TM-4: Planning Criteria

This Technical Memorandum presents the fundamental criteria upon which the Water Master Plan Update has been developed. The criteria include:

1. Planning Period
2. Level of Service
3. Redundancy
4. Reliability
5. Cost Estimates
6. Life Cycle Cost Analysis

1.0 Planning Period

DWSD's goal is to provide an update to its earlier 50-year Comprehensive Master Plan, which covered the years 2000 to 2050. The Master Plan Update is to cover a period of 20 years.

In order to provide synchronization with DWSD's annual Capital Improvement Program, the planning period for this Master Plan Update has been established as July 1, 2015, to June 30, 2035.

This planning period has the advantage of allowing continuing analysis and decision making during the remaining 16 months of this planning study, and it allows time for DWSD to incorporate recommendations from this plan into its FY2016 CIP starting in July 2015.

2.0 Level of Service

It is standard practice for water utilities to establish performance goals for their operations. These goals can be internal management guidelines, legal agreements, and/or externally communicated goal statements. Collectively, these performance goals form a statement on 'level of service'.

As of the Market Plan milestone of the Water Master Plan Update, discussion continues among the Master Plan Steering Team, the Retail Customer Steering Committee, and DWSD regarding a statement on level of service. The following statements capture the discussion to date, and they guide planning recommendations to date. These will be further developed as part of the March 2015 Service Management Interim Report.

1. Supply wholesale and retail water service in accordance with best practice, regulatory requirements, fire protection requirements, and public health standards, and contract volumes and pressure.
2. Build and maintain facilities for treatment, pumping, storage and transmission, and metering to provide redundancy in capital facilities.

3. Maintain and operate the system to achieve a high level of reliability consistent with practice of large water utilities.

4. Be the water supplier of choice by providing customer service, affordability, and water quality that yields a high level of customer satisfaction.

3.0 Redundancy

For the purpose of DWSD's water master planning, redundancy refers to capital facilities. These include intakes, treatment facilities, reservoirs, pumping stations, transmission mains, distribution mains, and wholesale meters.

The Analytical Work Group (AWG) developed the following statement on redundancy in 2013:

> "Redundancy is the ability for the system to provide continuous and adequate supply during the time that the single largest and/or most critical system component is unavailable. Redundancy is a goal, not an obligation that takes into account: the population that is served, volume of sales, the number of years that a customer has been served by the water system, and opportunities for expansion of the water system."

The Ten State Standards recommends that redundancy of capital facilities be provided based on an examination of the system and evaluation of single points of failure that could render the system unable to meet it design basis.

Based on the direction of the AWG, the Ten State Standards, AWWA guidelines, and experience in other major utilities, the following definitions and criteria are proposed as basic planning criteria for the water master plan update. Redundancy for individual design projects may be governed by additional redundancy requirements.

3.1 Definitions

Firm Capacity: Installed pumping and treatment units should provide Design Capacity with largest unit(s) out of service. ["N" refers to the number of the largest units]. **See Figure 3-1.**

- Pumping = N + 1
- Treatment Process (low mechanical, such as sedimentation) = N + 0
  Perform scheduled maintenance during months of lower daily water demand.
- Treatment Process (high mechanical) = N + 1
- Filtration: allow redundancy for one or more filters out of service during backwash cycle

Design Capacity: Capacity required to meet water demand projections, including peak hour water use, fire flow requirements, and emergency supply commitments.

Rated Capacity: MDEQ approved treatment capacity of a water treatment facility.

System Storage Requirement: Storage in the transmission system is evaluated based on several criteria in the Ten States Standards and guidance from MDEQ.

With respect to redundancy, storage facilities provide redundancy through storage capacity that is sufficient to meet wholesale contract demands, retail demands, and fire flow demands. The location of storage facilities to provide this redundancy should be evaluated under a range of operating scenarios.

The minimum storage capacity should be equal to the average daily demand, plus retail service fire flow requirements. Average day demand should include contract requirements plus estimated average retail demand. Wholesale customers maintain storage for their fire flow requirements.

This storage capacity equal to the average day demand may be reduced when the transmission and pumping facilities have sufficient capacity and redundancy with standby power to supplement peak demands of the system.

With respect to operation, storage facilities must be operated to avoid deterioration of water quality by maintaining a water age of generally 3 days or less prior to delivery at the wholesale and retail customer meters.

Mains

- **Transmission –** 24 inches diameter and larger (there are limited exceptions where transmission relies on existing 16-inch to 20-inch diameter mains)
- **Distribution –** 8 inches to 20 inches in diameter

Table 3-1: Proposed Planning Standard for Redundancy

System Element	Redundancy Planning Standard
Treatment Plant Intake	Intakes generally do not have redundancy at each location; intakes for other plants must provide spare capacity when an intake needs inspection or rehabilitation.
Low Lift Pumps	Design capacity should be met by firm pumping capacity.
Treatment processes	There should be sufficient treatment trains to allow for a minimum of one filter out of service for backwashing
Power Systems	In accordance with criteria established by MDEQ
Control Systems	Include redundancy or back-up method of control
Reservoir	Total reservoir capacity at each site should be provided by two or more storage tanks to allow for temporary maintenance of each tank. Where only a single tank exists, pump and transmission capacity should be sufficient to compensate for one local reservoir tank out of service. (Minimum system storage requirements will be defined at a later date.)
High Lift Pumps	Design capacity should be met by firm pumping capacity. If there is a common header, then there should be redundant means of discharge to the transmission system.
Transmission Main	Looped transmission is the preferred design. Where looped transmission is not provided, then the capacity of reinforcing arterial mains in the distribution grid should be considered for redundancy. Also, an Emergency Response Plan for the transmission main should be implemented.
Distribution Main	Standard is for looped distribution mains for 10 or more residential customers or equivalent. Where looped distribution is not provided, then the Emergency Response Plan should include protocols for dead end mains.
Wholesale Meter	There should be two or more wholesale delivery points. Individual meters should be provided with bypass piping to facilitate meter replacement, testing and calibration.
Emergency Connections	Where emergency connections exist, these should be considered as part of the design for redundancy.

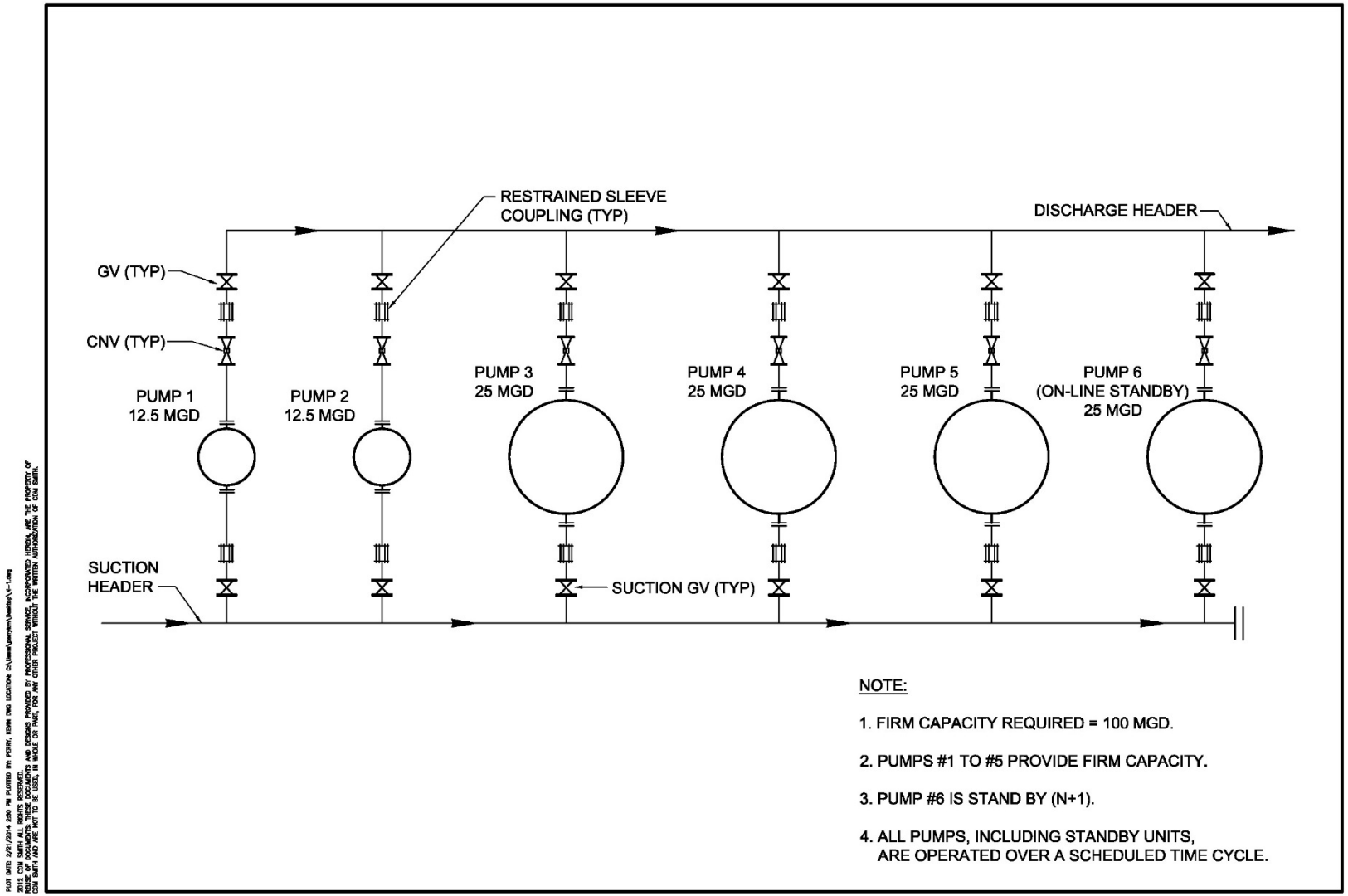

Figure 3-1: Example of N+1 Redundancy,

4.0 Reliability

The Analytical Work Group provided the following statement on reliability in 2013:

> "The ability of the system to perform and maintain its functions in routine, as well as probable unexpected, circumstances within the expected level of service"

Reliability can be measured as the ratio of the number of hours per year that the system maintains its design function divided by the total number of hours in the year. DWSD maintains records on pump running time and service time by which reliability can be measured.

Reliability is provided by:

- System redundancy
- Mechanical equipment selection
- Inspection and condition assessment program
- Scheduled maintenance program

DWSD programs for operation, maintenance, replacement and asset management should be performed to achieve major water utility industry standard reliability for service to all customers.

5.0 Cost Estimates

Cost estimates for the Water Master Plan Update are based on planning level investigations, and these cost estimates are intended for comparison of alternatives and general capital budgeting. Estimates in this report are expected to change as more detailed definition develops through facilities planning and design investigations. Cost contingency is added planning level estimates to allow for potential cost increase in later phases of implementation.

5.1 Terminology

The following terms and values are used in the planning level cost estimates

Construction Cost: Estimated construction contract cost for furnishing materials, equipment and labor, testing and warranties. Construction cost estimates are generally based on recent bids for similar construction.

Unit Prices: Unitized construction costs expressed as "$ per foot" for transmission mains or "$ per gallon" for reservoirs. Unit prices provide a basis comparing the relative cost of different projects.

Engineering Cost: The cost of engineering during design and construction. An allowance of 15 percent is used for the estimates in this report. If substantial geotechnical investigation or other special services are anticipate, additional allowances are added for these.

Administrative and Legal: The cost of the owner (DWSD) to procure, award, contract manage, administer and provide routine legal support for a project. An allowance of 5 percent has been used for the estimates in this report.

Land and Easements: The estimated cost of land and easement acquisition for a project. These are estimated on a case-by-case basis.

Contingency: An allowance for additional requirements that may be discovered in subsequent stages of engineering. An allowance of 15 percent is used for this report, which includes 10 percent for additional requirements during design, and 5 percent for construction change orders.

Note that the previous Needs Assessment reports for water treatment plants prepared in 2002 and 2003 used different factors for engineering, legal, and administrative services and project contingencies. Also, the 2004 Comprehensive Water Master Plan presented its estimates of capital cost based on different factors. The factors in those previous efforts ranged from 45 to 56 percent total allocations, compared to the 30 percent used in Phase 1of the Water Master Plan Update. The Phase 1 work includes more investigation and discussion with customers to improve project definition, and therefore justifies a lower contingency value.

5.2 Construction Cost Index

All construction costs have been normalized to prevailing costs in December 2013. Cost estimates from earlier years have been reconciled to December 2013 by using the Engineering News Record (ENR) Construction Cost Index. **Table 5-1** shows the last ten years of ENR cost indices.

Table 5-1: ENR'S Construction Cost Index History (2001-2013)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
2015	9972	9962			9975								
2014	9664	9681	9702	9750	9796	9800	9835	9846	9870	9886	9912	9936	9806
2013	9437	9453	9456	9484	9516	9542	9552	9545	9552	9689	9666	9668	9547
2012	9176	9198	9268	9273	9290	9291	9324	9351	9341	9376	9398	9412	9308
2011	8938	8998	9011	9027	9035	9053	9080	9088	9116	9147	9173	9172	9070
2010	8660	8672	8671	8677	8761	8805	8844	8837	8836	8921	8951	8952	8799
2009	8549	8533	8534	8528	8574	8578	8566	8564	8586	8596	8592	8641	8570
2008	8090	8094	8109	8112	8141	8185	8293	8362	8557	8623	8602	8551	8310
2007	7880	7880	7856	7865	7942	7939	7959	8007	8050	8045	8092	8089	7966
2006	7660	7689	7692	7695	7691	7700	7721	7722	7763	7883	7911	7888	7751
2005	7297	7298	7309	7355	7398	7415	7422	7479	7540	7563	7630	7647	7446
2004	6825	6862	6957	7017	7065	7109	7126	7188	7298	7314	7312	7308	7115
2003	6581	6640	6627	6635	6642	6694	6695	6733	6741	6771	6794	6782	6694
2002	6462	6462	6502	6480	6512	6532	6605	6592	6589	6579	6578	6563	6538
2001	6281	6272	6279	6286	6288	6318	6404	6389	6391	6397	6410	6390	6343

For example, if construction bids were received in November 2011, but for some reason the project was not implemented. If implementation is planned for November 2013, then a new estimate for the project could be developed by multiplying $100 x 9666/9147 = $106.

5.3 Construction Cost Estimates

5.3.1 Water Treatment Plants and Intakes

Water treatment plant upgrades and modifications will involve extensive work at existing facilities. For this reason, construction cost estimates have been developed based on a detailed assessment of required upgrades and modifications. Estimates from previous projects have been reviewed to confirm the scope of work, and then when applicable, the previous estimate has been updated to December 2013. These cost estimates are presented in Technical Memo 13.

5.3.2 Pumping Stations

New pump station costs have been estimated using the following equation. This is based on analyses done in the previous 2003 Comprehensive Water Master Plan and review of DWSD construction costs.

$$\text{Cost}_{\$1,000/MGD} = 364 - (0.229 \times \text{Capacity}_{MGD})$$

5.3.3 Reservoirs

The cost of new above-ground reservoirs has been estimated based on review of previous DWSD construction costs. A unit cost of $0.675 per gallon has been used.

5.3.4 Transmission Mains

Transmission main cost estimates are based on the following assumptions:

- All pipe to be put into paved roads, unless otherwise specified.
- Trench-width paving reclamation and new paving.
- Nominal groundwater is included – no major dewatering.
- No significant rock removal.
- Depth to top of pipe was assumed to be 5 feet.
- All trenching is done using trench boxes – no sheeting has been used.
- Crew productions assumed are:
  - 16” to 42”, 100 ft/day
  - 48” to 60”, 80 ft/day
  - 66” to 84”, 60 ft/day
  - 90” to 108”, 40 ft/day

Table 5-2: Pipe Installation Cost ($ per foot)

Diameter (Inches)	DI	PCCP	Steel
16	230	210	
24	302	227	
30	380	285	
36	469	360	
42	562	423	
48	694	524	
54	831	566	750
60		616	
66		802	
72		843	
78		888	
84		934	
90		1123	
96		1159	1550
102		1201	
108		1254	

Location Factors for Pipe Installation Costs		Minimum Crossing Lengths
Rural -- minor traffic control, minor utility conflicts	1	
Suburban -- traffic control requirements and utility conflicts	1.5	
Urban -- extensive traffic control requirements, extensive utility conflicts	2.0	
MDOT or County Highway Easement	1.6	
Rail or Highway Crossing	2.5	Rail = 50 feet; Highway = 100 feet
Stream/Wetland Crossing	1.5	Small stream = 50 feet; Large stream = 100 feet; wetland distance based on available mapping

Notes on Pipe Material
For pipe 30" diameter or less, ductile iron pipe is assumed.
New pipelines at water treatment plant sites should be steel pipe with cathodic protection in order to facilitate period yard piping service and excavation.

5.4 Operating Cost Estimates

A review was performed to understand the sources and reporting of operating costs for DWSD. There are factors that make the reporting of operating costs complex: DWSD continues to rely on the City of Detroit for reporting of operating costs; DWSD is updating its organizational and work force structure; and the requirements of the Emergency Manager and bankruptcy filing in July 2013. The different sources of data that were reviewed included:

- Actual operating costs for FY2012, FY2013, and FY2014

- Budgeted costs for FY2014 and FY2015
- Forecasted costs after organizational and work force optimization

Based on this review, it was determined to use the actual operating costs for FY2013 and FY2014 for the life cycle cost analyses performed for this Phase 1 report. The FY2013 and FY2014 actual costs provide the most complete picture of current operations, and the documentation of those costs is available and consistent level of detail. Also, the FY2013 and FY2014 actual costs include the full array of staff, utilities, materials, equipment, vehicle, and labor and service contract costs that were required to operate the water system.

Within the FY2013 and FY2014 actual costs, there were some minor differences between certain cost reports. The difference between cost reports are attributed largely to differences in timing of information, and the differences are less than 3 percent. It was decided to use the FAAR report (Funds Available Activity Report) of actual costs. The FAAR is the cost report provided by the City of Detroit. FAAR costs were used for all costs, except those for electricity. In the case of electricity, the operating costs are based on DTE bills.

The FY 2013 actual costs were compared to available benchmarking data from other water utilities. In order to compare DWSD's costs to those of other water utilities, the DWSD costs were normalized to a "dollars per million gallons" format. Selected major costs are shown in **Tables 5-3 and 5-4**.

Table 5-3: DWSD Water Operations Costs (Dollars per Million Gallons, FY 2013)

Type of Cost	$/Million Gallons
Chemical Costs	
Lake Huron	30.6
Northeast	23.5
Southwest	28.1
Springwells	23.5
Waterworks Park	68.5
Energy Costs	
Lake Huron	141.0
Northeast	82.8
Southwest	66.5
Springwells	70.8
Waterworks Park	74.2
Labor Costs	
Lake Huron	30.8
Northeast	44.2
Southwest	76.0
Springwells	31.5
Waterworks Park	88.5

Table 5-4: DWSD Water Operation Functional Costs (Dollars per Million Gallons, FY201 Budget)

Functional Cost	FY2014 Budget	Dollars per Million Gallons
Treatment and High Lift Pumping	$66,630,000	$330.6
Booster Pumping and Reservoirs	$15,910,000	$78.9
Pipeline Maintenance	$26,720,000	$132.6
Finance	$4,790,000	$23.8
Administration	$39,340,000	$195.2
Total	$153,420,000	$761.4

The AWWA 2009 benchmarking survey presents a range of water utility operation and maintenance from $836 per million gallons to $2,089 per million gallons, with an average of $1,341 per MG average. The value of $761.1 per million gallons for DWSD is comparable with the low end of the AWWA range. DWSD's costs are at the low end of the range from the AWWA survey due to the large volume of water that DWSD produces, the excellent quality of source water, and the previous investment in capital facilities.

6.0 Life Cycle Cost Analysis

6.1 Discount Rate

The life cycle cost evaluation was performed in accordance with the United States Office of Management and Budget Circular A-94.Revised, titled: "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs". These guidelines are generally used in programs when federal funding is provided for water and transportation projects.

In order to address the uncertainty around future costs, the life cycle evaluation was performed twice, once with a lower discount rate, then again with a higher discount rate. The low discount rate was 4 percent per year, and the high rate was 7 percent per year.

This range of rates is typical of the range of values currently used in the United States for cost-benefit studies performed in accordance with Circular A-94. The higher discount rate reflects a scenario of costs increasing at a higher rate than has been the case over the last 5 years. The lower discount rate reflects a scenario of costs increasing at approximately the same rate as over the last 5 years.

6.2 Service Life Estimates of Facilities and Pipe Lines

In the life cycle cost analysis, the economic service life for new water main and building structures was set at 100 years. Major mechanical equipment service life was set at 25 years, and smaller mechanical system and information technology system service life was established at 10 years. More specific estimates of service life are provided in the proposal capital improvement program in TM-17.

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