MOSSY BRAE WATER DISTRICT

(Water System OR41 00945)

TANK REPLACEMENT ANALYSIS

Prepared and Submitted by:

Grayling Engineers, PLLC
605 Barnes Street, Ste 203
Vancouver, WA 98661

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1.0 Introduction

The Mossy Brae Water District (District) serves approximately 50 single family homes in a residential neighborhood located south of Lake Oswego, adjacent to the Tualatin River. The sole water source for the District is a single 195 foot deep well which has an instantaneous water right of 0.1 CFS[1] (45 gpm), see **Appendix A** for details regarding the well. Water is stored in a 12.65-foot diameter elevated welded steel tank with a nominal storage capacity of approximately 32,400 gallons. The ground elevation at the base of the tank is approximately 230 feet[2]. The tank is raised about 5 feet above the ground on legs and the top of the tank is roughly 40 feet above ground level, equating to a maximum hydraulic grade line of 270 feet.

Water from the tank feeds a single pressure zone which ranges in elevation from 220 feet to 115 feet. The topography is such that the tank is located near the highest elevation within the service area, adjacent to 19510 SW Ecotopia Lane. The terrain generally slopes away from the tank to the south and west. With the tank full, static pressures in the system range from 21 psi in the upper services to 67 psi in the lower services[3]. The distribution system consists primarily of 6-inch diameter ductile iron main except for a section of smaller main along SW Ecotopia Lane and there are four fire hydrants serving the community. See **Appendix B** for a map of the District's drinking water system.

A third party condition assessment of the existing steel tank performed in 2011 recommended that the tank's coating system be replaced. Rather than allocate funds towards rehabilitating the existing tank, the District has considered replacing the tank in its entirety for the following reasons: 1) based on the year of construction, the tank will likely not meet current building codes which include seismic performance; 2) the tank does not currently provide or is very close to not providing the minimum required pressure for at least one customer in the upper portion of the service area except when completely full; 3) the tank is likely undersized, which is to be determined herein; 4) the wall thickness of the tank was measured in 2011 and based on an assumed rate of corrosion performed by an unknown third party at that time, failure was projected to occur in 2031; 5) a portion of the existing tank is located within the public right-of-way of SW Stafford Road based on a professional survey completed in 2007, a copy of the survey is included as **Appendix C**. In May of 2019, the District requested that Grayling Engineers assess its water system and make recommendations for possible water tank replacement alternatives.

[1] While a recent pumping test has not been performed, historically the well is reported to have been capable of producing the maximum instantaneous water right during normal pump operation.
[2] Elevations discussed herein are based on the North American Vertical Datum of 1988.
[3] Precise elevations of existing services unknown, static pressures shown are approximate.

2.0 Planning

2.1 Water Demands

This section establishes the planning criteria by which a replacement tank will be sized. Available monthly water production records from April 25, 2018 through March 4, 2019 were analyzed to determine existing water demands. These records, included in **Appendix D**, were used to calculate average day demand (ADD). Maximum day demand (MDD) and peak hour demand (PHD) were then estimated by referring to Sections 3.4.1 and 3.4.2 of the Washington State Department of Health's 2019 *Water System Design Manual*[4] (*WSDM*). **Table 1** summarizes the planning data that is used to size a replacement tank.

Table 1. Planning Data

Description	Value
Number of Connections[1]	50
Average Day Demand (gpd)[2]	9,684
Maximum Day Demand (gpd)[3]	33,342
Maximum Day Demand (gpm)[3]	23
Peak Hourly Demand (gpm)[3]	87

1. Current number of active service connections based on billing information provided by Hiland Water.
2. Calculated based on historical records.
3. Calculated using the 2019 Washington State Department of Health *Water System Design Manual*.

2.2 System Pressure

Under Oregon Administrative Rule 333-061-0025(7), water suppliers are responsible for "...maintaining a pressure of at least **20 pounds per square inch (psi)** at all service connections at all times."

This minimum system pressure is achieved in municipal drinking water systems in one of two ways: 1) via an open system, where system pressure is provided by gravity storage located at an appropriate elevation, 2) via a closed system, where system pressure is provided by booster pump(s). It is typically preferable to use an open system as this option is more reliable and less expensive to operate. However, an open system requires that the tank be located at an elevation high enough to provide the minimum 20 psi to all service connections under all flow conditions. Design is based on the "worst case" flow scenario. Per the *WSDM*, the "worst case" is either assumed to be PHD, or MDD + Fire Flow (FF), whichever is greater. As shown in **Table 1**, PHD is 87 gpm and MDD is 23 gpm.

[4] This document was recommended as a source of guidance for design by the Oregon Health Authority.

As for FF, ideally, the system would be designed to provide a minimum fire flow of 1,000 gpm for 60 minutes based on Appendix B of the *2014 Oregon State Fire Code*[5]. However, based on conversations with the local fire authority, a replacement tank would only need to provide FF and fire suppression storage in-kind with the existing tank. Since the original design parameters of the water system are unknown, an FF value of 500 gpm was assumed. This FF value was used in a previous engineering report prepared for the District in 1979 which is included as **Appendix E**. Therefore the MDD + FF value of 523 gpm will be the assumed design flow.

3.0 Engineering Calculations

This section describes the calculations used for sizing a new water storage tank as well as a booster pump station.

3.1 Tank Sizing

The required volume of water to be stored in a water system consists of up to five components: Operational Storage (OS), Equalizing Storage (ES), Standby Storage (SB), Fire Suppression Storage (FSS), and Dead Storage (DS). Using planning data listed in **Section 2** of this report and the equations and guidance found in the *WSDM*, the required storage volumes for each of the five components were determined and are described in the following sections.

Operational Storage

Operational storage is the volume of water stored between the normal on/off setting for the source, the well pump in this case. Using the pump cycling formula found in the *WSDM*, the minimum operational volume is determined as follows:

OS = 2.5 * Q = 2.5 * 45 = 113 gallons

Where,
OS = Operational storage volume in gallons
Q = Source production capacity in gpm (limited to water right of 45 gpm)

Because this is a very small volume, the limiting factor for determining the OS in reality will be the minimum spacing between the pump-off / pump-on float switches. Additionally, it is desirable to increase the operational storage volume to promote water turnover and therefore water quality. For the purposes of this analysis the operational storage volume is assumed to be **1,000 gallons**.

[5] Assumes all houses served are one- and two-family dwellings having a fire flow calculation area not exceeding 3,600 square feet.

Equalizing Storage

Equalizing storage satisfies peak demands that exceed source capacity. Using the formula found in the *WSDM*, the minimum equalizing storage volume is as follows:

ES = (PHD - Qs) * 150 = (87 - 45) * 150 = **6,300 gallons**

Where,
ES = Equalizing storage volume in gallons, existing condition
PHD = Peak hour demand in gpm, existing condition
Qs = Source production capacity in gpm (limited to water right of 45 gpm)

The equalizing storage numbers shown above are calculated based on existing demands. However, there are an estimated 18 additional parcels within the District's service area that have the potential to be developed, which would result in a total of 68 water service connections under buildout conditions. Assuming the average daily demand per customer remains constant, this would result in a buildout PHD of 108 gpm. Once again, referring to the *WSDM* for guidance, the buildout equalizing storage requirements were calculated as follows:

$\mathbf{ES_{BO}}$ = (PHD_{BO} - Qs) * 150 = (108 - 45) * 150 = **9,450 gallons**

Where,
ES_{BO} = Equalizing storage volume in gallons, buildout condition
PHD_{BO} = Peak hour demand in gpm, buildout condition[6]
Qs = Source production capacity in gpm (limited to water right of 45 gpm)

Standby Storage

Standby storage provides water during abnormal operating conditions, such as during maintenance activities and emergencies. Examples of emergencies include well pump failure and electrical outages. Using the standby storage formula found in the *WSDM*, the minimum standby storage volume was calculated as follows:

SB = (N) (SB_i) (T_d) = (50) (194) (2) = **19,400 gallons**

Where,
SB = Standby storage volume in gallons, existing condition
N = Number of residential service connections, existing condition
SB_i = Unit standby volume in gallons per day per service connection (assumed to be equal to the ADD per service connection value of 194 gpd)
T_d = Number of days selected to meet the standard of reliability (assumed to be 2 days)

[6] Calculated using Equation 3-1 from the *WSDM* with a buildout service count of 68.

The standby storage numbers shown above are calculated based on existing demands. Standby storage requirements under buildout conditions were calculated as follows:

$$\mathbf{SB_{BO}} = (C_{BO} / C_E) * SB = (68/50) * 19{,}400 = \mathbf{26{,}384\ gallons}$$

Where,
SB_{BO} =Standby storage volume in gallons, buildout condition
C_{BO} = Number of buildout connections
C_E = Number of existing connections
SB = Standby storage volume in gallons, existing condition

Fire Suppression Storage

As mentioned in **Section 2.2**, ideally fire suppression storage (FSS) would be sized to meet the the *2014 Oregon State Fire Code*[7], which is 60,000 gallons. However, based on conversations with the local fire authority, a replacement tank would only need to provide FSS in-kind with the existing tank. It is assumed that the standby storage volume under buildout conditions (SB_{BO}) would exceed the existing FSS. If it is also assumed that the FSS is nested within the SB_{BO}, the **FSS can be ignored for tank sizing purposes**. These assumptions should be re-verified with the local fire authority at the time of design if the District does decide to construct a new tank.

Dead Storage

Dead storage is the volume of stored water which is <u>not</u> available to all consumers at the minimum required pressure of 20 psi under a MDD + FF condition. If water is being pumped out of the tank, dead storage would be the water below the top of the outlet pipe. For the purposes of this report the height of an outlet pipe for a tank feeding pump station is assumed to be 8 inches. Therefore, **dead storage is assumed to be 8 inches high within a pumped storage tank**. Within a gravity tank, the dead storage would be all water below a minimum elevation required to provide sufficient pressure. Based on a preliminary modeling effort, **dead storage is assumed to be all water below an elevation of 258 feet[8] within a gravity storage tank**.

[7] Assumes all houses served are one- and two-family dwellings having a fire flow calculation area not exceeding 3,600 square feet.
[8] Assumes existing buried water mains in SW Ecotopia Lane have been replaced with 6-inch CL 52 ductile iron pipe. Also assumes an individual booster pump is provided for the water service located at 19510 SW Ecotopia Lane.

Total Usable Storage

The total minimum required usable storage values, comprised of the OS, ES, and SB for the water system under existing and buildout conditions are shown in **Table 2**. FSS is assumed to be nested within the standby storage volume and is therefore not shown. Because dead storage is a tank-specific property, it is also not included in **Table 2**.

Table 2. Calculated Usable Water Storage Volumes

Storage Description	Existing Condition	Buildout Condition
Operational Storage	1,000	1,000
Equalizing Storage	6,300	9,450
Standby Storage	19,400	26,384
Total Required Usable Storage	**26,700**	**36,834**

The **total required usable storage volume of 36,834 gallons** associated with the buildout condition will be used for assessing tank replacement alternatives.

3.2 Booster Pump Sizing

Per *WSDM* recommendations, a pump station serving a closed system should be designed to provide the PHD with the largest pump out of service. Using the buildout PHD value of 108 gpm and based on a preliminary modeling effort it is anticipated that a new booster pump station would include two 3 HP pumps for day-to-day demands, with each capable of providing 108 gpm. The 3 HP pumps would likely be equipped with variable frequency drives. Additionally it is anticipated that a single 7.5 HP pump would be included to meet a fire flow demand of 500 gpm.

4.0 Potential Tank Locations

Grayling Engineers was tasked with reviewing two alternative tank locations in addition to the existing tank site. As discussed in **Section 2.2**, determining an appropriate elevation to site a tank is a key step if a gravity storage tank is selected. To determine the topography of the region, Lidar data was downloaded from the Oregon Department of Geology and Mineral Industries' website. Contour information is accurate to within plus or minus one foot based on accompanying metadata. Utilizing the Lidar data, the figure included as **Appendix F** was created which shows the approximate bare earth ground elevations in and around the District's service area.

As mentioned in **Section 3.1**, the lowest water elevation at which water can be provided while still maintaining the required 20 psi residual is 258 feet. Ideally, the base elevation of a proposed gravity storage tank would be situated several feet higher than 258 feet, to an elevation closer to

270 feet in elevation. This additional elevation would act as a buffer for maintaining the minimum system pressure as well as help account for additional frictional losses which may be introduced into the system with the additional piping associated with the new tank. There are not, however, any properties within the District's service area with a ground elevation of 270 feet. In light of this fact, areas outside of the service area were considered. However, based on the assumed cost and difficulty associated with securing property rights and performing construction, these areas were deemed non-viable based on preliminary conversations with the District. Therefore, for the purposes of this investigation only locations within the District's service area were considered.

In addition to the property where the existing tank is located, which is identified as **Site A** in **Appendix F**, two additional properties were identified as potential future tank locations which are identified as **Site B** and **Site C**. The implications of constructing a new tank at each of these three sites is discussed below.

Site A, Existing District Property

Address: No Situs

Taxlot Number: 21E21BD02100

County Requirements: Based on discussions with the Clackamas County Planning and Zoning Division, the property owned by the District where the tank is currently located is zoned as "Non-Conforming Use". Constructing a new tank within the boundaries of this property would require "Alteration of a Non-Conforming Use" which is a Type II land use application process. While there are no definitive setback requirements associated with this land use category, the County would request that as much setback be maintained as reasonably possible.

Advantage: Constructing a new tank at Site A would be the most desirable from a property acquisition standpoint since the District already owns the property.

Disadvantage: The property boundaries are already set and the existing pump house and water tank are occupying a portion of the property, therefore space is very limited. Prior to construction of a new tank on this site, the existing tank would need to be demolished. In order to maintain water service during construction, the District would need to provide a temporary water system. Because of the limited space available at Site A, it is assumed that a cost effective new tank meeting the buildout usable storage requirement discussed in **Section 3.1** cannot be built at this site. Therefore, Site A will only be associated with rehabilitation of the existing tank.

Site B, Adjacent to District Property

Address: 19510 SW Ecotopia Ln, West Linn, 97068

Taxlot Number: 21E21BD01200

County Requirements: Based on discussions with the Clackamas County Planning and Zoning Division, siting a tank at this location would require either an easement or a new parcel to be created and a "Conditional Use" permit would need to be applied for via a Type III land use application process. The County would require a minimum setback of 30 feet from County right-of-way as well as a 10 foot setback from property lines for above ground structures located on this property.

Advantage: Constructing a new tank at Site B would allow for a larger tank to be built than what is possible on Site A. Locating a new tank at Site B would also be desirable as it limits the amount of piping that would need to be installed from the well to the new tank and from the new tank to the distribution system.

Disadvantage: Because of the topography, it is not cost effective to build gravity storage at Site B. Therefore only pumped storage will be considered at this location. Additionally, because of setback requirements, the tank would likely be constructed in a portion of the existing private owner's property that is deemed more valuable than other portions of the property.

Site C, North of District Property

Address: No Situs

Taxlot Number: 21E21BD02300

County Requirements: The same County requirements that apply to Site B also apply to Site C.

Advantage: Because this property is currently undeveloped, constructing a new tank at Site C would allow for a larger diameter tank to be built than what is possible on either Site A or Site B. Site C is also desirable because it allows for either a gravity storage tank or a pumped storage tank to be constructed on the property.

Disadvantage: Due to the distance from the well, constructing a tank at Site C would require the greatest amount of piping and conduit to be installed as well as a new electrical service if pumped storage is selected. Due to the steep terrain, it is anticipated that a new tank constructed on this property would need to be partially buried, or a small retaining wall would need to be constructed on the uphill side of the tank.

5.0 Tank Design

5.1 Configuration

Any of the following styles of tank can feed a distribution system via gravity or supply water to a booster pump station which then feeds the distribution system.

Reservoir

Reservoirs are storage tanks which have a greater diameter than height. They are typically constructed at the ground level.

Standpipe

Standpipes have a greater height than diameter and are typically constructed at the ground level. They are typically constructed when a site with an appropriate ground elevation cannot be obtained and the additional elevation in the standpipe is needed to provide adequate water elevation to maintain minimum system pressure. Therefore, they tend to have a large amount of dead storage.

Elevated

Elevated or pedestal tanks are used when standpipes are not economically viable due to the required height or when the additional dead water storage volume poses a water quality concern. Based on the topographic and water storage characteristics of the District's system, elevated tanks and pedestal tanks were considered to be too expensive and are not included in this evaluation.

5.2 Materials / Methods of Construction

The three most common materials / methods used in the construction of water storage tanks in the size range anticipated for the District are welded steel, bolted steel, and cast-in-place reinforced concrete.

Welded Steel

Welded steel is a common construction material for tanks ranging from 20,000 to over 1,000,000 gallons. Steel is suitable for both ground level storage reservoirs or tall standpipes. Because welded steel tanks are custom fabricated, designs are easily modified to tailor the tank to a particular project. Properly designed and maintained steel tanks can easily have a service life of 75+ years. Steel tanks do require recoating every 20 to 30 years to maintain adequate protection against corrosion. While welded steel tanks are often considered the most robust option, they

also carry the highest price tag of the three options. Welded steel tanks are not recommended for buried applications due to corrosion concerns.

Bolted Steel

Bolted steel tanks are well suited for remote areas where skilled labor or portland cement concrete are difficult to access. Bolted steel tanks typically come in premanufactured dimensions and are protected with either an epoxy or glass fused coating. Individual steel panels are shipped from the manufacturer directly to the job site where they are erected with mechanical fasteners. The joints are made water-tight with either a gasket or liquid sealant. Bolted tanks can be difficult to modify, and repair of the glass fused coatings is usually marginally effective. The bolted joints can be a prominent source of leaks. Manufacturers of bolted tanks estimate a service life of 40+ years with proper maintenance. Bolted steel tanks are not recommended for buried applications due to corrosion concerns.

Cast-in-Place Reinforced Concrete

Cast-in-place (CIP) reinforced concrete tanks can be constructed in a variety of ways. For the size of tank considered for this project, the walls would be formed using pre-manufactured slip forms which limits the available dimensions. The walls of this style of tank are typically poured in 5 foot tall courses after reinforcing steel is placed. A properly designed and maintained concrete reservoir is estimated to have a service life of 75+ years. Concrete tanks are able to be partially buried.

5.3 Cost

Table 3 lists the relative costs associated with these three materials / methods of construction. These numbers are based on construction of a 26-foot diameter by 15-foot tall water storage tank on a simple concrete foundation. These costs are for comparison purposes only and do not include design, site piping, surveying, property acquisition, etc.

Table 3. Tank Style Cost Comparision

Welded Steel	Bolted Steel	Cast-in-Place Reinforced Concrete
$417,000	$155,000	$88,000

6.0 Description of Alternatives

In addition to reconditioning the existing water storage tank, three tank replacement alternatives were considered. Below are descriptions of the four alternatives. It is assumed that with each of these alternatives, the existing buried water mains within SW Ecotopia Lane will be replaced with 6-inch CL 52 ductile iron pipe from the intersection with SW Pattulo Way to 375 feet to the north.

Alternative 1: Site A, Rehabilitation

Under this alternative, the existing 32,400 gallon tank would be rehabilitated via abrasive blasting and recoating. Additionally, an intertie would be constructed with the adjacent Shadow Wood water system and a booster pump station would be installed adjacent to the existing tank. As discussed in **Section 3.2**, the booster pump station would likely include three pumps: two pumps equipped with variable frequency drives to meet domestic water demands, and a single constant speed pump to meet fire flow demands.

While this alternative does not create additional storage for the District directly, it would allow for access to the roughly 80,000 gallons[9] of gravity storage associated with the Shadow Wood water system. While construction of a booster pump station is not absolutely necessary, it would allow for the District to utilize the entire 32,400 gallons of storage prior to having to rely on the Shadow Wood storage in emergency situations. Additionally, construction of a booster pump station would allow for the entire 32,400 gallons of storage to be conveyed to the Shadow Wood water system if needed, which creates a mutually beneficial relationship between the two water systems.

Alternative 2: Site B, Pumped Storage

Alternative 2 would involve the construction of a new 20-foot diameter by 25-foot tall standpipe at Site B along with a new booster pump station. The booster pump station would be similar to that described in Alternative 1. A 2-inch tank-fill pipe as well as electrical signal conduits would be constructed from the existing well house to the new tank. A new 8-inch water pipe would be constructed from the new tank to the existing 8-inch PVC water pipe running from the existing tank to SW Ecotopia Lane. It is anticipated that the electrical service serving the existing well house would be extended to the proposed booster pump station. The existing reservoir would be demolished once the new tank and booster pump station are operational.

Alternative 3: Site C, Pumped Storage

For Alternative 3 a 26-foot diameter by 15-foot tall reservoir and booster pump station would be constructed at Site C. The booster pump station would be similar to that described in Alternative 1. A 2-inch tank-fill pipe as well as electrical signal conduits would be constructed from the existing well house to the new tank. An 8-inch water pipe would be constructed from the new tank to the water main in SW Ecotopia Lane. A new electrical service would be required for the booster pump station. The existing tank would be demolished once the new tank and booster pump station are operational.

[9] Number includes 20,000 gallons of storage capacity which is currently unavailable until tank repairs are made based on correspondence with Hiland Water which owns and operates the Shadow Wood water system.

Alternative 4: Site C, Gravity Storage

Alternative 4 would involve construction of a 14-foot diameter by 45-foot tall standpipe on Site C. Based on available Lidar data, the ground elevation at the northeast corner of Site C is around 250 feet. While the ground elevation is not ideal, it is 20 feet higher than the existing tank site. This would allow for the new tank to serve the entire service area via gravity. A 2-inch tank-fill pipe as well as electrical signal conduits would be constructed from the existing well house to the new tank. An 8-inch water pipe would be constructed from the new tank to the water main in SW Ecotopia Lane. The existing tank would be demolished once the new tank is operational.

7.0 Alternatives Analysis

This section describes the criteria used to evaluate each alternative and summarizes the results of the analysis.

7.1 Evaluation Criteria

Each of the four alternatives were reviewed based upon the following criteria:

Level of Service - This criteria is associated with the ability of an alternative to provide adequate storage and meet anticipated demands while maintaining 20 psi to all service connections. This criteria also includes the ability of the proposed facilities to remain operational after a large seismic event.

Property Acquisition - Each alternative was evaluated based on the anticipated difficulty with which temporary and permanent easements could be acquired.

Property Constraints - Issues concerning property setbacks, topography, and constructability were considered.

Permitting - Anticipated permitting challenges, costs, and schedule implications were considered.

Capital Cost - A planning level construction cost estimate was prepared for each alternative and is included as **Appendix G**. The cost estimates were prepared in accordance with the Association for the Advancement of Cost Engineering International (AACE International) guidelines. The estimates are considered as Class 4 with the end usage being concept screening for long-range planning with an expected accuracy range of -30 percent to +50 percent. For clarity, only cast-in-place reinforced concrete tanks are compared between the three tank replacement alternatives, Alternatives 2 - 4.

Operation and Maintenance - Both short-term and long-term operation and maintenance of each alternative was considered.

7.2 Alternatives Analysis Results

Each of the four alternatives was evaluated and given a score of 1 - 3 based on each of the established criteria categories, with 1 representing the lowest score and 3 representing the highest or most desirable score. **Table 4** summarizes the results of the evaluation scoring.

Table 4. Alternatives Scoring Matrix

Alternative	Level of Service	Property Acquisition	Property Constraints	Permitting	Capital Cost	Operation & Maintenance	Average Score	Alternative Rank
1	2	3	2	2	2	1	2.00	2
2	3	1	2	1	2	2	1.83	3
3	3	2	3	1	1	2	2.00	2
4	3	2	2	1	3	3	2.33	1

A brief synopsis of the reasoning behind the scoring shown in **Table 4** is as follows:

Level of Service

All of the alternatives were given a score of 3 except for Alternative 1, which was given a score of 2. The reasoning is that it is assumed that the District's existing tank would fail during a large seismic event and it is unknown whether or not the Shadow Wood tanks would remain operational. Conversely, all of the new facilities associated with Alternatives 2 - 4 would be designed to meet current building codes and would likely withstand a large seismic event.

Property Acquisition

Alternative 1 was given the highest score as no additional property would need to be acquired. Alternative 2 was given the lowest score as it would require property acquisition from the property owner of Site B and has the greatest impacts to the value of the existing property. Alternatives 3 and 4 were each given a score of 2 because they do require property acquisition, but because Site C is undeveloped, there is more flexibility in tank placement and therefore less impacts to property value.

Property Constraints

A score of 2 was assigned to Alternative 1 because there is limited space to construct a new booster pump station within the existing property boundaries of Site A. Similarly, a score of 2 was given to Alternative 2 because there is limited available space at Site B. Alternative 3 was given a score of 3 since it could potentially be constructed anywhere on Site C, whereas Alternative 4

was given a score of 2 since it would need to be constructed near the northeast portion of the property in order to meet the elevation requirements associated with providing gravity storage.

Permitting

Alternative 1 was given a score of 2 because there will be County permitting involved in order to construct a new pump station on Site A as well as to construct a utility vault containing the proposed intertie in the County right-of-way. Alternatives 2 - 4 were each given a score of 1 because they will involve a greater level of permitting complexity than that required for Alternative 1.

Capital Cost

Included in **Appendix G** are planning level capital cost estimates associated with each of the alternatives. Property acquisition is not included in any of the estimates, nor are any connection fees which may be associated with the Shadow Wood intertie for Alternative 1. The District will be responsible for establishing those values. Based on the estimates, Alternative 4 was given a score of 3, Alternatives 1 and 2 were given a score of 2 and Alternative 3 was given a score of 1.

Operation and Maintenance

Because Alternative 1 includes construction of both a booster pump station as well as an intertie with the Shadow Wood water system, this alternative is the most complex from an equipment operation and maintenance standpoint and was therefore given a score of 1. Alternatives 2 and 3 include construction of a booster pump station and were given a score of 2. Because Alternative 4 relies solely on gravity to provide system pressure it was given a score of 3.

8.0 Selected Alternative

After reviewing the information provided in this memorandum, the District selected a **variation of Alternative 1** as the preferred alternative. The District has decided that the best use of funds will be to rehabilitate the existing tank and construct a small booster pump station. The following is a summary of the improvements chosen by the District:

- Removal and replacement of the interior tank coating system[10]
- Cleaning and overcoating of the exterior tank coating system
- Installation of a simplex booster pump station, primarily to increase system pressures for those services in the upper part of the water system[11]

It is recommended that in addition to the selected improvements listed above that the District consider hiring a geotechnical engineer to investigate the existing tank foundation and make

[10] It is recommended that the existing tank coating system is tested for lead prior to hiring a contractor to determine if lead abatement will be required.
[11] It is not anticipated that the future simplex booster pump station will be able to provide fire flow.

recommendations for possible seismic performance improvements. It is also recommended that the District reconsider construction of an intertie with the adjacent Shadow Wood water system. Not only would the intertie provide a backup source of water in emergency situations, but it would also act as a temporary water source while the existing tank is taken out of service for rehabilitation.

9.0 Funding Options

Shown below are brief descriptions of agencies which might be able to assist with the funding of infrastructure projects associated with the Mossy Brae Water District. It should be noted that because the Mossy Brae Water District is a public utility, under Oregon law the District must pay prevailing wage rates to contractors for projects totaling over $50,000.

9.1 Business Oregon Infrastructure Finance Authority (IFA)

The IFA is likely the best source for securing funding for District projects. Business Oregon administers several funding programs for public agencies which include:

- The Safe Drinking Water Revolving Loan Fund (SDWRLF)
- The Drinking Water Source Protection Fund (DWSPF)
- The Community Development Block Grant (CDBG)
- The Oregon Special Public Works Fund (SPWF)

Based on preliminary conversations with a Regional Development Officer from IFA, it is recommended that if the District is interested in receiving funding from one of the programs listed above, the District should first submit a Letter of Interest (LOI) which describes the proposed project and the amount of funds being requested. After this step a representative from the IFA would review the LOI and determine which funding option(s) are the best fit for a particular project. Based on the type of projects the District would be seeking to fund, it is likely that the SDWRLF would be the best fit. However, to be eligible for the SDWRLF the project must resolve existing or future non-compliance with state and federal drinking water standards. Projects involving consolidation, such as interties, are also more likely to receive funding through the SDWRLF. To receive funding through the SDWRLF it would likely be required that the District install individual customer service meters. Annual interest rates for the SDWRLF are currently at a historic low of approximately 2.07%.

9.2 United States Department of Agriculture Rural Development (USDA RD)

The goal of the USDA RD program is to provide loans, grants, and loan guarantees to help support the economic development of rural communities. Because the Mossy Brae Water District serves less than 10,000 people, the District is eligible to apply for funding from USDA RD. In order to qualify for grants or reduced interest loans, the District would need to show that the household median income (HMI) for the District's customers is below $52,855, which is the

established threshold for the area. It is anticipated that the District would not meet this criteria, but would still be eligible for a traditional loan. Traditional loans secured through USDA RD are offered at below market annual interest rates (currently around 2.75%) and the maximum repayment period is 30 years. Based on correspondence with USDA RD, it is unlikely that they would be the best source of funding for the District based on the size of the loan the District would likely seek[12] simply because there are several requirements associated with the funding, such as an environmental report (or assessment), bond counseling, and engineering feasibility study.

9.3 Rural Community Assistance Corporation (RCAC)

RCAC is a private non-profit organization that provides financial resources to improve rural communities. Rather than providing long-term loans for capital improvements, RCAC typically provides short-term loans (also known as bridge loans) with typical repayment terms of 2-3 years. These loans are typically used to fund pre-design and design phase efforts. Interest rates through RCAC are typically comparable to a private bank loan (currently around 5%). RCAC does issue some long-term loans, but because the requirements are the same as USDA RD and the interest rates aren't as low, these loans are seldom utilized.

9.4 National Rural Water Association (NRWA)

NRWA provides funding for small water and wastewater utilities to help improve rural utility infrastructure. The maximum loan amount is $100,000 and the maximum repayment period is 10 years. Currently annual interest rates are around 3%. While the application process for this loan is relatively simple compared to the other options described, if a project is slated to break new ground then an environmental impact report would need to be completed in accordance with the National Environmental Policy Act (NEPA) requirements.

[12] Loan amount assumed to be less than or equal to $400,000.

APPENDIX A

Water Well Report
&
Certificate of Water Right

RECEIVED OCT 30 1961 STATE ENGINEER SALEM, OREGON

CLAC 03244

File Original and First Copy with the STATE ENGINEER, SALEM, OREGON

WATER WELL REPORT

STATE OF OREGON

State Well No. 2/1-21F

State Permit No. G2117

(1) OWNER:

Name Mossy Brae Water District

Address R1, Box 221

West Linn - Ore.

(2) LOCATION OF WELL:

County Clackamas Owner's number, if any—

SE ¼ NW ¼ Section 21 T. 2S R. 1E W.M.

Bearing and distance from section or subdivision corner

SE Corner of Lot 122.

About 775 ft. N.E. of SW ~~¼ of~~ ~~¼~~ Corner of SE ¼ of NW ¼ Section

(3) TYPE OF WORK (check):

New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐

If abandonment, describe material and procedure in Item 11.

(4) PROPOSED USE (check):

Domestic ☒ Industrial ☐ Municipal ☐

Irrigation ☐ Test Well ☐ Other ☐

(5) TYPE OF WELL:

Rotary ☐ Driven ☐

Cable ☐ Jetted ☐

Dug ☐ Bored ☐

(6) CASING INSTALLED:

Threaded ☐ Welded ☒

10 " Diam. from 0 ft. to 63 ft. Gage Sto.

" Diam. from ft. to ft. Gage

" Diam. from ft. to ft. Gage

(7) PERFORATIONS:

Perforated? ☐ Yes ☒ No

Type of perforator used

SIZE of perforations in. by in.

perforations from ft. to ft.

perforations from ft. to ft.

perforations from ft. to ft.

perforations from ft. to ft.

perforations from ft. to ft.

(8) SCREENS:

Well screen installed ☐ Yes ☒ No

Manufacturer's Name

Type Model No.

Slot size Set from ft. to ft.

Slot size Set from ft. to ft.

(9) CONSTRUCTION:

Was well gravel packed? ☐ Yes ☒ No Size of gravel:

Gravel placed from ft. to ft.

Was a surface seal provided? ☒ Yes ☐ No To what depth? 63 ft.

Material used in seal—

Did any strata contain unusable water? ☐ Yes ☒ No

Type of water? Depth of strata

Method of sealing strata off CEMENT GROUT

(10) WATER LEVELS:

Static level 114 ft. below land surface Date JAN. 1949

Artesian pressure lbs. per square inch Date

Log Accepted by: M. A. Pettmon (President)

[Signed] M.B.W.D. (Owner) Date Oct. 25, 1961

(11) WELL TESTS:

Drawdown is amount water level is lowered below static level R.J. STRASSER

Was a pump test made? ☒ Yes ☐ No If yes, by whom? DRILL. CO

Yield: 50 gal./min. with 30 ft. drawdown after 8 hrs.

" " " "

" " " "

Bailer test gal./min. with ft. drawdown after hrs.

Artesian flow g.p.m. Date

Temperature of water Was a chemical analysis made? ☐ Yes ☒ No

(12) WELL LOG:

Diameter of well 10" & 8" inches.

Depth drilled 195' ft. Depth of completed well 195 ft.

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Top Soil	0	3'
Clay	3'	31'
Broken Decomposed Rock & Clay	31'	44'
Hard Gray Rock	44'	179'
Soft Porous Water Bearing Rock	179'	190'
Hard Rock	190'	195'

Work started OCT 1949 Completed JAN 1949

(13) PUMP:

Manufacturer's Name Peerless Pump Co

Type: #41 Peerless Hi-lift H.P. 3

Well Driller's Statement:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME R.J. STRASSER DRILLING CO (Person, firm, or corporation) (Type or print)

Address 8110 SE SUNSET LANE PORTLAND ORE

Driller's well number ~~70~~

[Signed] Paul O Rydman (Well Driller)

License No. 10 Date Oct 24, 1961

(USE ADDITIONAL SHEETS IF NECESSARY)

2/1-21 F

OREGON STATE BOARD OF HEALTH

Mineral Content of Water

Name of Water Supply Mossy Brae Water System

Source Well

Sampling Point Well House

Collected By F. G. Katzel Date 1-6-65

Analysis By A.W. Hose Date 1-14-65

Laboratory Number 883

	Mg/L		Mg/L
Color	1	Conductance (mc mho/cm)	201
Turbidity	2	Chlorides	3.0
Solids, Total	198	Sodium	8.8
Solids, Volatile	97	Potassium	4.0
Carbon Dioxide	34	Fluoride	0.26
pH	6.8	Phosphates	0.30
Alkalinity, Total as $CaCO_3$	109	Sulfates	1.0
Hardness as $CaCO_3$	94.7	Silicon	55
Calcium	21.0	Aluminum	<0.05
Magnesium	10.2	Nitrogen, Ammonia	0.43
Iron	<0.02	Nitrogen, Nitrite	<0.01
Manganese	<0.05	Nitrogen, Nitrate	0.28
Arsenic	<0.005		

REMARKS

WSSP-10, 6/62

2/1-21

OREGON STATE BOARD OF HEALTH

Mineral Content of Water

Name of Water Supply Shadow Wood

Source Well

Sampling Point Pump House

Collected By F. G. Katzel Date 1/6/65

Analysis By A.W. Hose Date 1/14/65

Laboratory Number 884

	Mg/L		Mg/L
Color	8	Conductance (mc mho/cm)	179
Turbidity	5	Chlorides	3.0
Solids, Total	188	Sodium	8.5
Solids, Volatile	57	Potassium	2.5
Carbon Dioxide	60	Fluoride	0.22
pH	6.5	Phosphates	0.25
Alkalinity, Total as $CaCO_3$	93	Sulfates	1.5
Hardness as $CaCO_3$	92.0	Silicon	55
Calcium	18.9	Aluminum	< 0.05
Magnesium	10.8	Nitrogen, Ammonia	0.53
Iron	0.26	Nitrogen, Nitrite	< 0.01
Manganese	< 0.05	Nitrogen, Nitrate	0.26
Arsenic	< 0.005		

REMARKS

WSSP-10, 6/62

Permit A—4M—5-64 SP*12907-119

STATE OF OREGON

COUNTY OF CLACKAMAS

CERTIFICATE OF WATER RIGHT

This Is to Certify, That MOSSY BREA WATER DISTRICT

of Route 1, Box 221, West Linn, State of Oregon, has made proof to the satisfaction of the STATE ENGINEER of Oregon, of a right to the use of the waters of Mossy Brea Water District Well

a tributary of Tualatin River (Willamette River) for the purpose of domestic and fire protection

under Permit No. G-1951 of the State Engineer, and that said right to the use of said waters has been perfected in accordance with the laws of Oregon; that the priority of the right hereby confirmed dates from September 14, 1961

That the amount of water to which such right is entitled and hereby confirmed, for the purposes aforesaid, is limited to an amount actually beneficially used for said purposes, and shall not exceed 0.10 cubic foot per second

or its equivalent in case of rotation, measured at the point of diversion from the stream. The point of diversion is located in the SE¼ NW¼, Section 21, T. 2 S., R. 1 E., W. M. Well located 24 ft. North and 8 ft. West from the SE corner Lot 122, Mossy Brea Subdivision

The amount of water used for irrigation, together with the amount secured under any other right existing for the same lands, shall be limited to _____ of one cubic foot per second per acre,

and shall conform to such reasonable rotation system as may be ordered by the proper state officer.

A description of the place of use under the right hereby confirmed, and to which such right is appurtenant, is as follows:

NE¼ SE¼
Section 20
SE¼ NW¼
NE¼ SW¼
NW¼ SW¼
Section 21
T. 2 S., R. 1 E., W. M.

The right to the use of the water for the purposes aforesaid is restricted to the lands or place of use herein described.

WITNESS the signature of the State Engineer, affixed this date. April 20, 1965

CHRIS L. WHEELER
State Engineer

Recorded in State Record of Water Right Certificates, Volume 24, page 32049

APPENDIX B

Mossy Brae Water District System Map

APPENDIX C

2007 Professional Survey of Existing Tank Site

SN2007-395 Sheet 1 of 2

SHEET 1 OF 2

RECORD OF SURVEY

PART OF LOTS 121, 122, 123, 127, AND 128,
"MOSSY BRAE" LOCATED IN THE
N.W. 1/4 OF SECTION 21, T.2S., R.1E., W.M.,
CLACKAMAS COUNTY, OREGON
DATE: SEPTEMBER 26, 2007 SCALE: 1"=50'
SURVEY PERFORMED FOR: ADAM HOGAN

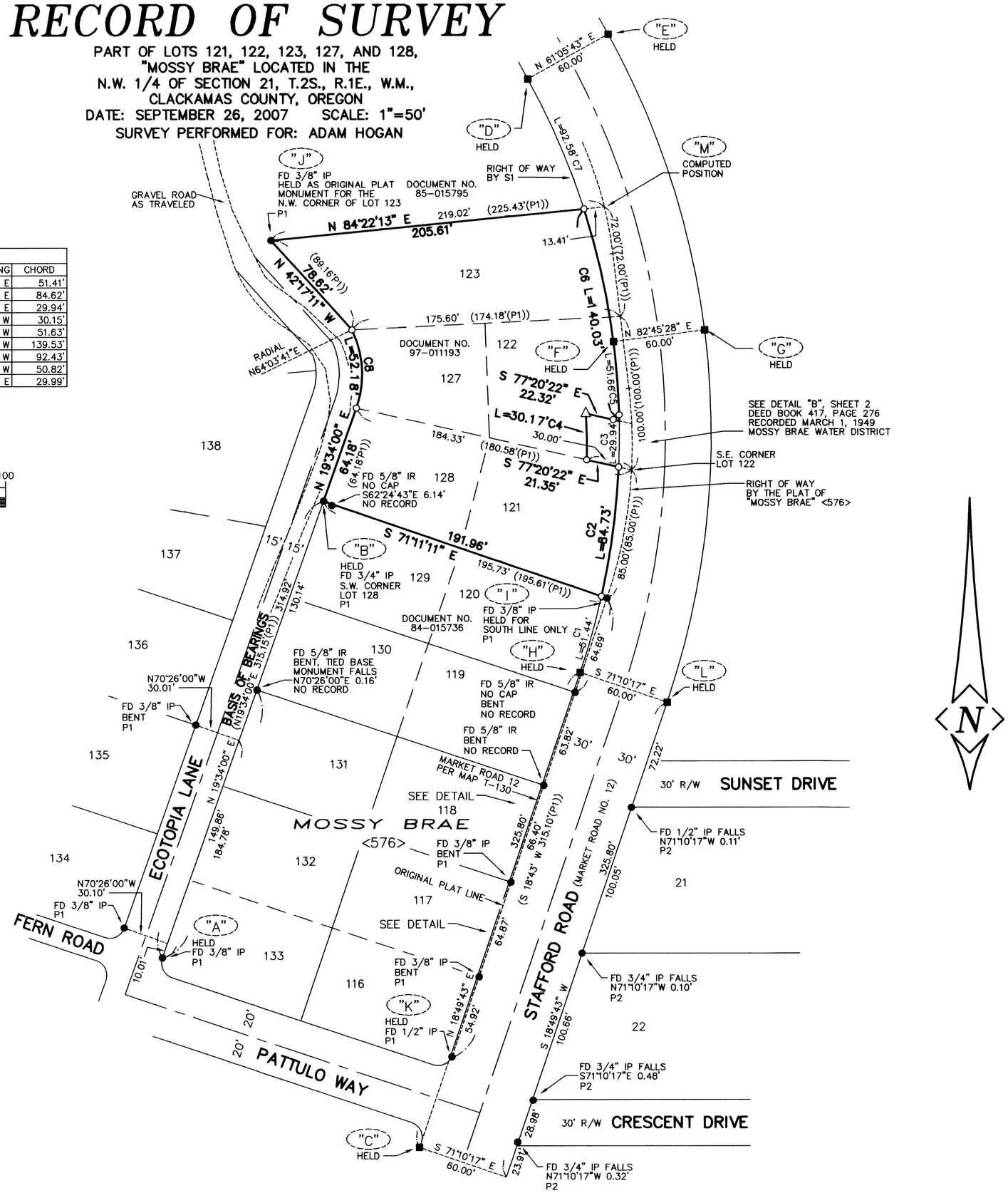
CLACKAMAS COUNTY SURVEYOR
RECEIVED: 10/03/2007
ACCEPTED FOR FILING: 11/21/2007
SURVEY NUMBER: SN2007-395

CURVE TABLE					
CURVE	LENGTH	RADIUS	DELTA	CHORD BEARING	CHORD
C1	51.44'	478.59'	6°09'28"	N 15°44'59" E	51.41'
C2	84.73'	478.59'	10°08'38"	N 07°35'56" E	84.62'
C3	29.94'	478.59'	3°35'04"	N 00°44'05" E	29.94'
C4	30.17'	279.46'	6°11'05"	N 01°03'59" W	30.15'
C5	51.66'	478.59'	6°11'05"	N 04°08'59" W	51.63'
C6	140.03'	478.59'	16°45'51"	N 09°26'23" W	139.53'
C7	92.58'	478.59'	11°04'59"	N 23°21'48" W	92.43'
C8	52.18'	65.70'	45°30'19"	N 03°11'10" W	50.82'
C9	30.00'	309.00'	5°33'46"	N 00°16'17" E	29.99'

GRAPHIC SCALE

50 0 50 100

(IN FEET)
1 INCH = 50 FEET



LEGEND:

- ○ SET 5/8" x 30" IRON ROD W/ RED PLASTIC CAP MARKED "CENTERLINE CONCEPTS INC." ON SEPTEMBER 26, 2007
- △ SET 1.17" COPPER DISC (BERNTSEN BP1) MARKED "CENTERLINE" IN LARGE ROCK ON SEPTEMBER 26, 2007
- ● FOUND MONUMENT AS NOTED
- ■ FOUND 3/4" IRON RODS (NO CAPS) FROM S1

SFNF = SEARCHED FOR, NOT FOUND
( ) = RECORD DISTANCES & BEARINGS
< > = PLAT NUMBER
IR = IRON ROD IP = IRON PIPE
FD = FOUND W/ = WITH
YPC = YELLOW PLASTIC CAP
R/W = RIGHT OF WAY
SN = SURVEY NUMBER
CLACKAMAS COUNTY SURVEYOR'S OFFICE
S1 = T-130 LEGALIZATION OF A PORTION OF MARKET ROAD 12 (1961)
P1 = "MOSSY BRAE" <576>
P2 = "SHADOW WOOD PARK" <540>

SIGNED ON: 10-29-07

REGISTERED PROFESSIONAL LAND SURVEYOR
Wade G Donovan III
OREGON
JULY 14, 1987
WADE G. DONOVAN III
2276

VALID THROUGH DECEMBER 31, 2007

I CERTIFY THAT THIS SURVEY WAS PREPARED USING HP PRODUCT #51640A ON CONTINENTAL JPC4M2 POLYESTER FILM

Centerline Concepts Inc.

700 MOLALLA AVENUE, OREGON CITY, OREGON 97045
503 650-0188 FAX 503 650-0189

DRAWN BY:MSG CHECKED BY: WGDIII ACCOUNT #150-5582
M:\PROJECTS\HOGAN-5582\HO-ROS

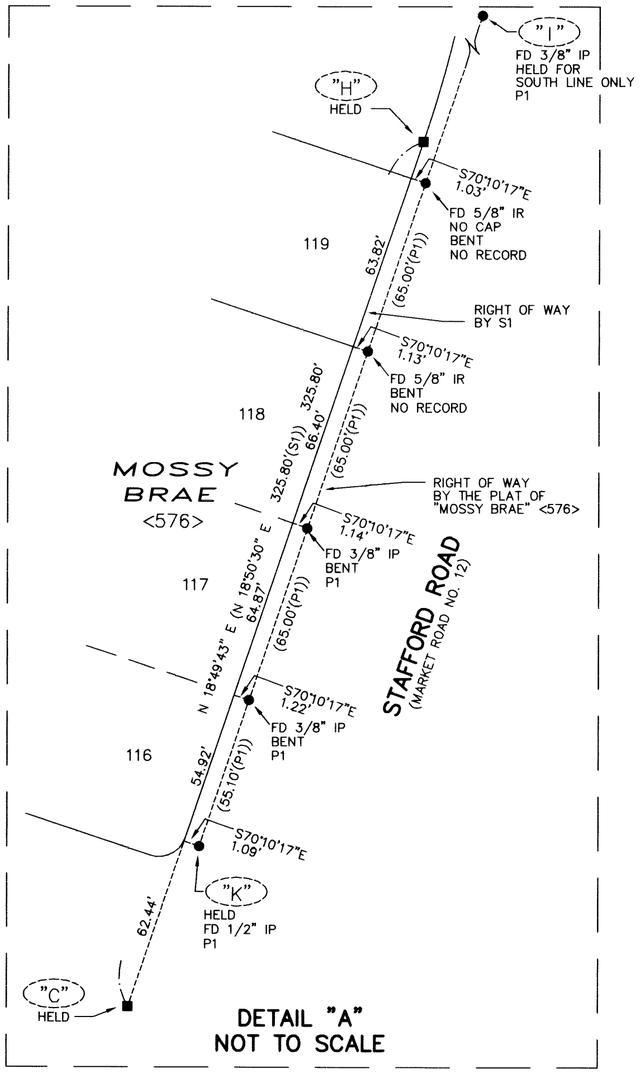
SN2007-395 Sheet 2of2

SHEET 2 OF 2

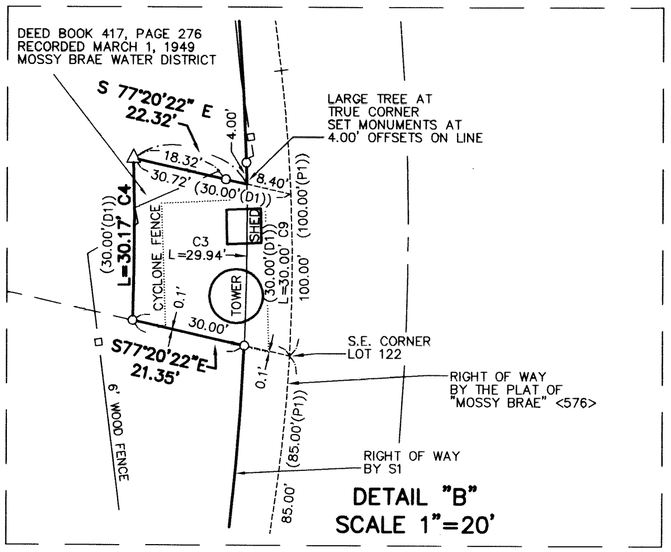
RECORD OF SURVEY

PART OF LOTS 121, 122, 123, 127, AND 128,
"MOSSY BRAE" LOCATED IN THE
N.W. 1/4 OF SECTION 21, T.2S., R.1E., W.M.,
CLACKAMAS COUNTY, OREGON
DATE: SEPTEMBER 26, 2007 SCALE: 1"=50'
SURVEY PERFORMED FOR: ADAM HOGAN

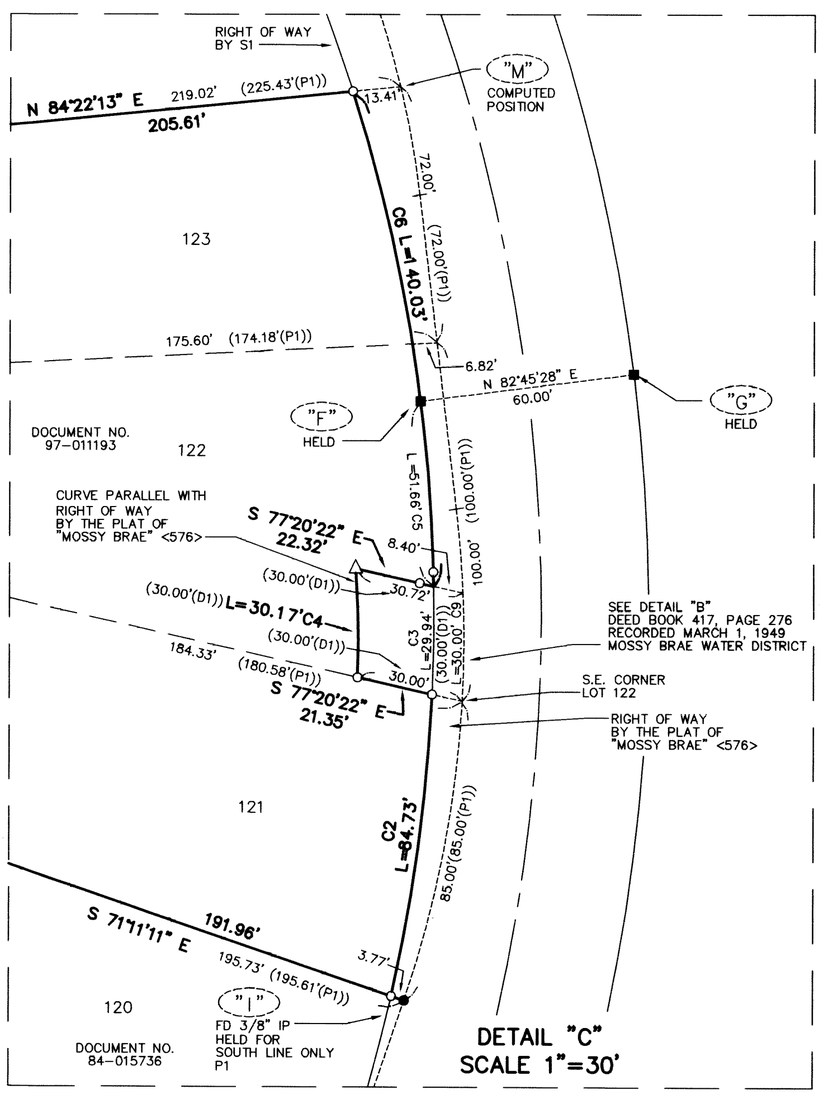
CLACKAMAS COUNTY SURVEYOR
RECEIVED: 10/03/2007
ACCEPTED FOR FILING: 11/21/2007
SURVEY NUMBER: SN2007-395



DETAIL "A"
NOT TO SCALE



DETAIL "B"
SCALE 1"=20'



DETAIL "C"
SCALE 1"=30'

CURVE TABLE					
CURVE	LENGTH	RADIUS	DELTA	CHORD BEARING	CHORD
C1	51.44'	478.59'	6°09'28"	N 15°44'59" E	51.41'
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C9	30.00'	309.00'	5°33'46"	N 00°16'17" E	29.99'

NARRATIVE:

1 – THE PURPOSE OF THIS SURVEY IS TO ESTABLISH THE BOUNDARY LINE FOR THAT TRACT OF LAND DESCRIBED IN DOCUMENT NO 97–011193, CLACKAMAS COUNTY DEED RECORDS, ALSO KNOWN AS LOTS 121, 122, 123, 127 AND 128 MOSSY BRAE EXCEPT THAT TRACT GRANTED IN DEED BOOK 417 PAGE 276 RECORDED ON MARCH 01, 1949.

2 – THE BASIS OF BEARINGS ARE FROM THE PLAT OF MOSSY BRAE USING HELD FOUND MONUMENTS "A" AND "B" FROM SAID PLAT.

3 – I RECOVERED AND HELD ORIGINAL PLAT MONUMENTS "B" AND "I" FOR THE SOUTHERLY LINE OF THE SUBJECT PROPERTY. I THEN HELD ORIGINAL PLAT MONUMENTS "B" AND "A" FOR THE WESTERLY LINE OF LOT 128, ALSO THE EASTERLY RIGHT OF WAY LINE OF ECOTOPIA LANE. I THEN COMPUTED, BY HOLDING THE PLAT DISTANCE OF 64.18 FEET THE NORTHWEST CORNER OF SAID LOT 128. THIS POINT, AS PER THE PLAT. IS THE CURVE POINT. THE PLAT GIVES A RADIUS OF 35.7 FEET FOR THE WESTERLY RIGHT OF WAY LINE OF ECOTOPIA LANE AND A WIDTH OF 30.00 FEET. I THEREFORE HELD THE RADIUS OF 65.70 FEET AND THE ARC DISTANCE OF 52.18 FEET, SHOWN ON THE PLAT, FROM SAID NORTHWEST CORNER OF LOT 128 AND COMPUTED THE NORTHWEST CORNER OF SAID LOT 127. FROM THE ESTABLISHED NORTHWEST CORNER OF SAID LOT 127, I HELD A TANGENT LINE TO FOUND MONUMENT "J". I BELIEVE SAID MONUMENT "J" TO BE AN ORIGINAL MONUMENT AS THE PLAT STATES THAT IRON PIPES WERE SET AT ALL LOT CORNERS AND I RECOVERED A PIPE AT SAID MONUMENT "J". THE PLAT, FROM THE NORTHWEST CORNER OF SAID LOT 127 DOES NOT GIVE SUFFICIENT DATA TO COMPUTE THE REMAINDER OF THE CURVES FOR THE ROAD, THEREFORE AS STATED, I HELD A TANGENT LINE FROM THE NORTH WEST CORNER OF SAID LOT 127 TO SAID MONUMENT "J".

4 – DOCUMENT NUMBER 97–011193 AND THE PLAT OF MOSSY BRAE CALL FOR THE EAST LINE TO BE THE WEST RIGHT OF WAY LINE OF STAFFORD ROAD. I HELD FOUND MONUMENTS "K" AND "I" AS ORIGINAL PLAT MONUMENTS AND TO REPRESENT SAID WEST RIGHT OF WAY LINE. I HELD THE PLAT RADII AND THE CENTERLINE ARC DISTANCES GIVEN ON THE PLAT TO COMPUTE THE INDIVIDUAL LOT CORNERS AND THE WEST RIGHT OF WAY LINE OF STAFFORD ROAD AS PLATTED. I THEN COMPUTED POSITION "M" AND HELD FOR THE NORTH LINE OF SAID LOT 123 TOGETHER WITH SAID MONUMENT "J". I RECOVERED MONUMENTS "C", "H", "F", "D", "E", "G" AND "L" FROM MAP T–130, THE LEGALIZATION OF A PORTION OF MARKET ROAD 12 (1961), AND HELD THEM FOR THE REVISED WEST LINE OF STAFFORD ROAD.

5 – DEED BOOK 417 PAGE 276 (RECORDED MARCH 01, 1949), CALLS FOR THE POINT OF BEGINNING TO BE THE SOUTHEAST CORNER OF SAID LOT 122. I COMPUTED SAID CORNER AS NOTED IN ITEM 4 OF THIS NARRATIVE AND HELD THE DEED DISTANCES TO COMPUTE THIS EXCEPTION TO DOCUMENT NO 97–011193. AS A RESULT OF SAID RESOLUTION AN EXISTING FENCE LINE FOLLOWS THE RESOLUTION OF THE SOUTH LINE OF LOT 122 WITHIN ACCEPTABLE TOLERANCES.

LEGEND:

- O SET 5/8" x 30" IRON ROD W/ RED PLASTIC CAP MARKED "CENTERLINE CONCEPTS INC." ON SEPTEMBER 26, 2007
- △ SET 1.17" COPPER DISC (BERNTSEN BP1) MARKED "CENTERLINE" IN LARGE ROCK ON SEPTEMBER 26, 2007
- ● FOUND MONUMENT AS NOTED
- ■ FOUND 3/4" IRON RODS (NO CAPS) FROM S1

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SN = SURVEY NUMBER
CLACKAMAS COUNTY SURVEYOR'S OFFICE
P1 = "MOSSY BRAE" <576>
S1 = T–130 LEGALIZATION OF A PORTION OF MARKET ROAD 12 (1961)
D1 = BOOK 417, PAGE 276 (MARCH 1, 1949)

SIGNED ON: 10-29-07

REGISTERED
PROFESSIONAL
LAND SURVEYOR
Wade G. Donovan III
OREGON
JULY 19, 1987
WADE G. DONOVAN III
2276

VALID THROUGH DECEMBER 31, 2007

I CERTIFY THAT THIS SURVEY WAS PREPARED USING HP PRODUCT #51640A ON CONTINENTAL JPC4M2 POLYESTER FILM

Centerline Concepts Inc.

700 MOLALLA AVENUE, OREGON CITY, OREGON 97045
503 650–0188 FAX 503 650–0189

DRAWN BY:MSG CHECKED BY: WGDIII ACCOUNT #150–5582
M:\PROJECTS\HOGAN–5582\HO–ROS

APPENDIX D

Water Source Production Records

Mossy Brae Water District Production Data				
Read Date	Days Between Read	Totalizer on Read Date (gal)	Demand Between Read Dates (gal)	Average Daily Demand for the Period (gal)
4/25/2018		47,887,330		
5/14/2018	19	47,998,000	110,670	5,825
6/22/2018	39	48,430,700	432,700	11,095
7/6/2018	14	48,661,100	230,400	16,457
8/31/2018	56	49,792,700	1,131,600	20,207
10/1/2018	31	50,290,600	497,900	16,061
10/25/2018	24	50,311,800	21,200	883
11/1/2018	7	50,380,500	68,700	9,814
12/1/2018	30	50,553,800	173,300	5,777
1/1/2019	31	50,638,700	84,900	2,739
2/1/2019	31	50,826,200	187,500	6,048
3/4/2019	31	51,186,200	360,000	11,613
			Total Average Daily Demand (gal)	9,684

APPENDIX E

1979 Preliminary Engineering Report and Feasibility Study

PRELIMINARY ENGINEERING REPORT

AND

FEASIBILITY STUDY

FEBRUARY, 1979
REVISED MAY 1979
5|28|80

MOSSY BRAE
WATER DISTRICT

CLACKAMAS COUNTY, OREGON

DORNER & TUNKS, INC.
CONSULTING ENGINEERS
PORTLAND OREGON

DORNER & TUNKS, INC. ENGINEERS

W.J. DORNER, P.E.
HOMER V. TUNKS, P.E.

519 S.W. THIRD AVENUE
PORTLAND, OREGON 97204
PHONE: (503) 228-3466

May 28, 1980

Honorable Chairman and Commissioners
Mossy Brae Water District
West Linn, Oregon 97068

To the Chairman and all Members:

I have made a physical measurement of the water storage tank of the Mossy Brae Water District and have found the following:

1. The tank is fabricated from 8'-0" wide by 40'-0" long steel plates. By squaring the ends of the plates and beveling for welding, there is remaining an inside circumference of 39.75 feet or a diameter of 12.65 feet.

2. The height of the tank is made up of the following plates:

4 Plates @ 8'-0"	32'-0"	
1 Plate @ 3'-0"	3'-0"	
Side wall height	35'-0"	
Deduction to overflow	- 8"	
	34'-4"	= 34.33' depth
Deduction for outlet for tanker trucks	- 1'-6"	
	32'-10"	= 32.83' depth

Computing for actual storage we have:

Domestic use, 12.65 x 12.65 x 0.7854 x 34.33 x 7.5 = 32,400 gal

For fire tankers, 12.65 x 12.65 x 0.7854 x 32.83 x 7.5 = 30,900 gal

I have neglected the volume in the cone at the bottom of the tank as it is insignificant.

The above storage capacities have been shown on pages 4 and 8, although they make no change in the remainder of the report.

Inflation has increased costs by approximately 12% since the date of the initial report, and any considerations must make allowance for these increased values.

This letter supplements my report of May 1979, of which I am returning 20 corrected copies.

Yours truly,

W. J. Dorner

W. J. Dorner, P.E.

DORNER & TUNKS, INC. ENGINEERS

W.J. DORNER, P.E.
HOMER V. TUNKS, P.E.

519 S.W. THIRD AVENUE
PORTLAND, OREGON 97204

PHONE: (503) 228-3466

May 29, 1979

Honorable Chairman and Commissioners
Mossy Brae Water District
West Linn, Oregon 97068

Job No. 78-29

Copy No. 18

To the Chairman and all Members:

Transmitted herewith are fifteen copies of our "Preliminary Engineering Report and Feasibility Study" on our investigation of the condition of the Mossy Brae water system, in particular regard to it's compliance with the requirements of the Oregon State Health Division, Department of Human Resources. Recommendations for compliance, made from the findings of this study, are summarized as follows;

1. For continued growth of the district the water system is inadequate in source, storage and distribution. For the present users, 42 in number, the source and distribution are barely acceptable and storage is only 60% of the minimum required.

2. The bonding capacity of the district is insufficient to bring all parts of the system up to minimum requirements. Therefore ways must be found for other water purveyors to supply elements of the system such as source and storage. Only in this manner can adequate domestic and fire service be provided.

3. Costs of required improvements have been estimated , but it can be seen that the district can not obligate itself to the full extent of the bonding capacity and stay within a realistic water rate. Taxes to retire all the bonds would initally require for the 42 users a monthly payment of approximately $25.00.

4. Federal aid might be obtained from the Farmers Home Administration, but it may take years for priority to be established.

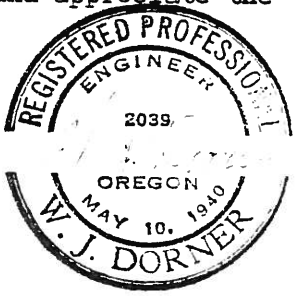
5. Perhaps it may be best to accomplish the things recommended under a $75,000 Bond Issue, Source and storage from the Rivergrove Water District and a partial improvement of mains within the district.

6. Then too, the district could do with the present system, with all of its deficiencies, and with no growth.

I wish to express my sincere thanks for the opportunity to work with the Board of Commissioners during this study, and appreciate the splended cooperation that has been given to me.

Respectfully submitted,

W. J. Dorner, P.E.



INDEX

LIST OF TABLES

LIST OF PLATES

CHAPTER I

INTRODUCTION

AUTHORIZATION

The Board of Commissioners of the Mossy Brae Water District, a municipal corporation of the State of Oregon, situated in and formed in Clackamas County, authorized the firm of Dorner & Tunks, Inc., consulting engineers, to conduct the necessary study of the water district to determine its adequacy, or improvements necessary to comply with the requirements of the Oregon State Health Division.

PURPOSE

The purpose of this study is to perform the necessary investigations, obtain basic data, and produce factual information such that the required studies can be made to ascertain the water system's weaknesses. From these findings, conclusions shall be drawn and recommendations made toward, if possible, improvements that are necessary to furnish adequate water and, if possible, fire service to the users, and more particularly those necessary or feasible.

SCOPE

The scope of the investigation shall be to cover an engineering study and feasibility report on the condition or adequacy of the source of supply, storage requirements, and the adequacy of the size of distribution mains. This study shall include:

A. Determine existing and future service loads

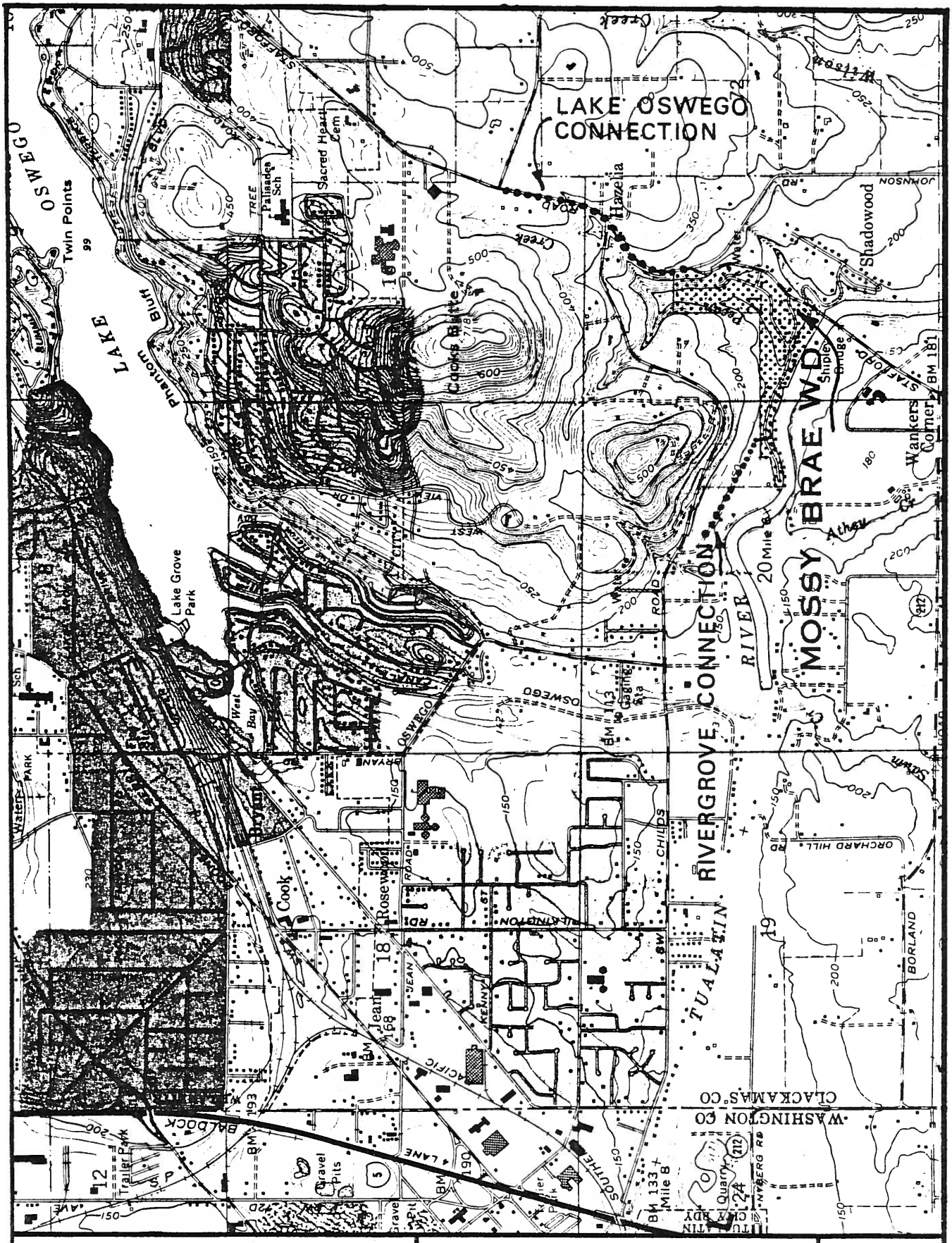
B. Determine the adequacy of the existing system including source, storage and distribution

C. Determine the requirements for source storage and distribution for future domestic and fire loads

D. Prepare estimated construction costs

E. Provide a fiscal study with its effects on rates and/or taxes

F. Draw conclusions and make recommendations



DORNER & TUNKS, INC. CONSULTING ENGINEERS PORTLAND OREGON	MOSSY BRAE W. D. 1978 ENGINEERING STUDY	PLATE 1

CHAPTER II

GENERAL DATA

LOCATION AND TOPOGRAPHY

The Mossy Brae Water District is located in the Tualatin Valley, Clackamas County, Oregon, situated on the north bank of the Tualatin River and west of Stafford Road, approximately three miles south of the City of Lake Oswego. Pecan Creek, a small intermittent stream, runs southerly through the district. The district consists of the plat of Mossy Brae and annexations totaling approximately 55 acres, consisting of 153 platted lots and 4 Tax Lots. The land is generally rolling and entirely residential, although some lots in the lower west end of the district are in the flood plain of the Tualatin River. The elevation varies from 98 feet (M.S.L.) at the river to 278 feet at the district's high point. See Plate 1, page 2.

ENVIRONMENT

Since the district is entirely residential in nature and no area in the district is zoned commercial, calculations are 100% residential. The area is not sewered and all sewage is taken care of with septic tanks and drain fields. Since percolation tests indicate that many platted lots are too small, the maximum residences possible is estimated at approximately 60 to75. Of course, if sanitary sewers were provided the residential density would be much greater. This report will not consider service to a sewered community because if this were to become a reality, many other factors would have to be considered which have little bearing at this time.

CHAPTER III

PRESENT FACILITIES

GENERAL

The existing system has grown over the years to try to keep up with requirements, but due to the small number of customers, 42 at the present time, funds have not been available to keep up. Plate 6, page 8, details these facilities as well as can be determined from some old records and those remembered by "old timers." There follows, then, a more detailed account of these facilities.

SOURCE OF SUPPLY

The district is now served by one well drilled in the southeast corner of Lot 122. Its ground elevation is approximately 225 feet (M.S.L.). The well is drilled to a depth of 195 feet and cased the top 68 feet with 10-inch diameter steel casing. The static level is 144 feet below ground surface and the yield was 50 gpm (gallons per minute) with 30-foot drawdown after 8 hours. It is estimated that the present yield is 45 gpm. Chlorination is provided by a hypochloride solution.

NET STORAGE

The existing storage is a steel tank having a volume of approximately 30,900 - 32,400 gallons. Its overflow elevation is approximately 260 feet (M.S.L.). This indicates that adequate service can be provided only to those services that are below elevation 180 feet to get a minimum pressure of 35 pounds. See Plate 3, page 10.

DISTRIBUTION

The existing distribution system consists of steel and galvanized pipe of the dimensions shown on Plate 6, page 8. Basically, a 4-inch main runs from the reservoir some 2,000 feet through the heart of the district. This 4-inch main, installed later, parallels the original 2-inch. The remainder of the system consists of 2-inch, $1\frac{1}{4}$-inch, and 1-inch. Some of the water mains are located on private property for which it is doubtful if easements were obtained. In fact, the location of property lines is not precisely known.

None of the present system is metered.

CHAPTER IV

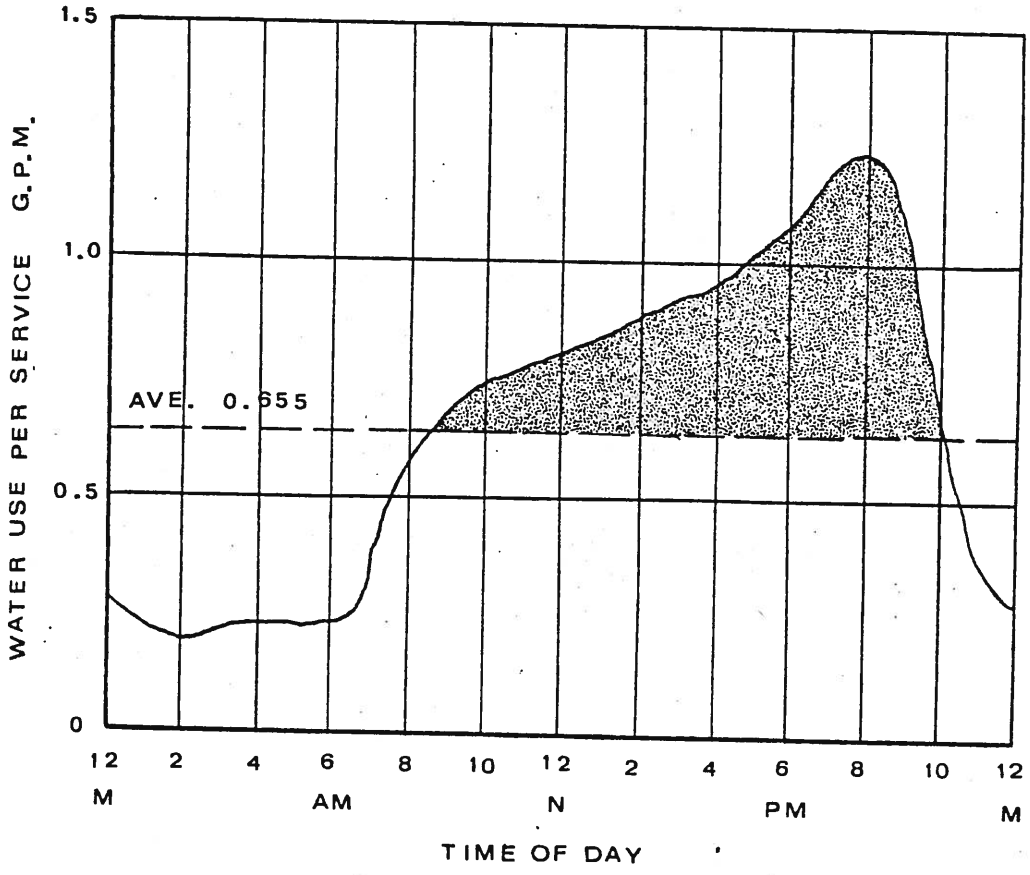
WATER REQUIREMENTS

GENERAL

In general, water requirements are based upon demand. In this instance all demand is residential, but shall be evaluated for fire flows also. The present number of users, as stated, is 42, and the ultimate, without sewers, is 68. This then will give us the minimum present requirements and the maximum requirements under this study.

WATER REQUIREMENTS

Fluctuating demands are made on a water system dependent upon the season of the year, type of community, and time of the day. For the



ESTIMATED HOURLY DEMAND VARIATIONS ON MAXIMUM DAY

Based upon equivilent systems and conditions in the Willamette Valley, State of Oregon.

DORNER & TUNKS, INC. CONSULTING ENGINEERS PORTLAND OREGON	MOSSY BRAE W. D. 1978 ENGINEERING STUDY	PLATE 2

Year	Fiscal Year	Users	Average Day Gal.	gpm	Maximum Day Gal.	gpm	Maximum Hour gpm
00	1979-79	42	18,910	13	47,250	33	62
1	79-80	44	19,800	14	49,500	34	65
2	80-81	46	20,700	14	51,750	36	68
3	81-82	49	22,050	15	55,125	38	73
4	82-83	51	22,950	16	57,375	40	76
5	83-84	54	24,300	17	60,750	42	80
6	84-85	56	25,200	17	63,000	43	83
7	85-86	59	26,550	18	66,375	46	88
8	86-87	62	27,900	19	69,750	48	92
9	87-88	65	29,250	20	73,125	51	97
10	88-89	68	30,600	21	76,500	53	101
11	89-90						
12	90-91						
13	91-92						
14	92-93						
15	93-94						
16	94-95						
17	95-96						
18	96-97						
19	97-98						
20	98-99						
21	99-00						

PLATE 4

PROJECTED DOMESTIC WATER DEMANDS

Note: All growth projected on a 5% annual increase.

purpose of this study, based upon other communities of the same environment, the following criteria are believed to be pertinent and realistic:

1. Average annual day requirements are set at 120 gpd (gallons per day) for each person, 360 gpspd (gallons per service per day) and will be at the rate of 0.250 gpmps (gallons per minute per service). The above is evaluated at three people per service, average.

2. Maximum day requirement, during the summer and early fall, is based upon the rate of 2.5 times that of an average annual day. These maximum day requirements then are 900 gpspd and will be at the rate of 0.625 gpmps. Plate 2, page 5, is a chart of variations on a maximum day.

3. Each day fluctuations occur during the 24 hour period, and the maximum hour demand is based upon a factor of 1.9 times the maximum day demand. On a maximum day the demand will be at 1.12 gpmps. This maximum hour determination is used only in the computation for distribution and storage.

4. Fire flows for a residential district are considered to be at the rate of 500 gpm for a duration of two hours.

Although the district does not have metered service, it is assumed that of necessity the control of water use will demand the installation of meters.

Under the above criteria it is determined, and as projected on Plate 4, page, 6, that for 42 users the maximum day requirement is 38 gpm and for 68 users the maximum day requirement is 62 gpm. These are of course continuous demands, 24 hours per day. Note here that the existing well, under a metered condition, is just adequate for the existing number of services. For any growth, additional source will be required. This plate indicates expected growth and the average, maximum day and maximum hour demands.

CHAPTER V

STORAGE REQUIREMENTS

GENERAL

Storage is used for several reasons; first, to have a reserve for heavy use and for fire protection; and secondly, to carry over heavy demand hours over slight use hours, thereby allowing pumps to be sized for their use only a portion of the day.

STORAGE REQUIREMENTS

Storage, in any event regardless of source, should be a volume at least t w o times the average annual daily demand, and in addition have adequate storage for fire. These requirements are computed as follows:

	42 Users	68 Users
Domestic use, 2 days @ 360 gpdps	37,800	61,200
Fire requirement 2 x 60 x 500	60,000	60,000
Total Storage Requirement	97,800	121,200

CHAPTER VI

DISTRIBUTION REQUIREMENTS

Basic needs for distribution are shown on Plate 7 , page 18, These are based upon State Health requirements of a 2-inch main not over 200 feet long, a 3-inch main not over 600 feet long, and a 4-inch main not over 1,400 feet long for domestic use. Fully rated fire hydrants should be on not less than a 6-inch main, and the main shall be not over 500 feet dead ended or looped.

CHAPTER VII

PRESENT SYSTEM ADEQUACY

SOURCE

It can be seen that the existing source is just barely able to hold its own on the existing number of users. Any additional users in the future will require that more source be available.

STORAGE

The existing storage (30,900 - 32,400 gal) is about 3/4 of the domestic requirement and less than 1/3 of the domestic and fire requirement for the existing number of users. Any additional users will require that considerable additional storage be provided. Storage should provide a minimum of 35 psi to the highest service.

DISTRIBUTION

The existing distribution system is not adequate, even considering no fire protection.

CHAPTER VIII

ALTERNATIVE SOLUTIONS

SOURCE

To obtain adequate supply for 68 users there are three alternatives:

1. Purchase a well site, at least one acre, drill a cased well, install pump, controls and housing.

2. Purchase water from an existing outside source, see Plate 1, page

   a. Rivergrove Water District

   b. City of Lake Oswego

Before going into costs, what are the benefits to the above alternates? A new district well complete would also require a new storage facility, which could be placed on the well site provided it was at an elevation high enough to provide adequate pressure, 35 pounds, at the high point of the district. Obtaining water from either Rivergrove Water District or the City of Lake Oswego would not require any storage within Mossy Brae, although a connecting pipe line would be necessary.

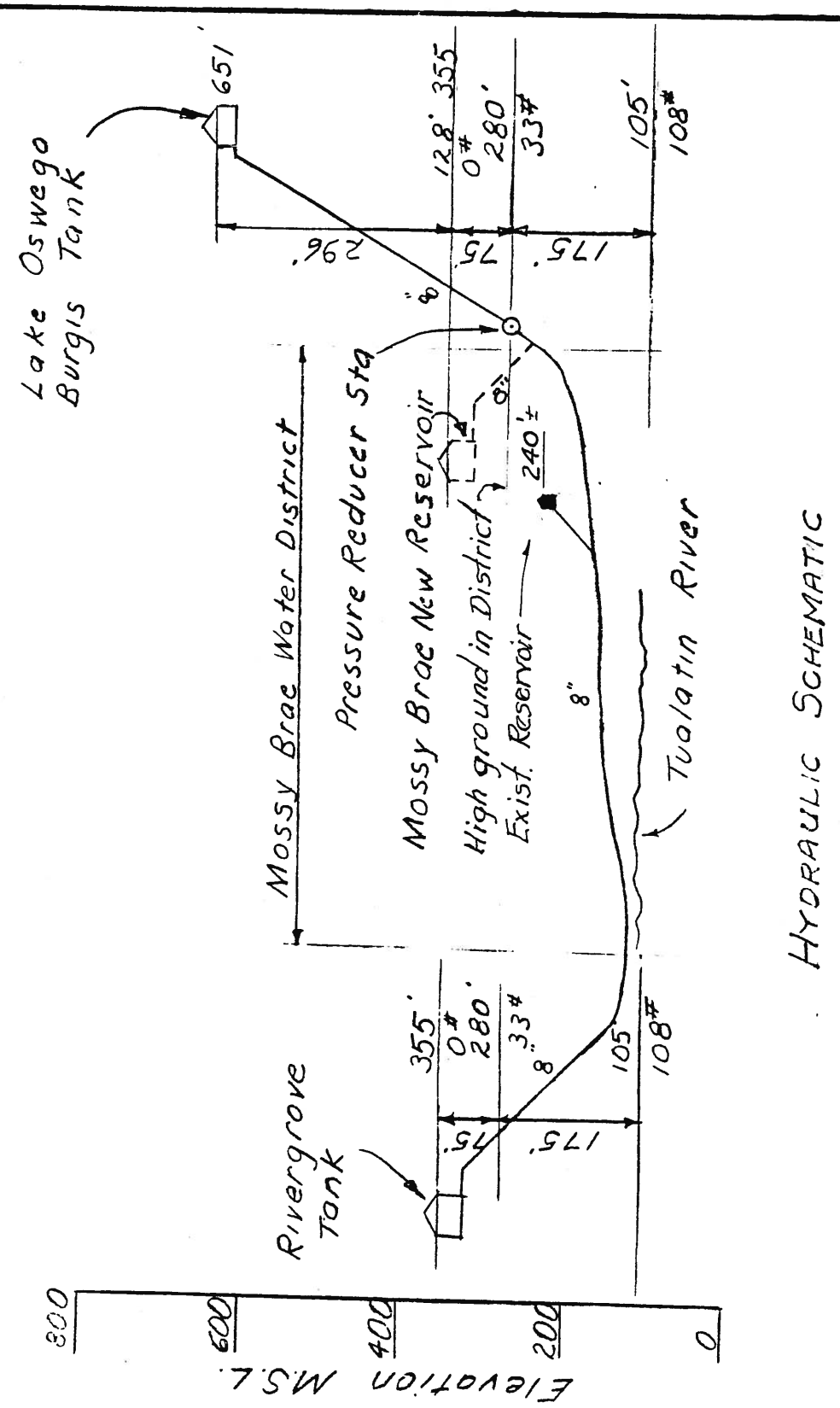
One thing of note here: the district's own storage would have to be somewhere outside the present district boundary and obtaining water from an outside purveyor, all would require the approval of the Portland Metropolitan Area Local Government Boundary Commission.

STORAGE

Additional storage is required, even now. The district's own storage, because it would be outside the present district boundary, would also require the approval of the Portland Metropolitan Area Local Government Boundary Commission.

DISTRIBUTION

Since most distribution mains are inadequate, although some may be salvaged, the 4-inch, under certain circumstances, particularly of full fire service, is not required. Plate 7, page 18, is the calculated size for full 68 user load and fire load.



HYDRAULIC SCHEMATIC

DORNER & TUNKS, INC. CONSULTING ENGINEERS PORTLAND OREGON	MOSSY BRAE W. D. 1978 ENGINEERING STUDY	PLATE 3

CHAPTER IX

COST ESTIMATES
(Based upon other projects in the vicinity)

SOURCE

New Well		
Drilling and casing 8" Well, 400' @ $55.00	$ 22,000	
Pump, pump house, complete	25,400	
Land (with reservoir site)	6,000	
	53,400	
Plus 20%	10,680	
		$ 64,080
Connection to Rivergrove		
Pipe 2,200 l.f. 8" Blackbrute @ $15.00	$ 33,000	
Master meter and vault	13,000	
Easement	1,200	
	47,200	
Plus 20%	9,440	
		$ 56,640
Connection to City of Lake Oswego		
3,500 l.f. 8" Blue Brute @ $16.50	$ 57,500	
Master meter, pressure reducer and vault	15,360	
System development charge	16,900	
	90,010	
Plus 20%	18,000	
		$108,010

STORAGE

150,000 gal. steel tank	$ 65,600	
Land (at well site)	- -	
	65,600	
Plus 20%	13,120	
		$ 78,720

DISTRIBUTION

	All	Part to 4"
8" - 2,850 l.f. @ $15.00	$ 42,750	
8" - 1,375 l.f. @ 15.00		$ 20,625
6" - 4,700 l.f. @ 12.00	56,400	
4" - 400 l.f. @ 10.00	4,000	
Fire hydrants, 3 @ $900	2,700	
Service meters, 42 @ $250	10,500	
	116,350	20,625
Plus 20%	23.300	4,125
	$129,650	$ 24,750

Note: Plus 20% is for Engineering, legal, administration and contingencies.

CHAPTER X

FINANCIAL ANALYSIS

GENERAL

To finance the construction of new facilities the bonds to be sold must be within the bonding capacity of the district, and the amount of bonds sold shall be within a reasonable monthly cost to the user, both in rate for water sales and the amount collected for taxation to retire the bonds.

BONDING CAPACITY

The bonding capacity of the district is limited to ten percent of the true cash value as established by Clackamas County. The 1978-79 true cash value is in the amount of $1,758,960, or a bonding capacity of $175,890. Before we go any farther, let us find out what the average amount of yearly taxes would be required to retire this amount over a 20-year period:

Principal	$175,000/20	$ 8,750/year
Interest @ 7%	175,000 @ 0.07/2	6,125/year
	Bond retirement cost	$ 14,875/year

This amounts for an initial year

$$\frac{\$14,875}{12 \text{ months} \times 42 \text{ users}} = \$29.50/\text{mo/customer}$$

This is much too high, and does not include cost of providing water nor the costs of maintenance and operation. It can be seen then, if we assume

The cost of water @		$ 5.50/mo.
Maintenance and operation		5.00/mo.
Cost of $75,000 bond issue		11.00/mo.
Then the monthly cost will be		$ 21.50/mo.
of which rate	= $ 10.50/mo.	
taxes	= 11.00/mo	
		$ 21.50/mo.

When we look at the costs of the proposed improvements, it becomes obvious that far from everything can be done. In fact, at $21.50/mo. the total expenditure should not exceed $75,000. The following table indicates the cost of an improvement and its adequacy for 42 and 68 users.

Option		Cost	Adequacy							
			Source		Storage		Fire Protection		Distribution Mains	
	Number of users		42	68	42	68	42	68	42	68
1	Existing	$_____	OK	No	No	No	No	No	No	No
2	New well	64,080	OK	OK	No	No	No	No	No	No
3	New reservoir	78,720	OK	No	OK	No	No	No	No	No
4	Rivergrove W.D. connection	56,640	OK	OK	OK	No	No	No	OK	No
5	Distribution mains, part	24,750	OK	OK	OK	OK	Part	No	OK	No

ADEQUACY OF IMPROVEMENTS

TABLE 1

Year	Fiscal Year	Users	True Cash Value	Outstanding Bonds	Princ. P'ments	Interest P'ments	Debt Service	Tax Mils
-1	1977-78	40	$1,526,540					
0	78-79	42	1,758,960	75,000		5,460	5,460	3.10
1	79-80	44	1,846,910	75,000		5,460	5,460	2.96
2	80-81	46	1,939,250	73,000	2,000	5,460	7,460	3.85
3	81-82	49	2,036,220	71,000	2,000	5,110	7,110	3.49
4	82-83	51	2,138,030	69,000	2,000	4,970	6,970	3.26
5	83-84	54	2,244,930	66,000	3,000	4,830	7,830	3.49
6	84-85	56	2,357,170	63,000	3,000	4,620	7,620	3.08
7	85-86	59	2,475,030	60,000	3,000	4,410	7,410	2.99
8	86-87	62	2,598,780	57,000	3,000	4,200	7,200	2.77
9	87-88	65	2,728,720	54,000	3,000	3,990	6,990	2.56
10	88-89	68	2,856,160	51,000	3,000	3,780	6,780	2.37
11	89-90			48,000	3,000	3,570	6,570	
12	90-91			44,000	4,000			
13	91-92			40,000	4,000			
14	92-93			36,000	4,000			
15	93-94			32,000	4,000			
16	94-95			27,000	5,000			
17	95-96			22,000	5,000			
18	96-97			17,000	5,000			
19	97-98			12,000	5,000			
20	98-99			6,000	6,000			
21	99-00				6,000			

PLATE 5

BOND RETIREMENT SCHEDULE

Notes:

Number of users and true cash value are at an annual 5% increase.

The debit service, principal and interest payments, at approximately the same amount through out the bonding period.

Principal payments are scheduled over a period of 20 years with a deferred payment for two years.

When bonds are sold a condition may be expressed whereby certain bonds may be "Callable" before their due date if the district is financially able to do so at that time.

The schedule, excepting bond payments, is not extended beyond the 68 users because growth is not expected beyond this time.

From Table 1, page 13, it is quite evident that the combination of the Rivergrove Water District connection along with a transmission main from the Rivergrove connection at the district boundary to the westerly end of the existing 4-inch main is about the extent of the improvements and would be almost within a $75,000 bond issue.

FISCAL ANALYSIS

Plate 5, page 14, is an analysis of the retirement of the $75,000 bond issue and is detailed as follows:

Column 1 is the year
Column 2 is the fiscal year
Column 3 is the number of users at a 5% growth rate
Column 4 is the true cash value at a 5% growth rate
Column 5 is the outstanding bonds
Column 6 is the principal payments each year
Column 7 is the interest payment each year
Column 8 is the sum of principal and interest payments each year
Column 9 is the approximate millage rate

Interest payments are limited by State law to 7 per cent. General obligation bonds are to be retired at approximately equal payments, principal and interest, during the pay-off period.

CHAPTER XI

CONCLUSIONS AND RECOMMENDATIONS

1. Of the existing system the source is marginal for even the existing users; storage is inadequate and the distribution is poor.

2. If additional users are desired and the cost can be kept under $75,000, no more than 68 users could be served, and at that fire protection would still be inadequate. These improvements would include a connection to the Rivergrove Water District and an 8-inch main inside the district to the westerly end of the existing 4-inch. The existing well and reservoir would be held as standby.

3. Improvement of 45% of the existing mains serving 75% of the users, and installing water meters to each service, could be accomplished for approximately $75,000. No new services above 42 could be connected because source and storage would be fully taxed.

4. The Water Board can recommend to the people to obligate the district to $75,000 improvement: either acquire a new source which insures adequate source and storage for 68 users, or make partial improvements to the distribution system and stay at 42 users.

5. Improvement limited to $75,000 within the district distribution system would make it more desirable for a city or water district to contemplate annexation at a future date.

6. Regardless of what improvements may be made, all except those within the existing district boundary will need the approval of the Portland Metropolitan Area Local Government Boundary Commission.

7. One last alternative is to do nothing. Live with what you have, and don't allow any new services. The Boundary Commission, Department of Environmental Quality or the Environmental Protection Agency may in the long run dictate further requirements at a future date.

RIVER ROAD

TUALATIN RIVER

March Line

DISTRICT BOUNDARY

Sect. 20 Sect. 21 1/4 Cor.

Mossy Brae Road

Stafford Road

Existing Well & Reservoir

Present elevation level (180') for adequate domestic service.

LEGEND:
- 4" LINES
- 2" LINES
- 1-1/4" LINES
- UNDER 1"
- 2" STAND PIPE
- VALVES UNKNOWN

MOSSY BRAE WATER DISTRICT
CLACKAMAS COUNTY, OR.
SECTIONS 20 & 21, T2S, R 2 E, W.M.

0 100 200 300 400 500 1,000

SCALE IN FEET

REVISION	DATE	DESCRIPTION	BY

MOSSY BRAE WATER DISTRICT

JOB No. 59-39
DESIGNED BY: N.S.D.
TRACED BY:
CHECKED BY:
DATE:
APPROVED BY:

EXISTING DISTRICT MAINS

SCALE: 1"=200' SHEET OF

DORNER & TUNKS, INC.
CONSULTING ENGINEERS
PORTLAND OREGON

PLATE 6

RIVERGROVE WATER DISTRICT CONNECTION

RIVER ROAD

TUALATIN RIVER

Match Line

DISTRICT BOUNDARY

Sect 20 Sect 21

1/4 Cor

Mossy Brae Road

Boones Ferry Road

Tualatin River

OPTION E

Scott Creek

Mossy Brae Water District
Clackamas County, Or.
Sections 20 & 21, T2S, R1E, W.M.

Scale in Feet

LEGEND
PROPOSED
EXISTING
F/H

REVISION	DATE	DESCRIPTION	BY

Mossy Brae Water District

JOB No. 78-23
DESIGNED BY: K.J.S.
TRACED BY:
CHECKED BY:
DATE:
APPROVED BY:

Ultimate Water System

SCALE: 1"=200' SHEET OF

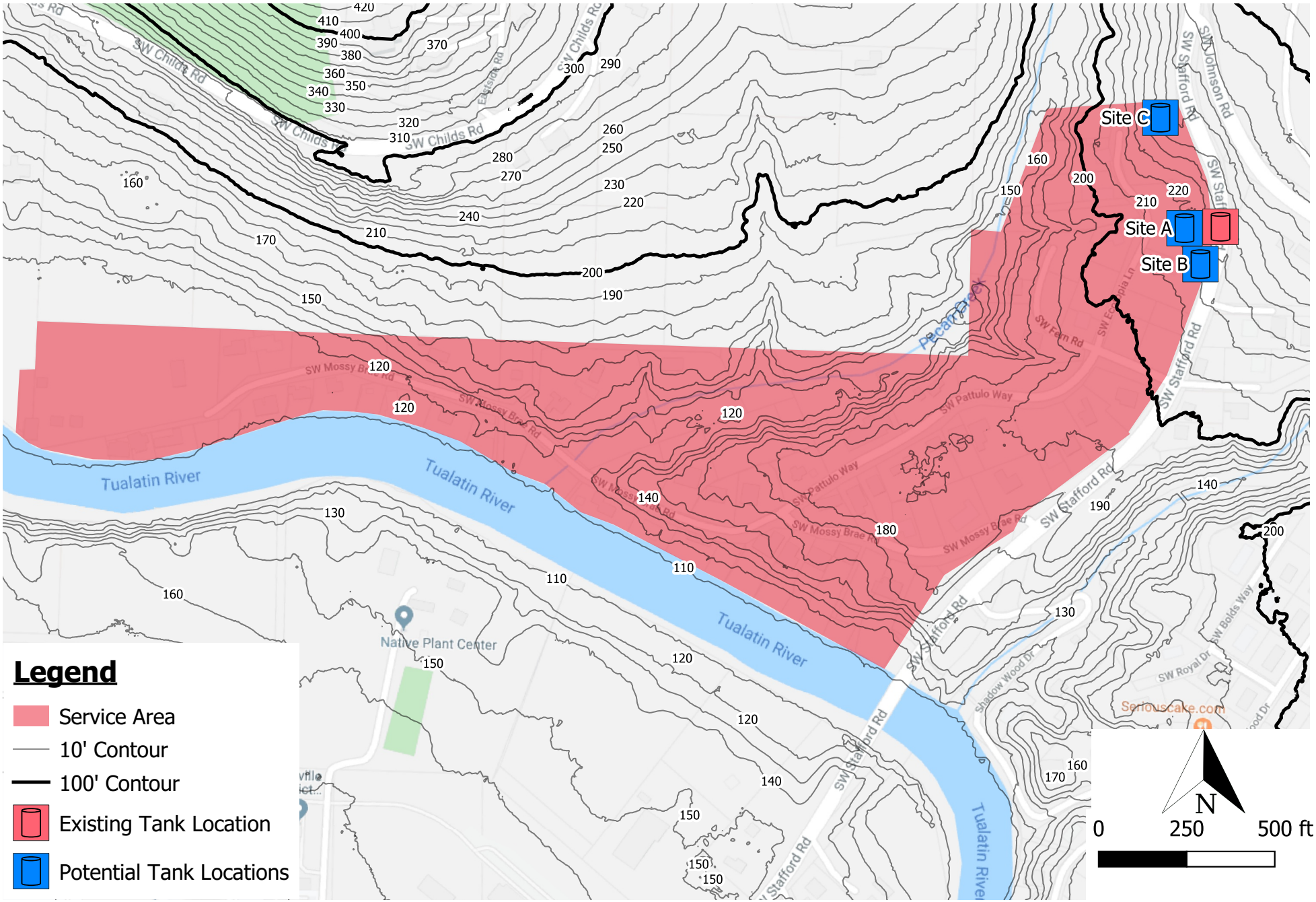
DORNER & TUNKS, INC.
CONSULTING ENGINEERS
PORTLAND OREGON

PLATE 7

APPENDIX F

Service Area, Contours, Existing and Proposed Tank Sites

Service Area, Contours, Existing and Proposed Tank Sites



APPENDIX G

Planning Level Capital Cost Estimates

	Alternative 1				Alternative 2				Alternative 3				Alternative 4			
Item Description	**Units**	**Qty.**	**Unit Cost**	**Total Cost**	**Units**	**Qty.**	**Unit Cost**	**Total Cost**	**Units**	**Qty.**	**Unit Cost**	**Total Cost**	**Units**	**Qty.**	**Unit Cost**	**Total Cost**
Mobilization, Bonds, Permitting, and Insurance (5% of remaining items)	LS	1	$ 14,029.50	$ 14,029.50	LS	1	$ 13,137.50	$ 13,137.50	LS	1	$ 15,237.50	$ 15,237.50	LS	1	$ 11,412.50	$ 11,412.50
Replace SW Ecotopia Lane Water Main w/ 6-inch DI	FT	375	$ 50.00	$ 18,750.00	FT	375	$ 50.00	$ 18,750.00	FT	375	$ 50.00	$ 18,750.00	FT	375	$ 50.00	$ 18,750.00
Site Preparation, Site Piping, Surface Restoration	LS	1	$ 5,000.00	$ 5,000.00	LS	1	$ 15,000.00	$ 15,000.00	LS	1	$ 15,000.00	$ 15,000.00	LS	1	$ 15,000.00	$ 15,000.00
Site Electrical and Controls	LS	1	$ 10,000.00	$ 10,000.00	LS	1	$ 15,000.00	$ 15,000.00	LS	1	$ 20,000.00	$ 20,000.00	LS	1	$ 10,000.00	$ 10,000.00
Testing, Flushing, Disinfection, and Startup	LS	1	$ 5,000.00	$ 5,000.00	LS	1	$ 5,000.00	$ 5,000.00	LS	1	$ 5,000.00	$ 5,000.00	LS	1	$ 3,500.00	$ 3,500.00
Pump Station w/ Enclosure	LS	1	$ 90,000.00	$ 90,000.00	LS	1	$ 90,000.00	$ 90,000.00	LS	1	$ 90,000.00	$ 90,000.00	Not applicable.			
Recoating Existing Tank Interior and Exterior	SF	3,092	$ 20.00	$ 61,840.00	Not applicable.				Not applicable.				Not applicable.			
Shadow Wood Intertie	LS	1	$ 90,000.00	$ 90,000.00	Not applicable.				Not applicable.				Not applicable.			
Electrical Service	Assumed existing electrical service will be utilized.				Assumed existing electrical service will be utilized.				LS	1	$ 5,000.00	$ 5,000.00	Not applicable.			
Tank and Foundation	Not applicable.				LS	1	$ 100,000.00	$ 100,000.00	LS	1	$ 88,000.00	$ 88,000.00	LS	1	$ 118,000.00	$ 118,000.00
2-Inch PVC Pipe and Conduit from Well to Tank	Not applicable.				FT	150	$ 40.00	$ 6,000.00	FT	650	$ 40.00	$ 26,000.00	FT	650	$ 40.00	$ 26,000.00
8-inch DI Pipe from Tank to Distribution	Not applicable.				FT	50	$ 60.00	$ 3,000.00	FT	450	$ 60.00	$ 27,000.00	FT	450	$ 60.00	$ 27,000.00
Demolition and Disposal of Existing Tank	Not applicable.				LS	1	$ 10,000.00	$ 10,000.00	LS	1	$ 10,000.00	$ 10,000.00	LS	1	$ 10,000.00	$ 10,000.00
Construction Subtotal				$ 294,619.50				$ 275,887.50				$ 319,987.50				$ 239,662.50
Survey				$ 5,000.00				$ 10,000.00				$ 10,000.00				$ 10,000.00
Geotechnical (Design and Construction)	Not applicable.							$ 10,000.00				$ 10,000.00				$ 10,000.00
Civil Engineering (Design and Construction, 15% of Construction Subtotal)				$ 44,192.93				$ 41,383.13				$ 47,998.13				$ 35,949.38
Permitting (2% of Construction Subtotal)				$ 5,892.39				$ 5,517.75				$ 6,399.75				$ 4,793.25
Mossy Brae Administration and Legal (5% of Construction Subtotal)				$ 14,730.98				$ 13,794.38				$ 15,999.38				$ 11,983.13
Estimated Total				**$ 364,435.79**				**$ 356,582.75**				**$ 410,384.75**				**$ 312,388.25**
AACE International, Class 4, Lower Limit (70% of Estimated Total)				**$ 255,105.05**				**$ 249,607.93**				**$ 287,269.33**				**$ 218,671.78**
AACE International, Class 4, Upper Limit (150% of Estimated Total)				**$ 546,653.69**				**$ 534,874.13**				**$ 615,577.13**				**$ 468,582.38**