION JOINT	QTY	QUANTITY		
EMBD	EMBED(MENT)	REF	REFERENCE		
EN	EDGE NAIL	REINF	REINFORCEMENT		
ENG	ENGINEER	SHT	SHEET		
EQ	EQUAL	SHTG	SHEATHING		
ES	EACH SIDE	SIM	SIMILAR		
EXT	EXTERIOR	SKW	SKEW(ED)		
FFE	FINISHED FLOOR ELEVATION	SPC	SPACING		
FN	FACE NAIL	SS	STAINLESS STEEL		
FND	FOUNDATION	STGR	STAGGER		
FO	FACE OF	STIFF	STIFFENER		

0 1" 2"
TWO INCHES AT FULL SCALE. IF NOT, SCALE ACCORDINGLY

Gray & Osborne, Inc.
CONSULTING ENGINEERS
2102 CARRIAGE DRIVE SW, BLDG. I
OLYMPIA, WA 98502 • (360) 292-7481

MYRON J. BASDEN · STATE OF WASHINGTON · 46334 · REGISTERED PROFESSIONAL STRUCTURAL ENGINEER

DATE: JUNE 2017
SCALE: NOTED
DRAWN: RAH
CHECKED: ZK
APPROVED: MJB

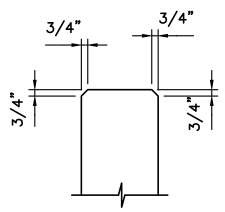
No.	REVISION	DATE	APP'D
	FOR PERMIT		

COVINGTON WATER DISTRICT
KING COUNTY WASHINGTON
C4 TAP & TRANSMISSION MAIN
STRUCTURAL NOTES

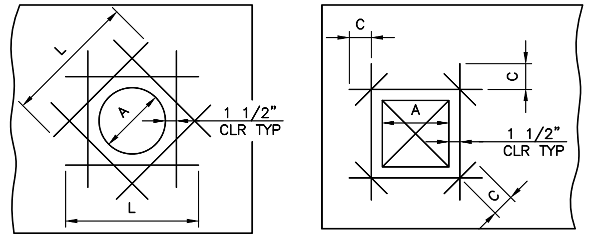
SHEET: S-1
OF: 2
JOB NO.: 16608
DWG:S_NOTES

REINF	LAP
#4	2'-4"
#5	3'-0"
#6	3'-6"
#7	4'-3"
#8	4'-10"
#9	5'-3"
#10	6'-6"
#11	8'-0"

1 TYP — TYP. LAP SCHEDULE
NOT TO SCALE



2 TYP — TYP. CHAMFER DETAIL
NOT TO SCALE

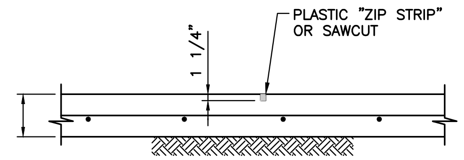


OPENING SIZE (A)	TYPE I MINIMUM BAR LENGTH (L)	TYPE I BAR SIZE	TYPE II (C)	TYPE II BAR SIZE
0" - 12"	3' - 9"	#5	1' - 0"	MATCH VERTICAL BARS OR LARGEST BAR IN SLABS OR WALKWAYS
13" - 18"	4' - 9"	#6	1' - 3"	
19" - 24"	6' - 9"	MATCH VERTICAL BARS OR LARGEST BAR IN SLABS OR WALKWAYS	2' - 6"	
25" - 36"	7' - 9"		2' - 6"	
36"—	8' - 9"		2' - 6"	

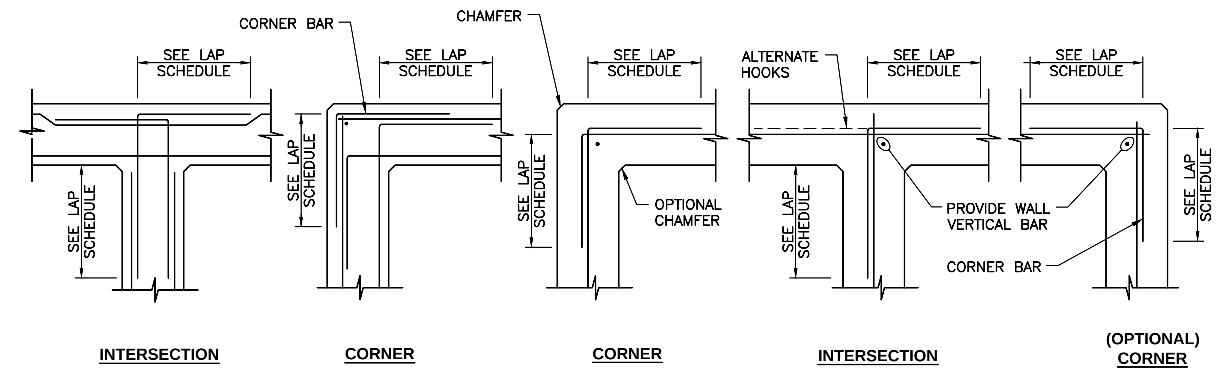
NOTE:

ALL BARS, EACH FACE. USE THESE BAR SIZES UNLESS OTHERWISE NOTED.

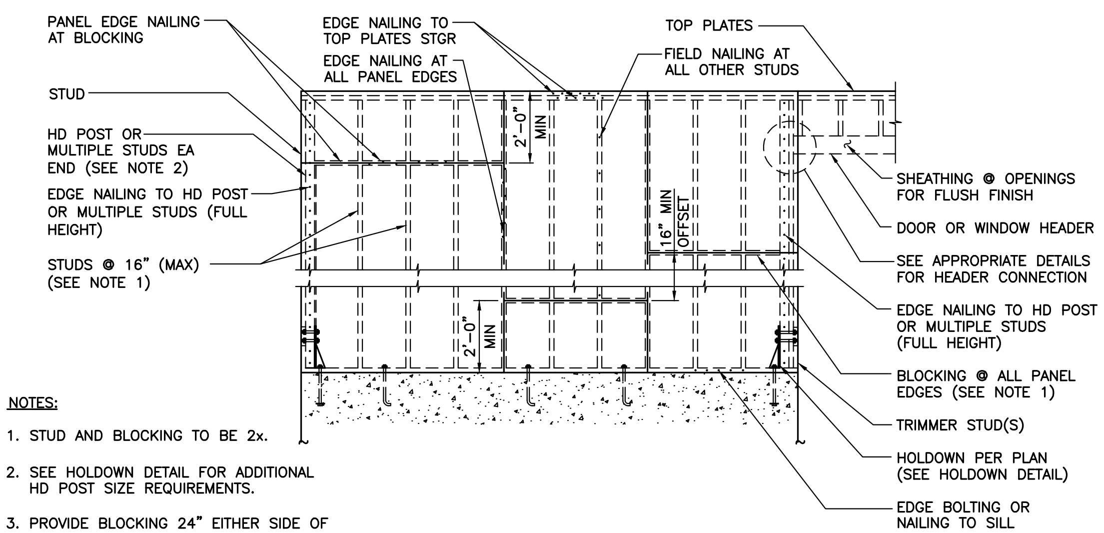
3 TYP — TYP PENETRATION REINFORCING DETAIL
NOT TO SCALE



4 TYP — TYP. SLAB JOINT DETAIL
NOT TO SCALE



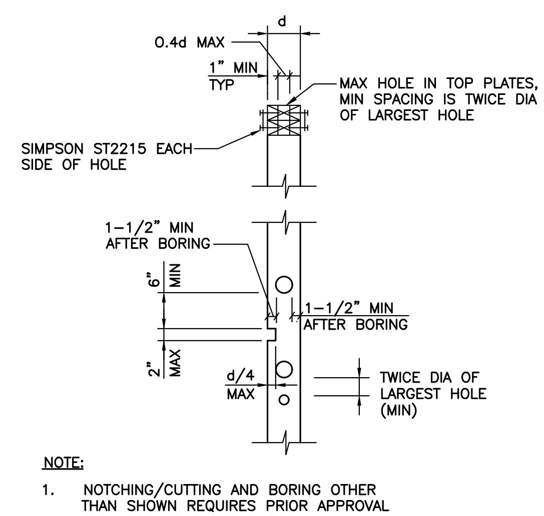
5 TYP — TYP REINFORCING @ WALL INTERSECTION DETAIL
NOT TO SCALE



NOTES:

1. STUD AND BLOCKING TO BE 2x.
2. SEE HOLDOWN DETAIL FOR ADDITIONAL HD POST SIZE REQUIREMENTS.
3. PROVIDE BLOCKING 24" EITHER SIDE OF OPENING 24" WIDE OR LESS.
4. USE COMMON WIRE NAILS FOR ALL STRUCTURAL SHEATHING.

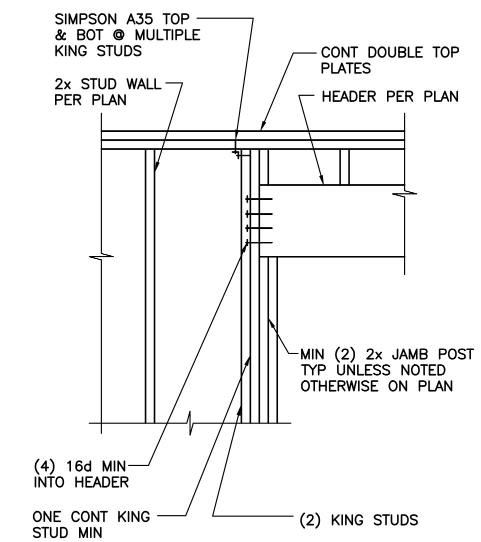
6 TYP — SHEAR WALL TYPES I AND II
NOT TO SCALE



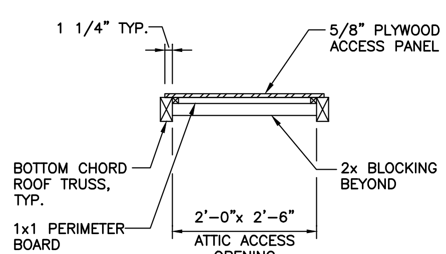
NOTE:

1. NOTCHING/CUTTING AND BORING OTHER THAN SHOWN REQUIRES PRIOR APPROVAL FROM STRUCTURAL ENGINEER.

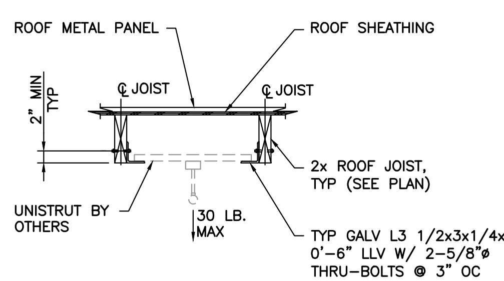
7 TYP — TYP ALL BEARING & SHEARWALLS FOR STUD NOTCHING/BOLTING & BORING
SCALE: 3/4"=1'-0"



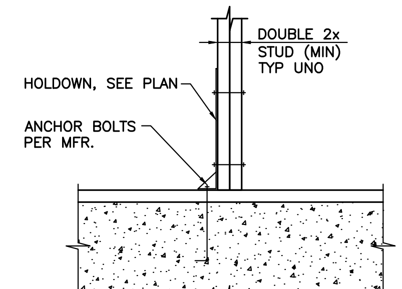
8 TYP — TYP HEADER DETAIL
NOT TO SCALE



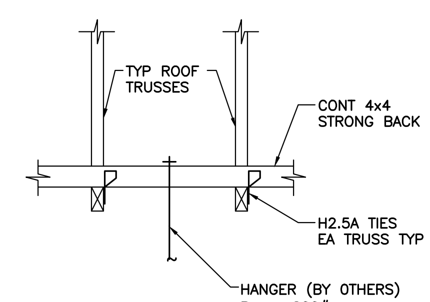
9 TYP — TYPICAL ATTIC ACCESS DETAIL
SCALE: 3/4"=1'-0"



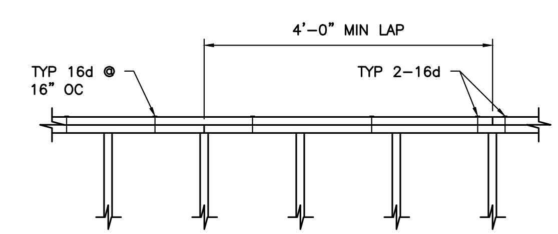
10 TYP — TYP LIGHTING FIXTURE MOUNTING DETAIL
SCALE: 3/4"=1'-0"



11 TYP — TYP HOLDOWN DETAIL
SCALE: 3/4"=1'-0"



12 TYP — TYP MECHANICAL SUPPORT WOOD TRUSS
NOT TO SCALE



13 TYP — TYP MINIMUM DOUBLE PLATE LAP & NAILING DETAIL
SCALE: 3/4"=1'-0"

0 1" 2"
TWO INCHES AT FULL SCALE IF NOT, SCALE ACCORDINGLY

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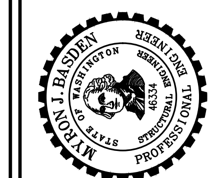
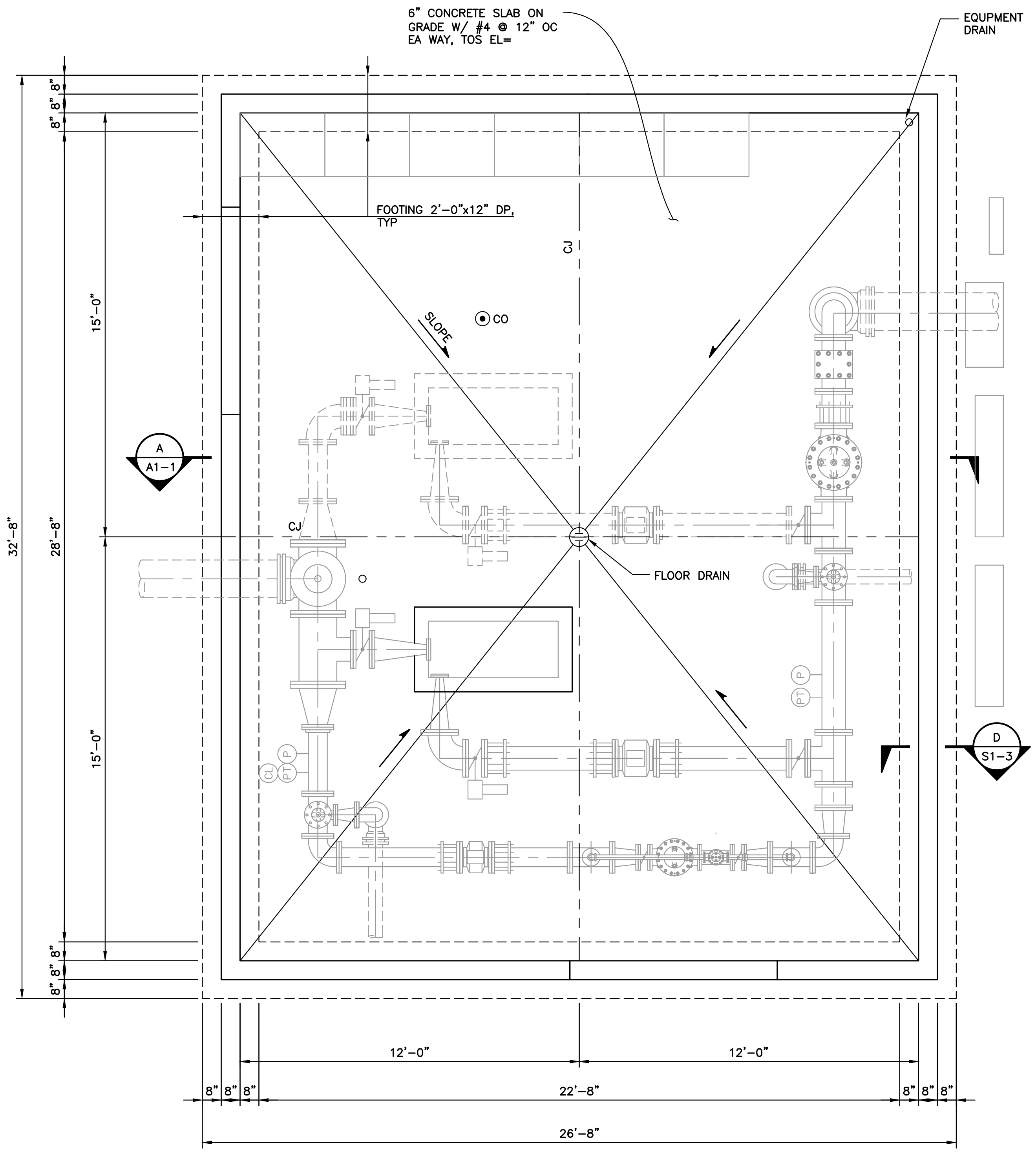


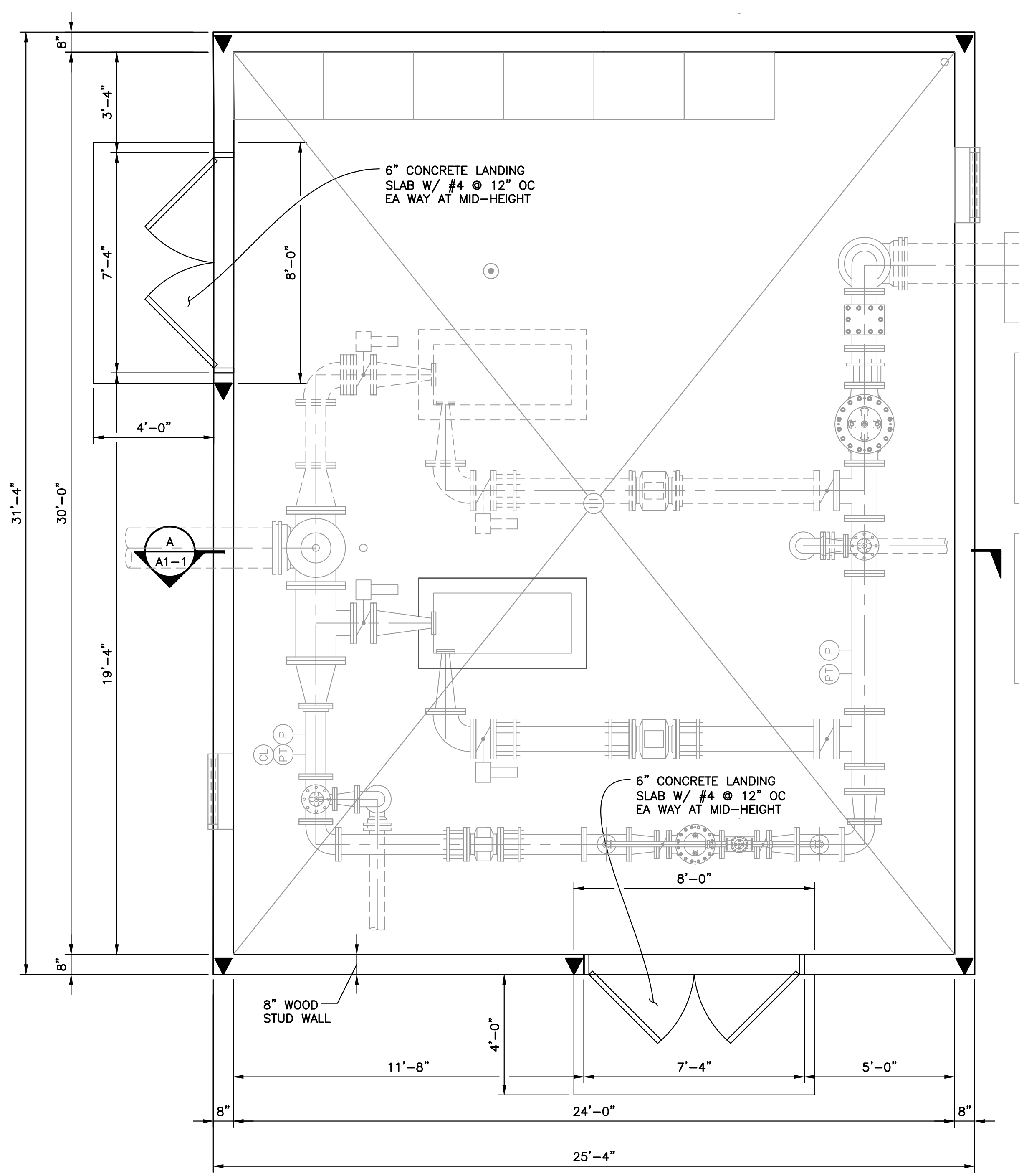
COVINGTON WATER DISTRICT
KING COUNTY WASHINGTON
C4 TAP & TRANSMISSION MAIN
TYPICAL STRUCTURAL DETAILS

SHEET: S-2
OF: 2
JOB NO.: 16608
DWG: S_NOTES



FOUNDATION PLAN

SCALE: 3/8"=1'-0"



FLOOR PLAN

SCALE: 3/8"=1'-0"

NOTES:

1. SEE SHEETS S-1 AND S-2 FOR GENERAL STRUCTURAL NOTES AND TYPICAL DETAILS.
2. DIMENSIONS SHOWN ON STRUCTURAL PLANS ARE FOR GENERAL INFORMATION ONLY AND MUST BE VERIFIED BY THE CONTRACTOR BEFORE START OF CONSTRUCTION. ANY DISCREPANCIES SHOULD BE BROUGHT TO THE ATTENTION OF THE ENGINEER IMMEDIATELY.
3. SLAB AND WALL PENETRATIONS ARE NOT SHOWN. CONTRACTOR SHALL COORDINATE SIZE AND LOCATIONS OF SLAB AND WALL PENETRATIONS WITH MECHANICAL AND ELECTRICAL SHEETS.
4. "▼" DENOTES SIMPSON HD5 HOLDOWN. SEE DETAIL E/S1-3. ALIGN HOLDOWN WITH EDGE OF DOORS ABOVE.

0 1" 2"
TWO INCHES AT FULL SCALE. IF NOT, SCALE ACCORDINGLY

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MYRON J. BASDEN, STATE OF WASHINGTON, 46334, PROFESSIONAL STRUCTURAL ENGINEER

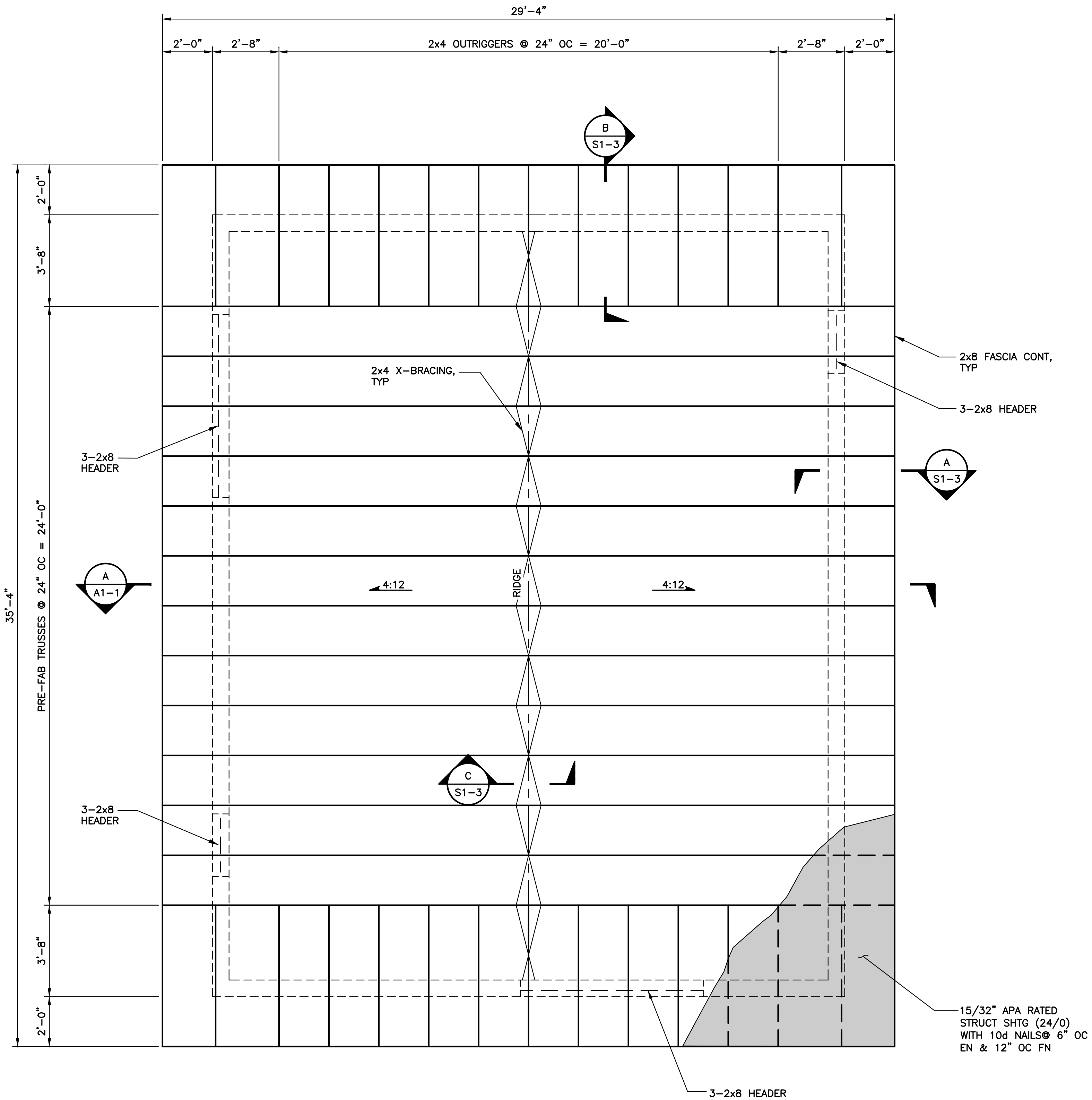
COVINGTON WATER DISTRICT
KING COUNTY WASHINGTON

C4 TAP & TRANSMISSION MAIN

FOUNDATION AND FLOOR PLANS

SHEET: S1-1
OF: 3

JOB NO.: 16608
DWG:S_TRBN_BLDG



ROOF FRAMING PLAN

SCALE: 3/8"=1'-0"

NOTES:

1. SEE SHEETS S-1 AND S-2 FOR GENERAL STRUCTURAL NOTES AND TYPICAL DETAILS.
2. NOT ALL ROOF OPENINGS AND PENETRATIONS MAY BE SHOWN. CONTRACTOR SHALL VERIFY NUMBER, SIZE, AND LOCATIONS OF ALL OPENINGS WITH ARCHITECTURAL AND MECHANICAL DRAWINGS.
3. DIMENSIONS SHOWN ON STRUCTURAL PLANS ARE FOR GENERAL INFORMATION ONLY AND MUST BE VERIFIED BY THE CONTRACTOR BEFORE START OF CONSTRUCTION. ANY DISCREPANCIES SHOULD BE BROUGHT TO THE ATTENTION OF THE ENGINEER IMMEDIATELY.
4. ALL FRAMING HARDWARE SHALL BE MANUFACTURED BY SIMPSON STRONG TIE COMPANY, INC. UNLESS OTHERWISE APPROVED BY THE ENGINEER.
5. TYP. DOOR/WINDOW HEADER TO BE 3-2x8 TYP., U.N.O.
6. USE MINIMUM OF TWO STUDS AT END OF SHEAR WALL, U.N.O.
7. FOR TYPICAL STUD NOTCHING/CUTTING/BORING DETAIL SEE 7/S-2.
8. FOR TYPICAL HEADER DETAIL SEE 8/S-2.
9. FOR DOOR AND ROOM FINISH SCHEDULE, SEE ARCHITECTURAL SHEETS.

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MYRON J. BASDEN
STATE OF WASHINGTON
46334
STRUCTURAL
PROFESSIONAL ENGINEER

COVINGTON WATER DISTRICT
KING COUNTY WASHINGTON

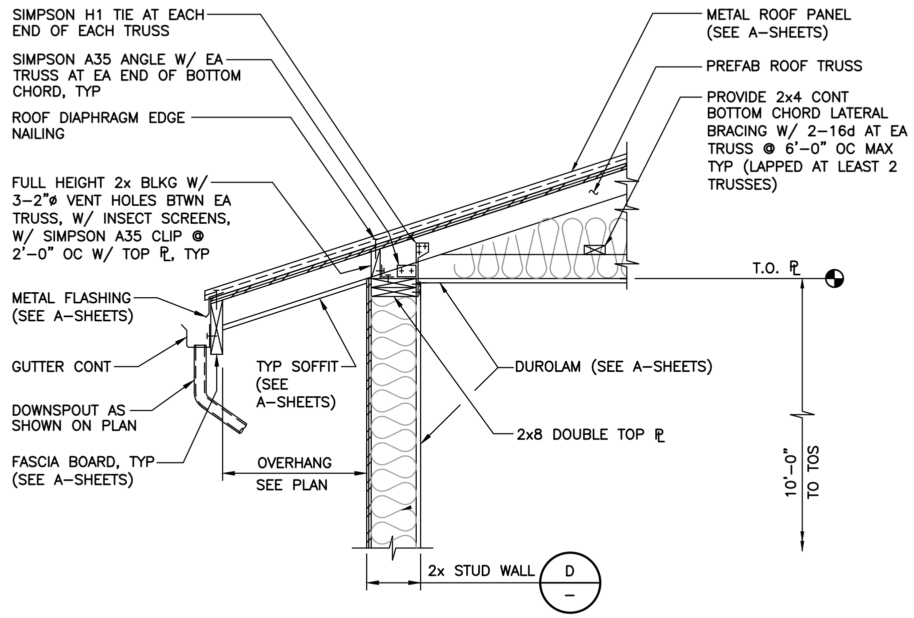
C4 TAP & TRANSMISSION MAIN

ROOF FRAMING PLAN AND BUILDING SECTION

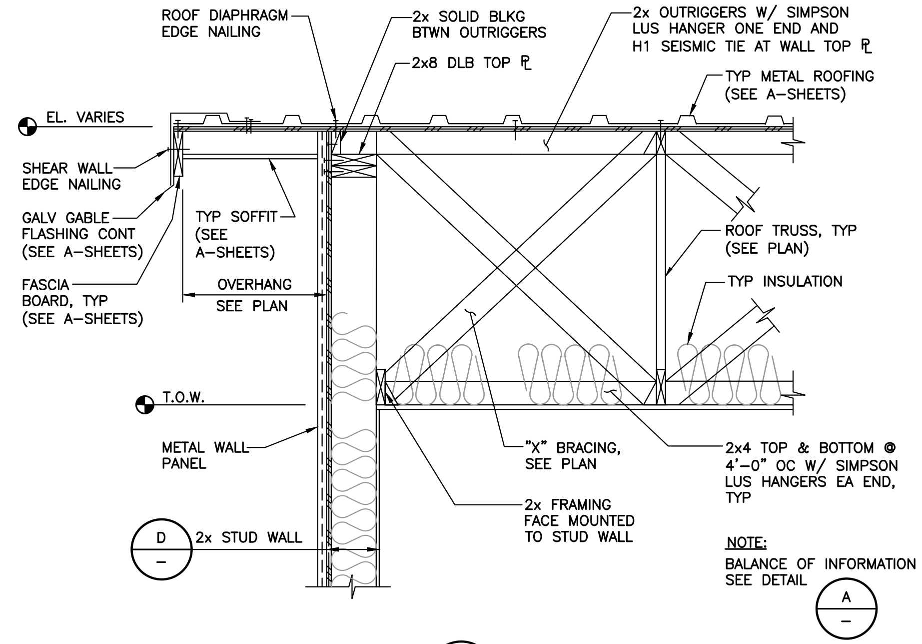
SHEET: S1-2
OF: 3

0 1" 2"
TWO INCHES AT FULL SCALE IF NOT, SCALE ACCORDINGLY

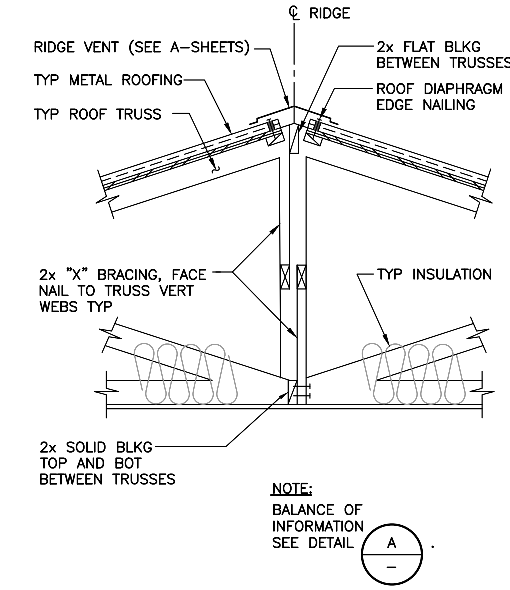
JOB NO.: 16608
DWG:S_TRBN_BLDG



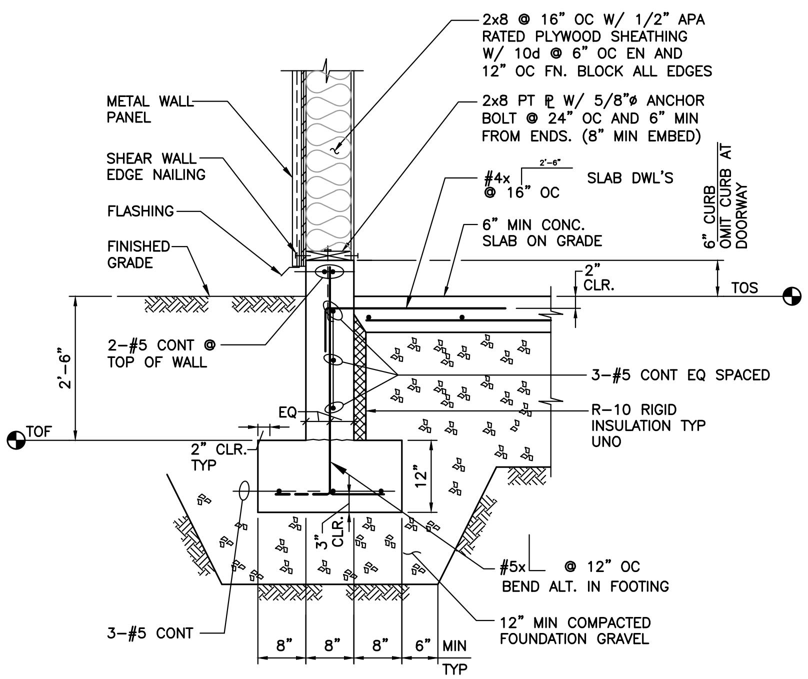
A
S1-2
SECTION
SCALE: 3/4"=1'-0"



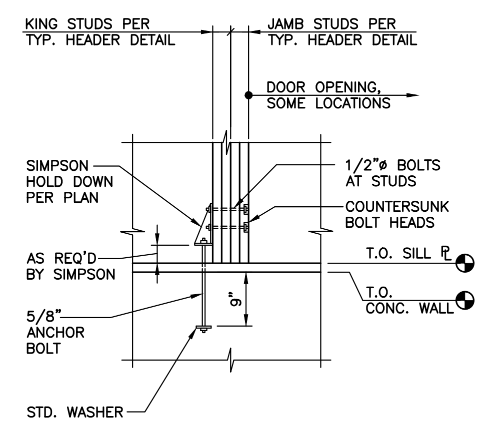
B
S1-2
SECTION
SCALE: 3/4"=1'-0"



C
S1-2
SECTION
SCALE: 3/4"=1'-0"



D
S1-1
SECTION
SCALE: 3/4"=1'-0"



E
S1-1
DETAIL
SCALE: 3/4"=1'-0"

0 1" 2"
TWO INCHES AT FULL SCALE IF NOT, SCALE ACCORDINGLY

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STATE OF WASHINGTON
46334
PROFESSIONAL STRUCTURAL ENGINEER

COVINGTON WATER DISTRICT
KING COUNTY
WASHINGTON

C4 TAP & TRANSMISSION MAIN
TYPICAL STRUCTURAL DETAILS

SHEET: S1-3
OF: 3

JOB NO.: 16608
DWG:S_TRBN_BLDG

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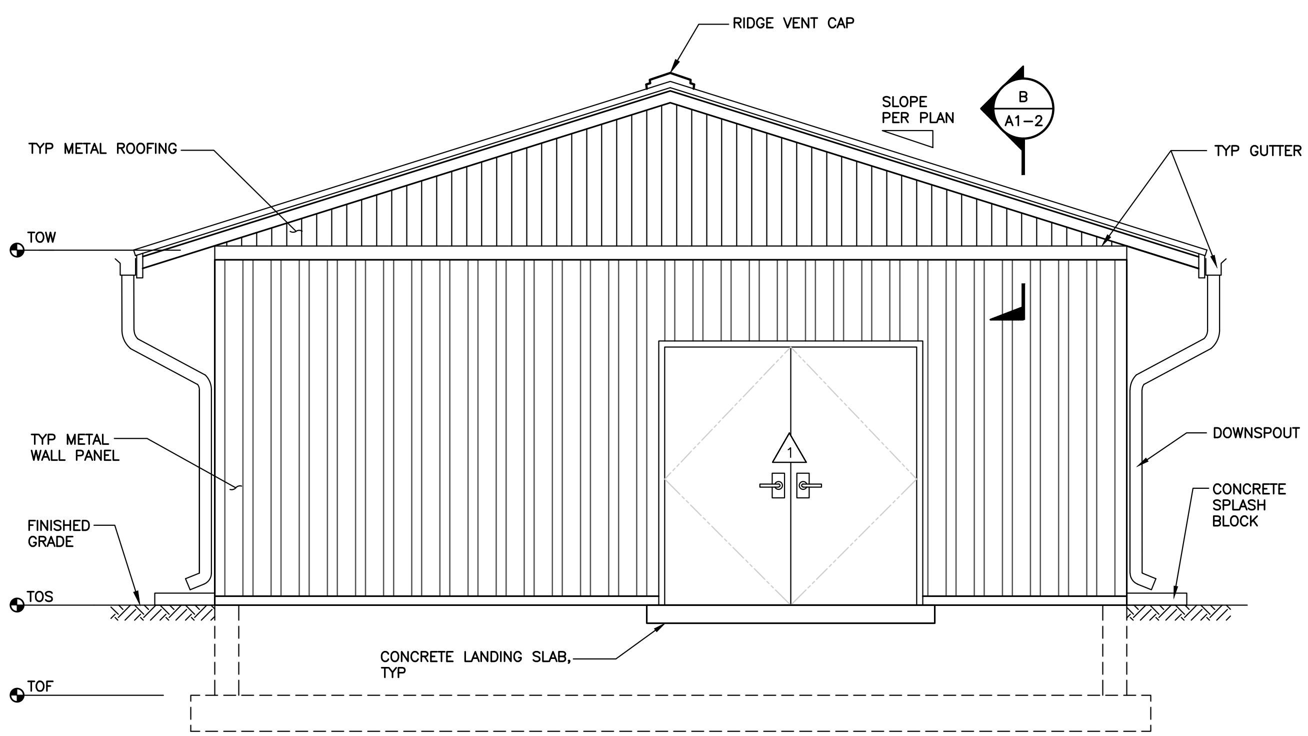
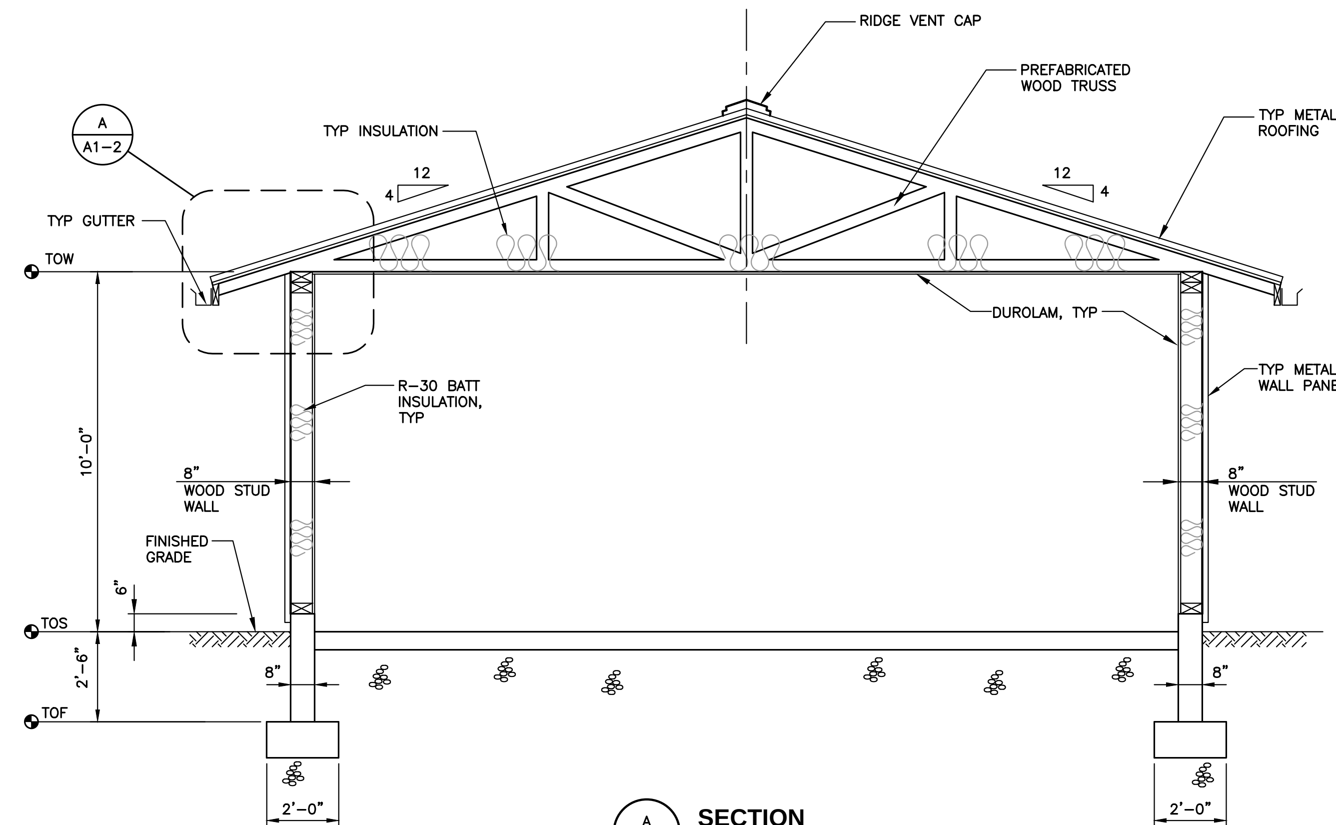
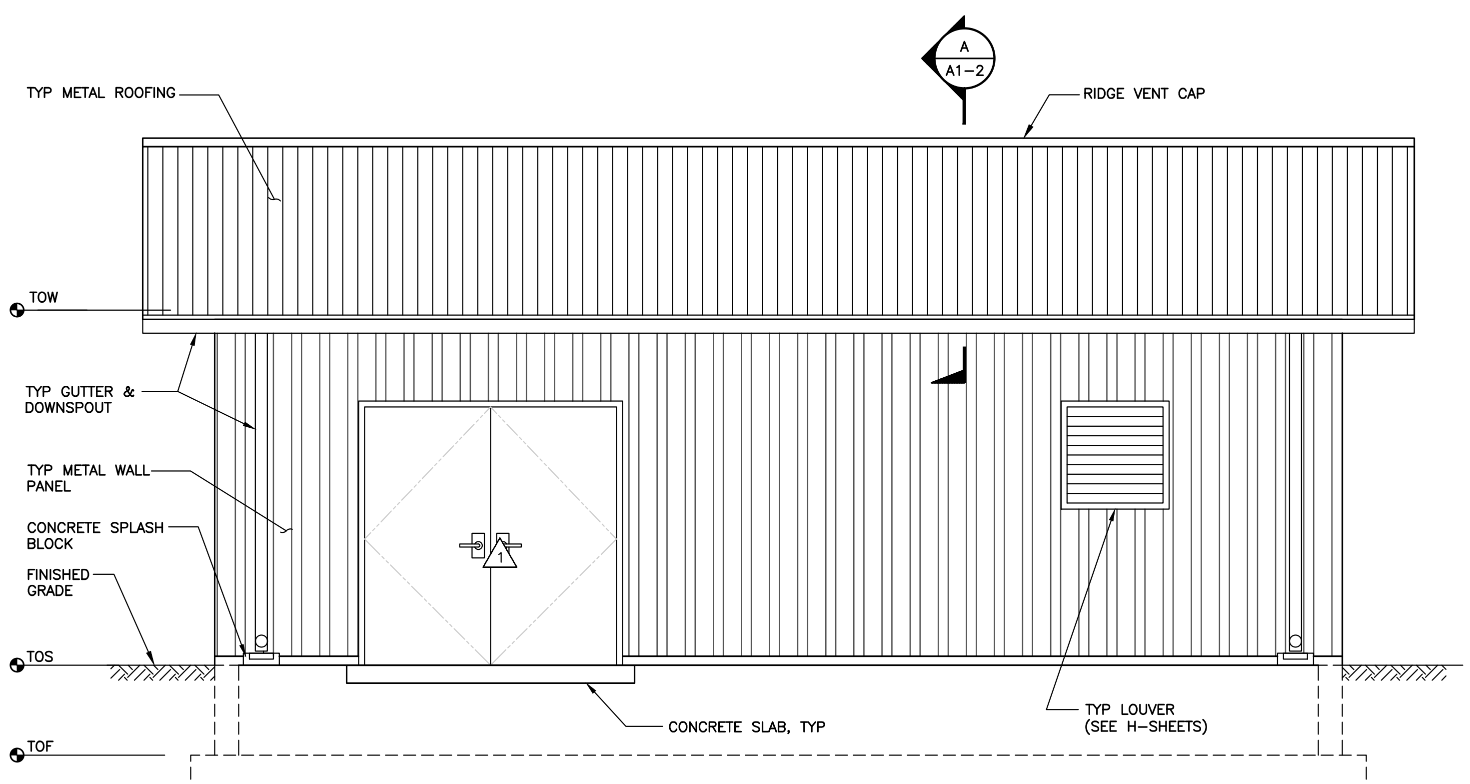


WEST ELEVATION
SCALE: 3/8"=1'-0"



SECTION
SCALE: 3/8"=1'-0"



NORTH ELEVATION
SCALE: 3/8"=1'-0"

PROJECT DATA

CODES:

IBC 2015 INTERNATIONAL BUILDING CODE
IMC 2015 INTERNATIONAL MECHANICAL CODE
IFC 2015 INTERNATIONAL FIRE CODE
UPC 2015 UNIFORM PLUMBING CODE
WSEC 2015 WASHINGTON STATE ENERGY CODE

PROJECT DESCRIPTION:

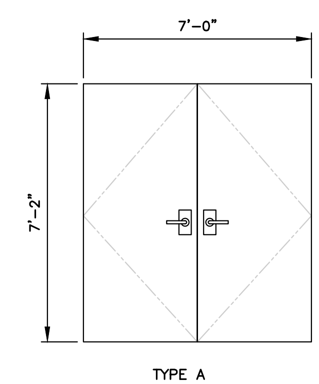
A SINGLE STORY WOOD-FRAMED BUILDING CONTAINING A TURBINE AND ASSOCIATED PIPING.

OCCUPANCY:

U – UTILITY

GENERAL NOTES:

1. SEE STRUCTURAL SHEETS FOR FOUNDATION, WALL AND ROOF FRAMING PLANS.
2. METAL ROOFING PANEL SHALL BE AEP SPAN KLIP RIB OR EQUAL. METAL WALL PANEL SHALL BE HR-36 OR EQUAL

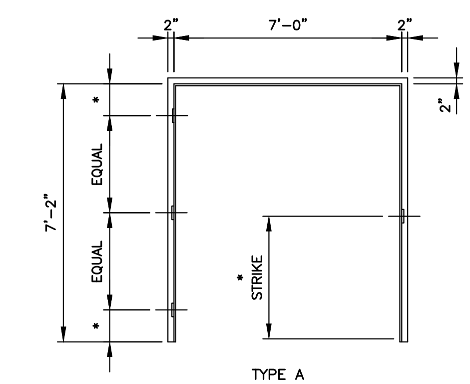


TYPE A

NOTE:

1. SWING DIRECTION AS SHOWN ON PLAN.

DOOR TYPE A
NTS



TYPE A

* = AS PER MANUFACTURER

DOOR FRAME TYPE A
NTS

DOOR SCHEDULE

NO.	MATERIAL AND TYPE	SIZE - WIDTH X HEIGHT X THICKNESS	DOOR TYPE	FRAME TYPE	FRAME GUAGE	FINISH	HARDWARE GROUP	INSULATION FACTOR
1	HOLLOW METAL INSULATED	7'-0" X 7'-2" X 1 3/4"	A	A	16	PAINT	1	U = 0.35

0 1" 2"
TWO INCHES AT FULL SCALE IF NOT, SCALE ACCORDINGLY

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OLYMPIA, WA 98502 • (360) 292-7481

DATE: JUNE 2017
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	FOR PERMIT		

COVINGTON WATER DISTRICT
KING COUNTY WASHINGTON

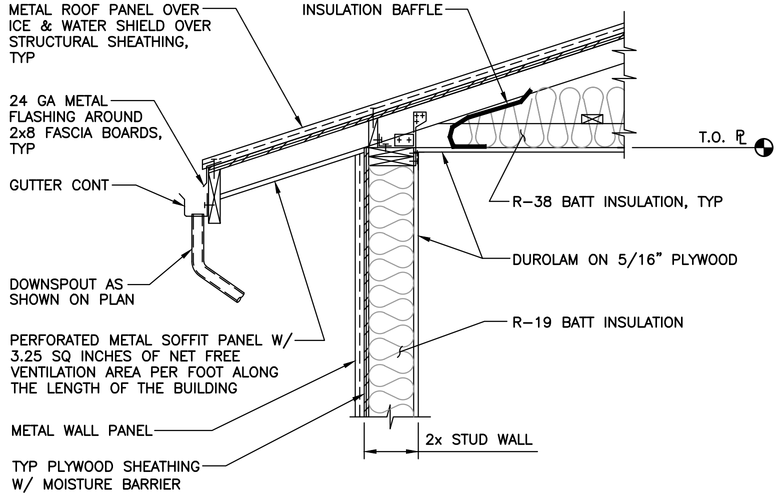
C4 TAP & TRANSMISSION MAIN

BUILDING ELEVATIONS, SECTION, AND DOOR SCHEDULE AND DETAILS

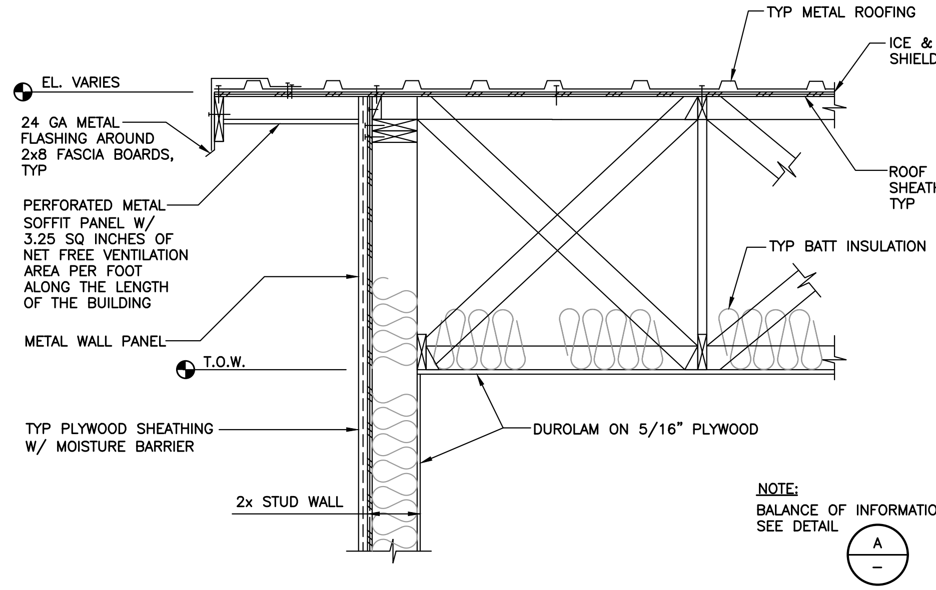
SHEET: A1-1
OF: 2

JOB NO.: 16608
DWG:A_TRBN_BLDG

i:\covington water district\16608.00 tacoma tap and transmission main\Design\Planset\Architectural\A_TRBN_BLDG.dwg, 6/14/2017 1:37 PM, JON SPURLIN

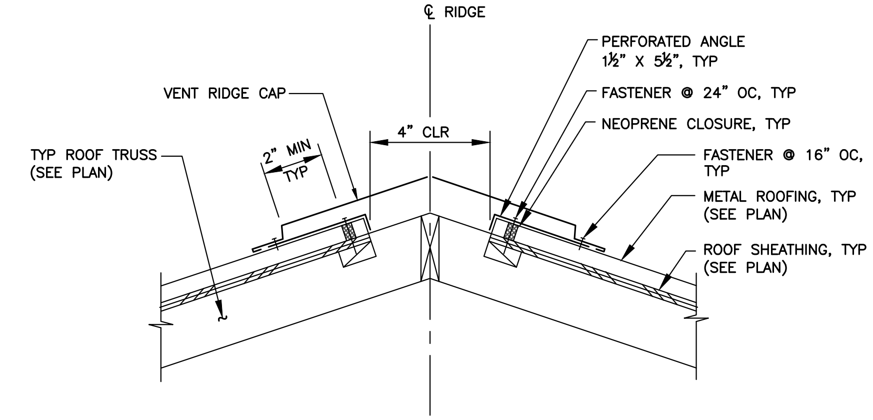


A / A1-1 **SECTION**
SCALE: 3/4"=1'-0"



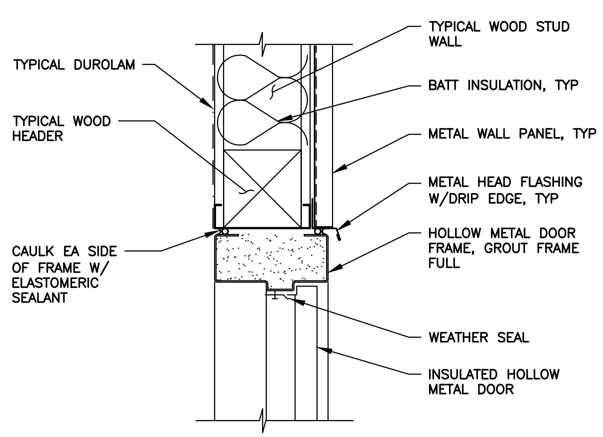
NOTE:
BALANCE OF INFORMATION SEE DETAIL A / –

B / A1-1 **SECTION**
SCALE: 3/4"=1'-0"

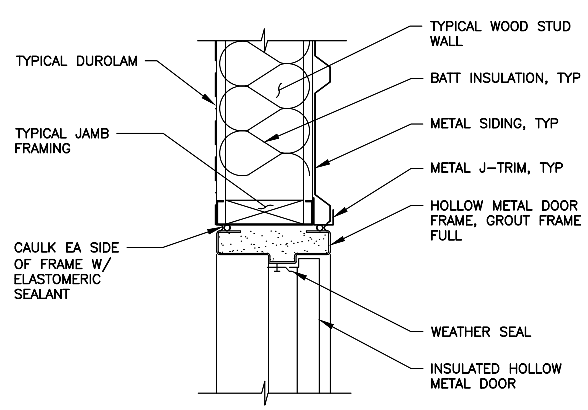


NOTES:
1. RIDGE CAP MUST PROVIDE A MINIMUM OF 6.5 SQUARE INCHES OF NET FREE VENTILATION AREA PER FOOT OF LENGTH.

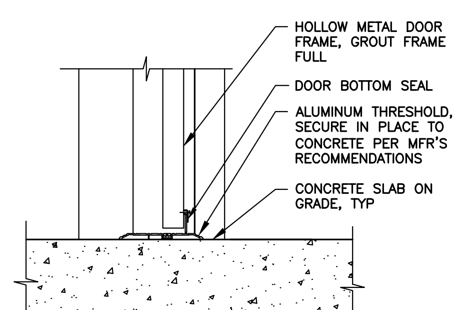
C / TYP **RIDGE VENT DETAIL**
NOT TO SCALE



D / TYP **TYPICAL DOOR HEAD SECTION**
SCALE: 1 1/2"=1'-0"



E / TYP **TYPICAL DOOR JAMB SECTION**
SCALE: 1 1/2"=1'-0"



F / TYP **TYPICAL DOOR SILL SECTION**
SCALE: 1 1/2"=1'-0"

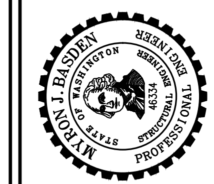
0 1" 2"
TWO INCHES AT FULL SCALE IF NOT, SCALE ACCORDINGLY

Gray & Osborne, Inc.
CONSULTING ENGINEERS
2102 CARRIAGE DRIVE SW, BLDG. I
OLYMPIA, WA 98502 • (360) 292-7481

DATE:	JUNE 2017
SCALE:	NOTED
DRAWN:	RAH
CHECKED:	AQ
APPROVED:	MJB

FOR PERMIT

No.	REVISION	DATE	APPD



COVINGTON WATER DISTRICT
WASHINGTON
KING COUNTY

C4 TAP & TRANSMISSION MAIN
ARCHITECTURAL DETAILS

SHEET: **A1-2**
OF: **2**
JOB NO.: 16608
DWG:A_TRBN_BLDG

Energy Savings Guarantee

3.1 Guarantee Overview

1. *Philosophy:*
   McKinstry is prepared to guarantee any portion of a project over which it has direct control. Where McKinstry does not have direct control (such as operating hours associated with lighting), we are prepared to work with the Owner and DES to devise a method of Measurement and Verification (M&V), which will provide the highest degree of assurance that the energy savings are achieved.

2. *This Project:*
   For this project, McKinstry guarantees the performance of the installed initiatives to reduce energy consumption. The target energy reductions for the initiatives that will be implemented are as follows: Refer to Section 3, Table 3.1. Based upon the stipulated conditions as enumerated by the Owner and DES personnel and the utility rates as described below, the utility cost savings estimates are also shown in Table 3.1.

3. *Ongoing Services:*
   Refer to Table 4.1 for the cost and duration of ongoing M&V. The cost of ongoing M&V beyond the duration listed in Table 4.1 is at the discretion of the Owner. McKinstry is prepared to continue the guarantee as long as the Owner continues the ongoing services as described herein. When the Owner chooses to cancel the ongoing services, the guarantee will also be terminated at the same point in time. Please refer to Section 3, Table 3.2 for a summary of the proposed measurement and verification scope.

3.2 FIM Specific Performance Assurance Methodology

1. *Guarantees:*
   Table 3.1 Energy Savings Guarantee Summary provides the specific energy consumption savings for each Facility Improvement Measure (FIM) and the guarantee that McKinstry will provide associated with that measure. Savings calculations are based upon both baseline operating characteristics and proposed operation criteria:

   a. Baseline: "Baseline" refers to the existing operating characteristics that were used to calculate energy cost savings. The baseline operating characteristics, including system performance and operational expenditures, which were used for this project are provided in Table 3.1. In general, all parties acknowledge the baseline associated with any specific measure has been derived from the following sources:

      i. Actual operating information gathered through field observation, measurement, micro-data loggers, and Owner's operating logbooks.

      ii. Owner provided information concerning stipulated factors such as burn hours, occupancy, or operational expenditures.

      iii. In some instances, a modified baseline may have been developed to address areas whereby pre-retrofit conditions do not reflect a system that is operating per current code or what the Owner may deem as normal operation.

2. *Proposed:*
   The proposed operating criteria, including system performance and operational expenditures, which were used for savings calculations are provided in Table 3.1. Systems must be operated per the proposed criteria to ensure energy savings are realized. McKinstry will provide the initial start-up, commissioning, and programming of the system to ensure the systems operate per the proposed operating criteria. The Owner acknowledges their responsibility to ensure these criteria are maintained and associated energy savings are realized. Energy Savings Guarantees are predicated based on the Owner maintaining their responsibilities as provided below in "Ongoing Owner Responsibilities" in Section 3.5.

Energy Savings Guarantee

3.3 Utility Rates

1. *Utility Rate:*
   For the purpose of calculating energy cost savings, the utility rates used will be the utility rates as paid by the Owner to the utility company at the time the Energy Services Proposal was developed. In the event that a building has multiple meters on different rate schedules, the per-unit cost of the utility will be the average of all the rate schedules in effect at that facility.

   a. *Base Utility Rate:*
      Refer to table 3.3 for the Base Utility Rates (including sales tax).

3.4 Standards Of Comfort Service

Where applicable, the following section provides the standards of comfort, which the Owner must maintain to ensure the comfort of the occupants and staff, and upon which all energy calculations were based.

HVAC COMFORT

Heating, ventilating, and air conditioning (HVAC) systems provided by McKinstry will provide comfort and indoor air quality in accordance with the Standards of Comfort below. This standard will pertain only to buildings and areas of buildings in which McKinstry is installing HVAC equipment that has direct control over space comfort conditions. HVAC comfort conditions cannot be guaranteed when operable windows or doors are open.

INDOOR CONDITIONS

Occupied:
Winter Heating Minimum Set-point – 70 degrees F (Superseded by DOH Regs)

Winter Heating Maximum Set-point – 74 degrees F (Superseded by DOH Regs)

Summer Cooling Minimum Set-point – 72 degrees F (where mechanical cooling systems are employed)

Summer Cooling Maximum Set-point – 78 degrees F (where mechanical cooling systems are employed)

Unoccupied:
Minimum – 55 degrees F

Maximum – 85 degrees F (where mechanical cooling systems are employed)

Relative Humidity (If humidity control provided):

Minimum - 40%

Maximum - 60%

Minimum outside air per occupant:
Minimum outside air per occupant shall be in accordance with American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) standards and Chapter 4 of the International Mechanical Code.

Less stringent conditions will not be proposed unless specifically approved by the Owner and DES (if applicable).

LIGHTING

Illumination Levels Verification:
McKinstry shall perform a light level survey of the existing conditions during the audit phase of the project

development. The existing lighting conditions shall be discussed with the Owner to gauge the preference for general illumination throughout the facility.

Illumination Levels Design:
It is McKinstry's intent to provide energy efficient lighting conditions that effectively meet the needs of the occupants and accommodate the application requirements. Where deemed appropriate, McKinstry will follow IESNA recommendations for illumination criteria in the absence of the Owner's preferred lighting standards.

3.5 Ongoing Owner Responsibilities

The Owner shall provide the following services as part of this energy services project. In the event that these services are not provided, energy savings and associated guarantees will be modified to reflect the associated impact.

1. Maintain all equipment per manufacturer's recommendations and proposed maintenance schedule.
2. Maintain all sequence of operations and performance criteria related to installed systems as proposed and designed.
3. Provide other FIM specific ongoing responsibilities as provided in Table 3.2 - "Performance Assurance Plan Outline."
4. Provide McKinstry with copies of actual monthly utility billing information on a quarterly basis for the duration of the M&V service period. This includes electric, natural gas, and fuel oil. The associated facilities where utility information shall be provided include all meters providing direct or indirect service to all buildings included in this project.
5. Provide McKinstry all internal sub-meter data, including electric and condensate meters, providing direct or indirect service to all buildings included in this project.
6. Provide McKinstry access to Energy Management and Control Systems for the purpose of collecting and logging data over time as required for performance verification.
7. The Owner shall notify McKinstry in writing concerning any changes or alterations to the building that will affect energy usage. This notification should be provided within two weeks of the change. This includes occupancy or use changes, computer load or other load changes, scheduling changes, and sequence of operations changes.

3.6 Non-Performance

In the event the equipment performance is not met, McKinstry accepts responsibility for additional electricity and natural gas used by the equipment, due to reduced performance. McKinstry may, at its option, execute any of the following options:

1. Repair or replace equipment as necessary to meet required performance.
2. Make payments for the extra energy consumption to the Owner. In the event that McKinstry chooses the payment option, McKinstry reserves the right to select either an annual payment for the duration of the guarantee term or a one-time lump-sum payment of the same amount. In either case, the payment will be calculated based upon the quantity of additional electricity or natural gas used and the Base Utility Rate as described above.

3.7 Change Of Use

In the event that the Owner chooses to make changes to the facility that require set point adjustments, longer operating hours, or continuous equipment operation, the Owner agrees that:

1. Savings deemed as met described above will continue to be deemed as met.

Energy Savings Guarantee

2. Additional cost of extended equipment operation is a cost of the change, not due to a failure of McKinstry or their equipment.
3. McKinstry shall not be responsible for any increase in energy, maintenance, or any other costs incurred because of the extended equipment operation.
4. During the M&V portion of the project McKinstry at its option may make a baseline energy use adjustment to identify and account for a change-of-use at the facility.
5. McKinstry will calculate the change in energy consumption due to the specific change made to the system’s operation.

Table 3.1 - Energy Savings Summary

Project	Covington Water District
Scenario	C-4 Intertie Pipeline Final ESP
Date	7/13/2017

					Electricity		Total **
Facility Improvement Measures	Facility	Guarantee Multiplier for Positive Numbers *	Guarantee Multiplier for Negative Numbers *	Net Effective Guarantee Multiplier *	kWh	kWh ($)	($)
10.03-CWD Provide Water Turbine at New Intertie	Admin Gas and Electric	100.0%	100.0%	100.0%	174,342	$16,066	$16,066
30.01-CWD Provide C-4 Intertie Pipeline	Admin Gas and Electric	90.0%	110.0%	90.0%	0	$0	$0
				Totals ***	**174,342**	**$16,066**	**$16,066**

* The savings shown in this table are less than the calculated savings unless a guarantee multiplier of 100% is shown.

** The guarantee is based on Key Performance Indicators shown in Table 3.2. Refer to Section 3 of the ESP for the method of converting Key Performance Indicators to dollars during the M&V period.

*** The guarantee is based on the aggregate savings for all FIMs, not on individual FIM savings.

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Table 3.2 - M&V Plan Outline

Project	Covington Water District
Scenario	C-4 Intertie Pipeline Final ESP
Date	7/13/2017

						Audit Stage (Baselining)	Post Retrofit (Commissioning)	Annual		
FIM Name	Facility	KPI	Key Performance Indicators	Baseline Values	Proposed Values	Tasks	Tasks	Tasks	Ongoing Owner Responsibilities	Stipulated Factors
10.03-CWD Provide Water Turbine at New Intertie	Admin Gas and Electric	1.	System Size	0 kW AC	11 kW to 27 kW output (20.9 kW output average)	Anticipated flow data provided by Covington Water District. Anticipated available head pressure provided by Design team.	Review as-builts and start-up reports to verify installed system configuration size has potential to meet design system kW output	Determine potential to perform by comparing the actual system output to the anticipated output, (within +/-5%). Will be confirmed through field measurement or system analysis during period of high head pressure delta p.	Owner shall notify McKinstry of any operational issues or damages, and shall maintain equipment per manufacturers recommendations	Water system demand and flow, available head pressure from water source, electric rates
		2.	Hours of Operation	0 hours/year	8,395 hours/year	Anticipated flow data provided by Covington Water District	Review as-builts and start-up reports to verify installed system configuration size has potential to meet design system kW output	Review trend report of actual turbine run-time	Owner shall notify McKinstry of any operational issues or damages, and shall maintain equipment per manufacturers recommendations	Water system demand and flow, available head pressure from water source, electric rates

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Table 3.3 - Base Utility Rates

Project	Covington Water District
Scenario	C-4 Intertie Pipeline Final ESP
Date	7/13/2017

Building_Name	Utility_Provider	Rate_Name	Utility_Type	Dollars_Per_Unit	Units	Published_Date_Effective
Admin Gas and Electric	Puget Sound Energy (PSE)	Administration Blended Gas Rate	Natural Gas	$1.282000	Therms	3/1/2015
Admin Gas and Electric	Puget Sound Energy (PSE)	Sch 25 Blended Rate	Electricity	$0.092153	kWh	1/31/2017

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Project Financials

4.1 Maximum Project Allowable Cost

McKinstry guarantees that the Maximum Project Cost will not exceed the guaranteed value shown in Table 4.1 – Budget Summary; this cost does not include sales tax, WA State Interagency fees, or the utility incentive. The sales tax and interagency fees are shown in Table 4.1 for reference, and the utility incentive is shown in Table 4.2 for reference. (McKinstry does not guarantee the value of sales tax, interagency fees, or the utility incentive.)

Costs presented in this proposal are valid for 30 days from the date of publication. If the notice to proceed is issued after 30 days from publication, McKinstry reserves the right to re-evaluate the project and make necessary modifications to the construction costs.

4.2 Project Cost Table

See Table 4.1 – Budget Summary. All fee percentages and costs are unique to the project.

4.3 Items Included in Maximum Project Cost

1. Engineering audit, which includes the cost for the preparation of this proposal
2. Engineering design
3. Construction management services
4. Installation of McKinstry Equipment including the following costs as specified in the scope of work:
    a. All costs paid by McKinstry for the installation of the equipment. This includes costs paid to subcontractors or directly to McKinstry personnel, when related to installation or system verification of McKinstry equipment.
    b. The portion of reasonable travel, lodging, and meal expenses of officers or employees incurred while traveling in discharge of duties connected with the work. McKinstry will comply with OFM guidelines for reimbursement of travel expenses.
    c. Cost of all materials, supplies, and equipment incorporated in the Work, including costs of transportation thereof.
    d. Cost or rental charges, including transportation and maintenance, of all materials, supplies, equipment, temporary facilities, and hand tools not owned by the workers, which are consumed in the performance of the work and cost less salvage value on such items used but not consumed which remain the property of McKinstry.
    e. Cost of premiums for all bonds and insurance, which McKinstry is required to purchase and maintain.
    f. Sales, use, or similar taxes related to the Work and for which McKinstry is liable imposed by a governmental authority.
    g. Permit fees, royalties, and deposits lost for causes other than McKinstry's negligence.
    h. Losses and expenses not compensated by insurance or otherwise, sustained by McKinstry in connection with the work, provided they have resulted from causes other than the fault or neglect of McKinstry. Such losses shall include settlements made with the written consent and approval of the Owner and the DES Energy Program. If, however, such loss requires reconstruction and McKinstry is placed in charge thereof, McKinstry shall be paid a fee for such services.
    i. Demolition cost and cost of removal of all debris unless specifically excluded within the Scope of Work.

j. Costs incurred due to an emergency affecting the safety of persons and property.

k. Other costs incurred in the performance of the Work if and to the extent approved in advance in writing by the Owner and DES.

l. Contingency as defined in Section 4.4.

m. Allowances as defined in Section 4.5.

n. Cost of equipment startup, training, system verification, and balancing performed by McKinstry.

o. Construction Bonds (including Performance & Payment Bond), Liability Insurance, and Builder's Risk Insurance.

p. McKinstry fee. This includes McKinstry's remuneration for compensation of personnel, expenses, risks related to the project, overhead, and profit.

4.4 Construction Contingency

A construction contingency as identified in Table 4.1 – "Budget Summary" has been established for this project. McKinstry can expend the contingency after a change order has been approved by the Owner, McKinstry, and the DES Project Manager for items necessary to complete the original scope of this project. The intent of the contingency is for "unforeseen conditions" beyond what was originally estimated. McKinstry and the Owner and DES will jointly manage any contingency left after the project scope is completed. All unused construction contingency funds shall reduce the overall project cost to the Owner.

4.5 Allowances

McKinstry may set aside allowances as identified in Table 4.1 - "Budget Summary" for specific areas of work that have been identified as a potential cost impact but cannot be determined at this stage. Should the allowance not be adequate, the Owner and the DES Project Manager will be advised. McKinstry will be compensated for any additional costs via Change Order to the contract should the Owner and the DES Project Manager agree. In extreme situations, McKinstry may request additional funds to cover cost overruns that could not have been foreseen by either party.

4.6 Ongoing Services

Refer to Table 4.1 for the cost and duration of any ongoing services.

4.7 Accounting Records

McKinstry shall check all material, equipment, and labor entering into the worksite and shall keep such full and detailed accounts as may be necessary for proper financial management under this Agreement. The Owner and the DES Project Manager shall be afforded access to all McKinstry's records, books, correspondence, instructions, drawings, receipts, vouchers, memoranda, and similar data relating to this Contract, and the McKinstry shall preserve all such records for a period of seven years, or for such longer period as may be required by law, after the final payment.

4.8 Reconciliation of Labor & Material Costs

The maximum project allowable cost is based on firm negotiated bids or estimated labor and material costs developed by McKinstry. In recognition that actual Labor & Material costs may vary from the estimate, the following procedures are established to reconcile this difference:

1. If the total maximum guaranteed project cost at completion exceeds the estimated amount (plus contingency), the additional costs will be borne by McKinstry at their expense.

Project Financials

2. If the total project costs at completion are less than the estimated proposal amount (less contingency), the savings will be retained by the Owner.
3. There shall be no cost savings split between the Owner and McKinstry.

The following Figure 4.A outlines proposed procurement and payment reconciliation methods. Changing the proposed method of reconciliation after the acceptance of the Proposal may require an adjustment to the Guaranteed Maximum Project Cost.

DEFINITIONS:

Major Equipment:
Major Equipment is any single piece of equipment purchased by McKinstry with a value over $5,000.

Negotiated:
Construction contract value is to be established through negotiations with a select or single contractor (i.e. owner preferred controls contractor, mechanical contractor, etc.).

Bid:
Construction contract value is to be established through a bid process based upon formal bid documents including plans and specifications which will be bid to a minimum of two (typically three) pre-qualified contractors as approved by McKinstry and the Owner.

Self-Perform:
McKinstry intends to perform work with McKinstry personnel.

Schedule of Values (SOV):
Cost shall be substantiated with a properly executed invoice from the subcontractor or supplier that matches the schedule of values in their contract or purchase order.

Time & Materials (T&M):
Published sell rates will be established prior to issuance of contract to subcontractor or commencement of work by McKinstry. A monthly labor and material report will be provided which will include labor hours and dollars per individual, and material and equipment invoices.

Firm:
Fees that are negotiated prior to proposal and are not reconciled at the end of the project.

FIGURE 4.A

CONSTRUCTION COST CATEGORY (REF TABLE 4.1)	PROPOSED CONSTRUCTION METHOD	END OF PROJECT – RECONCILED (SOV OR T&M)
Turbine Equipment	Negotiated Subcontract Sole Source	SOV
Major Equipment	Negotiated	SOV
Electrical	Subcontract Bid	SOV
Civil	Subcontract Bid	SOV
General Construction	Subcontract Bid	SOV
TAB/Start up	Negotiated Subcontract Sole Source	SOV
Commissioning	Negotiated Subcontract Sole Source	SOV

Project Financials

Change Order (CO)	As Specified in CO	T&M
Fees	Self-Perform	Firm

4.9 Compensation

1. TERMS:
   Net 30 days (45 days for State Treasurer payments) from the date of invoice, monthly billings as the job progresses.
2. PAYMENTS:
   At a minimum, payments will be made in the amount of 100% at the completion and implementation of any individual facility improvement measure (FIM) in the amount of that FIM as delineated in the contract. If more than one FIM is completed in a monthly period, all those FIMS will be paid.
3. FINANCE CHARGES ON UNPAID BALANCES:
   Payments due and unpaid shall be subject to interest charges within 30 days (45 days for State Treasurer payments) of receipt of a properly completed invoice per RCW 39.76. Finance charges will be calculated on the un-paid balance per RCW 39.76 which specifies the interest rate shall be one percent per month but not less than one dollar per month on amounts due beyond 30 days. Interest charges will be calculated daily, compounded monthly. Charges accrue until balances are paid in full.
4. SUBSTANTIATION OF FINANCE CHARGE:
   McKinstry will do an accounting of finance charges progressively through the project, and at contract completion submit a change request itemizing the summary of additional costs for implementation. The contract will then be increased to reflect the same and finance charges will be paid within 30 days of the date of approved substantiation.

4.10 Financing

McKinstry enjoys over 55 years of experience within the engineering and contracting industry and its financial strength exceeds the industry average. This strength makes it possible to provide and assist with the financing needs of its customers. Long standing relationships with vendors assures reasonable pricing and excellent payment terms.

LONG-TERM FINANCING:

The Owner has secured capital for this project and long-term financing is not planned through the State ESCO Program.

4.11 Termination Value

Should the owner choose to finance the project through McKinstry, a schedule will be provided showing the termination value of the financing agreement for each year during the term of the agreement.

4.12 Terms of Agreement

The Contract shall be effective and binding upon the parties immediately upon its execution and the period from contract execution until the Commencement of Energy Savings Date shall be known as the "Interim Period". All energy savings achieved during the interim period will be fully credited to the Owner.

4.13 Insurance & Bonding

McKinstry shall provide a payment and performance bond and builders Risk Insurance.

Project Financials

For The Purposes of This Agreement, the "Sum Amount of Bond" Shall Be (See Table 4.1 –"Budget Summary").

1. The bond amount consists of Labor and Materials and State Sales Tax.
2. This bond does not include any construction contingencies.
3. Certificates of General Liability Insurance will be provided prior to Contract Signing. The State of Washington shall be named as An Additional Insured on all insurance certificates.

McKinstry shall provide a payment and performance bond in the amount of 100% of the construction cost, as defined in the Energy Services Agreement Addendum. The amount shall include all authorized changes and state sales tax. The Bond shall be in the form attached to the Conditions of the Energy Services Agreement. The Contract listed on the bond form shall be the Addendum No. and Agreement No., which incorporates the work, and the "Contract Date" shall be the date of the Addendum. The full and just sum of the Bond shall be as defined above and shall include the actual cost of purchasing and installing McKinstry's Equipment. The Bond shall specifically exclude coverage for those portions of the Energy Services Agreement and/or Energy Services Agreement Addendum pertaining to design services, energy cost savings guarantee, maintenance guarantee, utility incentives, efficiency guarantees, and any other clauses which do not relate specifically to construction management and supervision of work for purchasing and installing of McKinstry's Equipment, or for work to be accomplished by the Owner. The Bond shall be with a Surety or Bonding Company that is registered with the State of Washington Insurance Commissioner's Office.

While McKinstry stands behind our safety record, we cannot control the work flow around items we have no control over. At no point does McKinstry assume any responsibility for the loss of use of any equipment and we exclude any and all claims for consequential damages therein.

4.14 Diverse Business Participation Goals for this Project

McKinstry has established the following diverse business participation goals for this project in consultation with the Owner and the DES Energy Program.

McKinstry will not be able to meet the McKinstry standard Inclusion Plan diverse business participation goals for the following reasons:

(1) This is a specialty turbine project and there will only be one subcontractor for construction of the turbine package.

McKinstry has provided information and training to many potential subcontractors, suppliers, and consultants on how to register for the State certifications.

The following tables are a list of diverse subcontractors or suppliers who may provide services or assistance on this project, and project specific inclusion goals.

FIGURE 4.C

CANYON HYDRO (SMALL BUSINESS)
ELECTRICAL CONTRACTOR (TO BE BID)
CIVIL CONTRACTOR (TO BE BID)

Project Financials

FIGURE 4.D

State Certification Categories	MESA Amendment No. 1 Percentages	For this Project: Percentages for Construction	For this Project: Percentages for Professional Services
Minority-owned business	10%	0%	0%
Women-owned business	6%	0%	0%
Veteran-owned business	5%	0%	0%
Small/mini/micro business	5%	9%	0%

Table 4.1 - Budget Summary

Project	Covington Water District
Scenario	C-4 Intertie Pipeline
Date	7/13/2017

Database ID	FIM Name	Mechanical	Electrical	EMCS	Lighting	General	Equipment	Other	Total
32495	10.03-CWD Provide Water Turbine at New Intertie	$ 69,733	$ 87,129	$ -	$ -	$ 70,560	$ 86,535	$ -	$ 313,957
33907	30.01-CWD Provide C-4 Intertie Pipeline	$ -	$ 150,725	$ -	$ -	$ 932,588	$ -	$ -	$ 1,083,313
	Total Base FIM Cost	$ 69,733	$ 237,854	$ -	$ -	$ 1,003,148	$ 86,535	$ -	$ 1,397,270

A. Construction Costs					
	Subtotal(FIM Cost and A)				*$ 1,397,270*
	Construction Bonds	%	1.00%	Percent of Subtotal (FIM Cost and A)	$ 13,973
				Total Construction Cost	$ 1,411,243

B. Professional Services Costs					
	Audit Fee	Lump	$34,055		$ 34,055
	Design	Lump	$207,800		$ 207,800
	Const. Management & Proj. Admin	%	6.00%	Percent of Total Base FIM Cost	$ 83,836
				Total Professional Services Cost	$ 325,691

C. Other Project Costs					
	Project Contingency	%	5.00%	Percent of Total Base FIM Cost	$ 69,864
	Performance Assurance (M&V) Yr 1	Lump	$1,500		$ 1,500
	Performance Assurance (M&V) Yr 2	Lump	$1,560		$ 1,560
	Performance Assurance (M&V) Yr 3	Lump	$1,682		$ 1,682
				Total Other Project Cost	$ 74,606

D. Overhead Costs & Fees					
	Overhead	%	10.00%	Percent of Total Construction Cost	$ 141,124
	Profit (Fee)	%	8.00%	Percent of Total Construction Cost	$ 112,899
				Total Overhead Cost & Fee	$ 254,024

E. Total Guaranteed Construction & ESCO Services (A + B + C + D)	$ 2,065,563

F. Non-Guaranteed Costs					
	Sales Tax	%	8.60%	Percent of Section E	$ 177,638
	WA DES Fee	Lump	$60,000		$ 60,000
				Total Non-Guaranteed Cost	$ 237,638

G. Total Maximum Project Cost (E + F)	$ 2,303,202

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Table 4.2 - Facility Improvement Measure (FIM) Summary

Project	Covington Water District
Scenario	C-4 Intertie Pipeline Final ESP
Date	July 13, 2017

			A	B	C	D = A - C	
Facility Improvement Measures	FIM Description	Facility	Budget *	Annual Utility Savings	Commerce Grant	Net Customer Cost (with Incentives)	Simple Payback (SPB) (with Grant)
10.03-CWD Provide Water Turbine at New Intertie	Provide an electric generation water turbine at the new C-4 intertie to generate electricity. This location is the new, planned intertie between the Tacoma Water system and the 660 pressure zone of the Covington Water District. It is gravity fed from the source at the Howard Hanson Dam. Design flow for the turbine will be an average 865 gpm for approximately 11.5 months out of the year, allowing for service down-time. Differential pressure is expected to be 170 to 220 feet of head (830 to 880 feet above sea level at the source down to 660 feet above sea level). The initial turbine size has a 28 to 47 kW output, using a 55.9 kW, 1800 rpm, 208 VAC, 60 Hz, 3 phase motor to produce electricity. Power from the turbine will be fed back to the Administration Building and would be net-metered with the PSE electrical service.	Admin Gas and Electric	$376,749	$16,066	$79,447	$297,302	18.5
30.01-CWD Provide C-4 Intertie Pipeline	Provide a new transmission main between the Tacoma Utilities C-4 tap and the 660 pressure zone in the Covington Water District water system per the Gray & Osborne Permit drawings, dated June 19, 2017.	Admin Gas and Electric	$1,926,453	$0	$0	$1,926,453	Needs Based
		Totals	**$2,303,202**	**$16,066**	**$79,447**	**$2,223,755**	

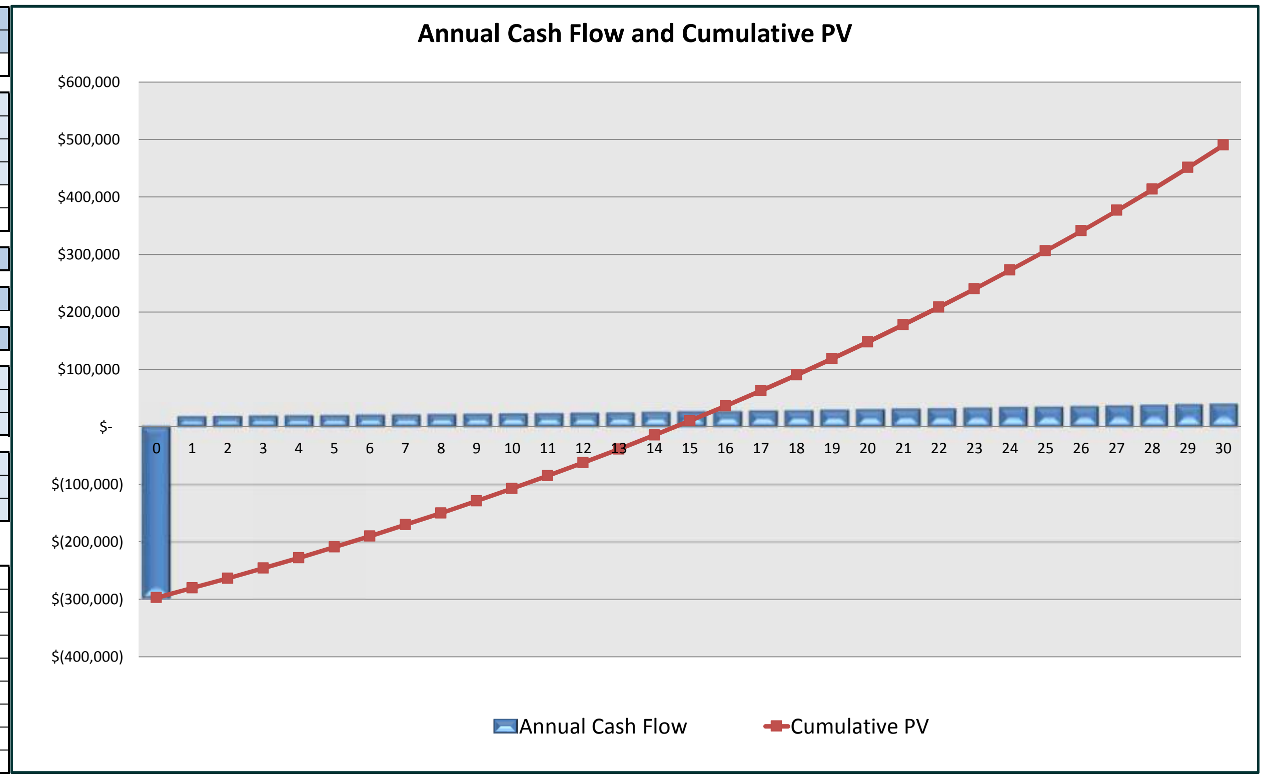
* Since design cost, audit cost, etc. are distributed among the FIMs, the total project cost will not go up or down by exactly the amounts shown here if a FIM or FIMs are dropped.
** For non recurring operational savings, the values are averaged over the 30 year length of this analysis.
*** Incentives are contingent on final approval and are not guaranteed. Funds are shown for reference only.

Table 4.3 - Cash Flow Analysis (10.03-CWD Provide Water Turbine at New Intertie)

Project:	Covington Water District
Scenario:	C-4 Intertie Pipeline Final ESP
Report Date:	July 13, 2017
Financing Source:	TBD

Inputs

First Cost	$376,749
Commerce Grant	$79,447
Net Customer Cost	$297,302
Financing Term (Years)	10
Annual Interest Rate %	4.00%
Amortization Type	Standard
Amount Financed	$0
Amount Financed	$0
Capital Infusion	$297,302
Length of Analysis (Yrs.)	30
Annual Electrical Utility Savings ($)	$16,066
Annual Opperational Savings ($)	$0
Annual Measure and Verification Fee (Included)	$0
M&V Start Year	1
M&V End Year	3
Discount Rate	0.0%
Cap Rate	3.0%
Customer Net Margin	3.0%



Results

Overall Net Present Value (NPV)	$489,982
Annual Equivalent Cash Flow	$16,333
Annual Revenue Increase Equivalent	$544,425
Asset Value Enhancement	$544,425
Internal Rate of Return (IRR)	6.6%
Savings NPV	$866,731
Investment NPV	-$376,749
Savings to Investment Ratio (SIR)	2.30
Breakeven Period (Yrs.)	15

Cash Flow Analysis:

Period	Escalation	0	1	2	3	4	5	6	7	8	9	10
First Cost Minus Financed Amount		$ (376,749)										
2017 Commerce Grant		$ 79,447										
Other Grants and Incentives		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Loan Payments			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual Electrical Utility Savings ($)	3.0%		$ 16,548	$ 17,045	$ 17,556	$ 18,083	$ 18,625	$ 19,184	$ 19,759	$ 20,352	$ 20,963	$ 21,592
Residual Value (Today's Dollars)												
Residual Value (Escalated)	3.0%											
M&V Fee (included)	2.0%		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual Cash Flow		$ (297,302)	$ 16,548	$ 17,045	$ 17,556	$ 18,083	$ 18,625	$ 19,184	$ 19,759	$ 20,352	$ 20,963	$ 21,592
Present Value (PV) Factor		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Annual PV		($297,302)	$16,548	$17,045	$17,556	$18,083	$18,625	$19,184	$19,759	$20,352	$20,963	$21,592
Cumulative PV		**($297,302)**	**($280,754)**	**($263,709)**	**($246,153)**	**($228,071)**	**($209,446)**	**($190,262)**	**($170,502)**	**($150,150)**	**($129,188)**	**($107,596)**

Period	11	12	13	14	15	16	17	18	19	20
First Cost Minus Financed Amount										
2017 Commerce Grant										
Other Grants and Incentives	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Loan Payments	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual Electrical Utility Savings ($)	$ 22,239	$ 22,906	$ 23,594	$ 24,301	$ 25,031	$ 25,781	$ 26,555	$ 27,352	$ 28,172	$ 29,017
Residual Value (Today's Dollars)										
Residual Value (Escalated)										
M&V Fee (included)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual Cash Flow	$ 22,239	$ 22,906	$ 23,594	$ 24,301	$ 25,031	$ 25,781	$ 26,555	$ 27,352	$ 28,172	$ 29,017
Present Value (PV) Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Annual PV	$22,239	$22,906	$23,594	$24,301	$25,031	$25,781	$26,555	$27,352	$28,172	$29,017
Cumulative PV	**($85,357)**	**($62,450)**	**($38,857)**	**($14,555)**	**$10,475**	**$36,257**	**$62,812**	**$90,163**	**$118,335**	**$147,353**

Covington Water Disctrict

C-4 Intertie Power Turbine

Investment Grade Audit

Revision 1

COVINGTON, WASHINGTON

July 13, 2017

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5. Directed Engineering Study

Table of Contents

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Directed Engineering Study cont.

5.1 PURPOSE AND ORGANIZATION

This exhibit documents the analysis performed to establish the utility and operational savings for the project.

The information is organized by FIM (Facility Improvement Measure) as follows:

- FIM Narrative with key assumptions and criteria
- Savings calculation methodology and analysis

Additionally, relevant site survey data, measurement and verification data, utility information and miscellaneous back-up information are provided in the sections following the various FIM sections.

Directed Engineering Study cont.

5.2 EXISTING FACILITY DESCRIPTION

General Information

The Covington Water District is located at 18631 SE 300th Pl, Kent, WA 98042.

Currently, Covington Water District is in the process of designing and installing a new intertie, designated C-4, with Tacoma Water (see the approximate routing in yellow above). This study proposes providing a water turbine near the Administration Building. The new intertie will serve the 660 Zone and future storage tank, located in the future at the north end of the new intertie. The pipeline will terminate at the existing north tank for this phase of the project.

See the following pages for a brief description of the buildings located at the Administration Site.

5.2.1 Administration Building

Facility Facts:
Administration Building
18631 SE 300th PL
Covington, WA 98042

Admin Site Energy Use Index (kBtu/ft^2/yr)	**41**
Admin Site Energy Cost Index ($/ft^2/yr)	**$0.97**
Gross Area (ft^2)	**15,336**
Year Built	**1969, Remodeled in 1999**
Estimated Average Number of Occupants	**40**
Estimated Number of Personal Computers	**40**
Preliminary Energy Star Score	**N/A**

Hours of Operation	
Monday	8:00 am to 5:00 pm
Tuesday	8:00 am to 5:00 pm
Wednesday	8:00 am to 5:00 pm
Thursday	8:00 am to 5:00 pm
Friday	8:00 am to 5:00 pm
Saturday	Closed
Sunday	Closed

Facility Use Description

The Administration Building is the main Office for the Covington Water District. The building has open as well as private/closed office space as well as conference rooms, a break room and storage.

General Facility Notes

Heating, Ventilation & Air Conditioning (HVAC) Equipment

System	Equipment Description	Notes
Cooling:	DX Cooling in packaged rooftoop units.	AHU-1 serves the majority of the building through VAV terminals (three stages of cooling). AHU-2 serves the Lunch Room one stage of cooling). AHU-3 serves the Boardroom (one stage of cooling).
	FCU-1 (Split Condenser Fan Coil Unit)	Cools the Computer Room.
Heating:	Gas-fired, packaged rooftoop units. Electric reheat at perimeter VAV boxes.	AHU-1 serves the majority of the building through VAV terminals. AHU-2 serves the Lunch Room. AHU-3 serves the Boardroom.
	No heat for FCU-1 (Computer Room)	Four stages of gas-fired heat at AHU-1. One stage of gas-fired heat at AHU-2 and AHU-3.
Air Dist:	Ducted variable air volume	17 VAV Zones on Main AHU-1.
	Single Zone Air Handlers	AHU-2 serves the Lunch Room. AHU-3 serves the Boardroom. FCU-1 serves the Computer Room.

Heating, Ventilation & Air Conditioning (HVAC) Controls

Item	Equipment Description	Notes
HVAC Controls:	Enertec / BAS Corporation Direct Digital Controls	EnerNet Server DDC Commercial Energy Management System, version 3.9i.46 (BAS.EXE, 12/9/2008). The control system was showing an incorrect outside air temperature of -12°F at the time of our site visit.
	Dell, 2.93 GHz Intel Core 2 Duo, Central Control Computer with 4 GB RAM	Microsoft Windows 7 Professional, version 6.1.7601 Service Pack 1 Build 7601

Lighting System

Item	Equipment Description	Notes
Fixture Type:	32 watt, T-8 lamps	Most offices spaces are lit by T-8 fixtures
	Compact Flourescent	Corridors and Conference Rooms are lit by CFL fixtures. Many common areas have their lights manually turned off.
	Metal Halide	Open office spaces have indirect metal halide lighting

Other Facility Information

Roofing:	Wood construction. Sheet metal roofing with insulation.	**Windows:**	Double Pane
Walls:	Masonry walls.	**# of Floors:**	2 (Basement Office, 2,140 sf gross area; Office Building, 12,584 sf gross area)
Water Fixtures:	Conventional 1.6 gpf toilets, 1 gpf urinals, 2 gpm aerators	**Domestic Hot Water:**	Confirm electric domestic hot water heater.

Facility Facts:
Office Building B
18631 SE 300TH PL
Covington, WA 98042

McKinstry
For The Life Of Your Building

Admin Site Energy Use Index (kBtu/ft^2/yr)	41
Admin Site Energy Cost Index ($/ft^2/yr)	$0.97
Area (ft^2)	1,970
Year Built	1974
Estimated Average Number of Occupants	5
Estimated Number of Personal Computers	5
Preliminary Energy Star Score	N/A

Hours of Operation	
Monday	8:00 am to 5:00 pm
Tuesday	8:00 am to 5:00 pm
Wednesday	8:00 am to 5:00 pm
Thursday	8:00 am to 5:00 pm
Friday	8:00 am to 5:00 pm
Saturday	Closed
Sunday	Closed

Facility Use Description

Small office building.

General Facility Notes

Site not visited in intial site walk.

Heating, Ventilation & Air Conditioning (HVAC) Equipment

System	Equipment Description	Notes
Cooling:		
Heating:		
Air Dist:		

Heating, Ventilation & Air Conditioning (HVAC) Controls

Item	Equipment Description	Notes
HVAC Controls:		

Lighting System

Item	Equipment Description	Notes
Fixture Type:		

Other Facility Information

Roofing:		Windows:	
Walls:	Wood frame walls	# of Floors:	1
Water Fixtures:		Domestic Hot Water:	

5.2.3 Shop Building C

Facility Facts:

Shop Building C
18631 SE 300TH PL
Covington, WA 98042

Admin Site Energy Use Index (kBtu/ft^2/yr)	41
Admin Site Energy Cost Index (\$/ft^2/yr)	\$0.97
Area (ft^2)	4,230
Year Built	1990
Estimated Average Number of Occupants	5
Estimated Number of Personal Computers	5
Preliminary Energy Star Score	N/A

Hours of Operation	
Monday	8:00 am to 5:00 pm
Tuesday	8:00 am to 5:00 pm
Wednesday	8:00 am to 5:00 pm
Thursday	8:00 am to 5:00 pm
Friday	8:00 am to 5:00 pm
Saturday	Closed
Sunday	Closed

Facility Use Description

Shop and operations office space.

General Facility Notes

The main shop is located in this building.

Heating, Ventilation & Air Conditioning (HVAC) Equipment

System	Equipment Description	Notes
Cooling:	Small packaged terminal air conditioner (PTAC).	
Heating:	Electric Heat. Gas furnace serving the office.	
	Gas unit heater in the Shop.	
Air Dist:	Small ducted furnace system for the office.	

Heating, Ventilation & Air Conditioning (HVAC) Controls

Item	Equipment Description	Notes
HVAC Controls:	Local thermostat control of the heaters.	

Lighting System

Item	Equipment Description	Notes
Fixture Type:	Primariliy T-8 Lighting	
	8' long, T-12 Lighting is present in the Shop (high bays)	

Other Facility Information

Roofing:	Wood roof with composite shingles	Windows:	Double pane
Walls:	Pre-fab Steel	# of Floors:	1 (Equipment Shop, 3,300 sf; Office, 930 sf)
Water Fixtures:	Conventional 1.6 gpf toilets, 1 gpf urinals, 2 gpm aerators	Domestic Hot Water:	Confirm electric domestic hot water heater.

5.2.4 Storage Garage / Office Building G

Facility Facts:

Storage Garage / Office Building G

18631 SE 300TH PL

Covington, WA 98042

Admin Site Energy Use Index (kBtu/ft²/yr)	**41**
Admin Site Energy Cost Index ($/ft²/yr)	**$0.97**
Area (ft²)	**2,420**
Year Built	**1999**
Estimated Average Number of Occupants	**5**
Estimated Number of Personal Computers	**5**
Preliminary Energy Star Score	**N/A**

Hours of Operation	
Monday	8:00 am to 5:00 pm
Tuesday	8:00 am to 5:00 pm
Wednesday	8:00 am to 5:00 pm
Thursday	8:00 am to 5:00 pm
Friday	8:00 am to 5:00 pm
Saturday	Closed
Sunday	Closed

Facility Use Description

Storage, garage and small office.

General Facility Notes

This is an active office for the field crew, including Water Resources Operations.

Heating, Ventilation & Air Conditioning (HVAC) Equipment

System	Equipment Description	Notes
Cooling:	Unit Ventilators	
Heating:	Electric Space Heaters.	
Air Dist:	Two general exhaust fans.	

Heating, Ventilation & Air Conditioning (HVAC) Controls

Item	Equipment Description	Notes
HVAC Controls:	Local thermostats.	

Lighting System

Item	Equipment Description	Notes
Fixture Type:	New T-8 lighting.	Check on lighting controls.

Other Facility Information

Roofing:	Sheet metal roofing. Peaked wood roof.	**Windows:**	Double Pane.
Walls:	Wood frame walls.	**# of Floors:**	1 (Office, 920 sf; Garage & Storage, 1,500 sf)
Water Fixtures:	Not present.	**Domestic Hot Water:**	Not present.

5.2.5 Garage/Storage Building F

Facility Facts:

Garage/Storage Building F
18631 SE 300TH PL
Covington, WA 98042

Admin Site Energy Use Index (kBtu/ft^2/yr)	41
Admin Site Energy Cost Index ($/ft^2/yr)	$0.97
Gross Area (ft^2)	1,080
Year Built	1998
Estimated Average Number of Occupants	0
Estimated Number of Personal Computers	0
Preliminary Energy Star Score	N/A

Hours of Operation	
Monday	8:00 am to 5:00 pm
Tuesday	8:00 am to 5:00 pm
Wednesday	8:00 am to 5:00 pm
Thursday	8:00 am to 5:00 pm
Friday	8:00 am to 5:00 pm
Saturday	Closed
Sunday	Closed

Facility Use Description

Garage and storage.

General Facility Notes

Heating, Ventilation & Air Conditioning (HVAC) Equipment

System	Equipment Description	Notes
Cooling:	Not present.	
Heating:	Electric wall heaters.	
Air Dist:	Not present.	

Heating, Ventilation & Air Conditioning (HVAC) Controls

Item	Equipment Description	Notes
HVAC Controls:	Local thermostat.	

Lighting System

Item	Equipment Description	Notes
Fixture Type:	T-8 lighting.	

Other Facility Information

Roofing:	Composite shingles over wood roof.	Windows:	None present. Steel roll-up doors.
Walls:	Wood frame walls.	# of Floors:	1
Water Fixtures:	Not present.	Domestic Hot Water:	Not present.

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Directed Engineering Study cont.

5.3 FACILITY IMPROVEMENT MEASURES – CALCULATIONS

FIM # 10.03-CWD PROVIDE WATER TURBINE AT NEW INTERTIE

Facility Improvement Measure (FIM) Detail

Project	Covington Water District
Scenario	C-4 Intertie Pipeline Final ESP
Date	July 13, 2017

FIM ID	32495	Facility	Admin Gas and Electric

FIM Name	10.03-CWD Provide Water Turbine at New Intertie

FIM Description

Provide an electric generation water turbine at the new C-4 intertie to generate electricity. This location is the new, planned intertie between the Tacoma Water system and the 660 pressure zone of the Covington Water District. It is gravity fed from the source at the Howard Hanson Dam. Design flow for the turbine will be an average 865 gpm for approximately 11.5 months out of the year, allowing for service down-time. Differential pressure is expected to be 170 to 220 feet of head (830 to 880 feet above sea level at the source down to 660 feet above sea level). The initial turbine size has a 28 to 47 kW output, using a 55.9 kW, 1800 rpm, 208 VAC, 60 Hz, 3 phase motor to produce electricity. Power from the turbine will be fed back to the Administration Building and would be net-metered with the PSE electrical service.

Savings Methodology

Spreadsheet calculation using the manufacturer's production output in kW and multiplying by the number of anticipated hours of operation that minimum flow is anticipated to be available per year.

McKinstry Calculation Template

10.03-CWD Provide Water Turbine at New Intertie

Project Information:

Project Name	Covington Water District	FIM Name	10.03-CWD Provide Water Turbine at New Intertie
TCO Project ID	854	Engineer	Mark Nieman
TCO Tool FIM ID	32495	Date	7/13/2017

Description of FIM From TCO Tool:

Provide an electric generation water turbine at the new C-4 intertie to generate electricity. This location is the new, planned intertie between the Tacoma Water system and the 660 pressure zone of the Covington Water District. It is gravity fed from the source at the Howard Hanson Dam. Design flow for the turbine will be an average 865 gpm for approximately 11.5 months out of the year, allowing for service down-time. Differential pressure is expected to be 170 to 220 feet of head (830 to 880 feet above sea level at the source down to 660 feet above sea level). The initial turbine size has a 28 to 47 kW output, using a 55.9 kW, 1800 rpm, 208 VAC, 60 Hz, 3 phase motor to produce electricity. Power from the turbine will be fed back to the Administration Building and would be net-metered with the PSE electrical service.

FIM Calculation Method From TCO Tool:

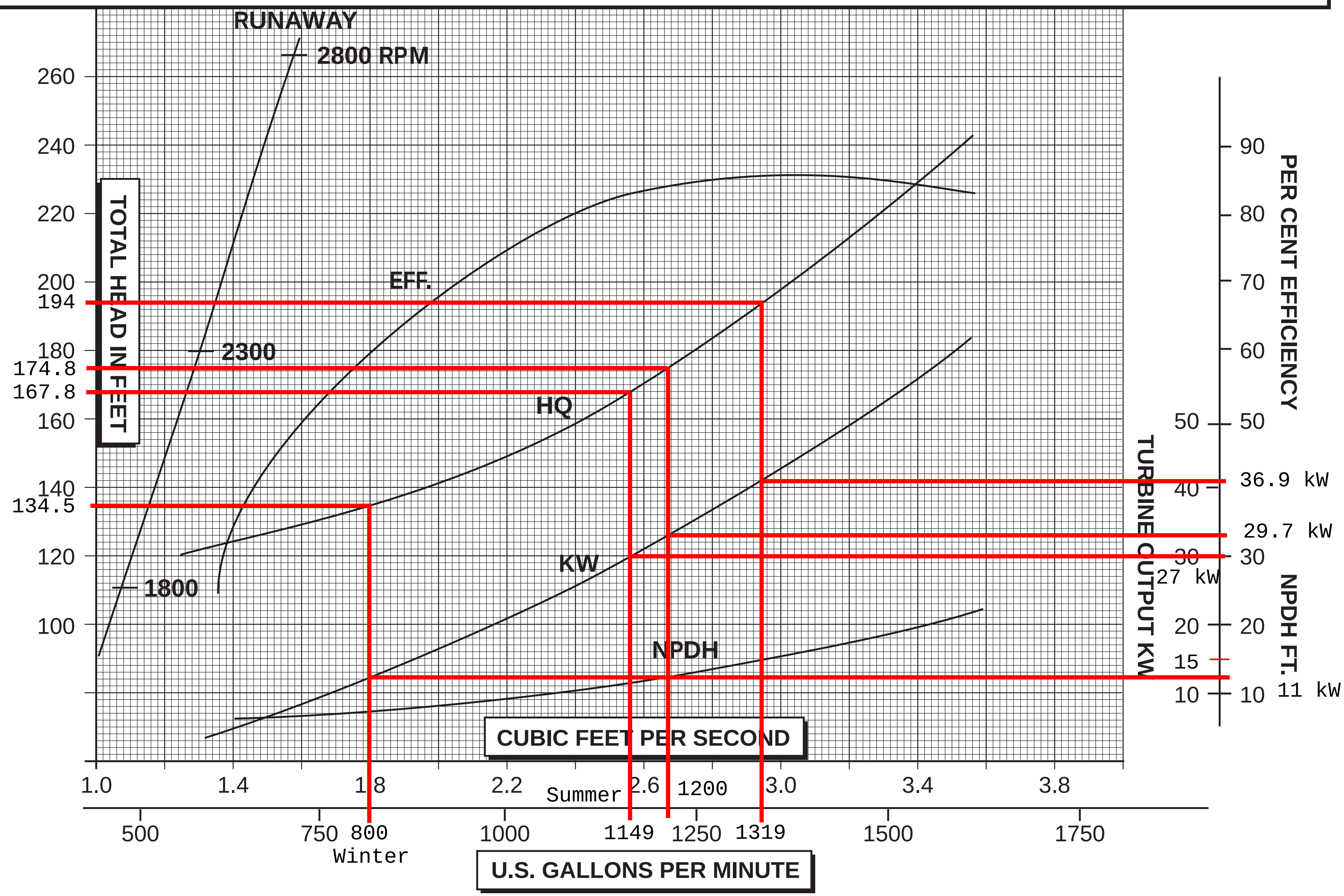
Savings is based on the **4TR2** turbine. Spreadsheet calculation using the manufacturer's production output in kW and multiplying by the number of anticipated hours of operation that minimum flow is anticipated to be available per year.

	Column:	A	B	C	D	E	F	G	H	
		Month	Head Differential (ft hd)	Flow (gpm)	Turbine Output (kW)	Available Hours	Utilization Factor (%)	Hours of Operation	kWh Production	Cost/kWh
	Formula:	Value	Chart	Chart	Chart	Hours/Mo.	Value	E*F	D*G	
C19		January	134.5	800	11.0	744	95%	707	7,775	$0.098371
C20		February	134.5	800	11.0	672	95%	638	7,022	$0.098371
C21		March	134.5	800	11.0	744	95%	707	7,775	$0.098371
C22		April	134.5	800	11.0	720	95%	684	7,524	$0.095230
C23		May	167.8	1,149	27.0	744	95%	707	19,084	$0.095230
C24		June	167.8	1,149	27.0	720	95%	684	18,468	$0.095230
C25		July	174.8	1,200	29.7	744	95%	707	20,992	$0.095230
C26		August	194.0	1,319	36.9	744	95%	707	26,081	$0.095230
C27		September	194.0	1,319	36.9	720	95%	684	25,240	$0.095230
C28		October	167.8	1,149	27.0	744	95%	707	19,084	$0.098371
C29		November	134.5	800	11.0	720	95%	684	7,524	$0.098371
C30		December	134.5	800	11.0	744	95%	707	7,775	$0.098371
C31		**Totals:**				**8,760**		**8,322**	**174,342**	

18 days down $ 0.092153 /kWh

$ 16,066 /year

INLET = 4.0 IN. EXHAUST = 6.0 IN.	N_S = 1290	SPEED = 1830 RPM	TURBINE MODEL — 4 TR2



4 TR2	CORNELL PUMP COMPANY • PORTLAND, OREGON	CORNELL

Directed Engineering Study cont.

5.4 FIMS FIM'S NOT USED IN THIS STUDY

The following FIM is not part of this study, as there is no energy or resource savings associated with the new pipeline itself.

- 07.01-CWD Upgrade Large Water Meters: Upgrade the three remaining large customer water meters that are no longer accurate or comply with the current meter reading protocol. This measure was performed by the District during normal O&M operations.

- 08.01-T1B Relocate Tank T-1B: Existing: Tank T-1B, located on the south part of the Covington Water District Administration and Facilities site, has a 20 hp circulation pump (86.8% NEMA nominal efficiency with F-class insulation). The circulation pump is operated for approximately two hours at a time, one to three times a week to facilitate circulation in Tank T-1B due to its low elevation within its pressure zone (the tank cannot drain without pump assistance). Proposed: Replace Tank T-1B with a different tank, located higher in its pressure zone, so that no pump is required. Eliminate the circulation pump.

  This measure will be executed at a later phase.

- 09.01-ADM Upgrade Interior Lighting: Interior lighting at the Administration Building is currently T-8 fluorescent, compact fluorescent can lights and some open office metal halide fixtures. The Administration Warehouse currently has T-12 lighting. This measure would upgrade interior lighting to LED throughout the Administration Facilities. Lighting control upgrades would also be investigated.

  This measure is recommended at a later phase.

- 09.02-ADM Upgrade Exterior Lighting: This measure investigates upgrading the exterior lighting to LED at the main Administration Site.

  This measure is recommended at a later phase.

- 10.01A-CWD Provide 50 kW Solar PV without Batteries: Provide a 43 kW array, located on the ground, over the septic field adjacent to the Administration Building. This option does not include battery storage and feeds directly into the local grid system.

  This measure was not selected by the District.

- 10.01B-CWD Provide 50 kW Solar PV with Batteries: Provide a 43 kW array, located on the ground, over the septic field adjacent to the Administration Building. This option includes a battery storage system for back-up power as well as feeding into the local grid system.

  This measure was not selected by the District.

- 10.02A-CWD Provide 11.5 kW Solar PV without Batteries: Provide a 11.5 kW array, located on the ground, over the septic field adjacent to the Administration Building. This option does not include battery storage and feeds directly into the local grid system.

  This measure was not selected by the District.

Directed Engineering Study cont.

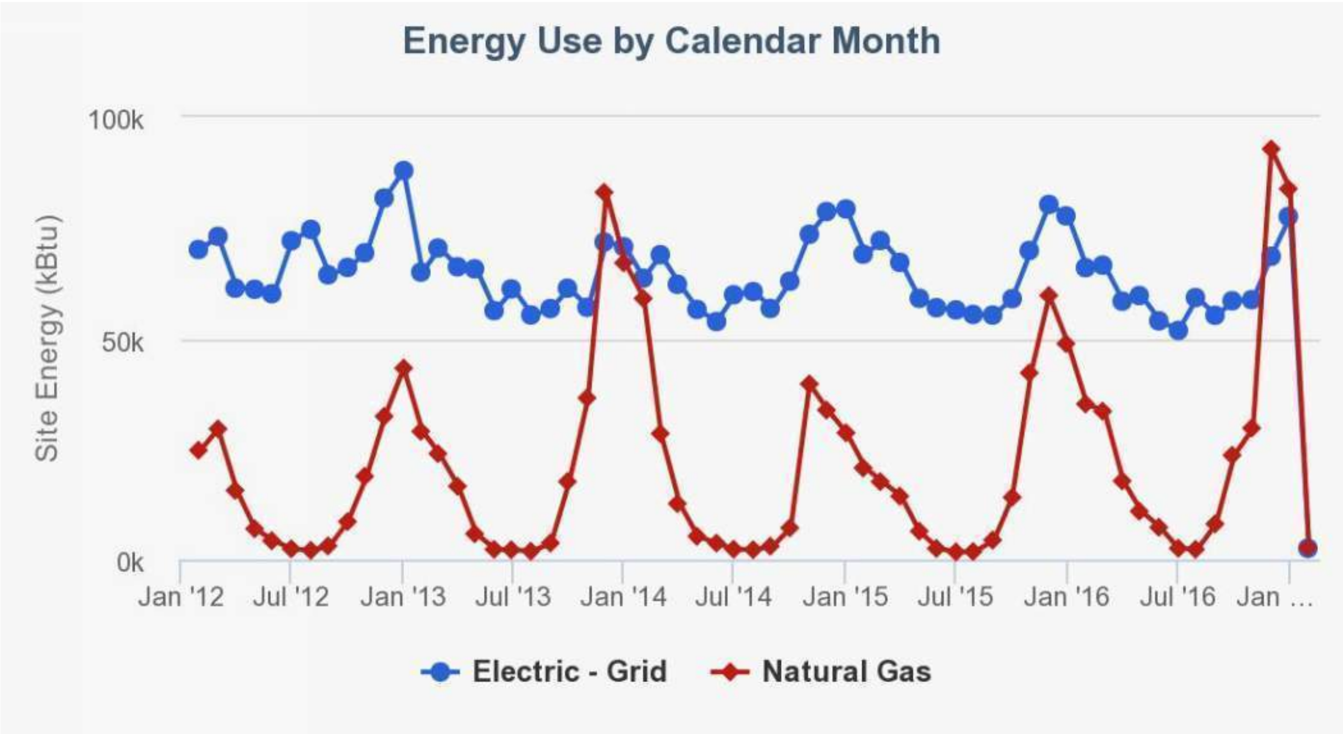
- 10.02B-CWD Provide 20 kW Solar PV with Batteries: Provide a 21.13 kW array, located on the roof of the Administration Building. This option includes a battery storage system for back-up power as well as feeding into the local grid system.

  This measure was not selected by the District.

Directed Engineering Study cont.

5.5 UTILITY DATA

Administration Site Energy Use



Administration Site Gross Square Footage Area (20,916 sf) by Use

Before and After Energy Utilization Index (EUI) Analysis

Project	Covington Water District
Scenario	C-4 Intertie Pipeline Final ESP
Date	July 13, 2017

Building	Sq Ft	Existing Total		Proposed Total		Proposed Savings		Existing kBtu		Proposed kBtu		Existing EUI (kBtu/sf/yr)			Proposed EUI (kBtu/sf/yr)		
		Electric [kWh]	Gas [Therms]	Electric [kWh]	Gas [Therms]	Electric [kWh]	Gas [Therm]	Electric [kBtu]	Gas [kBtu]	Electric [kBtu]	Gas [kBtu]	Electric EUI	Gas EUI	Total EUI	Electric EUI	Gas EUI	Total EUI
Admin Gas and Electric	20,916	212,791	2,635	38,449	2,635	174,342	0	726,042	263,458	131,187	263,458	34.7	12.6	**47.3**	6.3	12.6	**18.9**

Note: Utility Data between 2/1/2016 and 1/31/2017.

Covington Water District
Environmental Impact Calculator

NWPP **Select eGRID Subregion** **1.57907** **lbs CO_2e/kWh (eGRID Subregion Electricity Emissions Factor)**

Amount Each Utility Type Will Be Reduced Per Year

Utility	Amount	Unit		lbs CO_2	Metric Tonnes CO_2
Electricity	174,342	kWh	=	275,298 lbs CO_2	124.9 Metric Tonnes CO_2
Natural Gas	0	Therms	=	0 lbs CO_2	0.0 Metric Tonnes CO_2
Steam	0	Mlbs	=	0 lbs CO_2	0.0 Metric Tonnes CO_2
Fuel Oil	0	Gallons	=	0 lbs CO_2	0.0 Metric Tonnes CO_2
Propane	0	Gallons	=	0 lbs CO_2	0.0 Metric Tonnes CO_2
Total Reduction			=	275,298 lbs CO_2	124.9 Metric Tonnes CO_2

This Annual Emissions Reduction Is Equivalent To The Following:

24	Number of Vehicles Removed From Roads (Avg Size); or
466,607	Number of Miles Not Driven Per Year (Avg Size); or
3,441	Number of 75 Watt Light bulbs Not Energized; or
12	Number of Avg Sized Houses Removed From Power Grid; or
34	Acres of Trees Planted; or
128,644	Pounds of Coal Not Burned Per Year

Other Emissions Factors

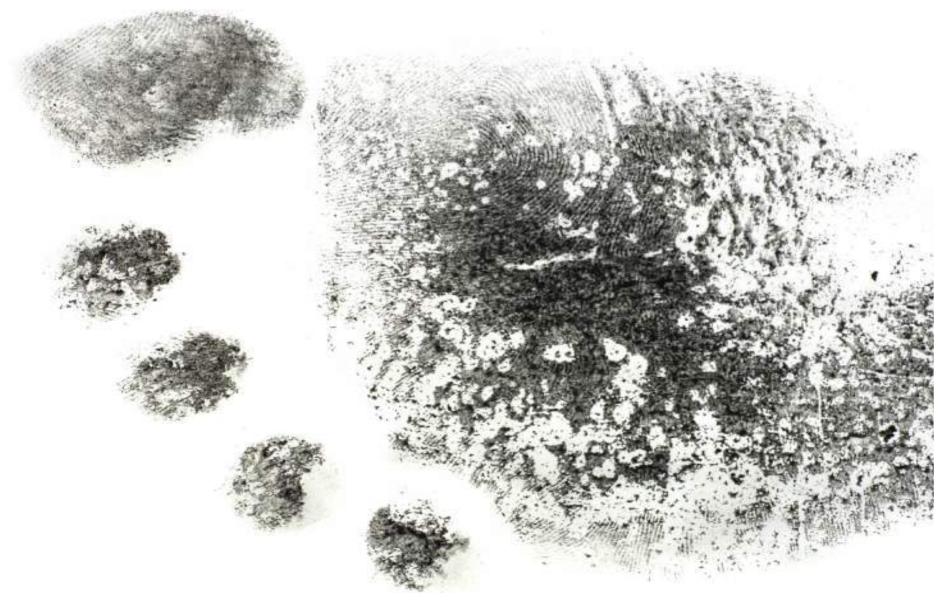
Natural Gas: 11.707 lbs CO_2 / Therm
Steam: 195.3636 lbs CO_2 / Mlbs (Seattle Steam)
Fuel Oil: 22.384 lbs CO_2 / gal
Propane: 12.5 lbs CO_2 / gal
Conversion: 2,204.623 lbs CO_2 / Metric Tonnes CO_2

Equivalents Conversions

Car Emmissions: 11,470 lbs CO_2 / car / yr
Tree Carbon Sequestation: 8,066 lbs CO_2 / acre / yr
Vehicle Mileage Emmissions: 0.59 lbs CO_2 / mile
75 W Light Bulb Emmissions: 80 lbs CO_2 / Light Bulb / yr
Tree Carbon Sequestation: 8,066 lbs CO_2 / acre / yr
Coal Emmisions: 2.14 lbs CO_2 / pound Coal
Houses Removed: 22,880 lbs CO_2 / house

Sources:

* Energy Information Agency (EIA)
* Environmental Protection Agency (EPA)
* ENERGY STAR
* eGRID 2012



ENERGY STAR® Statement of Energy Performance

N/A

ENERGY STAR® Score[1]

CWD Admin Building

Primary Property Type: Office
Gross Floor Area (ft²): 20,916
Built: 1969

For Year Ending: January 31, 2017
Date Generated: August 02, 2017

1. The ENERGY STAR score is a 1-100 assessment of a building's energy efficiency as compared with similar buildings nationwide, adjusting for climate and business activity.

Property & Contact Information

Property Address	Property Owner	Primary Contact
CWD Admin Building 18631 SE 300th Place Covington, Washington 98042	Covington Water District 18631 SE 300th Pl Kent, WA 98042 (____)____-______	Tom Malphrus 18631 SE 300th Pl Kent, WA 98042 253-867-0906 tom.malphrus@covingtonwater.com

Property ID: 5735777

Energy Consumption and Energy Use Intensity (EUI)

Site EUI
51.7 kBtu/ft²

Annual Energy by Fuel

Electric - Grid (kBtu)	733,640 (68%)
Natural Gas (kBtu)	347,113 (32%)

Source EUI
127.6 kBtu/ft²

National Median Comparison

National Median Site EUI (kBtu/ft²)	60
National Median Source EUI (kBtu/ft²)	148.1
% Diff from National Median Source EUI	-14%

Annual Emissions

Greenhouse Gas Emissions (Metric Tons CO2e/year)	84

Signature & Stamp of Verifying Professional

I __________________ (Name) verify that the above information is true and correct to the best of my knowledge.

Signature: ________________________Date: ___________

Licensed Professional

Mark Nieman
5005 3rd Ave S
Seattle, WA 98134
206-832-8152
markn@mckinstry.com

Professional Engineer Stamp
(if applicable)

My Portfolio: Covington Water District x
03/01/2017 06:28 PM EST
Total Properties: 1

Property Name	Portfolio Manager ID	Street Address	Street Address 2	City/Municipality	State/Province	Other State/Province	Postal Code	Country	Year Built	Property Type - Self-Selected	Construction Status	Gross Floor Area	GFA Units	Occupancy (%)	Number of Buildings	How Many Buildings?	Parent Property Name (if Applicable)	Parent Property ID	Is this Property Owned or Operated by the US or Canadian Federal Government?	Federal Agency/Department	Irrigated Area	Irrigated Area Units
CWD Admin Building	5735777	18631 SE 300th Place	Not Available	Covington	Washington	Not Available	98042	United States	1969	Office	Existing	20916	Sq. Ft.	100	More Than One	3	Not Available	Not Available	No	Not Available	Not Available	Not Available

Appendix 5: Patent Search Results

Title	Publication number	Publication date	Inventor(s)	Applicant(s)	International classification	Cooperative Patent Classification	Application number	Date of application	Priority number(s)	Patents cited in the search report
Hydro electric generating unit for micro-water-head hydroenergy development	CN202811180 (U)	2013-03-20	YOU ZANPEI HU LIWEI WENG YINGBIAO YANG LEIQI HU SHENGLU WU GUOYING	CHINA WATER RESOURCES PEARL RIVER PLANNING SURVERYING & DESIGNING CO LTD	F03B13/00 H02K7/18		CN20122507254U	20120929	CN20122507254U 20120929	
Micro-hydroelectric power plant	US4629904 (A)	1986-12-16	ROJO JR AGUSTIN [US] LEISECA JORGE [US]	ROJO JR AGUSTIN LEISECA JORGE	F03B13/08 F03B15/14 F03B13/08	F03B15/14 F03B13/086 Y02E10/22 Y02E10/226	US19840591952	19840321	US19840591952 19840321	US4117676 (A) US4182123 (A) US4188788 (A) US4311410 (A) US4364228 (A) US4437017 (A) US4467216 (A) US4476396 (A)
MICRO-HYDRO-PIEZO POWER UNIT	RO132352 (A2)	2018-01-30	STOIAN PETRACHE [RO] ILINCA MARIUS [RO]	STOIAN PETRACHE [RO] ILINCA MARIUS [RO]	F04F5/02		RO20160000495	20160711	RO20160000495 20160711	
IN-PIPE TURBINE AND HYDRO-ELECTRIC POWER GENERATION SYSTEM	PH12016500653 (A1)	2016-05-30	YESHWANT BHENDE UDAY [IN] PRAKASH JOSHI SANJAY [IN] RAMAKANT ADKAR PRASHANT [IN] SHAM MARATHE PRANAV [IN] SHARAD JOSHI ASHWIN [IN] MADHAV GANU SHIRISH [IN]	KIRLOSKAR ENERGEN PRIVATE LTD [IN]	F03B13/10 F03B17/06 H02K7/18	F03B13/086 F03B13/10 Y02E10/28 Y02E10/22 F05B2220/20 F05B2240/133 H02K7/1823	PH20161500653	20160408	IN2014MUM1630 20140513 IN2012MUM2004 20131010 WO2014IN00626 20140929	
MICRO GENERATING SYSTEM USING HYDRAULIC PRESSURE DIFFERENCE IN A WATER PIPE	KR101088381 (B1); KR20110033465 (A)	2011-03-31	KIM HOON [KR] PARK KWANG SUE [KR]	SUPER BOUND KOREA CO LTD [KR]	F03B17/06 F03B3/12 F03B13/00 F03B15/20	Y02B10/50 Y02E10/223 Y02E10/28 Y02E10/226 F03B3/12 F03B13/06 F03B15/20 F03B17/06 Y02B10/50 Y02E10/223 Y02E10/28 Y02E10/226 F05B2220/32	KR20090090978	20090925	KR20090090978 20090925	
MICRO-HYDRO POWER GENERATION METHOD AND APPARATUS USING SURPLUS PRESSURE	JP2006022745 (A)	2006-01-26	MORISHIMA RYUJI OKAWA TATSUYA NAKAMURA TOMOKI URANO KENJI	KUBOTA KK	F03B17/06	Y02E10/28	JP20040202519	20040709	JP20040202519 20040709	

Appendix 6: Sample energy Calculation

Available Energy

Water

Flow	Q	3,000.00	m^3/h
Pressure	p	2.50	bar
System run time	h	720.00	h
Potential energy	P	**177.10**	**kW**
Energy - Monthly		**1,27,510.20**	**kWh**

Avg unit price	0.69	**NOK/kWh**
Savings per month	87,982.04	**NOK**
Savings annualy	10,55,784.46	**NOK**

Appendix 7: Average Industrial Electricity pricing in the EU

EU Electricty industrial customer pricing 2017		Source: http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=ten00117&plugin=1
Country	**Euro / kWH**	
Albania	:	
Austria	€0.07	
Belgium	€0.09	
Bosnia and Herzegovina	€0.06	
Bulgaria	€0.10	
Croatia	€0.09	
Cyprus	€0.10	
Czech Republic	€0.07	
Denmark	€0.06	
Estonia	€0.07	
EU (27 countries)	€0.08	
Euro area (changing composition)	€0.08	
Finland	€0.06	
Former Yugoslav Republic of Macedonia,	€0.08	
France	€0.07	
Germany	€0.08	
Greece	€0.09	
Hungary	€0.07	
Iceland	€0.07	
Ireland	€0.12	
Italy	€0.08	
Kosovo (under United Nations Security Co	€0.07	
Latvia	€0.09	
Liechtenstein	€0.13	
Lithuania	€0.08	
Luxembourg	€0.08	
Malta	€0.14	
Moldova	€0.08	
Montenegro	€0.08	
Netherlands	€0.07	
Norway	€0.06	
Poland	€0.08	
Portugal	€0.09	
Romania	€0.06	
Serbia	€0.06	
Slovakia	€0.10	
Slovenia	€0.07	
Spain	€0.11	
Sweden	€0.06	
Switzerland	:	
Turkey	€0.07	
Ukraine	:	
United Kingdom	€0.10	

Appendix 8: Total Available Market calculation with sources

Verticals	Locations per vertical	Potential Turbines per location	Total Turbines per vertical	Primary Interest of vertical	Revenue per Turbine for vertical	TAM for Vertial		Source
Seawater Desalination plants	3685	1	3685	Energy Recovery	$ 150,000	$ 552,780,000	*	http://idadesal.org/desalination-101/desalination-by-the-numbers/
Offshore Production rigs	1332	1	1332	Energy Recovery	$ 150,000	$ 199,800,000		https://www.statista.com/statistics/279100/number-of-offshore-rigs-worldwide-by-region/
Metals mining	806	1	806	Energy Recovery	$ 150,000	$ 120,843,990	**	See notes below
Shipping; scrubbers	600	2	1200	Energy / Pressure	$ 100,000	$ 120,000,000		https://shipandbunker.com/news/world/983035-imo2020-scrubber-users-advised-to-secure-their-hsfo-supply
Offshore drilling rigs	790	1	790		$ 150,000	$ 118,500,000		https://ihsmarkit.com/products/offshore-oil-rig-data.html
Paper mills	350	1	350	Energy Recovery	$ 100,000	$ 35,000,000		https://en.wikipedia.org/wiki/List_of_paper_mills
Municipalities (water supply) - Nordic and Germany	29	n/a	278	Pressure Control	$ 100,000	$ 27,795,883		Attached seperately
Land based aquaculture - Norway	229	1	229	Energy Recovery	$ 100,000	$ 22,900,000		https://www.fiskeridir.no/Akvakultur/Statistikk-akvakultur/Akvakulturstatistikk-tidsserier/Totalt-hele-naeringen
Ferro Silica Plants	41	1	41	Energy Recovery	$ 150,000	$ 6,150,000		Attached Seperately
					Global TAM	**$ 1,203,769,873**		

* Total number of Desal plants globally are 18426, out of which QRRNT only interested in largest 20% of Desal plants which gives 3685 plants

** Active mines in US in 2015	13,294	https://www.cdc.gov/niosh/mining/statistics/allmining.html
of which metal mines	315	https://www.cdc.gov/niosh/mining/statistics/allmining.html
Percent of metal mines of total	2.37%	
Approximate total number of mine properties in wor	34,000	https://www.miningintelligence.com
Apply % of mines in US to Global total	806	

Municipalities with over 100,000 inhabitants

		Potential for Pressure Reducing Turbines	
Sweden (2015)			
Stockholm	1,515,017	51	Assume 1 PRT per 30,000 population. Based on data from Trondheim
Gothenburg	572,799	19	
Malmö	301,706	10	
Uppsala	149,245	5	
Upplands Väsby and Sollentuna	139,606	5	
Västerås	117,746	4	
Örebro	115,765	4	
Linköping	106,502	4	
Helsingborg	104,250	3	
	Source: https://en.wikipedia.org/wiki/List_of_urban_areas_in_Sweden_by_population		
Norway (2007)			
Oslo	634,463	21	
Bergen	278,121	9	
Trondheim	190,464	6	31744 PRT per population for Trondheim - Information from Trondheim kommune
Stavanger	130,754	4	
	Source: https://en.wikipedia.org/wiki/List_of_towns_and_cities_in_Norway		
Denmark (2017)			
Hovedstadsområdet	1,295,686	43	
Aarhus	269,022	9	
Odense	176,683	6	
Aalborg	113,417	4	
	Source: https://en.wikipedia.org/wiki/List_of_cities_in_Denmark_by_population		
Finland (2017)			
Helsinki	642,045	21	
Espoo	277,375	9	
Tampere	230,537	8	
Vantaa	221,821	7	
Oulu	201,124	7	
Turku	188,584	6	
Jyväskylä	139,260	5	
Lahti	119,395	4	
Kuopio	117,842	4	
	Source: https://en.wikipedia.org/wiki/List_of_cities_and_towns_in_Finland		
Scandinavian cities over 100k population	**29**	**278**	
Germany			
Berlin	3,520,031	117	
Hamburg	1,787,408	60	
Munich	1,450,381	48	
Cologne	1,060,582	35	
	Source: https://en.wikipedia.org/wiki/List_of_cities_in_Germany_by_population		
German cities over 100k population	**4**	**261**	
TAM Scandinavia and Germany	**33**	**539**	

Ferro Silica Plants

Europe

	Company	City	Country		
1	Sadaci	SADACI	Belgium	EUR	0.09
2	B.S.I. d.o.o.	Jajce	Bosnia-Herzegovina	EUR	0.06
3	Outokumpu Chrome OY	Tornio	Finland	EUR	0.06
4	Befesa valera	Gravelines	France	EUR	0.07
5	Eramet comilog manganese	Paris Cedex	France	EUR	0.07
6	Ferropem	Chambery	France	EUR	0.07
7	Elektrowerk weisweiler GmbH	Eschweiler -Weisweiler	Germany	EUR	0.08
8	RW SILICIUM GmbH	Pocking	Germany	EUR	0.08
9	Jugohrom ferroalloys doo	Jegunovce	Macedonia	EUR	0.08
10	Elkem AS	Oslo	Norway	EUR	0.06
		Bremanger	Norway	EUR	0.06
		Salten	Norway	EUR	0.06
		Thanshavn	Norway	EUR	0.06
		Byølvefossen	Norway	EUR	0.06
		Rana	Norway	EUR	0.06
		Fiskaa	Norway	EUR	0.06
11	Finnfjord smelteverk	Finnsnes	Norway	EUR	0.06
12	Huta laziska	Laziska Gorne	Poland	EUR	0.08
13	OFZ, a.s.	Istebné	Slovakia	EUR	0.10
14	Ferroatlantica sl	Madrid	Spain	EUR	0.11
15	Glencore international AG	Baar	Switzerland	:	

Number of facilities - Europe **21**

Source: http://www.euroalliages.com/membres.php?langue=english&cle_menus=1187970093

Rest of World

Elkem AS		
	Chicoutimi	Canada
		Iceland
	Ningxia Hui Autonomous Region	China
	Lanzhou city	China
	Nagpur	India
	Bintulu	Malaysia
Sakura Ferroalloys	Sarawak	Malaysia
Shanghai Shenjia Ferroalloys Co. Ltd.		China
OM Holdings LTD	Guangxi	China
NikoPol Ferroalloy Plant	Nikopol	Ukraine
Gulf Ferroalloys Company	Jubail Industrial city	Kingdom of Saudi Arabia
Brahm Group		
Dimension Steel and Alloys Pvt. Ltd.	Bankura	India
Nalari Ferro Alloys Pvt. Ltd.	Meghalaya	India
Khasi Alloys Pvt. Ltd.	Meghalaya	India
Ferroalloy Corporation Limited	ShreeramNagar	India
MORTEX Group		India
BAFA Bahrain	Hidd	Kingdom of Bahrain
Pertama Ferroalloys	Bintulu	Malaysia
Georgian American Alloys		
CC Metals & Alloys (CCMA)	Calvert City, Kentucky	USA
Felman Production, LLC	New Haven, West Virginia	USA
Georgian Manganese, LLC	Zestafoni Ferroalloy Plant	Georgia
DMS Powders	Meyerton	South Africa

Number of facilities - Rest of World **20**

Source: Internet search for individual company websites, research ongoing....

Number of facilities global total **41**

Appendix 9: Customer Discovery – Prospected Industries

CEMENT

Norcem-Brevik

Debayan Mrinalkanti Banerjee

From: Debayan Mrinalkanti Banerjee
Sent: 22 March 2018 10:17
To: ida.husum@norcem.no
Subject: FW: Masters' Thesis | Water usage and Energy recovery

Hei Ida,

I got your contact from Annika at your Kjøpsvik plant.

I have got the required data from Kjøpsvik plant and hope that I get similar data from your plant at Brevik.

I, Debayan Banerjee, am a Masters' student @ UiT.

I am doing my Masters' thesis on energy recovery systems. I was wondering if I can have some information by having answers to the questions below.

1. What are the types of Energy recovery systems used at Norcem Kjøpsvik? What percentage of energy is recovered in total vis a vis the total energy consumed ?

2. The amount of water used for production of finished product at Kjøpsvik. The question is subdivided below

   2a. Amount of water intake (in cubic metres per day or per month or per year) and it's sources (Sea Water, Municipal water, or other sources)

   2b. Amount of water used in production (in cubic metres per day or per month or per year)

   2c. Amount of unused water discharged or any waste water additionally generated (in cubic metres per day or per month or per year)

3. Water pressure during intake, during production and during discharge at your plant at Kjøpsvik

4. Diameter of pipe used to deliver water at inlet, production and discharge.

If there are any additional reports that you could send, then I would be highly obliged.

Hoping for a positive reply from your side.

Regards,
Debayan
46631681

From: Steien, Annika (Kjøpsvik) NOR <annika.steien@norcem.no>
Sent: 21 March 2018 15:31
To: Debayan Mrinalkanti Banerjee <dba022@post.uit.no>
Subject: SV: Masters' Thesis | Water usage and Energy recovery

Dear Debayan

I advise you to contact Ida Husum at Norcem Brevik

Phone: 35 57 22 40
Ida.husum@norcem.no

Kind regards
Annika

Fra: Debayan Mrinalkanti Banerjee [mailto:dba022@post.uit.no]
Sendt: 20. mars 2018 11:12
Til: Steien, Annika (Kjøpsvik) NOR
Emne: RE: Masters' Thesis | Water usage and Energy recovery

Dear Annika,

Thank you for your prompt and detailed response.

Is it possible that I can have the same info for your plant in Brevik?

If not, could you please provide a contact person name?

On the website it lists that they have some energy recovery procedures in place.

I would be highly obliged if I could receive this help from you.

Regards,
Debayan

From: Steien, Annika (Kjøpsvik) NOR <annika.steien@norcem.no>
Sent: 20 March 2018 09:24
To: Debayan Mrinalkanti Banerjee <dba022@post.uit.no>
Subject: SV: Masters' Thesis | Water usage and Energy recovery

Dear Debayan

1. Norcem do not recover any energy.
2. I have enclosed our water report from 2017. See if you find answer to your question in here.
3. Water pressure in plant is measured to about 3,5 bar. Some equipment is supplied with water from high pressure pumps. Se flowsheet, it is complex.
4. Water pipe for process water DN 150
   Water pipe municipal water DN 100

Kind regards

Annika Steien
Process and environmental manager
Norcem as Kjøpsvik
Phone: +47 75 78 50 62/+47 901 90 560
E-mail annika.steien@norcem.no
www.norcem.no

Fra: Debayan Mrinalkanti Banerjee [mailto:dba022@post.uit.no]
Sendt: 19. mars 2018 10:19

Til: Steien, Annika (Kjøpsvik) NOR
Emne: Masters' Thesis | Water usage and Energy recovery

Hei Annika,

I, Debayan Banerjee, am a Masters' student @ UiT.

I am doing my Masters' thesis on energy recovery systems. I was wondering if I can have some information by having answers to the questions below.

1. What are the types of Energy recovery systems used at Norcem Kjøpsvik? What percentage of energy is recovered in total vis a vis the total energy consumed ?

2. The amount of water used for production of finished product at Kjøpsvik. The question is subdivided below

   2a. Amount of water intake (in cubic metres per day or per month or per year) and it's sources (Sea Water, Municipal water, or other sources)

   2b. Amount of water used in production (in cubic metres per day or per month or per year)

   2c. Amount of unused water discharged or any waste water additionally generated (in cubic metres per day or per month or per year)

3. Water pressure during intake, during production and during discharge at your plant at Kjøpsvik

4. Diameter of pipe used to deliver water at inlet, production and discharge.

If there are any additional reports that you could send, then I would be highly obliged.

Hoping for a positive reply from your side.

Regards,
Debayan
46631681

CEMENT

Norcem-Kjøpsvik

Debayan Mrinalkanti Banerjee

From: Steien, Annika (Kjøpsvik) NOR <annika.steien@norcem.no>
Sent: 20 March 2018 09:24
To: Debayan Mrinalkanti Banerjee
Subject: SV: Masters' Thesis | Water usage and Energy recovery
Attachments: 2014-07-30 KJOPSVIK - Water flow diagram - FINAL.pdf; Water data 2017.xlsx; 2014-06-24 KJOPSVIK - CSI WATER Monitoring Plan - Comments Kjøpsvik.docx

Dear Debayan

1. Norcem do not recover any energy.
2. I have enclosed our water report from 2017. See if you find answer to your question in here.
3. Water pressure in plant is measured to about 3,5 bar. Some equipment is supplied with water from high pressure pumps. Se flowsheet, it is complex.
4. Water pipe for process water DN 150
   Water pipe municipal water DN 100

Kind regards

Annika Steien
Process and environmental manager
Norcem as Kjøpsvik
Phone: +47 75 78 50 62/+47 901 90 560
E-mail annika.steien@norcem.no
www.norcem.no

Fra: Debayan Mrinalkanti Banerjee [mailto:dba022@post.uit.no]
Sendt: 19. mars 2018 10:19
Til: Steien, Annika (Kjøpsvik) NOR
Emne: Masters' Thesis | Water usage and Energy recovery

Hei Annika,

I, Debayan Banerjee, am a Masters' student @ UiT.

I am doing my Masters' thesis on energy recovery systems. I was wondering if I can have some information by having answers to the questions below.

1. What are the types of Energy recovery systems used at Norcem Kjøpsvik? What percentage of energy is recovered in total vis a vis the total energy consumed ?

2. The amount of water used for production of finished product at Kjøpsvik. The question is subdivided below

   2a. Amount of water intake (in cubic metres per day or per month or per year) and it's sources (Sea Water, Municipal water, or other sources)

   2b. Amount of water used in production (in cubic metres per day or per month or per year)

2c. Amount of unused water discharged or any waste water additionally generated (in cubic metres per day or per month or per year)

3. Water pressure during intake, during production and during discharge at your plant at Kjøpsvik

4. Diameter of pipe used to deliver water at inlet, production and discharge.

If there are any additional reports that you could send, then I would be highly obliged.

Hoping for a positive reply from your side.

Regards,
Debayan
46631681

CHEMICALS

Yara

Debayan Mrinalkanti Banerjee

From: Debayan Mrinalkanti Banerjee
Sent: 21 March 2018 13:12
To: Leif Kristian Kristiansen
Cc: Anders Holst; Helge Wesseltoft; Dag Willoch
Subject: Re: Questions for Masters' thesis | Energy recovery & Water use data

Hello Leif,

Have you had the time to look at my e-mail yet?

I am quite certain that you are very occupied as it has been quite a challenge to get hold of you on the phone as well.

But if you could please take out a little time to help me out then I will be highly obliged.

Hoping for a positive response from your side.

Regards,
Debayan
+47-46631681

From: Helge Wesseltoft <helge.wesseltoft@yara.com>
Sent: 09 February 2018 14:05
To: Dag Willoch
Cc: Debayan Mrinalkanti Banerjee; Anders Holst; Leif Kristian Kristiansen
Subject: RE: Questions for Masters' thesis | Energy recovery & Water use data

Hi.

I think Leif Kristiansen in Glomfjord is the right person to answer those questions.
In Porsgrunn it is normally Anders Holst who should answer the energy-related questions, however he is very busy with start of SS4.

Regards
Helge Wesseltoft
Yara Porsgrunn
Mobile: 00 47 976 57 980
Helge.Wesseltoft@yara.com

www.yara.com

From: Dag Willoch
Sent: Friday, February 09, 2018 1:34 PM
To: Helge Wesseltoft
Cc: dba022@post.uit.no
Subject: FW: Questions for Masters' thesis | Energy recovery & Water use data

Hi Helge,

Received the questions below from Debayan, a student doing his Master thesis. Unfortunately, I don't know who would be the right person to ask. Do you have a name for Debayan?

Dag

Dag Willoch
Head of Global Energy
Strategy and Business Development
Mobile: +4791150156
Email: dag.willoch@yara.com

Yara International ASA
Drammensveien 131
0277 Oslo, NORWAY
www.yara.com

From: Debayan Mrinalkanti Banerjee [mailto:dba022@post.uit.no]
Sent: Friday, February 09, 2018 1:22 PM
To: Dag Willoch
Subject: Questions for Masters' thesis | Energy recovery & Water use data

Hello Dag,

Thank you for taking the time out to speak to me.

I am currently pursuing my Masters' thesis and researching the water use in the industry with respect to efficiency, use & recovery.

I would request you to answer the following questions.

1. Does the Yara facility at Glomfjord use any energy recovery systems? If yes, then what type?

2. The amount of water used for production of finished products at Yara Glomfjord. It would be really helpful if I get an answer in the format below.
   2a. Amount of water intake (in cubic metres per day or per month or per year) and it's sources (Sea water, municipal water or other sources)
   2b. Amount of water used in production (in cubic metres per day or per month or per year).
   2c. Amount of unused water discharged or any waste water additionally generated (in cubic metres per day or per month or per year)

3. Water pressure during intake, during production and during discharge.

Hoping for a positive reply from your side.

Can you kindly oblige me with the contact person in your Porsgrunn plant who could answer the same questions? I will forward a new mail to them too.

Thanking you in advance.

Regards,
Debayan
MSc Candidate.

DATA CENTRES

Balsfjord Kommune

Debayan Mrinalkanti Banerjee

From: Debayan Mrinalkanti Banerjee
Sent: 05 March 2018 10:22
To: john.vegar.gystad@balsfjord.kommune.no
Subject: Masters' Thesis | Energy Recovery systems & water usage

Hello John,

Thank you for taking the time out to speak to me.

I am currently pursuing my Masters' thesis and researching the water use in the industry with respect to efficiency, use & recovery.

Data centers as a potential industry vertical has only been recently brought to my attention.

I would request you to answer the following questions.

1. Do any of the facilities at your data centres use any energy recovery systems? If yes, then what type?

2. The amount of water used in cooling systems at your facilities. This question is further subdivided below.

   2a. Amount of water intake (in cubic metres per day or per month or per year) and it's sources (Sea water, municipal water or other sources)
   2b. Amount of water used in production (in cubic metres per day or per month or per year).
   2c. Amount of unused water discharged or any waste water additionally generated (in cubic metres per day or per month or per year)

3. Water pressure during intake, during cooling and during discharge at your facilities

These questions are with respect to the study of a potentially new energy recovery system.

Please reach out to me for any other queries or questions, should you have any.

Hoping for a positive reply from your side.

Thanking you in advance.

Regards,
Debayan
MSc Candidate.
+47-46631681

DATA CENTRES

Green Mountain

Debayan Mrinalkanti Banerjee

From: Stensland, Silje <silje.stensland@greenmountain.no>
Sent: 04 March 2018 20:46
To: Debayan Mrinalkanti Banerjee
Subject: RE: Masters' Thesis | Energy Recovery Systems & Water usage

Hi Debayan

I have forwarded your e-mail to our compliance manager. Due to our high security facility, we do not give out any information as to your questions below.

Sorry we can`t help you this time and goog luck with your Masters` thesis.

Med vennlig hilsen/Kind regards

Silje Stensland
Marketing and Media Coordinator

Mobile: +47 922 65 803

Green Mountain AS
Box 42. 4159 Rennesøy. Norway
greenmountain.no • Facebook • Linkedin • Twitter • Youtube
____
Stavanger • Telemark • Oslo • London • Toronto

From: Debayan Mrinalkanti Banerjee [mailto:dba022@post.uit.no]
Sent: tirsdag 27. februar 2018 14:01

To: Stensland, Silje <silje.stensland@greenmountain.no>
Subject: Masters' Thesis | Energy Recovery Systems & Water usage

Hello Silje,

Thank you for taking the time out to speak to me.

I am currently pursuing my Masters' thesis and researching the water use in the industry with respect to efficiency, use & recovery.

Data centres as a potential industry vertical has only been recently brought to my attention.

I would request you to answer the following questions.

1. Do any of the facilities at your data centres use any energy recovery systems? If yes, then what type?

2. The amount of water used in cooling systems at Greenmountain. This question is further subdivided below.

   2a. Amount of water intake (in cubic metres per day or per month or per year) and it's sources (Sea water, municipal water or other sources)
   2b. Amount of water used in production (in cubic metres per day or per month or per year).
   2c. Amount of unused water discharged or any waste water additionally generated (in cubic metres per day or per month or per year)

3. Water pressure during intake, during cooling and during discharge at Greenmountain.

These questions are with respect to the study of a potentially new energy recovery system.

Please reach out to me for any other queries or questions, should you have any.

Hoping for a positive reply from your side.

Thanking you in advance.

Regards,
Debayan
MSc Candidate.
+47-46631681

ENERGY COMPANIES

Nord-Trøndelag Energi (NTE)

Gmail

This message has been automatically translated: Norwegian -> English.

Debayan Banerjee <debayanbanerjee@gmail.com>

Fwd: SV: QRRNT energy recovery lavtrykksturbin

Julia Navarsete <jn@qrrnt.com> **Thu, Feb 22, 2018 at 10:42 PM**
To: debayanbanerjee@gmail.com

FYI

Best regards / Sincerely

Julia Navarsete
CEO / Managing Director

QRRNT AS

+47 900 80 800

Forwarded message:

From: Julia Navarsete < jn@qrrnt.com >
Date: 15 February 2018 kl. 11:24:27 CET
To: Stemland Kristin Mürer < Kristin.Murer.Stemland@nte.no >
Subject: Re: Re: QRRNT energy recovery low pressure turbine

Hello again Kristin,

Thanks for the update. It is completely understandable that the answer may take time, and that it is difficult to find the right decision maker.

Understand that I've been ukonsis in my previous e-mail when the project is not about to replace the current turbines. The project outlined is the addition to the existing infrastructure. Suggests that we can take a meeting with NTE Energy to a greater extent be able to explain the project. Expect that you can put me in touch with the right person.

Hear from you,

Best regards / Sincerely

Julia Navarsete
CEO / Managing Director

QRRNT AS

+47 900 80 800

9. February 2018 kl. 8:11 wrote Stemland Kristin Mürer < Kristin.Murer.Stemland@nte.no >:

Hello Julia

Has sent this out in the organization, to those I thought were the right people, which I think in this case NTE Energy. We're not so good at responding quickly, so why has it taken a few rounds of purring and when time passes.

NTE is a very set organization, with great pride how they have operated with energy production for 100 years (ergo not very development-oriented (we're working on it, but the fact is that on major issues - it requires quite as much)). In addition, our hydropower generation large-scale energy production, with large turbines and plants whose lifespan of almost 100 years. The turbines we use is what I have understood is not appropriate to replace or to be the object of testing something new. In addition to that this will be a major operation and you have into the mountain ...

The feedback I also have received is that it comes very unclear forward why NTE is interesting, and the value that can be in this for both you and us. It is therefore difficult to make a good assessment of the case study. Remember this is a large organization with many employees with different areas of responsibility and competence fields - is therefore also difficult to find the right decision maker when the inquiry is sufficiently general. This for Tips for future inquiries ☺

With best regards

Kristin Mürer Stemland | Department Manager Corporate Development | kristin.murer.stemland@nte.no | NTE Holding AS | Mobile 93 03 45 42 | www.nte.no

From: Julia Navarsete [mailto:jn@qrrnt.com]
Posted: 1st February 2018 2:03 p.m.
To: Stemland Kristin Mürer < Kristin.Murer.Stemland@nte.no >
Subject: QRRNT energy recovery low pressure turbine

Hey Kristin,

Thank you for a nice conversation.

On the basis that we QRRNT has developed a specially designed low-pressure turbine that can effectively extract energy already from just below 0.2 bar, we want to hear about this may be of interest to you in the NTE.

We run tests in cooperation with Hydropower Lab at NTNU and has mainly focused on energy recovery ships. In our environmental technology project with Innovation Norway, we want a partner based on countries to look at several verticals for the product. We see considerable potential benefits of being able to use our turbine on their system, based on the reduced knowledge we have about how the plants their built up in detail.

The reason why we contacted you is that in environmental technology project you have the opportunity to get tested technology affordable and we have the opportunity to get tested our product commercially in the country.

This means specifically that we pay for the turbine in its entirety and you pay for installation. In addition, it is expected that you contribute expertise and "in-kind" work hours over a six to nine month trial. (Here credited all individuals involved from NTE)

Is this of interest to you? Looking forward to hearing from you, thank you in advance!

Julia Navarsete

CEO

Mobile: +47 900 80 800

Question what you think you know about current.

w ww.qrrnt.com

QRRNT ENERGY RECOVERY

Kongensgt.30. 7012 Trondheim, Norway

FERRO SILICON

Elkem Thamshavn

Debayan Mrinalkanti Banerjee

From: Paul Wilpert <paul.wilpert@elkem.no>
Sent: 28 February 2018 07:49
To: Debayan Mrinalkanti Banerjee
Subject: SV: Masters' Thesis | Energy recovery & Water usage

See my comment below

Paul Wilpert
Mobile : +47 45166186
paul.wilpert@elkem.no

Elkem
A Bluestar Company

Fra: Debayan Mrinalkanti Banerjee [mailto:dba022@post.uit.no]
Sendt: 23. februar 2018 11:07
Til: Paul Wilpert <paul.wilpert@elkem.no>
Emne: Masters' Thesis | Energy recovery & Water usage

Hello Paul,

Thank you for taking the time out to speak to me.

I am currently pursuing my Masters' thesis and researching the water use in the industry with respect to efficiency, use & recovery.

I would request you to answer the following questions.

1. Do any of the facilities of Elkem use any energy recovery systems? If yes, then what type? I am specially interested in Elkem Thamshavn since it is closer to my place of residence (Trondheim)

2. The amount of water used for production of finished products at Elkem Thamshavn. It would be really helpful if I get an answer in the format below.
   2a. Amount of water intake (in cubic metres per day or per month or per year) and it's sources (Sea water, municipal water or other sources)

   I have send you wrong numbers for fresh water:
   We use between 750 and 800 m3/day

   2b. Amount of water used in production (in cubic metres per day or per month or per year).
   2c. Amount of unused water discharged or any waste water additionally generated (in cubic metres per day or per month or per year)

3. Water pressure during intake, during production and during discharge at Elkem Thamshavn

Hoping for a positive reply from your side.

Elkem Thamshavn is just an example, if you have data for any other elkem plant then that would suffice too.

Please revert should you have any further questions or if something is not clear.

Thanking you in advance.

Regards,
Debayan
MSc Candidate.

Debayan Mrinalkanti Banerjee

From: Paul Wilpert <paul.wilpert@elkem.no>
Sent: 28 February 2018 07:45
To: Debayan Mrinalkanti Banerjee
Subject: SV: Masters' Thesis | Energy recovery & Water usage

See my answers below.

I have no clue what you are after.

We are a silicon plant with a heat recovery system. Our focus lies in producing silicon, not electricity or district heat.

Paul Wilpert
Mobile : +47 45166186
paul.wilpert@elkem.no

Fra: Debayan Mrinalkanti Banerjee [mailto:dba022@post.uit.no]
Sendt: 23. februar 2018 11:07
Til: Paul Wilpert <paul.wilpert@elkem.no>
Emne: Masters' Thesis | Energy recovery & Water usage

Hello Paul,

Thank you for taking the time out to speak to me.

I am currently pursuing my Masters' thesis and researching the water use in the industry with respect to efficiency, use & recovery.

I would request you to answer the following questions.

1. Do any of the facilities of Elkem use any energy recovery systems? If yes, then what type? I am specially interested in Elkem Thamshavn since it is closer to my place of residence (Trondheim)

   The exhaust gas from our two furnaces is send through a boiler that can produces overheated steam. The steam goes through a steam turbine and produces electricity. We use either steam from the boiler or the turbine to supply the district heating in Orkanger. We also use water at 85°C to preheat the district heating, which comes from a cooling circuit from one furnace. In addition do we have ground heating and partly indoor heating.

2. The amount of water used for production of finished products at Elkem Thamshavn. It would be really helpful if I get an answer in the format below.
   2a. Amount of water intake (in cubic metres per day or per month or per year) and it's sources (Sea water, municipal water or other sources)
   We use about
   3000 m3/h of seawater
   120-200 m3/day of fresh water (municipal water)

   2b. Amount of water used in production (in cubic metres per day or per month or per year).

We use most of the fresh water for refill of the boiler. Otherwise we don't need any water in the production process of silicon

2c. Amount of unused water discharged or any waste water additionally generated (in cubic metres per day or per month or per year)

We do not have measures of unused water. But we have a few places, where we use fresh water for cooling. Right now I only know of two such systems which use about 110.000 m3/year. There are more, but not quantified (mostly cooling for pumps)

3. Water pressure during intake, during production and during discharge at Elkem Thamshavn

Seawater pressure is very low (right now 0,7 bar). But there is a booster pump for use further away. I have no clue about pressure for fresh water. Also it varies a lot in our pipenet.

Hoping for a positive reply from your side.

Elkem Thamshavn is just an example, if you have data for any other elkem plant then that would suffice too.

Please revert should you have any further questions or if something is not clear.

Thanking you in advance.

Regards,
Debayan
MSc Candidate.

FERRO SILICON

Finnfjord AS

Debayan Mrinalkanti Banerjee

From: Ståle Monsen <staalem@finnfjord.no>
Sent: 14 February 2018 21:08
To: Debayan Mrinalkanti Banerjee
Subject: SV: Energy Recovery systems

Dear Debayan,

I am available between 09:30 and 10:30 tomorrow.
Please go to the reception when you arrives, and ask for me.

Best regards
Ståle Monsen
Prosessleder Kraft og Silica

FINNFJORD
Phone: + 47 77 87 05 00
Mobile: + 47 906 87 921
E-mail: staalem@finnfjord.no

Fra: Debayan Mrinalkanti Banerjee [mailto:dba022@post.uit.no]
Sendt: onsdag 14. februar 2018 09:25
Til: Ståle Monsen
Emne: Energy Recovery systems

Hei Ståle,

I, Debayan Banerjee, am a Masters' student @ UiT. I got your number from Jo Hemming Strømholt.

I am doing my Masters' thesis on energy recovery systems. I was wondering if I could have a meeting with you tomorrow about the same. I am sending you the questions list in advance below.

1. What are the types of Energy recovery systems used at Finnfjord? What percentage of energy is recovered in total vis a vis the total energy consumed ?

2. The amount of water used for production of finished product at Finnfjord. The question is subdivided below

   2a. Amount of water intake (in cubic metres per day or per month or per year) and it's sources (Sea Water, Municipal water, or other sources)

   2b. Amount of water used in production (in cubic metres per day or per month or per year)

   2c. Amount of unused water discharged or any waste water additionally generated (in cubic metres per day or per month or per year)

3. Water pressure during intake, during production and during discharge at Finnfjord.

Since I live in Trondheim, I really hope that you can take the time out for me tomorrow.

Hoping for a positive reply from your side.

Regards,
Debayan
46631681

From: Julia Navarsete <jn@qrrnt.com>
Sent: 05 March 2018 13:07
To: fl@qrrnt.com; Debayan Banerjee
Subject: Fwd: QRRNT | Energy Recovery System | Pilot Kunde program

FYI

Best regards / Med vennlig hilsen

Julia Navarsete
CEO / Daglig leder

QRRNT AS

+47 900 80 800

Videresendt melding:

Fra: Julia Navarsete <jn@qrrnt.com>
Dato: 5. mars 2018 kl. 11:38:03 CET
Til: Morten Mæland Bakketun <mortenm@finnfjord.no>
Emne: Re: QRRNT | Energy Recovery System | Pilot Kunde program

Hei Morten,

Takk for epost, håper du har hatt en fin helg.
Vi har nå gjort beregninger basert på dine tall, og kommet frem til et forsiktig estimat som følger under. Det kan være noe mer energi tilgjengelig men det er ikke mindre enn beskrevet under. Her har vi også kalkulert og tatt ut tap i de 4 x 90 graders bendene på rørsystemet du beskriver.

6.000 m3/t
1,3 bar energi potensiale
184,2 kWh
0,28 kr/kWh
445.571,64 NOK årlig energi gjenvinnings potensiale.

Selve teorien rundt teknologien er i grove trekk at vi har en turbin i en rørgate hvor vi, i motsetning til standard turbiner ikke tar vannet gjennom en 360 grader syklus, men har flere bladoppsett etter hverandre som vrir vannet som gir en slags vortex effekt. Dette gjør at det i deres tilfelle blir 1,0 bar igjen på baksiden av turbinen, og at vi derfor kun tar ut den energien vi kan, uten å forhindre andre prosesser i bak/forkant. I tillegg er alle blader og vinklene på disse spesialdesignet for nøyaktig deres parametre og satt inn i vår unike algoritme.

Det unike med vår teknologi i tillegg til at den er designet med skreddersøm på deres tall, er at om hele turbinen står og ikke virker så vil det ikke påvirke resten av driften annet enn at dere ikke kan ta ut energi.

Vi har også mulighet for å installere en digital tvilling som gjør at dere har mulighet for å få live data på turbinen i form av ytelse, driftstimer, antall dager til vedlikehold, antall kWh produsert totalt og per time, RPM etc etc. Her kan dere også ha mulighet for å få egne parametre lagt inn om ønskelig. Teknologien er i sin helhet levert patent på i Norge og USA.

Gjennom Miljøteknologi prosjektet kan vi tilby følgende løsning:

-QRRNT betaler for turbinen i sin helhet
-Finnfjord betaler for frakt og installasjon (hvor dere tilbakefører energien er selvsagt opp til dere)
-Finnfjord får selvsagt all energi gjenvunnet under pilotperioden vederlagsfritt
-QRRNT står for vedlikehold under hele testperioden
-2.000 t drift på turbin
-Finnfjord bidrar med timer i prosjektet underveis slik at totalt prosjekt regnskap skal leveres Innovasjon Norge etter endt gjennomført prosjekt.
-Finnfjord kan selv bestemme om dere ønsker at turbinen skal fjernes på vår regning ved gjennomført prosjekt, eller om dere ønsker å kjøpe den ut til sterkt redusert kost, som vil være med en ROI på 2 år. Dette er deres valg.

Vi håper dere finner det av interesse å delta i dette pilotprosjektet, og ser frem til å høre fra dere snarligst.

Ta kontakt om dere har spørsmål i denne forbindelse.

Med de beste ønsker om en fin dag videre!

Med vennlig hilsen,

Julia Navarsete
CEO
Mobile: +47 900 80 800

Question what you think you know about current.

www.qrrnt.com

Kongensgt.30. 7012 Trondheim, Norway

2018-03-02 15:24 GMT+01:00 Morten Mæland Bakketun <mortenm@finnfjord.no>:

> Hei Julia!
>
> Prosjektet høres veldig interessant ut. Jeg vil gjerne lufte dette på neste energistyringsmøte i bedriften, men kunne tenkt meg en litt dypere teoretisk presentasjon enn vedlegget i denne mailen.

Her kommer litt informasjon om anlegget:

Rørgata er ca 240m lang og inneholder fire 90 graders bend. De siste 130 m før vannet går i sjøen er et rettstrekk. Det går ett rør mot sjøen, og dette er et Ø900 rør.

Flow er som nevnt 6000 m3/hr.

Total fallhøyde er 16m og trykket før fallet er ca 1 bara.

Mvh

Morten M Bakketun

Enegigjenvinning ogTurbin

Tlf: +47 91843035

FINNFJORD

Hei Ståle,

Takk for et hyggelig møte på siste torsdag.

Som vi snakket om ligger det vedlagt litt mer info om QRRNT. Det beskriver også Pilot kunde program i mer detalj. Vi er av den oppfatning at dette et et meget interessant mulighet for dere, og håper dere vil dele vår oppfatning av dette.

E-posten har to vedlegg.

1. QRRNT land presentasjon

2. Potenisell energi gjenvinning hos Finnfjord AS. Beregningene er basert på 6000 m3/t vannflyt og 2.5 bar.

Potensialet er avhengig om hvor mange rør du har på outlet siden. Vi har derfor behov for at du kan gi litt mer info om røroppsettet, slik at vi kan gi deg en nøyaktig beregning.

Vi imøteser deres snarlige tilbakemelding.

Mvh,

Debayan Banerjee

+47-46631681

---------- Forwarded message ----------
From: **Julia Navarsete** <jn@qrrnt.com>
Date: 2018-02-15 11:11 GMT+01:00
Subject: Fwd: QRRNT Land presentation
To: Debayan Banerjee <dba022@post.uit.no>

Hei,

QRRNT har utviklet en spesialdesignet lavtrykksturbin som henter ut energi fra ned mot så lave trykk som 0,2 bar. I forbindelse med at vi nå har bygd en fullskala pilot som testes på vannkraftlaboratoriumet hos NTNU, ønsker vi nå en pilot kunde i kommersiell drift gjennom vårt Innovasjon Norge Miljøteknologiprosjekt.

Prosjektet vil gå over 6-9 mnd med testing, i samarbeid med bedrift turbinen er installert hos. QRRNT betaler for turbinen i sin helhet og pilot kunde betaler for frakt fra produksjonssted og installasjon. Kunden bestemmer da selv også hvor de ønsker energien skal tilbakeføres i deres system. Her kan det være flere alternativer som for eksempel direkte inn på hovedstrømtavle, batteri eller tilbake til pumper etc. All energi som blir produsert er pilot kundens i sin helhet, vederlagsfritt. Under testperioden vil alle timer pilot kunden bruker på prosjektet også bli tilskrevet prosjektet som en del av deres bistand, dette etter krav fra Innovasjon Norge.

Miljøteknologiprosjektet er en støtteordning fra Innovasjon Norge som gjør at oppstarts bedrifter med ny teknologi, raskere kan prøve ut teknologien i kommersiell drift pga den økonomiske delingen. Dette skal være en vinn-vinn situasjon hvor vi får testet vår turbin kommersielt og pilotkunden ikke trenger å ta de store økonomiske investeringene eller risikoen.

Håper det vil være av interesse for dere å delta i et spennende og fremtidsrettet prosjekt som beskrevet over.

Vi tar gjerne et møte med dere hvis det skulle av interesse. Imøteser deres tilbakemelding.

Kind regards,

Julia Navarsete

CEO

Mobile: +47 900 80 800

Question what you think you know about current.

www.grrnt.com

MUNICIPALTIES

Mavlik Kommune

Gmail

This message has been automatically translated: Norwegian -> English.

Debayan Banerjee <debayanbanerjee@gmail.com>

QRRNT low pressure turbine

Julia Navarsete <jn@qrrnt.com> **Mon, Feb 26, 2018 at 12:51 PM**
To: randi.rasmussen@malvik.kommune.no
Bcc: debayanbanerjee@gmail.com

Hi,

QRRNT AS has developed a specially designed low-pressure turbine which extracts energy from down to as low pressure of 0.2 bar. In connection with that we now have built a full scale pilot tested on vannkraftlaboratoriumet at NTNU, we now have a pilot customer for commercial operation through our Innovation Norway Environmental Technology Project.

The project will run over 6-9 months with a company / municipality turbine is installed at. QRRNT pay for the turbine in its entirety and pilot customer pays for shipping the manufacturing and installation. The customer decides when even also where they want energy to be returned in their system. There may be several options for the return of energy, such as directly into the main power board, battery, directly into the net or reversal of pumps etc. All energy produced is pilot customer in its entirety during the pilot project, free of charge. QRRNT will also be responsible for all maintenance on the turbine during the pilot period. During the test period all hours pilot customer spends on the project can also be attributed to the project as part of their assistance, as this is requested by Innovation Norway.

Environmental Project is a support from Innovation Norway that allows startup businesses with new technologies faster to try out the technology in commercial operation due to the economic division. This should be a win-win situation where we have tested our turbine commercial and pilot customer does not need to take the huge financial investment or risk.

Hope it will be of interest to you to participate in an exciting and innovative project as described above.

We gladly meet with you in the event of interest. Welcomes their feedback.

With best regards,

Julia Navarsete
CEO
Mobile: +47 900 80 800

Question what you think you know about current.
w ww.qrrnt.com

QRRNT
ENERGY RECOVERY

Kongensgt.30. 7012 Trondheim, Norway

QRRNT Land Customer Presentation feb 2018.pdf
12848K View as HTML Download

MUNICIPALTIES

Trondheim Kommune

From: Julia Navarsete <jn@qrrnt.com>
Sent: 07 March 2018 15:23
To: Odd Tveit; Trond Ellefsen; frank-justice.batey@trondheim.kommune.no; hilde.bellingmo@trondheim.kommune.no
Cc: Fredrik Linge; Debayan Banerjee
Subject: QRRNT lavtrykksturbin Pilot prosjekt - Trondheim Kommune

Hei alle sammen,

På vegne av Fredrik og Debayan vil vi i QRRNT takke for et veldig konstruktivt og godt første møte i går. Jeg hadde dessverre ikke mulighet for å delta på grunn av akutt sykdom. Beklager dette.

Vi ser mange muligheter fremover i et samarbeid med dere, og ønsker i utgangspunktet at dere finner én eller flere potensielle muligheter for installasjon av turbin i et pilot prosjekt.

For å kunne gi dere estimater på potensiell energigjenvinning ønsker vi at dere sender følgende info:

-Rørdiameter
-m3/t
-bar

Basert på de 3 punktene over kan vi gjøre beregninger for dere.

Undertegnede vil være point of contact for Trondheim Kommune, og hvis ikke annet er instruert, vil våre kontakter hos dere være Trond Ellefsen og Frank Batey i kommunikasjonen videre.

Vi ser frem til å høre fra dere snarlig. Med de beste ønsker om en fin dag videre!

Med vennlig hilsen,

Julia Navarsete
CEO
Mobile: +47 900 80 800

Question what you think you know about current.
www.qrrnt.com

Kongensgt.30. 7012 Trondheim, Norway

METALS

Norsk Hydro Homestrand

Gmail

Debayan Banerjee <debayanbanerjee@gmail.com>

Water Usage | Norsk Hydro - Holmestrand

Debayan Banerjee <debayanbanerjee@gmail.com> Wed, Feb 7, 2018 at 12:25 PM
To: jn@qrrnt.com
Cc: Rupert Pearn <rp@qrrnt.com>, Qrrnt Fredrik Linge <fl@qrrnt.com>, Kim Sedgwick <ks@qrrnt.com>

Hello,

PFA water usage details from Norsk-Hydro Holmestrand plant. A friend of mine works there and has got hold of these numbers indirectly via his environmental manager.

It seems there is more information required to make sense of these numbers. Nevertheless, I have reworked his picture into an excel sheet (which is also attached in this email).

Sr No 1 and 2 are highlighted since it gives us the complete value chain of the water use, i.e Suppy, production and discharge.

I hope these numbers are enough for Fredrik to proceed to evaluate their potential as a pilot customer, meanwhile I am still on it to get more info.

Regards,
Debayan

2 attachments

Supply		Unit	2017
Municipal water	Kirkeveien 1	t	223163
	Weidemanns g 8	t	94614

Delivery		Unit	2017
Evaporation	Kirkeveien 1	t	3912
	Weidemanns g 8	t	27276
River	Kirkeveien 1	t	69181
Sea	Total	t	154857
Municipal drainage	Total	t	63351

OBS! Det eneste vi måler av tallene over er vannet inn til Weidemanns gat

27781393_1584213438299834_963883069_n.jpg
46K

Norsk Hydro - Holmestrand.xlsx
11K

PAPER

Holmen Energi

Debayan Mrinalkanti Banerjee

From:	fredrik.nordqvist@holmenenergi.com
Sent:	24 March 2018 07:30
To:	Debayan Mrinalkanti Banerjee
Subject:	Fwd: SV: Masters' Thesis | Energy Recovery and water usage
Attachments:	image003.jpg

Hi,
Se below, good luck

Mvh /
Fredrik Nordqvist, Holmen Energi
Tfn. 070 224 58 50
fredrik.nordqvist@holmenenergi.com

Vidarebefordrat brev:

Från: Rydstrand Magnus <magnus.rydstrand@holmenpaper.com>
Datum: 22 mars 2018 15:08:57 CET
Till: Nordqvist Fredrik <fredrik.nordqvist@holmenenergi.com>
Kopia: Ramberg Anna <Anna.Ramberg@holmenpaper.com>
Ämne: SV: Masters' Thesis | Energy Recovery and water usage

Hej Fredrik,
Se svar nedan i blått. Kontakta gärna Anna Ramberg om det finns mer detaljerade frågor gällande vatten.

Magnus Rydstrand
Produktionsingenjör TMP

Holmen Paper AB
Hallsta Pappersbruk
763 81 Hallstavik
Tel +46 175 26 945
Mobil +46 739 999 507
magnus.rydstrand@holmenpaper.com
www.holmen.com

Från: Nordqvist Fredrik
Skickat: den 20 mars 2018 22:22
Till: Rydstrand Magnus
Ämne: VB: Masters' Thesis | Energy Recovery and water usage

Hej Magnus,

Kan du hjälpa till med svaren på nedanstående är du snäll. Du kan svara på svenska till mig så översätter jag. Det är en studentuppgift som du ser

Mvh Fredrik N

Från: Debayan Mrinalkanti Banerjee [mailto:dba022@post.uit.no]
Skickat: den 22 februari 2018 11:04
Till: Nordqvist Fredrik
Ämne: Masters' Thesis | Energy Recovery and water usage

Hello Fredrik,

Thank you for taking the time out to talk to me yesterday.

I, Debayan Banerjee, am a Masters' student at the University of Tromsø (UiT) in the city of Tromsø, Norway.

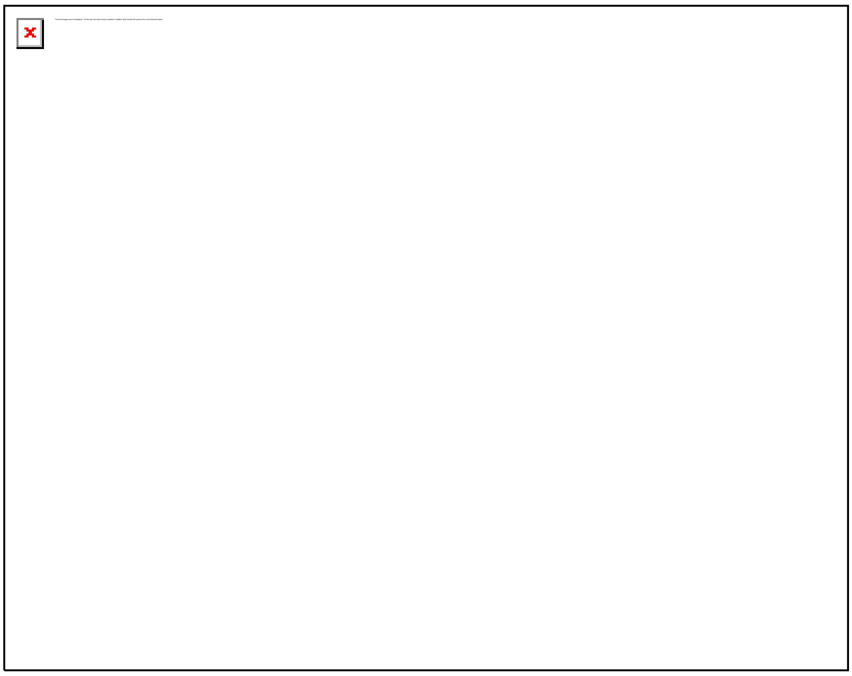
Originally I was searching for MODO, but then was lead to Holmen group and then specifically to Holmen Energi.

Since I am researching Energy recovery systems and water usage, I am looking for data on those specifically from your paper production facilities, which are traditionally water intensive.

I request you to answer following questions below.

1. What are the types of Energy recovery systems used at the paper production facility? What percentage of energy is recovered in total vis a vis the total energy consumed ?
   In Hallstavik and Braviken were we produce pulp & paper from virgin fibre in a TMP process. We have a high percentage of energy recovery. In Hallstavik we recover 50-60% of the refining energy in steam reboilers were 3,0 bar TMP-steam is condensed. 2,5-bar steam is produced, in the reboilers, and used in our low pressure steam net. TMP-steam covers 90% of the steam demand, which is 600 GWh/year. The main steam consumer is the paper machines were paper is dried.
   Energy from the TMP-process is also transferred to the paper machine with water as an energy carrier since pulp is transferred (pumped) together with water.
   There is a lot of water needed in the process since the pulp produced needs to be washed and dirty water needs to go to the effluent treatment plant. Energy to heat hot water is recovered in heat exchangers in two steps; 1. From outgoing humid air leaving the paper machine, 2. From dirty water leaving the TMP-plant. One can say that we use the same energy several times in Hallstavik, but on different temperature levels.

2. The amount of water used for production of finished product at the paper production facility. The question is subdivided below
   Picture below gives answer to some questions regarding Hallsta were we have PM 11 and PM 12.



2a. Amount of water intake (in cubic metres per day or per month or per year) and it's sources (Sea Water, Municipal water, or other sources)

2b. Amount of water used in production (in cubic metres per day or per month or per year)

2c. Amount of unused water discharged or any waste water additionally generated (in cubic metres per day or per month or per year)

3. Water pressure during intake, during production and during discharge at the paper production facility.
   We have many different pressure levels in the mill I Hallsta. We also have different water qualities.
   - Cooling water from the sea is pumped through heat exchangers in two positions since we have two separate cooling nets (North and South). The sea water pumps in these positions only work with the pressure drop in the heat exchangers
   - All incoming water from the upstream river is filtered. After that, the mechanically cleaned water is pumped to the pressure of 3,5 bar. In some positions were needed this pressure is increased with booster pumps up to 10 bars.
   - The mechanically cleaned water that is used in the process is chemically cleaned and filtered in sand filters. This water is then pumped up to the pressure of around 5 bars.
   - A large portions of the chemically cleaned water is heated to produce hot water that is stored in large tanks (1000+2000+500 m3). Hot water is pumped up to a pressure of about 4 bars.
   - Chemically cleaned water is also used for production of feed water to our reboilers and boilers. Feed water pressure is 7 bars for our reboilers and around 40 bars for our other boilers.
   - At discharge from the mill, water is going through the effluent treatment plant were the pressure is atmospheric (0 bar).

This is with regards to a stud of the commercial potential of a new energy recovery solution.

Hoping for a positive reply from your side.

Please feel free to get in touch with any queries that you might additionally have.

Regards,
Debayan
46631681

PAPER

Norske Skog

Debayan Mrinalkanti Banerjee

From: Nonstad, Per (SKOGN) <per.nonstad@norskeskog.com>
Sent: 27 February 2018 11:27
To: Debayan Mrinalkanti Banerjee
Subject: RE: Masters' thesis | Water usage & Energy recovery systems

Hei
Jeg mente 8.mars

Mvh
Per

From: Debayan Mrinalkanti Banerjee [mailto:dba022@post.uit.no]
Sent: Tuesday, February 27, 2018 11:26 AM
To: Nonstad, Per (SKOGN) <per.nonstad@norskeskog.com>
Subject: Masters' thesis | Water usage & Energy recovery systems

Hei.

Takk for en hyggelig samtale.

18 mars er Søndag. Så bare lurte på hvis jeg hørt noe feil dato.

Mvh,
Debayan
+47-46631681

From: Debayan Mrinalkanti Banerjee
Sent: 23 February 2018 10:36
To: 'Nonstad, Per (SKOGN)' <per.nonstad@norskeskog.com>
Subject: RE: Masters' thesis | Water usage & Energy recovery systems

Hello Per,

Those are some interesting numbers.

Having analysed them, I was wondering if I could get a meeting with you to discuss some issues further.

They are mainly to understand if the assumptions that are used to predict a scenario are correct or not. To verify this, it is critical to get first hand data for my Masters' thesis.

I promise I will not take too much of your time. Max 15 minutes.

I can gladly come up to your office at any day and time of your convenience next week (except 28th Feb).

Hoping that you will allow me an audience.

Mvh,
Debayan
+47-46631681

From: Nonstad, Per (SKOGN) <per.nonstad@norskeskog.com>
Sent: 22 February 2018 08:39

To: Debayan Mrinalkanti Banerjee <dba022@post.uit.no>
Subject: RE: Masters' thesis | Water usage & Energy recovery systems

Hi, look at the red lines.

BR
Per

From: Debayan Mrinalkanti Banerjee [mailto:dba022@post.uit.no]
Sent: Wednesday, February 21, 2018 3:13 PM
To: Nonstad, Per (SKOGN) <per.nonstad@norskeskog.com>
Subject: Masters' thesis | Water usage & Energy recovery systems

Hello Per,

Thank you for taking the time out to talk to me.

I, Debayan Banerjee, am a Masters' student @ UiT.

I am doing my Masters' thesis on energy recovery systems and water usage and I was wondering if you could help me with the questions below.

1. What are the types of Energy recovery systems used at Skogn? What percentage of energy is recovered in total vis a vis the total energy consumed ?

Heat energy is recovered from the termo mechanical process.
El energy are put in and steam and heat is recovered, about 60%

2. The amount of water used for production of finished product at Skogn. The question is subdivided below

   2a. Amount of water intake (in cubic metres per day or per month or per year) and it's sources (Sea Water, Municipal water, or other sources)

27 Mill kbm/ year from a local lake/ river system

   2b. Amount of water used in production (in cubic metres per day or per month or per year)

   15 kbmeter pr tonn of paper

   2c. Amount of unused water discharged or any waste water additionally generated (in cubic metres per day or per month or per year)
   Colling water 20 Mill kbm/year

3. Water pressure during intake, during production and during discharge at Skogn.

6 kg/cm2

If you have the answers for the same questions at your plant in Saugbrugs then I would be really happy to have them as well.

This is with regards to a study of the commercial potential of a new energy recovery solution.

Hoping for a positive reply from your side.

Regards,
Debayan
46631681

PAPER

Ranheim Papir Fabrikk

Debayan Mrinalkanti Banerjee

From:	Magne Guldberg <Magne.Guldberg@ranheim-pb.no>
Sent:	05 March 2018 13:14
To:	Debayan Mrinalkanti Banerjee
Subject:	SV: Masters' Thesis | Energy recovery

Hello Debayan
We use a little of this water for cooling water on hydraulics, lubrication system and so on, but most goes direct to the process. We don't need any pressure reduction before we use it, but of course we could have taken out some energy before using it. The pressure reduction is achieved in the regulating valves..

Med vennlig hilsen/Best regards

Magne Guldberg

Overingeniør

RANHEIM
PAPER & BOARD

Tlf: +47 98229081
E-mail: Magne.Guldberg@ranheim-pb.no

http://www.ranheim-pb.no

Fra: Debayan Mrinalkanti Banerjee [mailto:dba022@post.uit.no]
Sendt: 5. mars 2018 13:05
Til: Magne Guldberg <Magne.Guldberg@ranheim-pb.no>
Emne: Masters' Thesis | Energy recovery

Hello Magne,

Thank you for taking the time out to talk to me.

I just forgot to ask one question. You mentioned that you have a water pressure of 12 bar at the inlet. Do you need to reduce the pressure before the water goes in production? If yes, then how much pressure do you need the water to be in before it can be used in production? How is this pressure reduction achieved?

Regards,
Debayan
MSc Candidate
+47-46631681

From: Julia Navarsete <jn@qrrnt.com>
Sent: 05 March 2018 13:47
To: fl@qrrnt.com
Cc: db@qrrnt.com
Subject: Re: Masters' Thesis | Energy recovery

Fredrik, what do you think after reading Ranheim paper and boards email?

I think they maybe don’t get the potential. A lot of potential pressure even though the m3/h is low.

Best regards / Med vennlig hilsen

Julia Navarsete
CEO / Daglig leder

QRRNT AS

+47 900 80 800

5. mar. 2018 kl. 13:30 skrev Debayan Banerjee <db@qrrnt.com>:

> Hello Julia,
>
> I just had a word with Magne Guldberg from Ranheim paper fabrik. The numbers are too little to be financially viable.
>
> 115 cum/h discharge at outlet.
>
> No pressure, freefall height of 15 to 20 m
>
> Heat exchangers used for energy recovery.
>
> They have a 12 bar pressure at the inlet, but I just confirmed with Magne (see mail below) that they use most of the water directly at that pressure.
>
> Therefore I feel that we can cross out Ranheim paper fabrik from our list.
>
> **Debayan Banerjee**
> Business Development
> Mobile: +47 466 31 681
>
> ***Question what you think you know about current.***
> **www.qrrnt.com**

Kongensgt.30. 7012 Trondheim, Norway

---------- Forwarded message ----------
From: **Debayan Mrinalkanti Banerjee** <dba022@post.uit.no>
Date: 5 March 2018 at 13:21
Subject: FW: Masters' Thesis | Energy recovery
To: "db@qrrnt.com" <db@qrrnt.com>

From: Magne Guldberg <Magne.Guldberg@ranheim-pb.no>
Sent: 05 March 2018 13:14
To: Debayan Mrinalkanti Banerjee <dba022@post.uit.no>
Subject: SV: Masters' Thesis | Energy recovery

Hello Debayan

We use a little of this water for cooling water on hydraulics, lubrication system and so on, but most goes direct to the process. We don't need any pressure reduction before we use it, but of course we could have taken out some energy before using it. The pressure reduction is achieved in the regulating valves..

Med vennlig hilsen/Best regards

Magne Guldberg

Overingeniør

<image001.png>
Tlf: +47 98229081
E-mail: Magne.Guldberg@ranheim-pb.no

http://www.ranheim-pb.no

Fra: Debayan Mrinalkanti Banerjee [mailto:dba022@post.uit.no]
Sendt: 5. mars 2018 13:05
Til: Magne Guldberg <Magne.Guldberg@ranheim-pb.no>
Emne: Masters' Thesis | Energy recovery

Hello Magne,

Thank you for taking the time out to talk to me.

I just forgot to ask one question. You mentioned that you have a water pressure of 12 bar at the inlet. Do you need to reduce the pressure before the water goes in production? If yes, then how much pressure do you need the water to be in before it can be used in production? How is this pressure reduction achieved?

Regards,

Debayan

MSc Candidate

+47-46631681

SHIPS

General Info

Debayan Mrinalkanti Banerjee

From: nair prathiush <nairprathiush@gmail.com>
Sent: 11 March 2018 11:09
To: Debayan Mrinalkanti Banerjee
Subject: Re: Engine cooling systems in ships

Hello Debayan,

Inview of your summary , kindly go through the following ammendments

3. Sea water is used only to regulate the temperature of the fresh water. There is no storage of sea water. There are pumps which regulate the entry of sea water.

4. The fresh water system has only one inlet and one outlet of the cooling system, although there might be many branches in between. This is a pressurised system and is usually kept at a minimum pressure of 4 bar.

5. The capacity of the fresh water and sea water pump and design of the cooling system depends on the thermal performance of the heat exchangers, the rate of flow of heat ie the temperature gradient between fluids , thermal conductivity of the wall material and heat generation of the engine system (which is related to the BHP or KW of the engine)

Rest the summary is correct as per our telephonic conversation.

Regards,
Prathiush Nair
B.S in Marine Engineering
Designation: Chief Engineer Officer on Ships
Certificate of Competency as Marine Engineer Officer Class 1 no: 95W-8610
Issuing authority: Govt of India

On Mar 4, 2018 11:04 PM, "Debayan Mrinalkanti Banerjee" <dba022@post.uit.no> wrote:

> Hi Prathiush,
>
> Thanks for a lovely informal chat.
>
> Since this was for my Masters' thesis requirements, I am required to document this. I am hereby sending you a summary of our conversation. Kindly go through it and confirm if this is correct or not per reply mail.

1. There are multiple cooling systems inside a single engine. High temperature components in the engine use Water cooling, whereas lube oil cooling is used at lower temperatures and where direct contact with the engine component is required.

2. Water cooling inside the engine is fresh water. This is a closed and a pressurised system. The fresh water is recirculated inside the ship and is usually not required to be changed. It is only changed and refilled once a year during the ship's annual maintenance.

3. Sea water is used only to regulate the temperature of the fresh water. There is no storage of sea water. There are pumps which regulate the entry of sea water. There is only one inlet and one outlet of the sea water cooling system, although there might be many branches in between. This is a pressurised system and is usually kept at a minimum pressure of 4 bar. The capacity of the sea water pump is directly proportional to the load carrying capacity of the ship.

Kindly append any other information which we discussed about but has not been incorporated in the summary.

Thanks once again.

Regards,

Debayan Banerjee

+47-46631681

MSc Candidate

BCE 2016-18

MINES

General Info

Debayan Mrinalkanti Banerjee

From: Rahul Verma <rahul.verma@utexas.edu>
Sent: 21 March 2018 15:46
To: Debayan Mrinalkanti Banerjee
Subject: Re: Water usage in Mining operations

1. Does water usage in mining operations vary from the type of mineral/product being mined?

Not with the mineral directly, but with the mine design. The mine design are very often standard for certain mineral types. For example, iron ore mines are generally open cast mines, coal may be open-cast or underground. But there are exceptions.

2. What determines the scope of water usage apart from the type of product (Quarry site location, size and depth of the mine etc.)

Quarry depth, area, strata (depth of the water level, aquifers, porosity). I think there are too many to list.

3. Are you personally aware of any energy recovery systems that are employed in the mining industry at present.

I've come across some systems that recover potential energy from downward motion of large shovels and drag lines. Then I think there was a pilot to recover some energy from the vibrations that moving truck cause. Some of the start ups fail because mines change a lot. The roads and tunnels all change and it becomes a hassle to move all the energy infrastructure. It's a hassle to move the pipes themselves and no body wants to move all the energy infra.

If the answer to question no 1 is yes, then kindly base the answers to the following questions which require highest water consumption.

4. Amount of water during intake, production & discharge (in cubic metres per hour , per month etc.)

I don't have this number. I'm sure you can google all this. Just look up "water management in mining" or something else that works.

5. Amount of water pressure during intake, production & discharge (in bar)

Usually mines have a reservoir where all the strata water collects and then pumped up. So the intake pressure for the pump is just the atmospheric pressure. At the discharge end it's slightly over what is necessary to pump the water from bottom to surface. Don't have the bar number but may be slightly above 1 bar or something.

And just to take the conversation forward with others.

6. Who are the major players in the mining industry in your area?

Peabody

7. Contacts if any.

Not really

On Wed, Mar 21, 2018 at 8:03 AM, Debayan Mrinalkanti Banerjee <dba022@post.uit.no> wrote:

> Hi Rahul,
>
> Thanks for taking the time to talk to me.
>
> I am currently working on my Masters' thesis and the queries are with regards to that only. Since I am doing a Masters' in Business, I have partnered up with a start-up and using a real life scenario for my thesis. Thus, I am interning with this startup and at the same time writing my thesis.
>
> This startup is into energy recovery. Without getting into too much details, this start-up has a product which recovers energy from 'low pressure' systems such as water pipes.
>
> Thus I am prospecting the industry verticals for which this product might be a attractive choice. This is where I need your help since I am now prospecting the mining industry.
>
> To gauge the industry attractiveness, I request you to please answer the following questions.
>
> 1. Does water usage in mining operations vary from the type of mineral/product being mined?
>
> 2. What determines the scope of water usage apart from the type of product (Quarry site location, size and depth of the mine etc.)
>
> 3. Are you personally aware of any energy recovery systems that are employed in the mining industry at present.
>
> If the answer to question no 1 is yes, then kindly base the answers to the following questions which require highest water consumption.

4. Amount of water during intake, production & discharge (in cubic metres per hour , per month etc.)

5. Amount of water pressure during intake, production & discharge (in bar)

And just to take the conversation forward with others.

6. Who are the major players in the mining industry in your area?

7. Contacts if any.

Since you are working, I request you to explicitly state your name, designation and organisation in your signature as then it will be valid for use as documentation (primary data) for my thesis.

Please do not hesitate to contact me for any other info or clarifications that you might need.

As this info is for my thesis, I am little pressed for time, and I hope that you will answer as soon as you feel convenient.

Thanking you in advance.

Regards,

Debayan

+47-46631681

MSc. Candidate

BCE-2016-2018

Debayan Mrinalkanti Banerjee

From:	Debayan Mrinalkanti Banerjee
Sent:	27 February 2018 14:40
To:	coropciuc@euromines.be
Cc:	drielsma@euromines.org
Subject:	Masters' Thesis | Market Research | Water use in mining

Hello Mirona,

Thank you for taking the time out to speak out to me.

I, Debayan Banerjee, am a Masters' student at the University of Tromsø, in Norway. I am doing my thesis, on the field of energy recovery and water use in industries.

Mining as a industry is vastly important for my thesis and research since it is one of the most energy intensive industries.

My question can be divided into the following parts.

1. Mining for which material (Metals, minerals etc) consumes the most water? Or water usage in mining is independent of the material?
2. Water usage statistics in Europe in the field of mining (for eg So many cubic metres of water per hour to extract Aluminium in Norway). Partial data will also do.

These questions are in the regards of a commercialization potential study of a new energy recovery solution.

This mail is sent from my student mail id to prove my credentials. Should you need any more info, then please do not hesitate to ask.

Hoping for a positive reply from your side.

Regards,
Debayan
+47-46631681

Appendix 10: Customer Understanding – Follow up Questionnaire

Steve Blank – Four Steps to the Epiphany

Phase 2c | Test Problem | Customer Understanding

Customized checklist for Energy recovery product offered by QRRNT AS

1. Verify the assumptions

☐ Is the flow rate assumption correct?

☐ Is the pressure assumption correct?

☐ Is the electricity cost assumption correct?

2. Verify customer understanding

☐ What is the biggest problem that the department/person is currently facing?

☐ Is it related to energy recovery and efficiency?

☐ If yes, then how big is the pain? Is it an organization wide problem or a department problem?

☐ How important is energy recovery in their plans? Is it high priority or it doesn't feature at all?

☐ Does the interest level change when you quantify the benefits of using an energy recovery system?

☐ What will be the impact of the solution?

☐ Are they interested in the product if it is offered as a pressure control valve with an additional benefit of energy recovery?

3. Gauging customer interest for product offered by QRRNT AS

☐ Are they aware of any competitors in the energy recovery business? Or if they use their products?

☐ Are they aware of any competitors in the energy recovery business **who use the exact same technology** as offered by QRRNT AS? If yes, who are they?

☐ Are the USP's offered by QRRNT AS attractive enough for them?

☐ What will be the deciding factor in buying our product? Price? Features? Etc.?

4. Command and control structure

☐ How do they learn about new products?

☐ Are there any internal statutory approvals that must be taken before a decision can be made?

☐ Who will make the purchase decision?

5. General

☐ Next round of conversations?

☐ Other references to talk to?

Appendix 11: Product details of Competitors

CleanPower

TURBINATOR®

Your Eco-flow turbine solution

www.cleanpower.no
www.turbinator.com

TURBINATOR®

All-in-one turbine with integrated generator

Key features

Single unit: Easy to install
Robust: One rotating part
Low CAPEX: Minimized civil works, power house not needed
Low OPEX: Remote operated
High efficiency

Key properties

100 to 3000 kW output capacity
Up to 50m net head
Powerhouse not needed due to sealed oil filled stator compartment directly cooled by water flow.
Significantly lower installation costs compared to a traditional Kaplan turbine
Total efficiency of turbine generator 80-85%
Simple flange connection
Base model is unregulated and direct to grid

Easy installation
No power house
Reduced civil works

The Turbinator is a sealed unit that does not need a power house, which significantly reduces the civil works, capital investments and construction time.
It generates at low voltage (440 or 690 V) and is directly switched into the grid transformer.

Technical description

The turbine section is an axial flow, semi regulated Kaplan turbine with fixed pitch runner wheel and adjustable guide vane.

Using patented technology, it is integrated with a direct drive synchronous permanent magnetized generator (PMG).

The resulting assembly is a compact unit with only one rotating part.

The Turbinator is a robust and cost efficient alternative to a traditional full regulated Kaplan installation.

Using a PMG gives a compact unit with high energy density and small footprint, in a sealed unit that does not need a protecting power house.

Models	T500	T600	T750	T1000	T1250	T1500
Hydraulic diameter [mm]	500	600	750	1000	1250	1500
Flow rate [m^3/s]	0,5 - 1,3	0,8 - 2,0	1,3 - 3,1	2,0 - 4,9	3,9 - 7,6	6,1 - 11,9
Flow rate [cfs]	18 - 46	28 - 71	46 - 109	71 - 173	138 - 268	215 - 420
Power range [kW]	75 - 280	55 - 550	70 - 670	190 - 1700	370 - 2000	190 - 3300

Applications


Eco-flow turbine


Canals, conduits,
Irrigation systems


Industrial energy recovery


Fish hatchery and farming

Turbinate your Eco-flow!

The CleanPower Eco-flow solution will manage your eco-flow while producing energy.

Key features:

- Stable flow with varying head
- Calendar-driven flow
- Control panel manages turbine and bypass valve to secure flow
- Bypass ensures flow during power outage etc.
- Compact
- Easy to install
- Remote operated (SCADA, VPN, ...)

Get in touch

CleanPower AS

Setesdalsveien 110
N-4617 Kristiansand S
Norway

Org. # NO 882 170 462 MVA

Phone +47 71 56 66 00

Email post@cleanpower.no

www.cleanpower.no
www.turbinator.com

CleanPower

Design & graphics - EXMACHINA.NO

How it Works

lucidenergy.com/how-it-works

LucidEnergy™

PLAY VIDEO

The LucidPipe™ Power System (LPS)

Water Origin & Pressure

Water from snow and rainfall fills remote reservoirs, feeding pipelines that move water to the point-of-use. As the water flows downhill, gravity creates pressure in the pipeline that is normally relieved by pressure-reducing valves.

LucidPipe Power System

The LPS can be placed in-line in the pipes of a water transmission network, and can generate electricity from excess pressure in the pipeline, reducing the work done by pressure-reducing valves.

Distribution

The point-of-use for the water is the customers of the water utility. The LucidPipe Power System is “invisible,” that is, it does not affect water delivery.

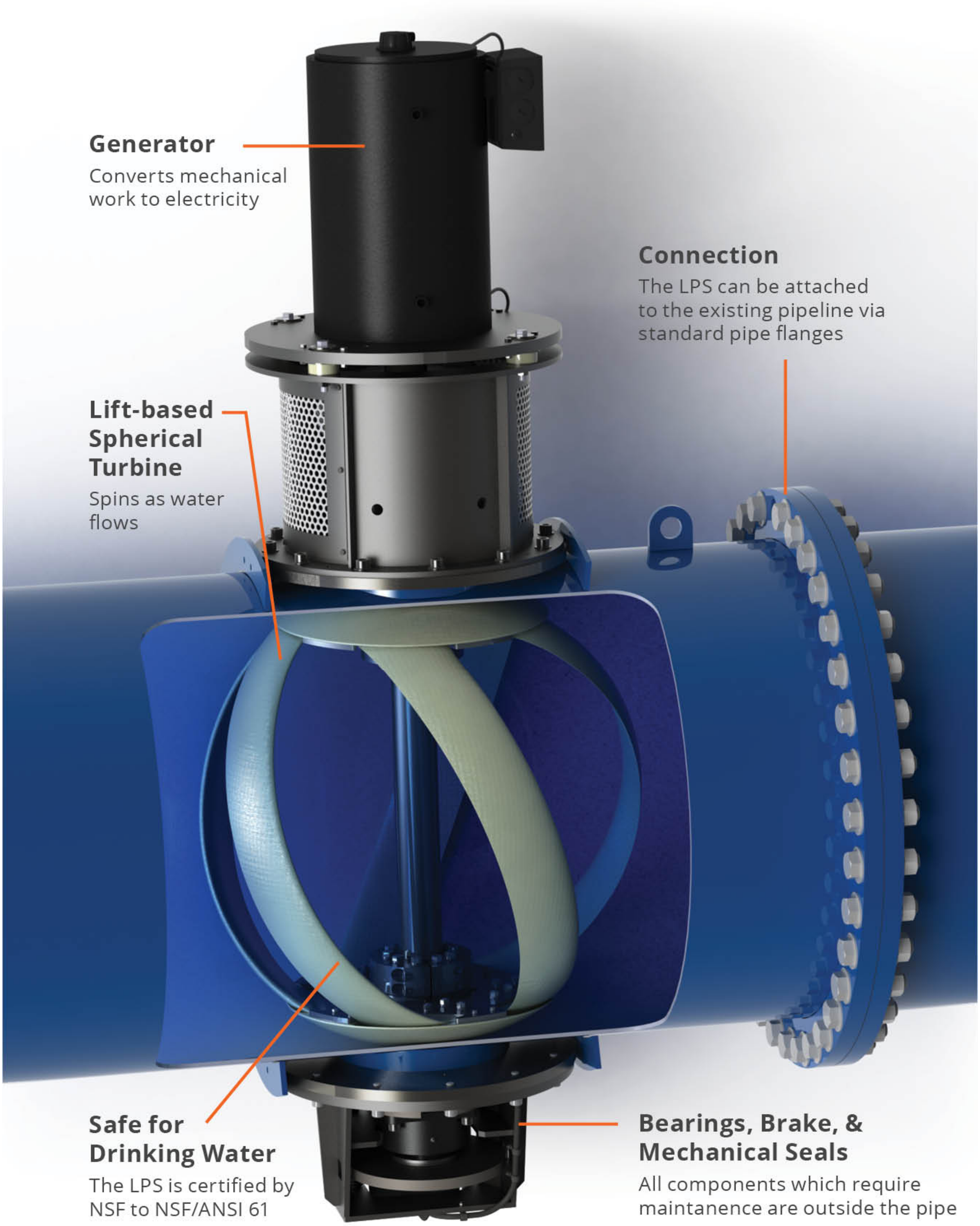
Technology & Safety

The LucidPipe™ Power System generates environmentally-friendly hydropower with no impact on water delivery. Unique, spherical turbines are installed inside large-diameter (24" – 60") gravity-fed water transmission pipelines. The turbines spin as water passes through them, converting excess head pressure into electricity. Multiple turbines can be mounted in series, one after the other, to maximize energy output.

Unlike conventional hydropower* and in-pipe PRV replacement** technologies, the LucidPipe Power System does not inhibit water delivery and operates in a wide range of pipe diameters and pressure/flows.

** Conventional hydropower technologies have been adapted for in-pipe applications, but are not suitable for use in water transmission pipelines because they deplete 95% of the pressure and usually require bypass loops.*

*** In-pipe pressure reduction valve (PRV) replacement technologies extract significant pressure and are not suitable for use in large-diameter water transmission pipes where pressure and flow velocity must be maintained.*



Power Output & Water Flow Requirements

18 kW

POWER CAPACITY

24 MGD
(1.0 m^3/s)

MINIMUM FLOW REQUIRED

24” (600mm)

50 kW

POWER CAPACITY

61 MGD
(2.7 m^3/s)

MINIMUM FLOW REQUIRED

42” (1050mm)

100 kW

POWER CAPACITY

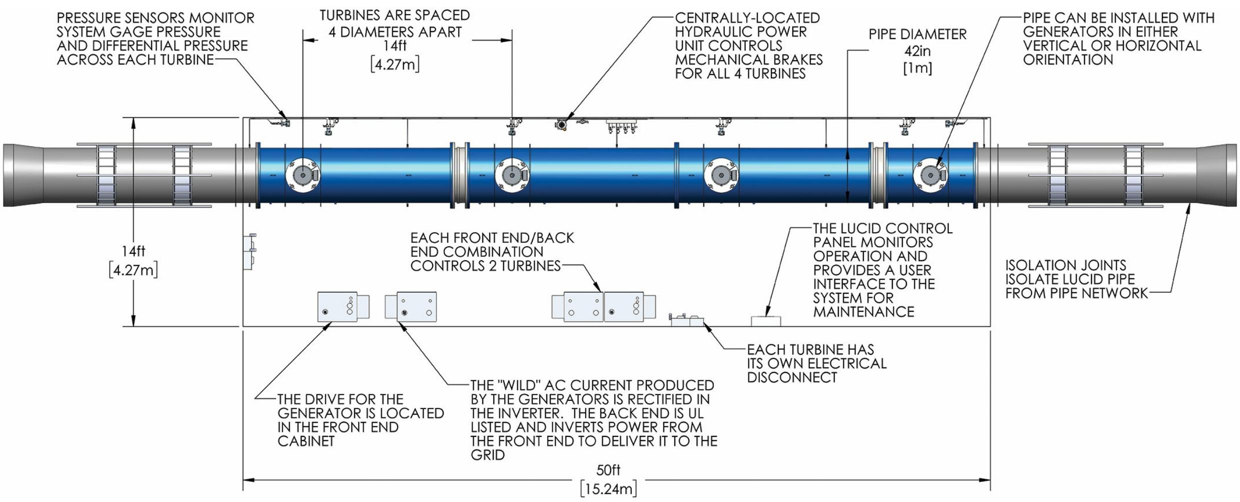
128 MGD
(5.6 m^3/s)

MINIMUM FLOW REQUIRED

60” (1500mm)

Power output per LucidPipe Turbine with the current technology. Turbines are placed in series, 4 diameters apart for maximum energy potential. Next generation turbines are expected to produce twice the power output per turbine.

Footprint of Four-turbine Installation for 42” Pipe



Return On Investment

Electricity generated by the LucidPipe Power System can be used behind the meter or sold to energy utilities through power purchase agreements (PPA). The target Levelized Cost of Electricity (LCOE) is between $0.05 and $0.12 per kilowatt hour, depending on local energy rates and other project financing factors. Target project payback is 10 years.

Advantages of LucidPipe

- Hydropower that doesn't harm ecosystems
- Can generate consistent, predictable energy 24/7
- No impact on water delivery
- Turns excess pressure into a revenue stream through power purchase agreements
- Provides grid-connected or off-grid power
- Use for distributed electricity, peak-energy and battery charging

Case Studies

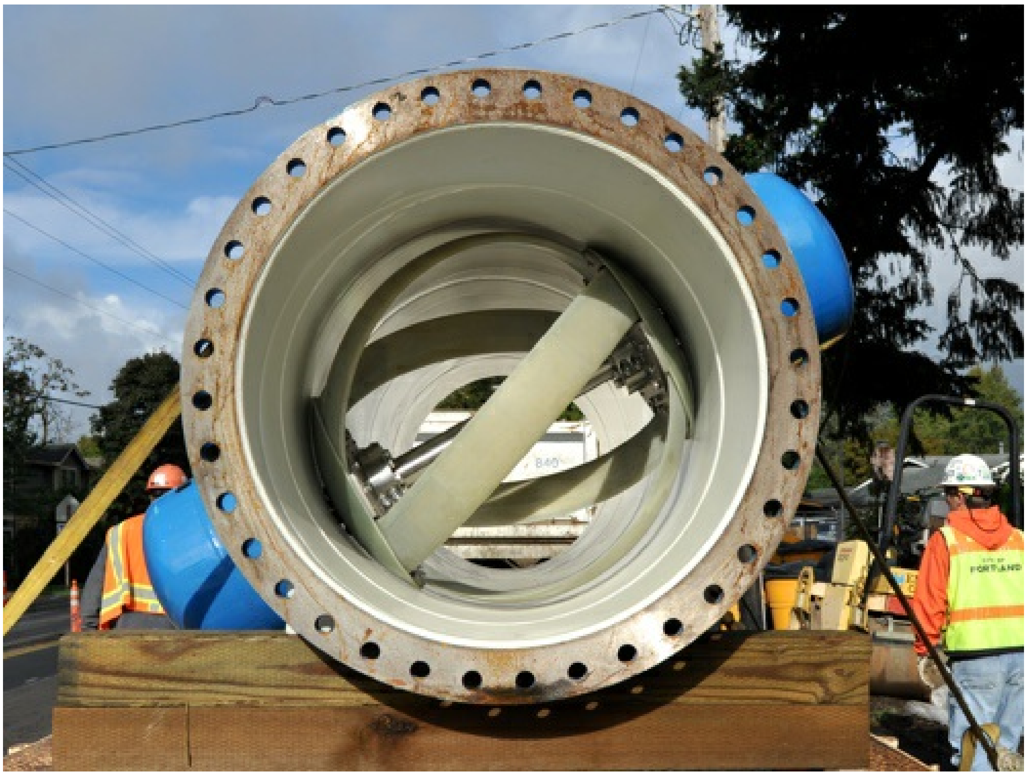
Water agencies today face increasing financial challenges. The high cost of energy, coupled with energy efficiency mandates and the need to repair or replace aging infrastructure all require creative solutions to keep operations sustainable.

By using their water pipelines to generate renewable energy from an otherwise untapped energy source, the LucidPipe Power System can be part of the solution. Pipeline repairs and installations provide opportunities to deploy LucidPipe on a wide scale, producing megawatts of renewable energy nationwide.

Two innovative water utilities have deployed the first generation LucidPipe Power System in their transmission pipelines: Portland Water Bureau and Riverside Public Utilities.

These installations have proven the LucidPipe concept and now serve as models for water agencies around the world to explore the value of in-pipe hydropower.

- Portland, OR
- Riverside, CA



Portland Water Bureau

Portland, Oregon

- Under contract with the City of Portland and the Portland Water Bureau (PWB), Lucid Energy installed a 42” four-turbine system as part of a PWB system upgrade. The site came online in January 2015.
- The LucidPipe system extracts pressure from the pipeline upstream from a flow control valve, which reduces the work required of the valve and will reduce valve wear over time.
- A 20-year Power Purchase Agreement is in place with Portland General Electric, the local power utility, to purchase the energy generated by the system.
- The project will help the city meet its Climate Action Plan goals by generating an average of 900 MWh per year, enough electricity to power approximately 100 homes.*

**Or approximately 600 average, electrified homes in China.*

Download Case Study

Riverside Public Utilities

Riverside, California

- Lucid Energy successfully field-piloted three generations of the LucidPipe Power System in a water pipeline at the Western Municipal Water District in Riverside.
- In October 2011, Riverside Public Utilities (RPU) received the Outstanding Energy Management Award from the California-Nevada Section of the American Water Works Association (AWWA) for its ongoing, in-system study of the LucidPipe Power System.
- In January 2012 Lucid Energy completed the first commercial installation of a single-turbine, 42” LucidPipe System at RPU.
- The system in Riverside operated for more than four years, providing power for streetlights at night and water agency operations during the day, and now serves as an ongoing test bed for development of the second generation LucidPipe turbine.

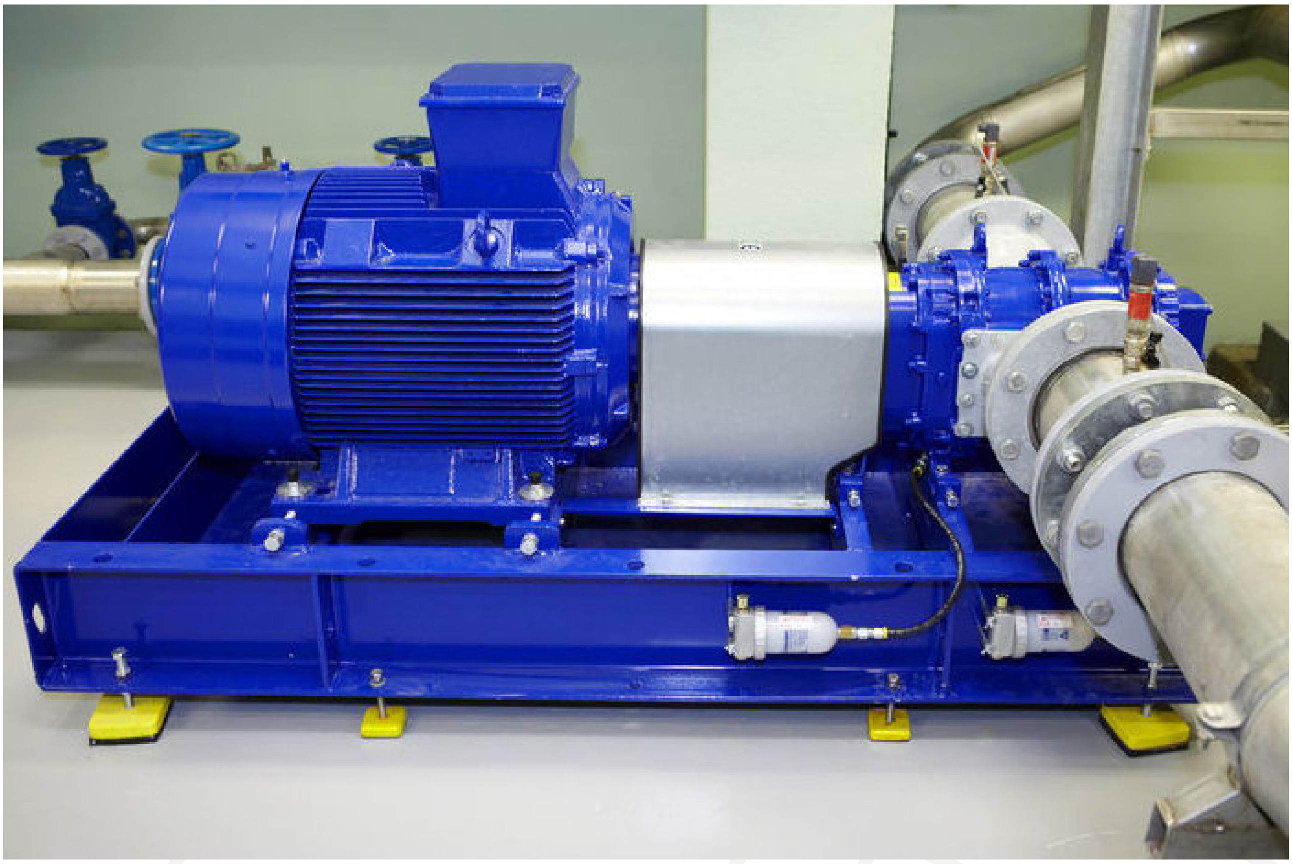
Download Case Study

Is The LucidPipe Power System right for you?

The LucidPipe Power System is designed for use by water utilities that have:

- Gravity-fed water delivery pipelines
- Large (24” to 60” diameter) pipes with flow and pressure matched to turbine size
- Excess pressure available to be removed
- Planned pipeline repair or installation, or above-ground location
- Grid connection for sale of electricity through power purchase agreements, or
- Off-grid connection for behind-the-meter use, distributed energy, battery charging

CONTACT



Difgen specifications

The Difgen is delivered as a complete operational system, ready for grid connection and start-up. A power meter will normally be supplied by the grid owner. If extra grid protection is required, an optional grid protection unit (eg, G59 in the UK) can be delivered.

The Difgen comes with two main components: the control power module (CPM) and the turbine generator module (TGM). The TGM is delivered with the turbine and generator on a skid frame, ready for installation. Flange adapters are delivered with the required PN/DN class for simple installation.

DATASHEET

Configurations

MODEL	Flow rate min-max [l/s]		Max inlet pressure [bar] 1)	Max diff. pressure [bar]	Max diff. pressure 10-pole gen	Min operat. diff. pressure
DG13-14	7	35	14	10	N/A	1.5
DG13-21	11	53	12	10	N/A	1.5
DG13-28	15	70	10	8	N/A	1
DG18-13	15	70	16	10	N/A	1.5
DG18-18	21	100	14	10	N/A	1.5
DG18-26	30	140	12	9	10	1.5
DG18-36	45	200	10	6.2	7.2	1
DG18-52	60	240	7	4.5	5	1
DG18-73	85	300	4	2.8	3	1
DG18-13L	15	70	13	13	N/A	1.5
DG18-18L	21	100	13	12	13	1.5
DG18-52HP	60	240	12	4.5	5	1
DG18-73HP	85	300	8	2.8	3	1

Note: Max flow limitations might apply for 10-pole generator systems.

Physical properties TGM

MODEL	H (mm)	W (mm)	D (mm)	Weight (kg)	Standard flange
DG13-14	2 000	950	1 150	1 500	DN125/PN16
DG13-21	2 200	950	1 150	1 700	DN150/PN16
DG13-28	2 400	950	1 150	2 200	DN150/PN16
DG18-13	2 000	950	1 150	1 500	DN150/PN16
DG18-18	2 200	950	1 150	1 700	DN150/PN16
DG18-26	2 400	950	1 150	2 200	DN200/PN16
DG18-36	2 400	950	1 150	2 600	DN250/PN16
DG18-52/52HP	2 700	950	1 150	3 000	DN250/PN16
DG18-73/73HP	2 900	1 016	1 150	3 500	DN350/PN16
DG18-13L	2 400	1 016	1 150	2 200	DN150/PN25
DG18-18L	2 400	1 016	1 150	2 600	DN150/PN16

Mains connection

ITEM	VALUES	COMMENTS
Mains power	Up to 110kW	Depends on voltage range and inverter sizes
Mains voltage	380-500V	
Mains frequency	50 or 60Hz	
Phases	Requires three phases	
Power factor	cos1= 1 (fundamental)/cos = 0.99 (total)	
Power quality	Built-in LCL filter	For distortion-free regenerative operation

1) Limitations apply. Seal mean pressure must not exceed 10 bar during operation. Formula for seal mean pressure:

- (inlet pressure + outlet pressure)/2 - for all Difgen models except L models
- (inlet pressure + outlet pressure + (inlet pressure - outlet pressure/2))/2 - for L models

Certifications

ITEM	VALUES
Distributed generation	IEEE 1547 UL1741 G59
CE markings	Machine EMC Low voltage
Electric safety	UL 508
Electromagnetic compatibility	EN 61800-3
Drinking water compatibility	ANSI 61/ DWI

Physical properties CPM

Depth	600mm
Width	600mm
Height	2 000mm
Weight	350kg
Cabinet colour	RAL 7035

Standard scope

#	Item	Description
1	VFD	Variable regenerative frequency drive. Output 230-690V (limitations on current for some models, check for each site. Transformer might be required), 3 phase, 50/60Hz output
2	Flange adapter	Standard flange adaptor from turbine to pipe
2	Pressure transmitters	Measurement sensor for pressure control. Sensors pressure ranges are specified to meet site parameters (code alternatives _I0x)
1	Turbine	Rotating lobe turbine
1	Generator	To be specified for each site. Forced ventilation fan included.
1	Cabinet	Enclosure for electrical equipment excluding generator
1	HMI touch screen	10inch colour touch screen operator panel in front door (CPM Solo only)
1	Skid	Generator and turbine mounted on a skid
2	Buffer chamber canisters	Including pressure gauges for pressurised buffer chambers
1	Basic logging	Web access to basic performance parameters (pressures, flow rate, kW, kWh, CO2 savings, status). Client is responsible for internet access (DMZ, GPRS modem or equivalent)
1	Backup battery	CPM battery backup - 7Ah (CPM Solo only)
1	Documentation	Installation and commissioning manual (MAN1016) O&M manual (MAN1000) ▪ Certificates ▪ Conformity of materials ▪ Approvals Communications manual (MAN1019) Standard CPM drawings (DRW0162 or DRW0166) ▪ Schematic diagrams of CPM ▪ Dimensional drawings ▪ Interface wiring diagram Dimensional drawings of TGM System specification for delivered system (SPCxxxxx) Test reports

Environment

ITEM	VALUES	COMMENTS
Ambient temperature operating	0 to 30°C [32 to 86°F]	
Ambient temperature storage	-20 to 70°C [-4 to 158°F]	Must be fully drained of water if ambient temperature is below freezing
Ambient temperature transport	-20 to 70°C [-4 to 158°F]	No condensation allowed
Relative humidity	5 to 85%	Without derating
Altitude	0 to 2 000m above sea level	Derating (1% /100m) above 1 000m

Options and alternatives - TGM

Ordering code: TGMxx-xx_Gxx_Axx_Pxx_Ixx+(sequence of options)

Name	Description	Delivery time	Code
Model name	E.g. TGM18-52	N/A	TGMxx-xx
Generator size	For internal Zeropex use. Difgen is a high-torque device, and generator is selection from max torque criteria - 37kW, 8-pole, 400V - 45kW, 8-pole, 400V - 55kW, 8-pole, 400V - 75kW, 8-pole, 400V - 90kW, 8-pole, 400V - 75kW, 8-pole, 500V - 90kW, 8-pole, 500V - 110kW, 8-pole, 500V - 75kW, 10-pole, 400V - 90kW, 10-pole, 400V - 75kW, 10-pole, 500V - 90kW, 10-pole, 500V - 110kW, 10-pole, 500V	All within standard delivery time	_G01 (alt) _G02 (alt) _G03 (alt) _G04 (alt) _G05 (alt) _G06 (alt) _G07 (alt) _G08 (alt) _G21 (alt) _G22 (alt) _G23 (alt) _G24 (alt) _G25 (alt)
IP 65 on generator	Upgrade from IP55 (standard) to IP65. Consists of an additional seal integrated into the generator to make it dust tight.	Within standard delivery time	+IP65 (opt)
Surface treatment	- Blue colour (RAL5002), TT 120 micrometer, 2K Paint system cat C3 (ISO12944) - Blue colour (RAL5002), TT 150 micrometer, 2K Paint system cat C4. Recommended if TGM is installed outdoors or in high humidity or corrosive areas. (ISO 12944-2).	Within standard delivery time	_P01 (std) _P02 (opt)
TGM Arrangements	In-line direct drive, horizontal. - Horizontal water inlet/outlet. Paint coated - Vertical water inlet/outlet (90 degree rotated turbine). Paint coated - Horizontal water inlet/outlet. Paint coated. Galvanized skid - Vertical water inlet/outlet (90 degree rotated turbine). Paint coated. Galvanized skid - Vertical water inlet/outlet (90 degree rotated turbine). Paint coated. 500mm elevated skid base.	_A01 to _A04 within standard delivery time Add 4-6 weeks	_A01 (std) _A02 (opt) _A03 (opt) _A04 (opt) _A05 (opt)
Alternative flange adapters	Alternative flange sizes outside our standard range (ref. table physical properties TGM) - PN16/DN125 - PN16/DN150 - PN16/DN200 - PN16/DN250 - PN16/DN300 - PN16/DN350 - 150lbs, ANSI 6" - 150lbs, ANSI 10" - 150lbs, ANSI 14"	All within standard delivery time	+F01 (opt) +F02 (opt) +F03 (opt) +F04 (opt) +F05 (opt) +F06 (opt) +F50 (opt) +F51 (opt) +F52 (opt)
Special flange adapters	Special flange adapter for flange sizes outside our standard and option range range - on request	Add 2-4 weeks	+F99 (opt)
Pressure transmitters	Pressure transmitter range for inlet/outlet pressure - 6 bar - 10 bar - 16 bar - 25 bar	All within standard delivery time	_I01 (alt) _I02 (alt) _I03 (alt) _I04 (alt)
Block and bleed valves	Set of two block and bleed valves for pressure transmitters. Each consists of three manual valves mounted in a "Y" configuration. One outlet is available for connecting an external instrument. Mounted on the turbine flange connector, together with the pressure sensors. - 6 bar with block and bleed - 10 bar with block and bleed - 16 bar with block and bleed - 25 bar with block and bleed	All within standard delivery time	_I11 (opt) _I12 (opt) _I13 (opt) _I14 (opt)
Stainless steel housing for turbine	Stainless steel housing.	Add 8-10 weeks	On request
Wetted turbine parts in stainless steel.	All internal metal parts in contact with fluid are in stainless steel or corrosion-free material.	Add 8-10 weeks	On request
Extended pressure	Reinforced housing for extended pressure applications. Must be analyzed and confirmed by Zeropex prior to ordering	Add 8-10 weeks	+K01 (opt)

Options and alternatives - TGM cont.

Name	Description	Delivery time	Code
Pressure transmitter (for pressurised buffer chambers only)	Set of two pressure transmitters for monitoring pressure in buffer chambers (one in each buffer chamber) connected to the Difgen system.	Within standard delivery time	+S01 (opt)
Bearing monitoring nodes	Four SPM measuring points for bearing diagnostics. Mobile diagnostic equipment must be brought to the site to measure and analyse. Ref. www.spminstrument.com.	Within standard delivery time	+R01 (opt)
Bearing monitoring system	Data acquisition units for continuous monitoring of bearing conditions. Includes 4 - 20mA signals for interfacing to client's SCADA. Ref. www.spminstrument.com	Delivered separately	+R02 (opt)
Difgen condition monitoring (temp)	Set of 2 temperature sensors (PT100) mounted on turbine. Used to measure surface temperature in gear box and QD cover. To be connected to suitable inputs at PLC, Difgen MC or similar.	Within standard delivery time	+M01 (opt)
Difgen condition monitoring (vibration)	Set of 2 vibration transmitters measuring overall machine vibration in X and Z direction. To be connected to suitable inputs at PLC, Difgen MC or similar.	Within standard delivery time	+M02 (opt)

Options and alternatives - CPM

Ordering code: CPM_FExx_BExx_Pxx_Vxx+(sequence of options)

Name	Description	Delivery time	Code
CPM Solo/Slave	CPM Solo or CPM Slave	N/A	_FE00_BE00 _FE01_BE01
Power	CPM Power rating (determined by load/torque analysis of operational conditions)	N/A	_Pxxx
Grid voltage	Grid voltage range - 380-415V - 380-500V	All within standard delivery time	_V01 (alt) _V02 (alt)
GPU G59	Grid protection unit/grid safety relay (UK:G59-2). Independent G59/EN60225 protection relay to trip supply circuit breaker - automatic reset	Within standard delivery time	+G01 (opt)
Special cabinet colour	Special cabinet colour. RAL7035 is standard	Add 1-2 weeks	+RALxxxx (opt)
IP/NEMA cabinet	Higher IP/NEMA protection of cabinet (from IP 43). High classes require water- cooled cabinet. Water connection by client	Add 4 - 6 weeks	On request
Transformer	Depending on configuration, site parameters and grid interconnection properties, a transformer might be required. Can also be used to isolate electric noise issues	Add 6-10 weeks	On request
Continuous control	Resistor load dump system for continuous gridloss operation. Includes cage for protection of resistive heat element. - 27kW continuous - 53kW continuous - 80kW continuous - 106kW continuous	Within standard delivery time Add 6-8 weeks Add 6-8 weeks	+CC01 (opt) +CC02 (opt) +CC03 (opt) +CC04 (opt)

COMMUNICATION OPTIONS

Name	Description	Delivery time	Code
Modbus ethernet for CPM Solo	Modbus TCP/IP interface. Hardware only included. Setup and configuration is client responsibility.	Within standard delivery time	+D01 (opt)
Modbus ethernet for CPM Slave	Modbus TCP/IP interface. Hardware only included. Setup and configuration is client responsibility.	Within standard delivery time	+D02 (opt)
Profibus DP Slave for CPM Solo	Profibus DP Slave. Hardware only included. Setup and configuration is client responsibility	Within standard delivery time	+D03 (opt)
Profibus DP Slave for CPM Slave	Profibus DP Slave. Hardware only included. Setup and configuration is client responsibility	Within standard delivery time	+D04 (opt)
Remote logging	3G Modem with top mounted antenna. (Only for CPM Solo)	Withing standard delivery time	+L01 (opt)

GENERAL OPTIONS

Name	Description	Delivery time
FAT	Extra day client-witnessed full-scale performance and functionality test in flow laboratory. Does not include client costs for eg. travel, accommodation, etc.	Within standard delivery time
SAT/commissioning support	Site acceptance test and commissioning support. Priced per day.	N/A
ZCE training	Please contact Zeropex.	N/A

Configuration examples

TGM18-36_K0_G24_A03_P02_I02+F05+S01+M01+R01+IP65

- TGM18-36
- _K0: standard pressure rating for selected turbine
- _G24: Generator size (internal use, determined by configuration): 110kW, 500V, 10 pole, IP55
- _A03: Horizontal water inlet/outlet. Paint coated. Galvanized skid
- _P02: Blue colour (RAL5002), TT 150 micrometer, 2K Paint system category C4
- _I02: 10 bar pressure transmitter rating (0-10bar)
- +F05: PN16, DN300 flange adapter
- +S01: Buffer chamber monitoring by 2 pressure transmitters
- +M01: 2 x Temp. transmitters for turbine surface temperature
- +R01: 4 x fixed plugs for bearing condition monitoring
- +IP65: IP65 water ingress protection

CPM_FE01_BE01_P110_V02+D04

- CPM_FE01_BE01: CPM Slave (requires Difgen MC or other master control)
- _P110: 110 kW power rating
- _V02: 380 - 500 VAC grid voltage
- +D04: Profibus DP Slave for CPM Slave

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Inline Hydro Turbine

Inline Series, ILT-XX
4" - 24" Pipe Sizes
25 - 570 Feet Head
100 - 30,000 GPM Flow Rates

Soar's Inline Turbines are a series of compact, highly efficient hydro power generation units. These turbines are site specific for maximum efficiency but share a number of common parts for competitive pricing and quick lead times. Designed specifically for conduit power recovery, the ILTs are available for standard pipe sizes from 4 to 24 inches.

The Francis turbine covers flows ranging from 100 to 30,000GPM and heads from 25 to 570 feet. Flange-to-flange lengths of Inline Turbines are shared with common pressure reducing valves for drop-in replacement and the flanges are manufactured to meet ANSI standards. Adjustable wicket gates maintain efficiency over a wide flow range to maximize power recovery and with a low maintenance design the unit is a viable economic choice.

Packaged systems are available with all necessary components from generation to power grid connectivity.

Manufactured and assembled in the USA
Patent Pending

Inline Turbine // GPRV Hydro

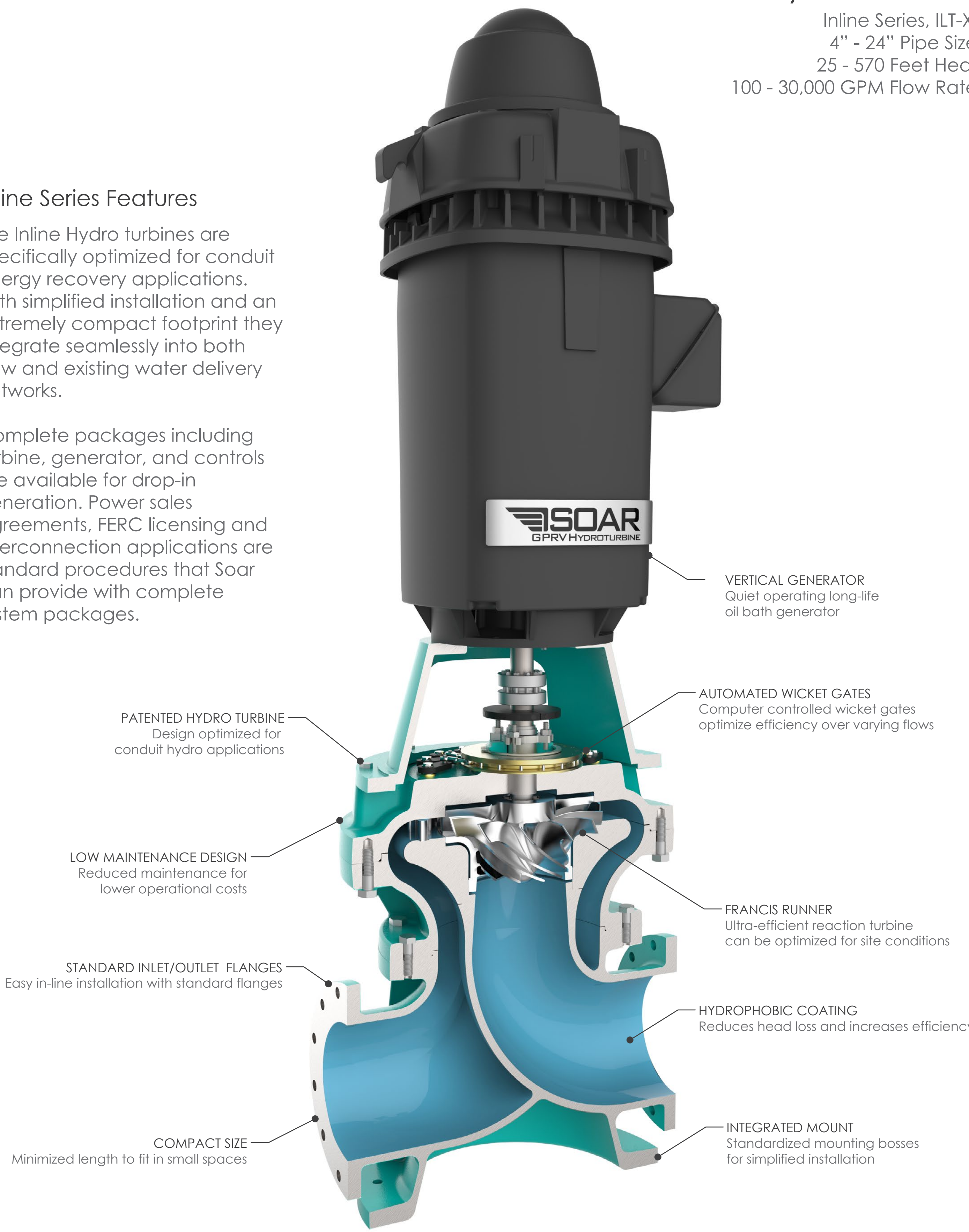
Inline Hydro Turbine

Inline Series, ILT-XX
4" - 24" Pipe Sizes
25 - 570 Feet Head
100 - 30,000 GPM Flow Rates

Inline Series Features

The Inline Hydro turbines are specifically optimized for conduit energy recovery applications. With simplified installation and an extremely compact footprint they integrate seamlessly into both new and existing water delivery networks.

Complete packages including turbine, generator, and controls are available for drop-in generation. Power sales agreements, FERC licensing and interconnection applications are standard procedures that Soar can provide with complete system packages.



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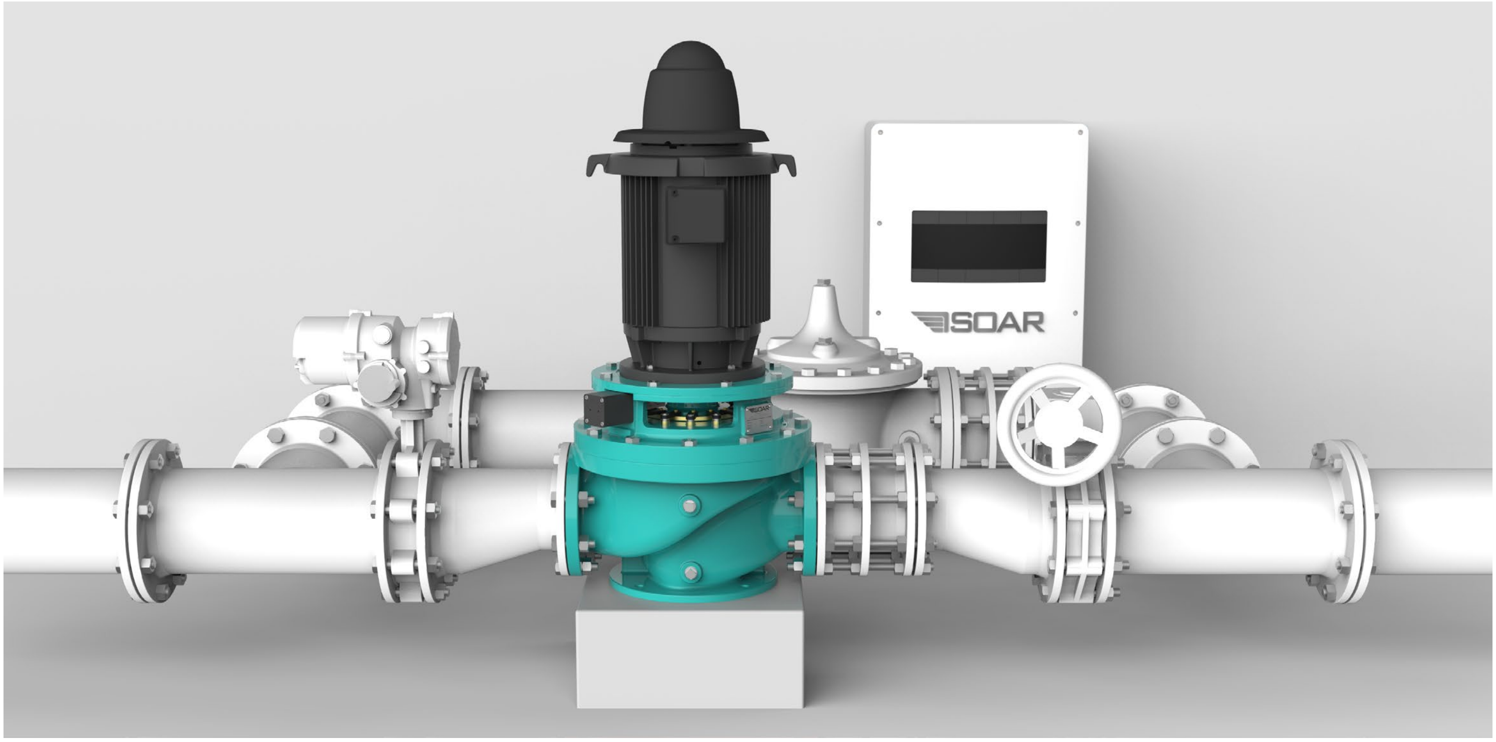
Inline Turbine // GPRV Hydro

Inline Hydro Turbine



Inline Series Specifications

The Inline Series Turbines utilize the same nominal flange size for both inlet and discharge flanges. Typical flanges are manufactured to meet ANSI standards and other standards can be used upon request. The flange-to-flange length of the Inline turbines is standard by size but the overall height can change based on site and generator requirements. Sizing, head, and flow ranges listed for each model are for reference only as exact specifications are site specific. For detailed sizing and application support contact Soar directly.

Imperial Turbines	ILT-04	ILT-06	ILT-08	ILT-12	ILT-16	ILT-20	ILT-24
Pipe Diameter	4"	6"	8"	12"	16"	20"	24"
Pressure Rating (PSI)	250	250	250	250	250	250	250
Min Flow (GPM)	150	500	800	1,800	4,400	6,700	9,900
Max Flow (GPM)	600	1,400	2,400	7,600	12,500	19,600	25,200
Overall Length	15.00"	20.00"	25.38"	34.00"	41.38"	52.0"	61.5"

Metric Turbines	ILT-100	ILT-150	ILT-200	ILT-300	ILT-400	ILT-500	ILT-600
Pipe Diameter	100mm	150mm	200mm	300mm	400mm	500mm	600mm
Pressure Rating (Bar)	16	16	16	16	16	16	16
Min Flow (M^3/H)	25	100	175	400	1,000	1,500	2,250
Max Flow (M^3/H)	150	225	550	1,725	2,850	4,500	5,725
Overall Length	381mm	508mm	645mm	864mm	1,051mm	1,321mm	1,562mm

M300 // MICRO HYDRO

Micro Hydro Turbine

Micro 300 Series, M300-XX
50mm or Larger Pipe Sizes
300 Watt Maximum Power Output
12-24VDC/120VAC Configurations

Soar Hydropower's Micro turbine series are designed for power generation in new or existing water networks and can be installed on any two inch or larger pipeline. Installation is simple and systems are plug-and-play. With minimal site prep requirements they are ideal for both local and off-grid applications. Common applications are installed in parallel with existing control or pressure reducing valves.

Micro Hydro turbines are ideal for running Remote terminal units (RTUs), SCADA systems, monitoring equipment, sump pumps, lighting, blowers, fans, and pressure management devices. Systems can be configured for 12-24VDC, or 120VAC, and maximum power output is 300 Watts. Generated power can be used as it is generated and excess is stored through a sophisticated battery charging system. When auxillary batteries are fully charged, the turbine automatically shuts down to prolong system life.

There are two versions of the M300 Micro Turbine. The M300-60 is engineered for higher head applications (up to 42 meters) while the M300-30 is engineered for lower head (up to 21 meters). Power output for both models depends on site specifics but both share the same 300W maximum potential.

For purchasing and application support contact your distributor or Soar directly

M300 // MICRO HYDRO

Micro Hydro Turbine

Micro 300 Series, M300-XX
50mm or Larger Pipe Sizes
300 Watt Maximum Power Output

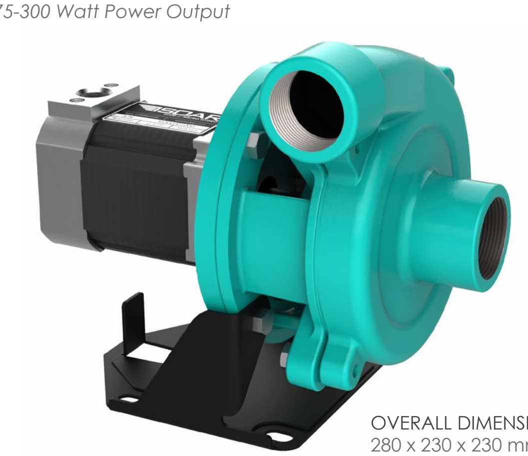
Micro Series Features

Soar's Micro Hydro Turbines are packaged solutions with simplified installation and an extremely compact footprint. They integrate seamlessly into both new and existing water delivery networks. Typical systems include turbine, generator, and controls and come ready for drop-in generation.

M300-30

Micro Hydro 300-30

7-21 meters, 9.1-13.6 m³/hour
75-300 Watt Power Output

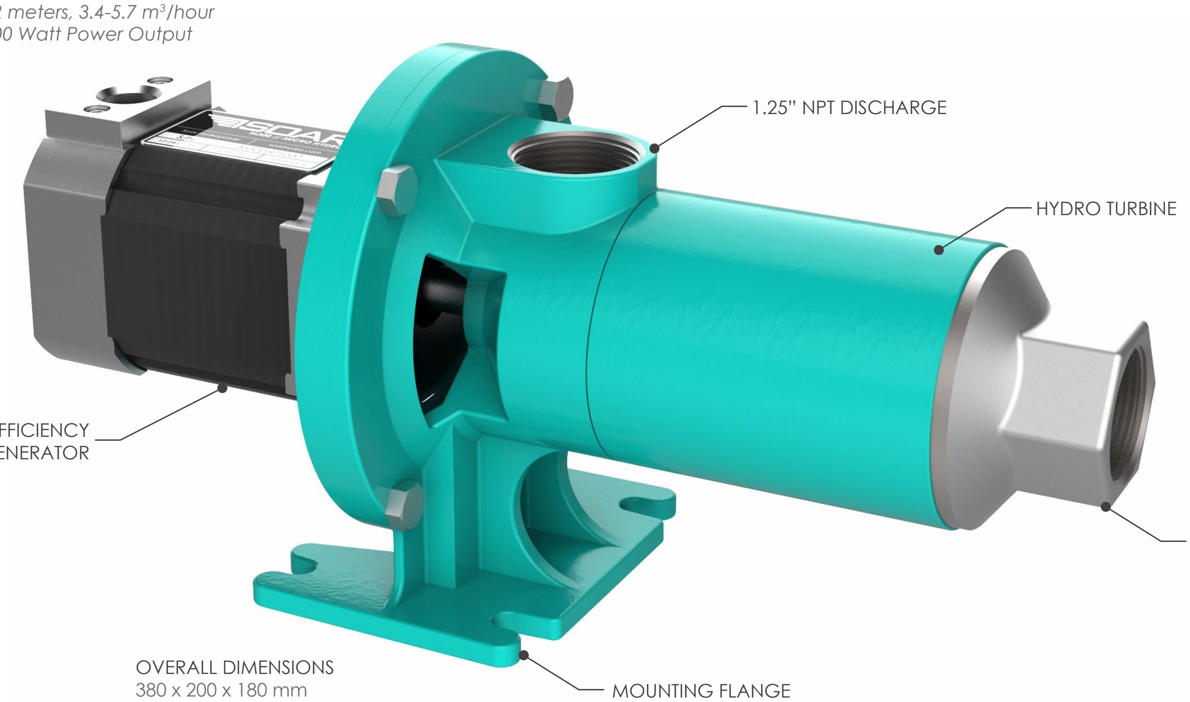


OVERALL DIMENSIONS
280 x 230 x 230 mm
1.25" NPT Inlet - Top
1.50" NPT Discharge - Center

M300-60

Micro Hydro 300-60

14-42 meters, 3.4-5.7 m³/hour
25-300 Watt Power Output



OVERALL DIMENSIONS
380 x 200 x 180 mm

For purchasing and application support contact your distributor or Soar directly

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M300 // MICRO HYDRO

Micro Hydro Controller

Micro Controller 2500 Series, MHC2500
25A Maximum Current Capacity
12-24VDC/120VAC Configurations

MHC2500 Controller Features

Soar's Micro Hydro Controller pairs seamlessly with the M300 series hydro turbines. With an intuitive interface and twist-lock wiring connections the MHC2500 is ready to manage power generation out of the box.

The controller automatically adapts system voltage from 12-24 Volts and can be configured for 120 Volt applications as well. The MHC2500 is compatible with turbine generation systems up to 25 Amps and charges an external battery bank that can be used actively or as needed.

MHC2500

Micro Hydro Controller

12-24/120 Volt Configurable
25A Max Battery Charge Rate
Isolated/Power Grid Applications

OVERALL DIMENSIONS
300 x 270 x 160 mm

For purchasing and application support contact your distributor or Soar directly

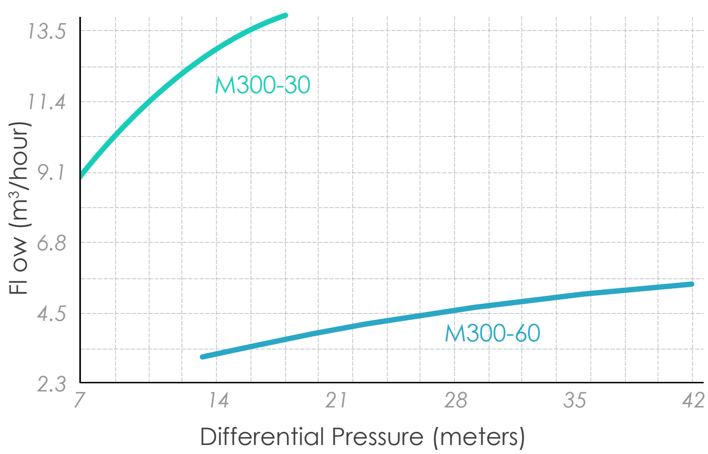
M300 // MICRO HYDRO

Micro Hydro Turbine

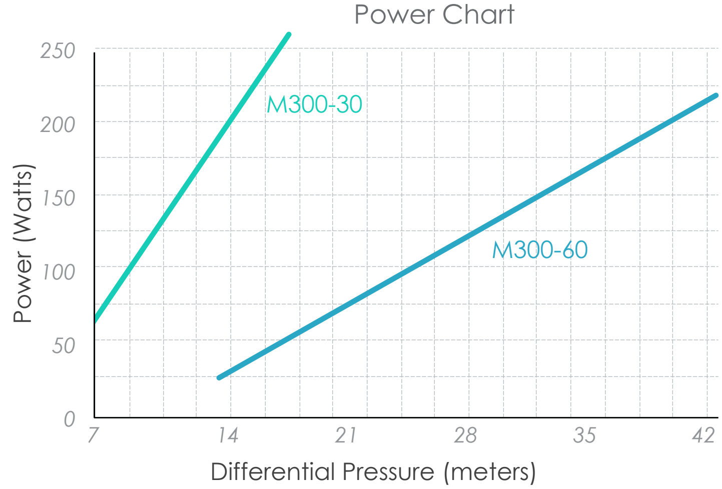
Technical Specifications

Turbine Range Charts

Flow Chart

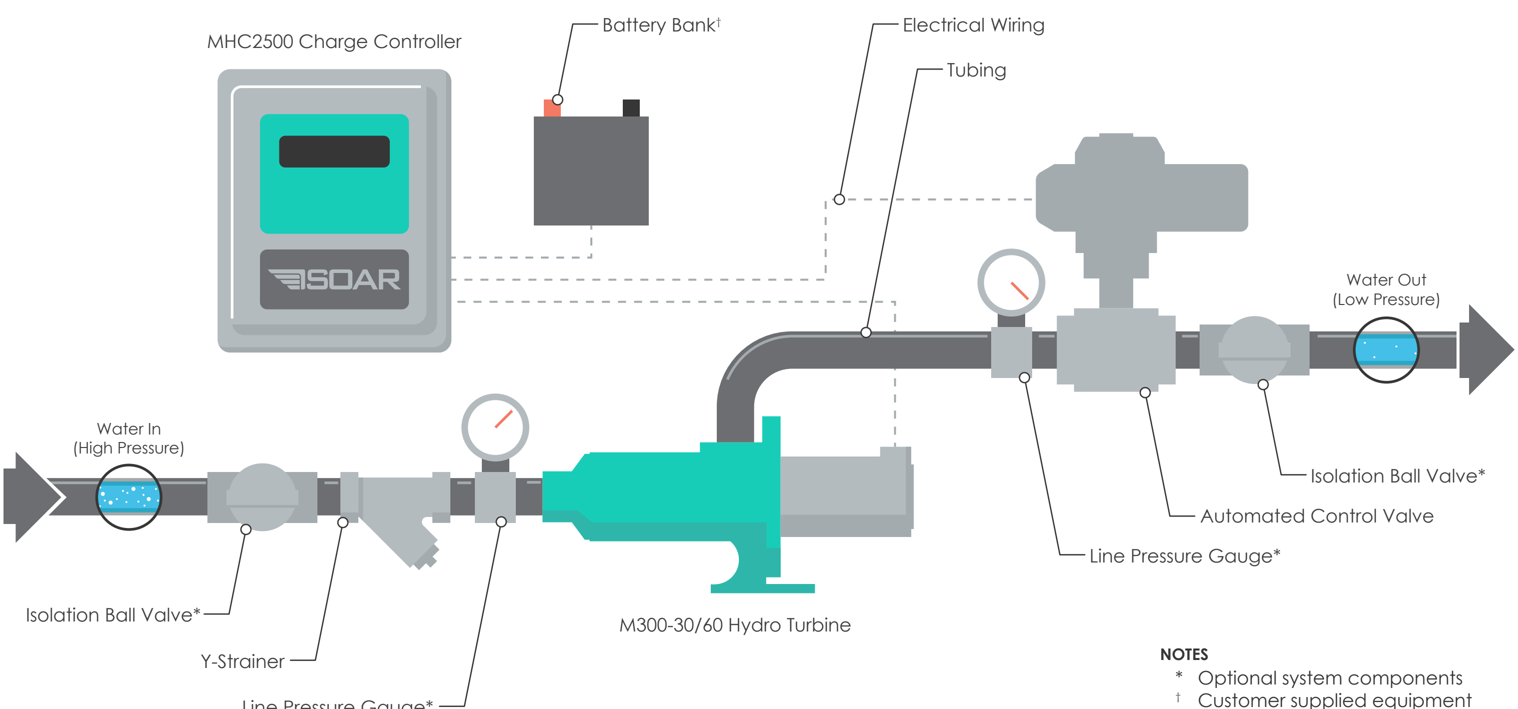


Power Chart



Flow and power output are both functions of system pressure differential. Differetial pressure must be known to determine turbine performance. To calculate the flow rate or power output, start with the differential pressure value and track upwards to where it intersects the turbine curve. From that point on the turbine curve track directly left to determine the flow or power output. Excess flow or pressure can be diverted if necessary.

Standard Installation Schematic

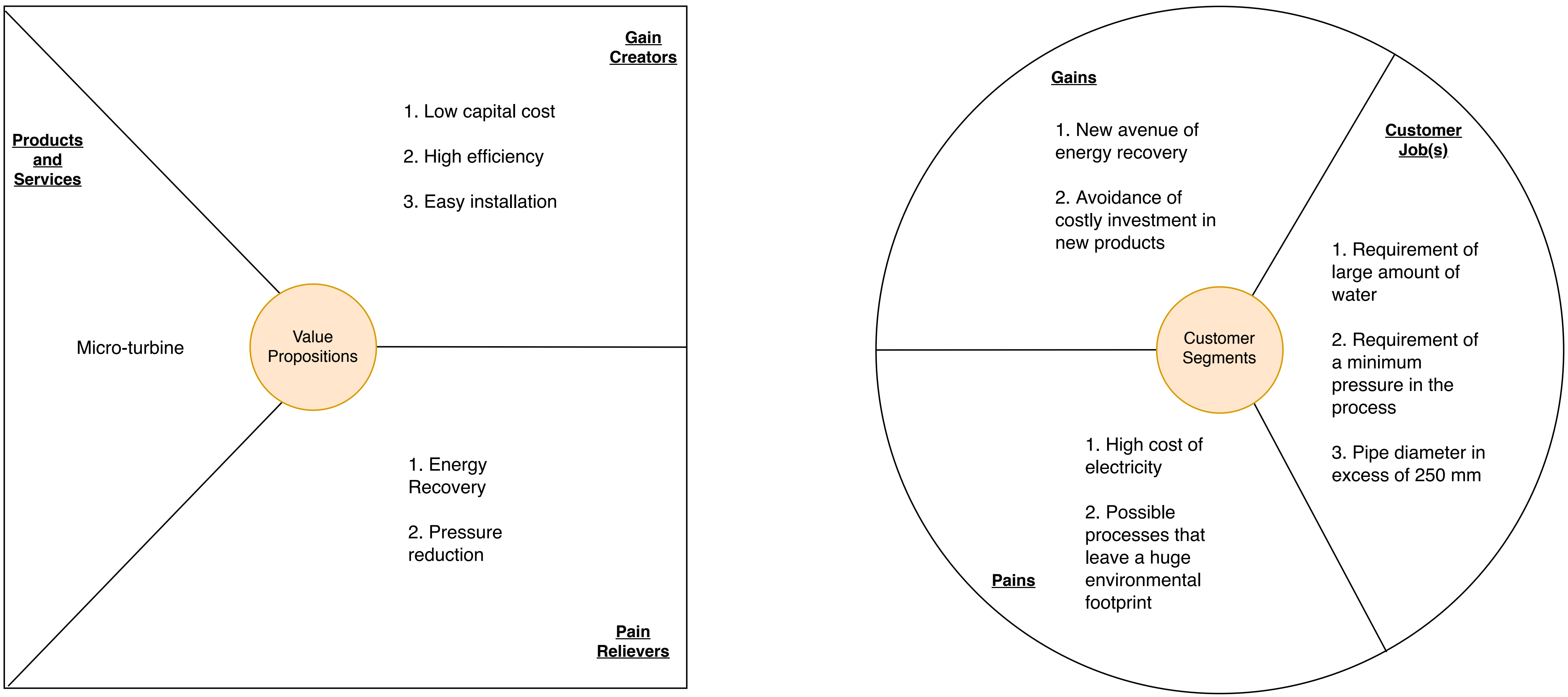


NOTES

* Optional system components
† Customer supplied equipment
2" or larger tubing required

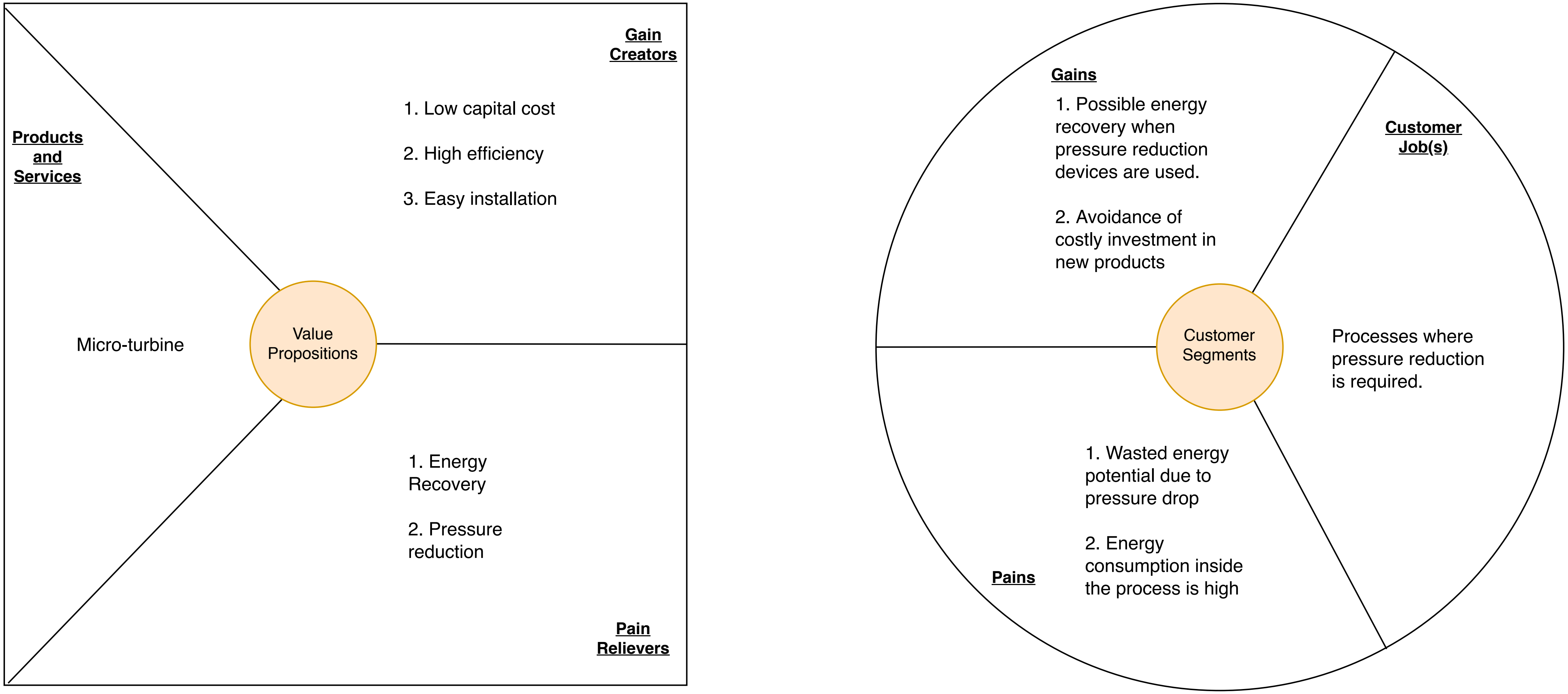
For purchasing and application support contact your distributor or Soar directly

Appendix 12: Value Proposition Canvas for Energy Recovery & Pressure Reduction customers



Osterwalder's Value Proposition Canvas

Value Proposition Canvas for Energy Recovery Customers.



Osterwalder's Value Proposition Canvas

Value Proposition Canvas for Pressure Reduction Customers.

Appendix 13: Financial Projections

Financial Projection

Important Assumptions

1. Sale of 80 turbines by Q4-2020
2. Gradual increase in employees from 4 to 47 employees.
3. Cash injection required to the tune of 30 MNOK.
4. Revenue realization is staggered upon sale of turbine. The schedule is given as follows.

	Q1	Q2	Q3	Q4
Revenue	30%	30%	40%	0%
Production costs	0%	100%	0%	0%
Freight	0%	0%	100%	0%
Installation costs	0%	0%	100%	0%

The Profit & Loss statement and Cash flow details are attached herewith.

P& L Statement for QRRNT AS | 2018-2020

1NOK | 0.103 | EUR

	2018				2019				2020			
	Q1-18	Q2-18	Q3-18	Q4-18	Q1-19	Q2-19	Q3-19	Q4-19	Q1-20	Q2-20	Q3-20	Q4-20
Net Sales Wellboats	0	24,00,000	48,00,000	1,04,00,000	2,00,00,000	2,80,00,000	4,00,00,000	4,16,00,000	5,04,00,000	5,04,00,000	5,36,00,000	5,04,00,000
Net Sales Scrubers	0	0	0	24,00,000	72,00,000	1,10,00,000	1,33,00,000	1,39,00,000	2,95,00,000	4,91,00,000	7,18,00,000	8,20,00,000
Other Net Sales	0	0	0	0	0	3,00,000	9,00,000	16,00,000	32,00,000	50,00,000	72,00,000	83,00,000
Other revenue (service agreements)	0	0	0	0	0	5,68,000	5,68,000	17,04,000	39,76,000	36,21,000	50,41,000	66,74,000
Sum revenue (NOK)	**0**	**24,00,000**	**48,00,000**	**1,28,00,000**	**2,72,00,000**	**3,98,68,000**	**5,47,68,000**	**5,88,04,000**	**8,70,76,000**	**10,81,21,000**	**13,76,41,000**	**14,73,74,000**
Sum revenue (€)	**0**	**2,47,200**	**4,94,400**	**13,18,400**	**28,01,600**	**41,06,404**	**56,41,104**	**60,56,812**	**89,68,828**	**1,11,36,463**	**1,41,77,023**	**1,51,79,522**
COGS												
Product cost	0	0	34,66,000	34,66,000	1,03,98,000	2,42,62,000	1,86,29,750	2,72,94,750	3,03,27,500	5,32,89,750	5,71,89,000	6,32,54,500
Freight	0	0	0	1,60,000	1,60,000	4,80,000	11,20,000	8,60,000	12,60,000	14,00,000	24,60,000	26,40,000
Installation costs	0	0	0	12,00,000	12,00,000	36,00,000	84,00,000	64,50,000	94,50,000	1,05,00,000	1,84,50,000	1,98,00,000
Production slack	0	3,60,000	6,72,000	12,80,000	13,60,000	3,98,680	-1,09,536	-1,76,412	-3,48,304	-6,48,726	-11,01,128	-14,73,740
Subcontractors installation (prior to hiring)	0	0	0	10,48,000	20,96,000	44,54,000	88,03,200	63,73,150	84,67,840	1,06,89,600	1,81,10,750	2,76,14,800
Maintanance cost	0	0	0	0	0	2,84,000	2,84,000	8,52,000	19,88,000	18,10,500	25,20,500	33,37,000
Accruals/ WIP	0	14,47,800	-5,70,400	18,47,600	61,17,600	-35,22,921	21,84,263	-1,12,060	70,15,692	-61,22,924	-77,68,525	-1,76,48,837
Sum product costs (NOK)	**0**	**18,07,800**	**35,67,600**	**90,01,600**	**2,13,31,600**	**2,99,55,759**	**3,93,11,677**	**4,15,41,428**	**5,81,60,728**	**7,09,18,200**	**8,98,60,597**	**9,75,23,723**
Sum product costs (€)	**0**	**1,86,203**	**3,67,463**	**9,27,165**	**21,97,155**	**30,85,443**	**40,49,103**	**42,78,767**	**59,90,555**	**73,04,575**	**92,55,641**	**1,00,44,944**
Wages	8,34,500	14,16,900	32,49,600	41,71,600	57,58,350	66,47,745	81,60,897	93,82,063	99,75,530	1,05,84,078	1,07,12,527	1,11,12,527
AGA	1,17,665	1,99,783	4,58,194	5,88,196	8,11,927	9,37,332	11,50,686	13,22,871	14,06,550	14,92,355	15,10,466	15,66,866
Vacation pay	1,00,140	1,70,028	3,89,952	5,00,592	6,91,002	7,97,729	9,79,308	11,25,848	11,97,064	12,70,089	12,85,503	13,33,503
AGA vacation pay	75,240	23,974	54,983	70,583	97,431	1,12,480	1,38,082	1,58,745	1,68,786	1,79,083	1,81,256	1,88,024
Pension	48,740	75,267	1,34,100	1,60,100	2,20,350	2,47,600	3,02,333	3,49,267	3,70,600	3,83,600	3,83,600	3,99,600
Insurances	7,500	14,000	25,500	30,000	46,500	50,500	56,500	61,000	67,500	70,500	70,500	70,500
Other personell costs	2,10,375	2,82,250	5,02,875	6,00,375	8,26,313	9,28,500	11,33,750	13,09,750	13,89,750	14,38,500	14,38,500	14,98,500
Sum personell costs	**13,94,160**	**21,82,202**	**48,15,204**	**61,21,446**	**84,51,873**	**97,21,886**	**1,19,21,556**	**1,37,09,543**	**1,45,75,779**	**1,54,18,205**	**1,55,82,353**	**1,61,69,521**
Rent of premises	1,18,101	4,24,851	4,85,788	3,36,538	6,88,010	3,91,010	3,94,010	3,95,510	3,98,510	4,00,010	4,00,010	4,00,010
Equipment (tools, workwear,etc)	10,000	10,000	10,000	10,000	1,22,500	1,22,500	2,05,000	1,90,000	1,60,000	1,60,000	10,000	10,000
Sales/marketing costs	20,776	5,95,255	4,47,000	97,000	3,56,031	2,10,000	97,000	97,000	3,06,031	4,60,000	97,000	97,000
IT + phones	18,250	11,81,600	3,66,350	3,00,500	6,52,150	2,25,750	5,50,350	3,62,650	2,97,250	2,17,550	1,83,550	1,83,550
Hardware	0	3,09,000	1,63,000	95,000	3,43,000	68,000	2,24,000	1,12,000	68,000	34,000	0	0
Software	18,250	1,97,600	1,28,350	1,30,500	2,34,150	82,750	2,51,350	1,75,650	1,54,250	1,08,550	1,08,550	1,08,550
Maintainance servers, etc.	0	6,75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000
Training costs	0	3,10,000	3,60,000	30,000	3,30,000	4,20,000	1,20,000	3,60,000	1,20,000	3,60,000	0	3,00,000
Legal	0	1,65,000	1,65,000	0	1,65,000	0	1,65,000	0	1,50,000	1,65,000	0	1,65,000
R&D	0	1,66,438	1,66,438	58,438	2,08,438	58,438	58,438	58,438	1,66,438	58,438	1,66,438	58,438
Board	87,500	87,500	87,500	87,500	87,500	87,500	87,500	87,500	1,00,000	1,00,000	1,00,000	1,00,000
Hiring	0	1,80,000	1,00,000	20,000	2,20,000	80,000	80,000	40,000	80,000	40,000	0	0
Administration	42,500	1,15,000	1,12,500	1,30,000	2,42,500	1,67,500	2,12,500	1,82,500	2,52,500	2,47,500	1,82,500	2,47,500
Travels	58,750	3,57,500	4,32,500	7,17,500	7,77,500	10,17,500	10,73,500	14,57,500	20,97,500	23,77,500	24,17,500	24,97,500
Sales	40000	300000	375000	600000	650000	800000	700000	900000	900000	900000	900000	900000
Installation/subcontractors	0	20000	20000	80000	90000	180000	336000	520000	1160000	1440000	1480000	1560000
administration	18750	37500	37500	37500	37500	37500	37500	37500	37500	37500	37500	37500
Sum other costs	**3,55,877**	**35,93,143**	**27,33,076**	**17,87,476**	**38,49,629**	**27,80,198**	**30,43,298**	**32,31,098**	**41,28,229**	**45,85,998**	**35,56,998**	**40,58,998**
Sum cost	**17,50,037**	**75,83,145**	**1,11,15,880**	**1,69,10,522**	**3,36,33,102**	**4,24,57,843**	**5,42,76,531**	**5,84,82,068**	**7,68,64,735**	**9,09,22,402**	**10,89,99,947**	**11,77,52,242**
EBIT	**-17,50,037**	**-51,83,145**	**-63,15,880**	**-41,10,522**	**-64,33,102**	**-25,89,843**	**4,91,469**	**3,21,932**	**1,02,11,265**	**1,71,98,598**	**2,86,41,053**	**2,96,21,758**

	2018	2019	2020
Net sales	**2,00,00,000**	**18,06,40,000**	**48,02,12,000**
Growth		803%	166%
COGS	1,43,77,000	13,21,40,464	31,64,63,247
GM % (excl. Own hours)	28%	27%	34%
Labour	1,45,13,011	4,38,04,859	6,17,45,858
% av sales	73%	24%	13%
Other costs	84,69,572	1,29,04,221	1,63,30,221
% av sales	42%	7%	3%
Total costs	**3,73,59,583**	**18,88,49,543**	**39,45,39,327**
EBIT	**-1,73,59,583**	**-82,09,543**	**8,56,72,673**

Cash Injection Q1-2018	-	NOK
Cash Injection Q1-2018	**-**	EUR

Free Cash Flow Calculation and Cash Injection requirements for QRRNT | 2018-2020

	2018				2019				2020			
	Q1-18	Q2-18	Q3-18	Q4-18	Q1-19	Q2-19	Q3-19	Q4-19	Q1-20	Q2-20	Q3-20	Q4-20
Cash BoP	20,00,000	3,21,139	-36,54,753	-1,09,17,446	-1,59,66,288	-2,00,17,359	-2,77,02,073	-3,00,90,974	-3,03,27,328	-2,17,67,636	-1,30,83,316	7,53,886
EBIT	-17,50,037	-51,83,145	-63,15,880	-41,10,522	-64,33,102	-25,89,843	4,91,469	3,21,932	1,02,11,265	1,71,98,598	2,86,41,053	2,96,21,758
Change in working capital	-71,175	-12,07,253	9,46,814	9,38,320	-23,82,031	50,94,871	28,80,370	5,58,285	16,51,573	85,14,278	1,48,03,851	1,67,68,499
Capital injection	-	-										
Cash Flow	-16,78,861	-39,75,891	-72,62,693	-50,48,842	-40,51,071	-76,84,714	-23,88,901	-2,36,354	85,59,692	86,84,320	1,38,37,202	1,28,53,259
Cash at the EoP	3,21,139	-36,54,753	-1,09,17,446	-1,59,66,288	-2,00,17,359	-2,77,02,073	-3,00,90,974	-3,03,27,328	-2,17,67,636	-1,30,83,316	7,53,886	1,36,07,145
Acc FCF (NOK)	3,21,139	-36,54,753	-1,09,17,446	-1,59,66,288	-2,00,17,359	-2,77,02,073	-3,00,90,974	-3,03,27,328	-2,17,67,636	-1,30,83,316	7,53,886	1,36,07,145
Acc FCF (EUR)	33,077	-3,76,440	-11,24,497	-16,44,528	-20,61,788	-28,53,313	-30,99,370	-31,23,715	-22,42,066	-13,47,582	77,650	14,01,536

Cash required:	**3,03,27,328**	NOK
	31,23,715	EUR

1NOK	0.103	EUR