City of Fort Collins

FINAL Report

Irrigation System Planning Toolbox

Prepared for the City of Fort Collins Parks Department

Aqua Engineering Inc.

October 16, 2019

FORT COLLINS IRRIGATION SYSTEM PLANNING TOOLBOX

Report Documents and Structure

This report consists of multiple separate documents. The following list outlines these documents and provides a brief description of their content:

- **Document Cover and Introduction (this sheet)**
- **Executive Summary**
  A synopsis of the project report and a summary of the most recent System Ranking Analysis.
- **Periodic Irrigation System Ranking Analysis (multiple documents)**
  This section of the report contains ranking analysis reports in preparation for each BFO cycle.
  - Result presentation and conclusions
  - Analysis framework conditions
    - Settings, performance aspects under investigation, limitations
    - Data structure and availability
  - Statistical systems analysis
  - Single system reports
- **Project Report**
  - Context, goal, and scope
  - Implementation
    - Decision process
    - Performance indicator definition
    - DST theory and practice
  - Current limitations and outlook
- **DST Documentation**
  A technical description and user manual for the Decision Support Tool.
- **Irrigation System Standards**
  - Design Guidelines
  - Equipment and Installation Details
  - Specifications

Please use the above list to familiarize yourself with the project structure and to easily navigate to the subject of interest. Each document contains a separate table of contents that allows rapid lookup of specific topics.

FORT COLLINS IRRIGATION SYSTEM PLANNING TOOLBOX

Executive Summary

Project Description

The City of Fort Collins Parks Department maintains more than 200 irrigation systems to support landscapes in parks, streetscapes and facilities. Parks alone require roughly 190 million gallons water annually and the operation of irrigation systems represent more than 13% of the Parks Department's budget ($1,569,874 in 2018). It is the largest maintenance program expenditure. These figures underline the importance of a thorough infrastructure asset management system.

In September 2018 the City of Fort Collins Parks Department consulted Aqua Engineering Inc. to identify irrigation system improvement opportunities and assist with prioritization. This project, funded through the Parks Life Cycle Program, was identified largely due to the increasing average age of parks and the limited funding to make site-wide irrigation improvements. Several City of Fort Collins Departments apply advanced maintenance and reinvestment planning tools to large scale infrastructure assets, and outreach was conducted as part of this study. Concrete project goals and approaches include:

Create a transparent and data driven planning process that prioritizes needs: A formalized Decision Process requires planners and decision makers to use a Decision Support Tool. The tool processes data from an Irrigation System Inventory to rank irrigation systems based on various Performance Indicators (see below). This leads planners and decision makers to focus on sites where investments have the greatest impact. Tool results also allow to rapidly identify, locate, and learn from existing problems and bright spots.

Maximize input from all levels of the City organization: **Decision Process** and **Performance Indicator** development was guided by **rigorous stakeholder input**. Specific site data was provided by Parks staff through an irrigation system inventory form.

Improve design and construction consistency: Updated **Irrigation System Standards**[b] support all previous goals and strategies e.g. by incorporating the priorities that performance indicators reflect. Standards also ensure clarity of design intent for project recommendations associated with the plan.

Methods

Decision Process: The project team initially developed an irrigation system ranking flowchart that defines data collection and three analysis levels. Analyzing a few performance indicators for all systems starts the ranking workflow. Subsequent levels require additional data but focus only on systems that show inadequate performance in the previous step. While the first two analysis steps adhere to a predefined Performance Indicator set, the final analysis is flexible and introduces less predetermined criteria.

Performance Indicators: The project team brought a set of abstract decision criteria , the result of expert knowledge and data availability research, to expert guided group meetings. Management teams, crew chiefs and field crews assigned decision criteria to each analysis level, reflecting the priority of each criterion[c]. The outcome of these exercises (119 criteria allocations) and the evaluation of data availability and usability lead to the development off following Performance Indicators[d].

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[a] As of 2019 park irrigation infrastructure has been built on average 30 years ago.

[b] Design Guidelines, Equipment, Installation Details, and Specifications.

[c] Section B.4.2 of the Project Report provides further insights into the Performance Indicator definition process.

[d] Some Performance Indicators are the product of multiple sub Performance Indicators. Please refer to a current Analysis Report for a complete list of indicators.

Level 1	Level 2	Level 3
• Maintenance Cost • Age - System • Relative Water Use • System Safety	• System Integrity • Plant Material • BMP's and City Standards	• Other operational cost • ROI • Alignment with park planning • …

Inventory: The irrigation system inventory is a detailed data collection of infrastructure elements, environmental- and performance-variables. Various sources feed into inventory table records. Exports from the department's Resource Allocation and Measurement System (RAMS) software, water use and budgeting data are readily available. A questionnaire for field crew members adds information about system components and performance.

Decision Support Tool: The tool implements the system inventory and supports the analysis steps of the decision process. It uses an intuitive Multiple Criteria Decision Analysis method to calculate a System Condition Index (SCI) for each system at each analysis level. It further supports score analysis, visualization and reporting.
The tool's database schema not only contains inventory date. It also includes the analysis configuration. This approach allows to change Performance Indicators and other analysis settings. Rapid adjustment to different analysis requirements (e.g. new data, varying criteria for other types of sites such as streetscape irrigation) is possible.

Outcomes

Elements of the toolbox are available to the Parks Department for continued use and integration. Based on a well maintained inventory, regular system evaluations support irrigation asset management efforts. Immediate outcomes of this project are the results of an initial (2018) data collection and analysis.

Data Collection

Information about 46 Irrigation systems is available for the 2018 analysis. 276 irrigation system component definitions in five categories allow for evaluating the remaining useful life. 169 water budget and 2,264 performance records in 26 categories are available to evaluate the system condition with respect to the four 1st and the three 2nd level Performance Indicators. 27 voluntary field crew comments provide additional insights into existing operational problems and may prove to be valuable input for the third level analysis.

2018 Irrigation System Analysis

Based on the 2nd level analysis and the current tool settings, the System Condition Index systems in Table 1 below is high enough to qualify them for a third level analysis. Please note that the 2nd level Ranking Table result (see Table 2) includes more irrigation systems and that it highlights the 3rd level candidates in the SCI column.

TABLE 1 FIVE IRRIGATION SYSTEMS WITH THE HIGHEST NEED FOR INFRASTRUCTURE REINVESTMENT.

Rank	System	SCI	Replacement Cost Estimate[e]
1.	Library Park - Irrig.Sys.	24.0	$310,000
2.	Rolland Moore Park - Irrig.Sys.	22.4	$3,200,000
3.	City Park - Irrig.Sys.	19.1	$4,250,000
4.	Freedom Square Park - Irrig.Sys.	18.0	$23,000
5.	Washington Park - Irrig.Sys.	18.0	$225,000

Top ranking systems typically show consistent performance deficits over most economic, social, and ecological aspects under investigation. It should be noted that top ranked Community Parks' Maintenance Cost are relatively low due to the ability to distribute costs across many acres. These systems' poor performance in other aspects let them flow to the top. The 3rd Level analysis may use Table 2 below as a starting point.

TABLE 2: 2ND LEVEL RANKING TABLE. THE FIVE PARKS WITH THE HIGHEST SCI REQUIRE FURTHER ANALYSIS IN THE 3RD LEVEL ANALYSIS PROCESS.

System	Location Type	Irrigated Area [ac.]	Maintenance Cost	Age - System	Relative Water Use	System Safety	System Integrity	Plant Material	BMP's and City Standards	SCI
Library Park - Irrig.Sys.	Neighborhood Park	3.59	4.0	4.7	5.0	4.0	3.6	1.5	1.2	24.0
Rolland Moore Park - Irrig.Sys.	Community Park	40.44	0.8	3.6	4.1	3.0	4.8	5.0	1.2	22.4
City Park - Irrig.Sys.	Community Park	48.98	0.1	5.7	1.6	3.0	3.2	3.5	2.0	19.1
Freedom Square Park - Irrig.Sys.	Mini Park	0.26	3.0	6.4	3.4	3.5	0.4	0.0	1.2	18.0
Washington Park - Irrig.Sys.	Mini Park	2.56	0.9	5.1	5.0	2.0	2.2	1.5	1.2	18.0
Buckingham Park - Irrig.Sys.	Neighborhood Park	3.28	2.3	5.1	2.5	1.5	4.2	1.5	0.8	17.9
Lee Martinez Park - Irrig.Sys.	Community Park	15.82	1.6	4.8	1.6	3.0	0.4	3.5	2.4	17.2
Troutman Park - Irrig.Sys.	Neighborhood Park	17.42	0.0	3.2	4.7	1.5	2.0	3.5	1.2	16.1

Following paragraphs summarize PI-Score findings for each system:

Library Park: This system shows average to poor performance at most performance indicators. Maintenance Cost, Water Use, System Safety, and System Integrity are PIs where this system performs worse than most other systems. Stressed turf was reported in 2018 despite the high water use.

Rolland More Park: While this system has rather low Maintenance Cost due to its large acreage, its physical integrity is exceptionally poor. Failures occurred across all component types in 2018. Stressed turf, dying plant material, and the need for hand watering may be a direct result of failing infrastructure.

City Park: Many system components are 52 years old, however, two new controllers lower the Age -score from a straight 6 (the maximum achievable age score for community parks) to 5.7 points. Its relative water use is low as well. This, on the other hand, may be the reason for poor turf appearance and the need for hand watering. This system shows the lowest Maintenance Cost at this analysis level due to its large acreage. The City Park system irrigates 48 acres and the project team urges the evaluation of its sub systems. Currently, this is not possible due to data constraints.

Freedom Square Park: Exceptionally old system components and system safety are the main contributors to the high rank of this system. While the system integrity seems to be good, it should be noted that this score is based on only one year of data. While no major component breakdowns occurred in 2018, a high

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[e] Replacement Cost Estimates are the product of 2018 construction unit cost of $ 2 per ft^2 and irrigated acreages. Pump station updates are not included. The estimates include hard and soft cost.

risk of failure stands to reason as many components are significantly older than their typical useful life. The poor System Safety performance is a consequence of missing automatic shutdown capabilities and a sprinkler layout that overspray's hardscapes.

Washington Park: This Mini Park system has a high Age and Water Use score and shows unusually low maintenance cost. Despite the high water use score, stressed turf was reported in 2018.

Other Observations: Part of any analysis is the validation of input data and Performance Indicator score calculations. As exceptionally high or low values may indicate erroneous data, these indicators are a good starting point for investigations.

The correlation between different indicators can provide insights into the source of existing problems. Failure to meet expected correlations may also indicate erroneous data. Therefore, it seems advisable to focus 3rd level investigations on systems where performance indicators score high, while other performance indicators show counterintuitive behavior.

Investigations of the interaction between Relative Water Use, Plant Material and Hydrozones[f] could yield a better understanding of the cause and effect of existing problems.

Outlook

Next Steps

An important first step of the third level analysis is to confirm the validity of all Performance Indicator variables for the top ranking irrigation systems. The Decision Support Tool provides individual system data reports that alleviate this task. If data quality issues appear, iterative inventory updates and ranking analysis are necessary until all issues are resolved.

The third level analysis is an open process and can include park programming, environmental, economic, and social data. This process can further include the evaluation of specific infrastructure improvement alternatives (e.g. replacement of specific sections of mainline, adjustment of zones to new park programming, water resource management).

While the third level analysis is an open process, it is also a continuation of the previous steps. Therefore, it is important to clearly define Performance Indicators (variables, functions, weights) for this analysis level.

Future Opportunities

Both, the Inventory and the Decision Support Tool design allow to store time referenced records and to analyze historical data. Most performance records of the current irrigation system inventory are only a snapshot in time, but continued data collection will lead to more reliable system evaluations.

Following opportunities would add to the quality of the system analysis and user friendliness:

- **RAMS program code changes:** The toolbox can store and evaluate certain performance indicators for individual irrigation system components. However, the tool uses lump sum expenses because RAMS expense data is not available at this level of detail. Breaking down the 1029 program code would allow a detailed analysis of maintenance efforts and improvement opportunities. For example, code 1029.A indicates mainline maintenance, 1029 B indicates control system maintenance, and so on.
- **Data-centralization & GIS integration:** Keeping inventory data in a relational database management system has several advantages (performance, flexibility, maintainability, security, etc.). The Parks

[f] Hydrozones is a sub Performance Indicator to "BMP's and City Standards"

Department already uses a geodatabase inventory for parks and irrigation infrastructure. Integrating the planning toolbox inventory in this database creates multiple positive outcomes such as:

  - Reduced redundancy due to central storage; files are not stored on workstations.
  - Improved data maintenance due to the ability to use advanced data management features.
  - Opportunity to unlock evaluation potential (see below) and result visualization.

- The integration process may require additional fields in existing feature tables, or to add and reference new tables that enable the analysis process. Continued use of the decision support tool is unproblematic since its design allows rapid adaption to centralized storage.
- **Improve analysis:** The current decision support tool does not quantify irrigation system component records. Thus, each component definition has the same impact on a performance indicator score (only component types have different weights). Adjustment of the inventory (see GIS integration) and the respective performance indicator functions result in improved modeling and evaluation capabilities and reduced result validation as part of each analysis.

  For example, while it is already possible to define multiple mainline sections for one irrigation system, all sections have the same impact. The Decision Support Tool does not know that only a few yards of mainline from 1972 are remaining and the rest was recently built. When the tool evaluates the system age, both components will have the same impact on the final grade.

Contents

A Introduction

The Fort Collins Irrigation System Planning Toolbox project involved applying the Decision Support Tool (DST) to existing park irrigation infrastructure to support essential elements of the irrigation infrastructure planning and investment process. It automates the first and the second analysis steps as described in the Decision Process section[1(secB.4.1)] of the Project Report.

This document presents the final (2nd level) irrigation system analysis results in Section B. The DST presents results for each system and each Performance Indicator (PI) in a Ranking Table. High PI-Scores indicate bad performance and the DST uses the sum of all PI-Scores to rank irrigation systems[1(secB.4.4)]. Figure 1depicts condensed DST Ranking Table results for the 1st and 2nd level analysis. The System Condition Index (SCI) of the following five systems is high enough to qualify them for a third level analysis[a]:

Rank	System	SCI	Replacement Cost Estimate[b]
1.	Library Park - Irrig.Sys.	24.0	$ 310,000
2.	Rolland Moore Park - Irrig.Sys.	22.4	$ 3,200,000
3.	City Park - Irrig.Sys.	19.1	$ 4,250,000
4.	Freedom Square Park - Irrig.Sys.	18.0	$ 23,000
5.	Washington Park - Irrig.Sys.	18.0	$ 225,000

Top ranking systems typically show consistent performance deficits over most economic, social, and ecological aspects under investigation. The top ranked Community Parks form an exception: Their Maintenance Cost is relatively low and poor performance in other aspects let them flow to the top.

The DST results become more meaningful through answering following questions:

- What forms the basis for the analysis?
  - How is analysis input data structured, what information is available and what is its source?
  - What are other framework conditions for the analysis (Settings, Assumptions and Limitations)?
- What is the reference scale for each Performance Indicator (PI) and the SCI?

For the interested reader, the appendix includes additional information for each of these aspects. Section F describes the framework conditions for the analysis and covers the DST configuration and the dataset that is in place for the 2018 analysis process. The statistical Performance Indicator (PI) analysis in section F.3 provides a valuable context for the interpretation of individual system results.

To document the full analysis process, the appendix contains a section that presents the performance indicator analysis at the 1st analysis level (Section F.4).

[a] A third level analysis entails studying each system and its surrounding environment in detail. This phase also includes the alignment of infrastructure investment decisions with strategic park planning and other plan/program objectives. This lies outside the scope of the DST and this analysis.
[b] Replacement Cost Estimates are the product of 2018 construction unit cost of $ 2 per ft^2 and irrigated acreages. Pump station updates are not included. The estimates include hard and soft cost.

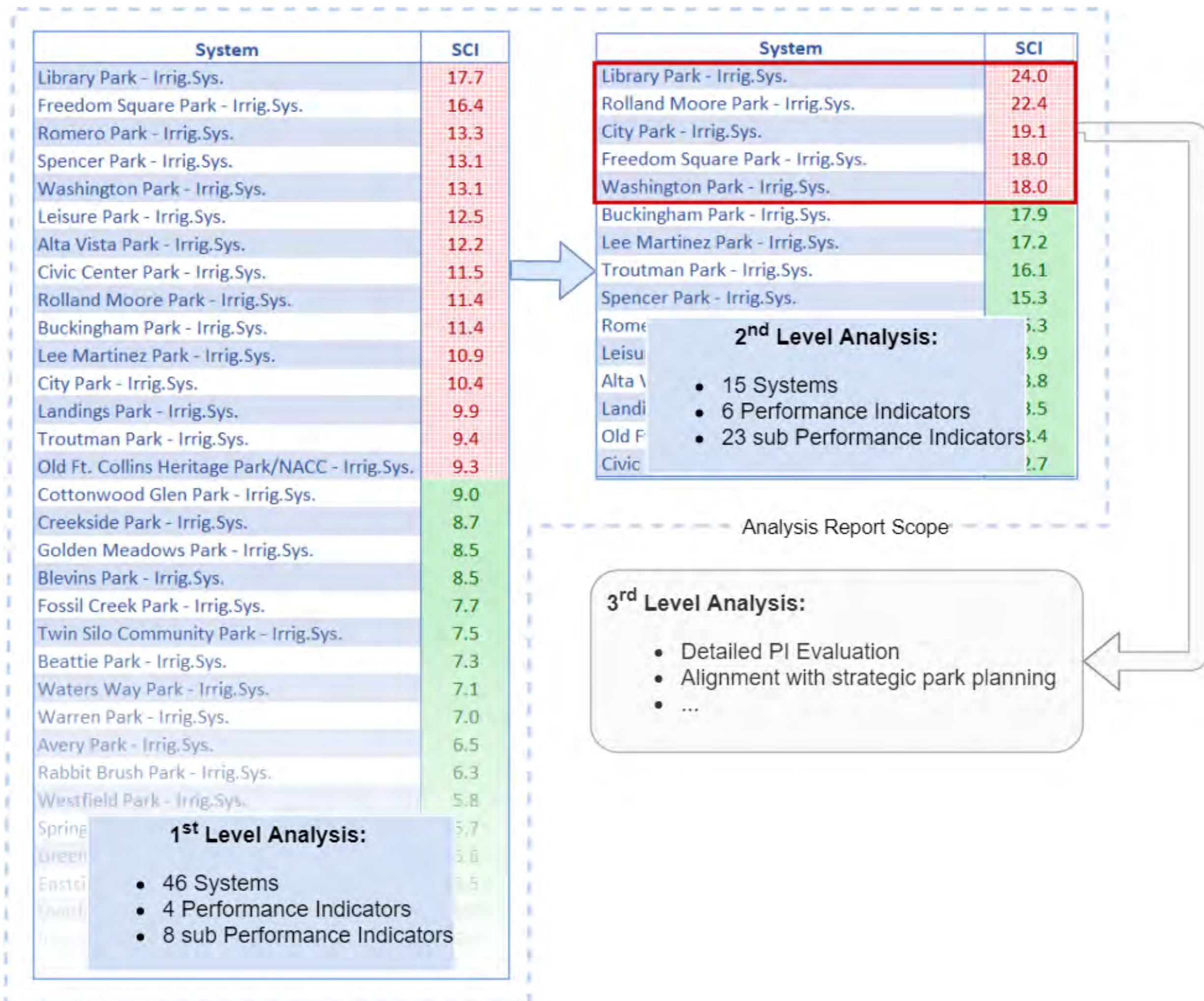


FIGURE 1: THE DST ANALYSIS PROCESS AND RESULTS

B Analysis and Results

This section presents the results of the 2nd level system assessment and with that, the main outcome of this analysis. It provides a brief overall description of the PIs and the ranking table at this decision process stage. Subsequent explanations cover the top ranking/poorest performing systems. Exceptionally high or low PI-Values and potential input data inadequacies are laid out in detail.

Since this analysis focuses solely on irrigation systems, the report uses park names as synonyms for irrigation infrastructure. The term "system" is used interchangeably with "irrigation system".

B.1 Performance Indicator Analysis

The 1st level analysis is comprised of the following Performance Indicators:

- Maintenance Cost
- Age – System
  - Age - Mainline
  - Age - Controller
  - Age - RCV's
  - Age - Control Wire
- Relative Water Use
- System Safety
  - Auto-Shutdown Working
  - Overspray
  - Excessive Mainline Depth
  - Old Griswold RCV's

The following table provides a reference for these indicators. The PI statistics are based on all 46 Systems. Please refer to section F.3 for additional information about PI-Score statistics.

TABLE 1: PERFORMANCE INDICATOR REFERENCE VALUES (1ST LEVEL PI STATISTICS)

Performance Indicator	Good Performance	Average Performance	Poor Performance
Maintenance Cost	0.2	1.2	1.8
Age - System	0.5	2.4	4.7
Relative Water Use	0.3	1.9	3.2
System Safety	1.5	2.3	3.1

The 2nd level analysis focuses on following three PIs and their respective sub-PIs:

- System Integrity
  - Integrity - Mainline Split
  - Integrity - Fittings
  - Integrity - Joint Failure
  - Integrity - Gaskets
  - Integrity - Low Voltage Wiring
  - Integrity - Operations
  - Integrity - RCV's
- Plant Material
  - Plants Lost
  - Stressed Turf
  - Hand Watering
- BMP's and City Standards
  - Watering Window
  - Controller to Standard
  - Water Rental
  - Hydrozones
  - Flow Monitoring

Table 2 below provides a reference for all indicators at this level. It shows what scores indicate a good, average and poor performance. Please refer to section F.3 for additional details about PI-Score statistics:

TABLE 2: PERFORMANCE INDICATOR REFERENCE VALUES (2ND LEVEL PI STATISTICS)

Performance Indicator	Good Performance	Average Performance	Poor Performance
Maintenance Cost	0.9	2.1	3.0
Age - System	3.5	4.3	5.3
Relative Water Use	1.6	3.2	4.7
System Safety	2.0	2.5	3.0
System Integrity	0.8	2.0	3.2
Plant Material	0.0	1.4	3.5
BMP's and City Standards	0.8	1.1	1.2

Note that the PI-Score statistics are different between Table 1 and Table 2. The reason is that Table 1 samples all 46 systems, and Table 2 uses only the systems whose SCI is above the 2nd level threshold. Good or poor performance is therefore relative to the sample (i.e. analysis level dependent).

B.2 Ranking table results

Table 3 shows the 1st level PI and sub-PI-Scores for each of the 15 systems whose SCI is greater than the 2nd level threshold (see F.2.1.2 SCI Thresholds):

TABLE 3: 1ST LEVEL ANALYSIS RANKING TABLE OF SYSTEMS WITH AN SCI GREATER THAN THE 2ND LEVEL THRESHOLD

System	Location Type	Irrigated Area [ac.]	Maintenance Cost	Age - System	Age - Mainline	Age - Controller	Age - RCV's	Age - Control Wire	Relative Water Use	System Safety	Auto-Shutdown	Overspray	Excessive Mainline Depth	Old Griswold RCV's	SCI
Library Park - Irrig.Sys.	Neighborhood Park	3.59	4.0	4.7	0.4	0.0	0.2	0.2	5.0	4.0	0.4	0.3	0.0	0.1	17.7
Freedom Square Park - Irrig.Sys	Mini Park	0.26	3.0	6.4	0.4	0.1	0.2	0.2	3.4	3.5	0.4	0.3	0.0	0.0	16.4
Romero Park - Irrig.Sys.	Mini Park	0.14	3.0	5.3	0.3	0.1	0.2	0.2	2.5	2.5	0.4	0.0	0.0	0.1	13.3
Spencer Park - Irrig.Sys.	Mini Park	0.47	2.8	5.3	0.3	0.1	0.2	0.2	3.1	2.0	0.4	0.0	0.0	0.0	13.1
Washington Park - Irrig.Sys.	Mini Park	2.56	0.9	5.1	0.3	0.0	0.2	0.2	5.0	2.0	0.4	0.0	0.0	0.0	13.1
Leisure Park - Irrig.Sys.	Mini Park	0.56	2.6	4.7	0.3	0.1	0.2	0.1	1.3	4.0	0.4	0.3	0.0	0.1	12.5
Alta Vista Park - Irrig.Sys.	Mini Park	0.33	2.9	5.5	0.4	0.0	0.2	0.2	1.3	2.5	0.4	0.0	0.0	0.1	12.2
Civic Center Park - Irrig.Sys.	Community Park	1.25	4.0	0.5	0.0	0.0	0.1	0.0	5.0	2.0	0.4	0.0	0.0	0.0	11.5
Rolland Moore Park - Irrig.Sys.	Community Park	40.44	0.8	3.6	0.3	0.0	0.1	0.2	4.1	3.0	0.0	0.3	0.2	0.1	11.4
Buckingham Park - Irrig.Sys.	Neighborhood Park	3.28	2.3	5.1	0.5	0.0	0.2	0.2	2.5	1.5	0.0	0.3	0.0	0.0	11.4
Lee Martinez Park - Irrig.Sys.	Community Park	15.82	1.6	4.8	0.4	0.0	0.1	0.2	1.6	3.0	0.0	0.3	0.2	0.1	10.9
City Park - Irrig.Sys.	Community Park	48.98	0.1	5.7	0.5	0.0	0.2	0.3	1.6	3.0	0.0	0.3	0.2	0.1	10.4
Landings Park - Irrig.Sys.	Neighborhood Park	7.1	1.6	3.5	0.2	0.1	0.2	0.1	2.8	2.0	0.4	0.0	0.0	0.0	9.9
Troutman Park - Irrig.Sys.	Neighborhood Park	17.42	0.0	3.2	0.2	0.0	0.2	0.1	4.7	1.5	0.0	0.3	0.0	0.0	9.4
Old Ft. Collins Heritage Park/N/	Neighborhood Park	4.9	2.6	1.5	0.2	0.0	0.0	0.1	3.8	1.5	0.0	0.3	0.0	0.0	9.3

1st level analysis outcomes are an integral part of the 2nd level ranking, since the SCI is always the sum of all PI's at a given level. Thus, the following sections also present these four PIs. Section F.4 and corresponding Tables provide a more detailed presentation and analysis of the 1st level analysis scores.

As a result of considering the three additional 2nd level PIs, the system ranking and SCI values are different between Table 3 and Table 4 and Figure 2 below.

Irrigation systems in the 2nd level analysis have a SCI between 12.7 and 24.0 points. Table 4 lists the 2nd level analysis results for all 15 systems. Figure 2 shows all 2nd level system results as well. It depicts the total SCI and the distribution and variability of contributing PI's for each system:

TABLE 4: 2ND LEVEL ANALYSIS RANKING TABLE (PIS ONLY)

System	Location Type	Irrigated Area [ac.]	Maintenance Cost	Age - System	Relative Water Use	System Safety	System Integrity	Plant Material	BMP's and City Standards	SCI
Library Park - Irrig.Sys.	Neighborhood Park	3.59	4.0	4.7	5.0	4.0	3.6	1.5	1.2	24.0
Rolland Moore Park - Irrig.Sys.	Community Park	40.44	0.8	3.6	4.1	3.0	4.8	5.0	1.2	22.4
City Park - Irrig.Sys.	Community Park	48.98	0.1	5.7	1.6	3.0	3.2	3.5	2.0	19.1
Freedom Square Park - Irrig.Sys.	Mini Park	0.26	3.0	6.4	3.4	3.5	0.4	0.0	1.2	18.0
Washington Park - Irrig.Sys.	Mini Park	2.56	0.9	5.1	5.0	2.0	2.2	1.5	1.2	18.0
Buckingham Park - Irrig.Sys.	Neighborhood Park	3.28	2.3	5.1	2.5	1.5	4.2	1.5	0.8	17.9
Lee Martinez Park - Irrig.Sys.	Community Park	15.82	1.6	4.8	1.6	3.0	0.4	3.5	2.4	17.2
Troutman Park - Irrig.Sys.	Neighborhood Park	17.42	0.0	3.2	4.7	1.5	2.0	3.5	1.2	16.1
Spencer Park - Irrig.Sys.	Mini Park	0.47	2.8	5.3	3.1	2.0	1.0	0.0	1.2	15.3
Romero Park - Irrig.Sys.	Mini Park	0.14	3.0	5.3	2.5	2.5	0.8	0.0	1.2	15.3
Leisure Park - Irrig.Sys.	Mini Park	0.56	2.6	4.7	1.3	4.0	1.0	0.0	0.4	13.9
Alta Vista Park - Irrig.Sys.	Mini Park	0.33	2.9	5.5	1.3	2.5	0.4	0.0	1.2	13.8
Landings Park - Irrig.Sys.	Neighborhood Park	7.1	1.6	3.5	2.8	2.0	3.2	0.0	0.4	13.5
Old Fort Collins Heritage Park - Irrig.S	Neighborhood Park	4.9	2.6	1.5	3.8	1.5	1.4	1.5	1.2	13.4
Civic Center Park - Irrig.Sys.	Community Park	1.25	4.0	0.5	5.0	2.0	0.8	0.0	0.4	12.7

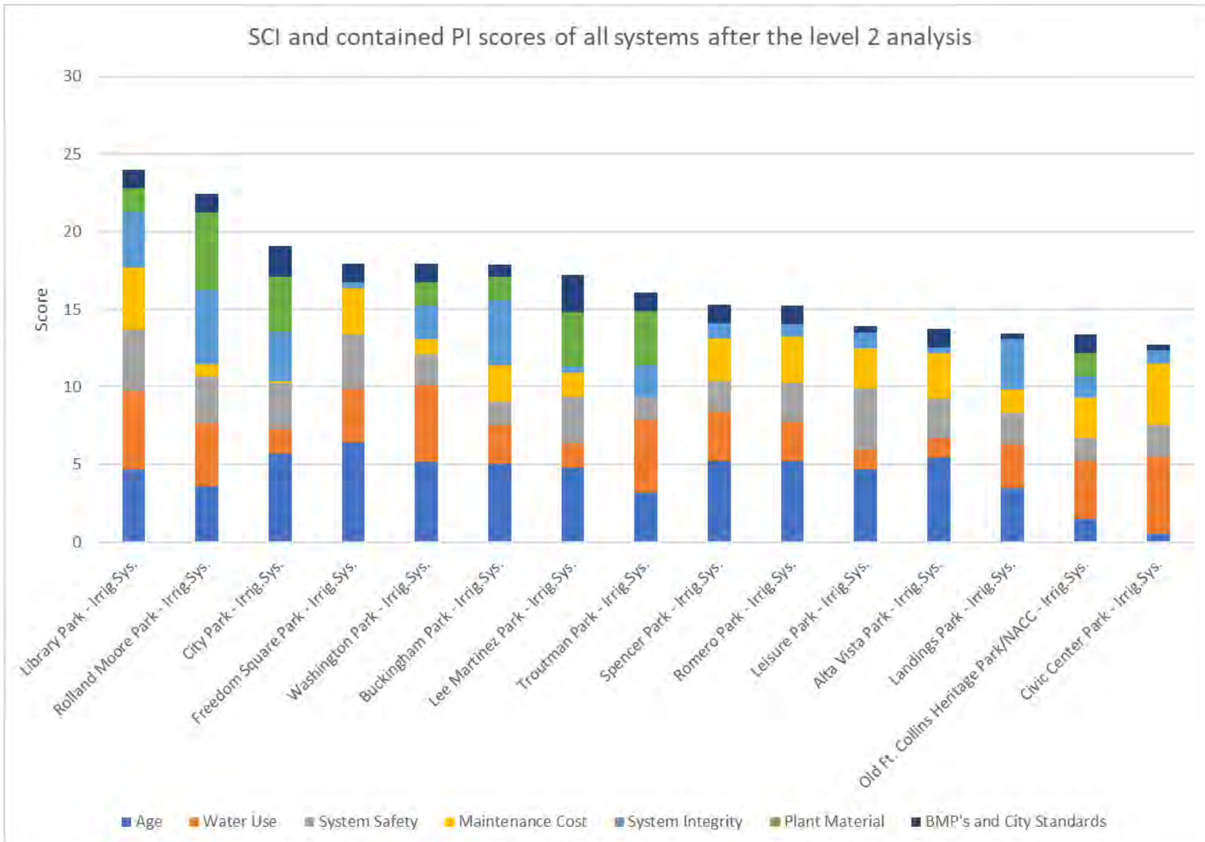


FIGURE 2: LEVEL 2 ANALYSIS RESULTS: SCI AND COMPRISING PI-SCORES (DISTRIBUTION/VARIABILITY) FOR EACH SYSTEM.

The SCI threshold value for the third level analysis is 17.92 points. A 3rd level analysis is recommended for following five systems.

1.	Library Park - Irrig.Sys.	24.0
2.	Rolland Moore Park - Irrig.Sys.	22.4
3.	City Park - Irrig.Sys.	19.1
4.	Freedom Square Park - Irrig.Sys.	18.0
5.	Washington Park - Irrig.Sys.	18.0

B.2.1.1 Top 5 (unfiltered)

At the 1st analysis level, four out of the top five systems are Mini Parks. At the 2nd level, due to adding three more PIs, more Community and Neighborhood Parks float to the top of the ranking. The SCIs of Rolland Moore and City Park increase because of System Integrity and Plant Material scores.

TABLE 5: LEVEL 2 SYSTEM RANKING OF THE FIVE HIGHEST SCI (LOWER IS BETTER)

System	Location Type	Irrigated Area [ac.]	Maintenance Cost	Age - System	Relative Water Use	System Safety	System Integrity	Plant Material	BMP's and City Standards	SCI
Library Park - Irrig.Sys.	Neighborhood Park	3.59	4.0	4.7	5.0	4.0	3.6	1.5	1.2	24.0
Rolland Moore Park - Irrig.Sys.	Community Park	40.44	0.8	3.6	4.1	3.0	4.8	5.0	1.2	22.4
City Park - Irrig.Sys.	Community Park	48.98	0.1	5.7	1.6	3.0	3.2	3.5	2.0	19.1
Freedom Square Park - Irrig.Sys.	Mini Park	0.26	3.0	6.4	3.4	3.5	0.4	0.0	1.2	18.0
Washington Park - Irrig.Sys.	Mini Park	2.56	0.9	5.1	5.0	2.0	2.2	1.5	1.2	18.0

For these five parks, the findings can be summarized as follows:

Library Park: This system shows average to poor performance at most performance indicators. Maintenance Cost, Water Use, System Safety, and System Integrity are PIs where this system performs worse than most other systems. The plant material does not indicate a failing irrigation system, however, stressed turf was reported in 2018 despite the high water use.

Rolland More Park: While this system has rather low maintenance cost, its physical integrity is exceptionally poor. Failures occurred across all component types in 2018. Stressed turf, dying plant material, and the need for hand watering may be a direct result of failing infrastructure.

City Park: This system shows the lowest maintenance cost at this analysis level. Its relative water use is low as well. This, on the other hand, may be the reason for poor turf appearance and the need for hand watering. Many system components are 52 years old, however, two new controllers lower the Age -score from a straight 6 (the maximum achievable age score for community parks) to 5.7 points.

Freedom Square Park: Old system components and system safety are the main contributors to the high rank of this system. While the system integrity seems to be good, it should be noted that this score is based on only one year of data. While no major component breakdowns occurred in 2018, a high risk of failure stands to reason as many components are beyond their typical useful life. The poor System Safety performance is a consequence of missing automatic shutdown capabilities and a sprinkler layout that overspray's hardscapes.
With respect to Plant Material, no poorly performing indicators were reported in the 2018 data collection. It is plausible that no plants died, and hand watering was not required, since Freedom Square Park has a simple vegetation layout, no apparent drip zones, and established trees. However, assessment of stressed turf is a subjective matter and reevaluating this indicator is recommended.

Washington Park: This Mini Park system has a high Age and Water Use score and shows unusually low maintenance cost. Despite the high water use score, stressed turf was reported in 2018.

B.2.1.2 Comparing Apples with Apples

Table 6 below shows that only Rolland Moore and City Park add to their SCI through the Water Rental sub-PI. This indicator's input variable are expenses that are related to raw water ownership. Systems with a potable water source cannot have raw water rental scores. One option to level the playing field is to disable this sub-PI. Table 7 below shows the Ranking Table results after this adjustment.

TABLE 6: TOP FIVE SCI SCORES AND THEIR CONSTITUTING 2ND LEVEL PIS AND SUB-PIS.

System	System Integrity	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Plant Material	Plants Lost	Stressed Turf	Hand Watering	BMP's and City Standards	Watering Window	Controller to Standard	Water Rental	Hydrozones	Flow Monitoring	SCI
Library Park - Irrig.Sys.	**3.6**	0.3	0.2	0.0	0.0	0.1	0.1	0.3	**1.5**	0.0	0.3	0.0	**1.2**	0.0	0.0	0.0	0.2	0.1	24.0
Rolland Moore Park - Irrig.Sys.	**4.8**	0.3	0.2	0.2	0.2	0.1	0.1	0.3	**5.0**	0.3	0.3	0.4	**1.2**	0.0	0.0	0.3	0.0	0.0	22.4
City Park - Irrig.Sys.	**3.2**	0.3	0.2	0.2	0.0	0.1	0.0	0.1	**3.5**	0.0	0.3	0.4	**2.0**	0.0	0.0	0.3	0.2	0.0	19.1
Freedom Square Park - Irrig.Sys	**0.4**	0.0	0.0	0.0	0.0	0.0	0.0	0.1	**0.0**	0.0	0.0	0.0	**1.2**	0.0	0.0	0.0	0.2	0.1	18.0
Washington Park - Irrig.Sys.	**2.2**	0.3	0.0	0.0	0.0	0.1	0.1	0.1	**1.5**	0.0	0.3	0.0	**1.2**	0.0	0.0	0.0	0.2	0.1	18.0

The City Park's BMP's and City Standards PI-Score drops from 2.0 to 0.8 points. With a total SCI of 17.9 points the system is on par with Buckingham Park. See Table 7 below.

TABLE 7: SECOND LEVEL RANKING TABLE WITH PIS AND SUB-PIS. DISABLED (RAW) WATER RENTAL SUB-PI.

System	System Integrity	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Plant Material	Plants Lost	Stressed Turf	Hand Watering	BMP's and City Standards	Watering Window	Controller to Standard	Water Rental	Hydrozones	Flow Monitoring	SCI
Library Park - Irrig.Sys.	**3.6**	0.3	0.2	0.0	0.0	0.1	0.1	0.3	**1.5**	0.0	0.3	0.0	**1.2**	0.0	0.0	0.0	0.2	0.1	24.0
Rolland Moore Park - Irrig.Sys.	**4.8**	0.3	0.2	0.2	0.2	0.1	0.1	0.3	**5.0**	0.3	0.3	0.4	**1.2**	0.0	0.0	0.0	0.0	0.0	22.4
Freedom Square Park - Irrig.Sys.	**0.4**	0.0	0.0	0.0	0.0	0.0	0.0	0.1	**0.0**	0.0	0.0	0.0	**1.2**	0.0	0.0	0.0	0.2	0.1	18.0
Washington Park - Irrig.Sys.	**2.2**	0.3	0.0	0.0	0.0	0.1	0.1	0.1	**1.5**	0.0	0.3	0.0	**1.2**	0.0	0.0	0.0	0.2	0.1	18.0
Buckingham Park - Irrig.Sys.	**4.2**	0.3	0.2	0.2	0.0	0.1	0.1	0.3	**1.5**	0.0	0.3	0.0	**0.8**	0.0	0.0	0.0	0.2	0.0	17.9
City Park - Irrig.Sys.	**3.2**	0.3	0.2	0.2	0.0	0.1	0.0	0.1	**3.5**	0.0	0.3	0.4	**0.8**	0.0	0.0	0.0	0.2	0.0	17.9

It is prudent to conduct a similar volatility analysis with other performance indicators. For example, assume one park has a simple layout, large continuous turf areas, only few shrub beds, and all the park's trees are well established. The likelihood of plant's dying due to a failing irrigation system is much lower compared to a second park that has a complex landscaping layout and many drip or hydro zones. One failing zone, especially with only one year of data, does not necessarily indicate that the latter system is in worse shape than the first example. It is advisable to review, validate, and continue the collection of user data input for such systems.

B.2.2 Observations

The interaction between different PIs sometimes does not follow intuitive or logical rules. For example, one would expect that Plant Material scores are low, when the relative water use is high. When this is not the case, water application must be highly inefficient or breaks and irrigation system downtimes result in the loss of plants. Therefore, it seems advisable to focus 3rd level investigations on systems where performance indicators score high, while other performance indicators show counterintuitive behavior.

For example, one would expect a correlation between maintenance expenses and other system performance indicators. However, both top ranking community parks reported low irrigation maintenance expenses but also indicated hand watering certain plants or areas. It is important to note that, while irrigation system related maintenance cost may be low, replacing dead plants and the need for hand watering adds cost to other programs.

Part of any analysis is the validation of input data and PI-Score calculations. As exceptionally high or low values may indicate erroneous data, these PIs are a good starting point for investigations. For example, Washington Park's per acre maintenance expenses are low, especially for a Mini Park (see Statistical

Analysis). Expenses between $3,184 (2014) and $1,464- (2017) per acre are low, but don't indicate erroneous data.

The same holds true for Library Park: while it has the highest Maintenance Cost score of the top five systems, absolute expenses for this system are consistent over time and do not indicate erroneous data. Expenses vary between $4,782 and $5,511per acre for the years 2014 through 2017.

B.3 Further Information

As mentioned in the introduction, please refer to Sections F, F.3, and F.4 for a description of the analysis framework conditions, a statistical analysis of PI-Scores, and the 1st analysis level of the decision process, respectively. The interested reader will find information about irrigation system data management, the multiple criteria and multi-step decision analysis process, performance indicators, and the implementation of said elements in the two reference documents.

C References

1. Aqua Engineering, Inc. Irrigation System Planning Toolbox - Project Report. October 2019.

2. Aqua Engineering, Inc. Irrigation System Planning Toolbox - DST Documentation. October 2019.

D List of Figures

E List of Tables

F Appendix

F.1 Terminology and Acronyms

Below is a list of acronyms and terms that are important in the context of the Irrigation System Planning Toolbox.

Acronym or Term	Description
Decision Criteria	In decision theory, criteria values are the consequences of the decisions we make. In the context of the DST, performance indicators are the cause for a decision being more or less favorable. The terms describe the cause or the result of decisions and can be used interchangeable.
Decision Process	One of the tools of the Irrigation System Planning Toolbox. A flowchart that defines several processes and if-then statements to rank and filter investment alternatives.
DST	Decision Support Tool, in this context, it refers to the MS Excel based tool to calculate SCI's
FK	Foreign Key. A (often integer) database field used to reference parent table records.
GIS	Geographic Information System
Inventory	A data structure and its content that describes irrigation system infrastructure, and the infrastructure environment. The inventory forms the basis for system assessments.
MDCA	Multiple Criteria Decision Analysis
PI	Performance Indicator.
PI-Code	A code defined for each PI and sub-PI. It follows a distinct pattern that allows grouping sub-PIs.
PI-Function	A function that uses performance input variables and outputs a PI-Score.
PI-Label	A name tag for PIs
PI-Score	The score or numeric value for a specific PI and system.
PI-Weight	The importance that a PI has in the overall assessment of a system
PI-Variable	Input data for PI-Functions. Examples are system age, maintenance cost, or if the system has automatic shutdown capabilities.
PK	Primary Key. A (integer) database field with unique values used to identify table records.
RAMS	Resource Allocation Measurement System: A accounting database that the City of Fort Collins Parks department uses to track expenses and more.

***Ranking* Table**	The Ranking Table (found at the DST Ranking Analysis Worksheet) displays the result of the DST system analysis process. It lists all irrigation systems that are under investigation at the current analysis level and shows PI-scores and SCI's for each system.
SCI	System Condition Index. A calculated indicator that aims to describe the overall condition of an irrigation system.
System	In the context of this documentation, the term system refers to an irrigation system. It comprises the physical infrastructure required to irrigate landscaped areas.
UserForms	Documents used for data collection. To collect 2018 irrigation system (master and performance) data, an excel spreadsheet that allows user input has been developed.
***WaterUse* workbook**	*An* Excel workbook with a distinct layout used by the Parks Department to collect and store water consumption data.

F.2 Analysis Framework

This section provides additional context for the irrigation system analysis. Following aspects underline the importance of this section:

- Analysis outcomes are a direct result of:
  - Analysis Settings: Performance indicators and associated weights reflect the City of Fort Collins Parks Department's policies. As value systems and policies may change over time, documenting the status at the time of the analysis is part of a complete report.
  - Available Data: Analysis result calculations use several system definitions and PI input variables. Describing and documenting these inputs ensures repeatability of the analysis and the validity of its results.
- Initial Data Collection: In preparation of this analysis, most System Data have been defined, collected, and systematically stored for the first time. The following considerations are important:
  - In contrast to Performance Data (periodically collected), persistent Master Data not only affects the results of 2018 but also the results of any future analysis (see F.2.3.1).
  - Data collection shapes the result. By giving insights into the collection strategies, this report ensures a transparent decision process and repeatability.
  - Understanding the structure and extent of the DST Inventory, and the effect it has on the performance evaluation, allows detecting potentially erroneous data records. Please refer to the Individual System Reports in Appendix F.6 for comprehensive documentation of data associated with each system.

F.2.1 DST Settings

The appendix contains tables that list all PI-Weights and PI requirements for the 2018 analysis (see Table 22 and Table 23 respectively). The 2018 analysis ignores certain PIs that the DST implements. For example, while the tool can process maintenance costs for each component type separately (C_1.1 through C_1.4), limited data availability requires the 2018 analysis to lump all these costs into a single PI (C_1). These additional PIs may be useful in the future when the data is appropriately recorded and therefore the DST continues to implement them.

All settings tables in this report hide unused PIs.

The DST configuration marks pump station data to be relevant only at the third analysis level (see Table 23). This approach has several advantages:

- It ensures comparability between systems with and without pump stations.

- This approach prevents weak pump station performance to affect the results of irrigation systems. This is relevant since, especially at bigger systems, reinvestments in pump and irrigation infrastructure are in fact two separate decisions.
- Incorporating pump station data at a final step allows to investigate, if pump station failures are potential causes for other negative conditions of a system. Sudden pump station failures, for example, can be the cause for increased pipe and fitting failures.

F.2.1.1 PI-Weights

Three columns, one for each park type, are available in the weight settings table.:

TABLE 8: PI-WEIGHTS FOR EACH PARK TYPE (HIDDEN SUB-PI-WEIGHTS).

PI-Label	Performance Indicator	Community Park	Neighborhood Park	Mini Park
Pump Station	C_0	3.00	3.00	3.00
Maintenance Cost	C_1	4.00	4.00	3.00
Age - System	C_2	6.00	6.00	7.00
Relative Water Use	C_3	5.00	5.00	5.00
System Safety	C_4	5.00	5.00	5.00
System Integrity	C_5	4.00	4.00	4.00
Plant Material	C_6	5.00	5.00	5.00
BMP's and City Standards	C_7	4.00	4.00	4.00
O-Cost Power	C_8	1.00	1.00	1.00
O-Cost Water	C_9	3.00	3.00	3.00
	Total	**40.00**	**40.00**	**40.00**

One difference in the PI-Weights addresses the fact that maintenance costs are higher at Mini Parks for reasons that do not necessarily depend on the condition of irrigation systems (e.g. crew travel expenses are proportionally higher per acre). The Maintenance Cost weight is therefore lower at Mini Parks compared to other system types. Similarly, the System Integrity weight is higher for Mini Parks compared to other systems types. As Table 8 shows, the total sum of PI-Weights is the same (40) for each category. This allows to compare different park types in the same ranking.

F.2.1.2 SCI Thresholds

The DST-settings that control SCI thresholds between the three analysis levels are not static. The thresholds configuration dynamically highlights all SCI's in the third quartile of the SCI vector. This separates the top 33% of the systems for the next analysis level. Table 24 illustrates this threshold with the color schema of the result column.

F.2.2 Limitations

Following limitations of the current DST implementation are important to note:

- Equal-weighted consideration of the age of all component definition within one component type category.
- Shared components: the DST cannot represent shares of irrigation component (e.g. a pump station) that are part of multiple systems. This requires defining multiple instances of the same component, one for each system. While this introduces minor data management burdens, the requirement for consistent and correct cost allocation is a more significant issue.
  Failure to allocate expenses correctly can have various reasons, such as a simple lack of

information at the staff level, or the inability of the ERP system to track expenses correctly. This may result in over or underestimated significance of component shares.

F.2.3 Inventory Data and Collection Strategies

F.2.3.1 Data Types

Two additional documents, the Project Report and the DST Manual, explain the differences in data that is required for an analysis:

- **System Data**: All the information that describes the actual infrastructure under investigation.
  - **Master Data**: More persistent data that describes physical objects and that does not frequently change (e.g. System Components, Park Areas, etc.).
  - **Performance Data**: Time referenced data that provides information about the performance of irrigation systems. Performance Data (PI-Variables, see according sections in the Project Report[1(secB.4.2.2)]) is countable or categorizable.
- **Meta Data**: Information that aligns the DST and the DST Inventory with the infrastructure under investigation. (Examples are Component Types or Plant Materials).

Most Meta Data definitions result from the DST development process. Refer to the Project Report for additional information[1(secB.5)]. The DST Documentation, especially the sections under Inventory Table Types, also contains valuable information about the information the DST uses to assess the overall condition of irrigation systems[2(secD.5.2)].

F.2.3.2 2018 Inventory Data and Data Sources

F.2.3.2.1 META DATA TABLES

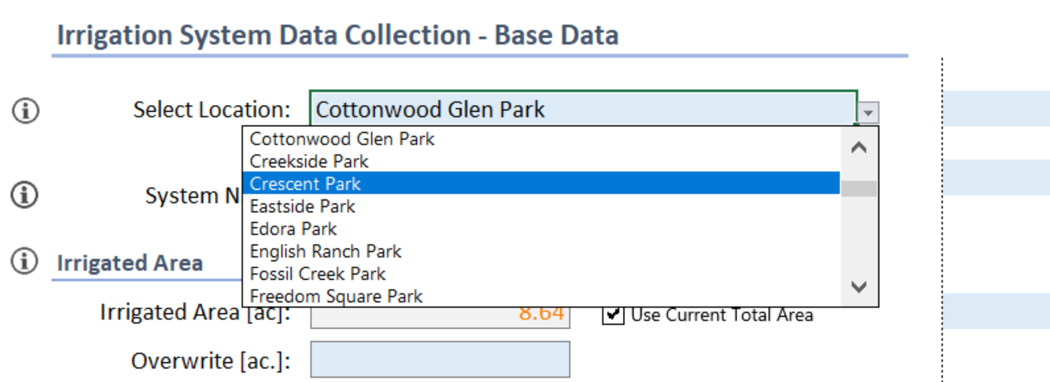
Please refer to corresponding sections in the DST Documentation [2(secD.5.2.1)] as well as in the project report[1(secsB2 and B4.2)] for information about these tables and their content. Tables 15 through 20 in the appendix document the record status for the 2018 analysis.

F.2.3.2.2 MASTER DATA TABLES

F.2.3.2.2.1 SYSTEM DATA

The following table explanations expand on the information in the Tool Documentation[2(secD.5.2.2)]:

- **Location**: 50 data records describe parks names and associated Area-Codes[3]. Each record references a LocationType. Not all Location records are referenced by a System as some parks have no irrigation system.
  Collection/Definition: The current set of records comes from a User Form field. Figure 3 shows the drop down field that contains all park label data from the department's ERP system.



[3] The term Area Code describes a subledger in the Department's RAMS structure.

FIGURE 3 USER FORM LOCATION DROP DOWN FIELD

- **System:** This table contains 46 irrigation system definitions at the time of writing this report. The fields define an irrigation system name and each record references a location.
  Collection/Definition: The import routine for User Forms automatically creates System records if no matching entry exists. Therefore, the origin of this data is the number of User Forms that where returned as part of the user generated data collection process. Figure 4 highlights the User Form check box that allows to name the irrigation system automatically. If checked, the resulting name is the concatenation of the Location name and the string "Irrig.-Sys".
- **Area:** This table contains 46 records at the time of writing this report. This corresponds with the system count, since no area differentiation that reflects hydro-zones exists.
  Collection/Definition: The current set of records comes from a User Form field. At the time of User Form distribution, this was pre-filled with data from the department's ERP system. Figure 4 highlights the area value populated to a form field after selecting a Location.

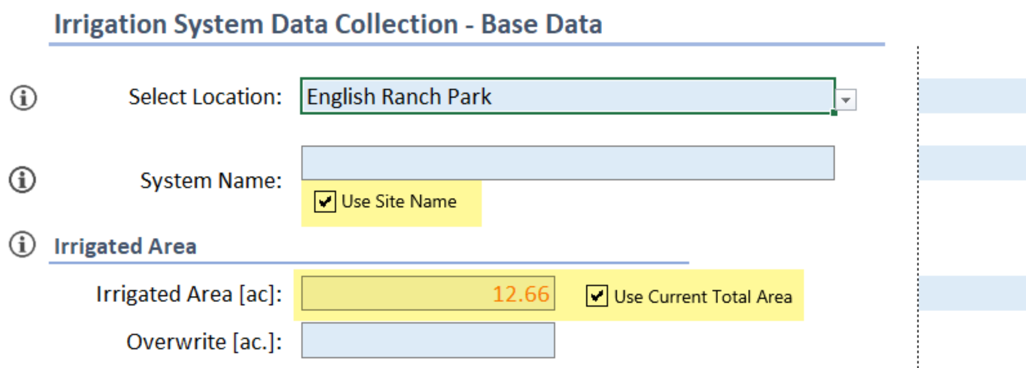


FIGURE 4 USER FORM SITE NAME AND ACREAGE DEFINITION

- **Component:** The table contains 276 component definitions at the time of writing this report. Each record represents pieces of one of the 46 irrigations systems. All pieces one record describes have similar properties such as the component type and age (e.g. All original remote control valves from 1994).
  Collection/Definition: These records are the result of the User Form data collection. User Forms allow to define up to 10 components and associated dates. Figure 5 shows the data collection table and the drop down field for selecting the component type. The yellow box in the top right corner indicates that data is missing. However, users seem to ignore this warning as several user form replies did not include age information.

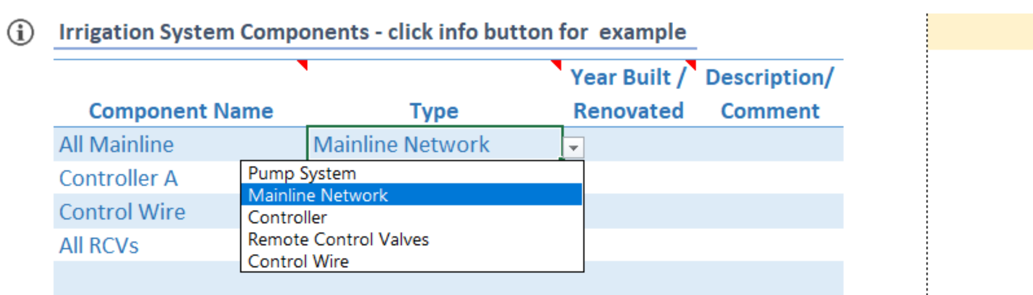


FIGURE 5 USER FORM COMPONENT DEFINITION TABLE

F.2.3.2.2.2 PERFORMANCE DATA

Following table explanations expand upon the information in the Tool Documentation[2(secD.5.2.3)]:

- **Performance:** This table contains records of both numeric and categorical (yes/no) PI-Variables [1(secB.4.2.2)]. At the time of writing this report, the table contains 2,264 records.
    - Water consumption data is available for the years 2014 through 2017.
    - Maintenance cost data is available for the years 2013 through 2017.
    - Specific expense data (see below) is available for the years 2013 through 2017.
    - Other performance data (i.e. most categorical PIs) is available for the year 2018.

  Collection/Definition: Performance data has several different sources. Most categorical data for the 2018 analysis is the result of the User Form data collection. Figure 11 shows an excerpt of the User Form that allows to enter data for the first and for the second level of analysis (Refer to the Project Report for additional information on the tiered analysis process).

  One categorical PI is the result of an RAMS data analysis: A RAMS table export lists all invoices with the subledger (or Program) code 1029 (Water Mngmt/Repair; see Section Table 5 of the Project Report). This table allows to identify if for a given year expenses occurred for the rental of additional ditch water (C_7.3 Water Rental). The invoice related RAMS export allows one to extract cost of electrical power and potable water as well.

  Other numeric PI-Variables are the result of analyzing either Water Use tables or additional RAMS exports. The DST Inventory manager features automated Water Use data extraction. Please refer to the corresponding sections in the DST Documentation for additional information. Maintenance cost data. A RAMS table export that lists annual sums of labor and non-labor cost forms the basis for Maintenance Cost related PIs. The tables include information on the Program and the Area for each record. This allows filtering for Irrigation System related expenses and allocation to the correct irrigation system record in the DST inventory.

- **Budget:** 166 budget records support the 2018 irrigation system analysis. The data covers the years 2014 through 2017.
  Collection/Definition: The DST Inventory manager gathers this data simultaneously to extracting water use data from Water use Spreadsheets. Please refer to the corresponding sections in the DST Documentation for additional information [2(secD.5.5.2)].

F.2.3.3 Data Quality

The PI definition carefully considers the availability of data or if it is possible to collect it[1(secB.4.2)]. Despite all these efforts, some improvements to irrigation system metering capabilities are necessary before a gapless data collection is possible for all systems. Following Table shows missing, inadequate, or data with a deviating source on an irrigation system level:

Table 9 Data Inconsistencies in the DST-Inventory for the 2018 System Analysis

Irrigation System	PI-Variable	Explanation
Crescent Park - Irrig.Sys.	Relative Water Use	Completion in 2018, data collection incomplete.
Eastside Park - Irrig.Sys.	Relative Water Use	Shared mainline with PSD, no own/separate meter.
Harmony Park - Irrig.Sys.	Relative Water Use	Shared mainline with PSD, multiple connections, no own/separate meter.
Romero Park - Irrig.Sys.	Age	Definitions include two RCV and two controller type components each. The User form only included age information for one controller and one RCV definition. The age of other components is assumed to be the same.

Stewart Case Park - Irrig.Sys.	Relative Water Use	Shared mainline with PSD, multiple connections, no own/separate meter.
Twin Silo Community Park - Irrig.Sys.	Relative Water Use	Completion in 2017; No 2017 Data available. 2018 Data used istead.
Twin Silo Community Park - Irrig.Sys.	Maintenance Cost	Data for years 2014 through 2017 exist. Not representative as irrigation system completed in 2017 only.

The analysis result presentation in this report considers these data inconsistencies and describes the possible impact on the assessment as good as possible.

F.2.3.4 Data Quantity

The DST design allows and aims to incorporate data from previous years (i.e. historical data) in the analysis (see PI-Functions[1(secB.4.2.3)]). Currently, only records for the year 2018 are available for most of the categorical PIs. This makes the resulting PI-Scores especially prone to data collection errors such as user misconception. It is therefore advisable to validate the input data for all systems that are relevant in the decision making process (i.e. the top 5 systems of the 2nd level analysis ranking table).

F.3 Statistical Analysis

The Ranking Table includes six PIs at the second analysis level. Four of them are based on a total of 23 sub-PIs. The table ranks 46 irrigation systems according to their SCI. Knowledge of statistical parameters that describe the distribution of PIs, sub-PIs, and SCIs helps with the interpretation of individual system results. Following sections present these parameters for each analysis level. Note that the 2nd level analysis is a sub-set of systems that performs particularly poor in the 1st analysis level. Consequently, most statistical parameters show higher values (e.g. the average PI-Score).

F.3.1 Level 1

The 46 SCI in Table 24 vary significantly and take values between 1 and 17.6. Figure 6 categorizes the systems by their SCI value into five bins. The histogram bars represent the count of irrigation systems within each bin. The positively skewed SCI indicates that a majority of the systems are in relatively good condition.

Figure 7 visualizes several statistical parameters for the SCI of Mini, Neighborhood, and Community Parks. For Neighborhood parks it shows an average SCI of 6.1 and a median of 5.2 points (The chart shows averages as crosses and medians as horizontal lines within the box). While 50 percent of Neighborhood park systems have an SCI between 4.3 and 7.8 (Box and Whisker charts show the lower and upper quartile as the lower and upper boundary of the box), the diagram shows one outlier with 17.6 points.

Neither Mini Park nor Community Park system SCI's show any outliers and all systems lie within 4.5 to 16.0 and 4.5 to 13.3 points respectively (whisker ends represent lowest and highest observations).

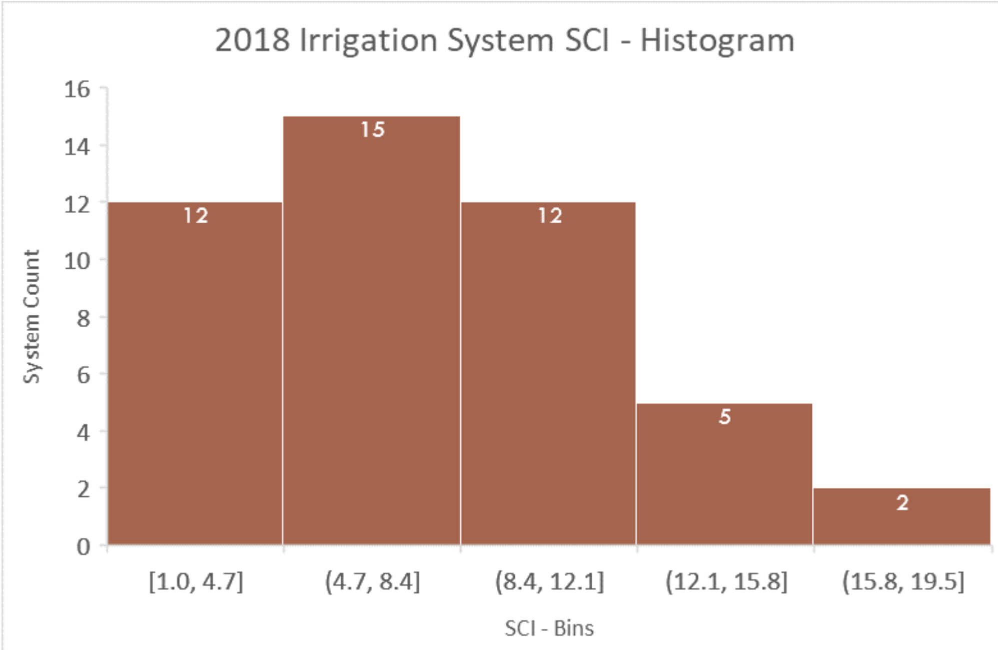


FIGURE 6 HISTOGRAM OF 1ST LEVEL SCI RESULTS

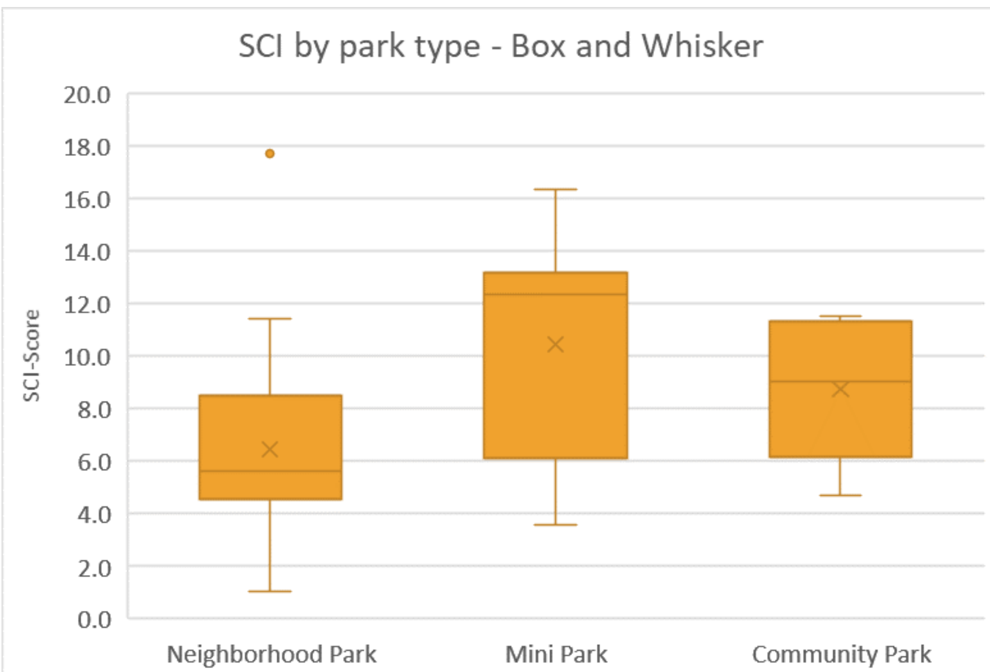


FIGURE 7 SCI BOX AND WHISKER CHART BY PARK TYPE

F.3.1.1 Largest drivers for SCI

Table 10 lists the average (and median) PI-Score for each level 1 PI. Figure 8 visualizes this information and shows that on average the PIs System Safety and Age contribute more to an Irrigation system's high score than the other PIs at this level. This is especially meaningful for System Safety, as this PIs Weight is at the same level or only slightly higher than other weights.

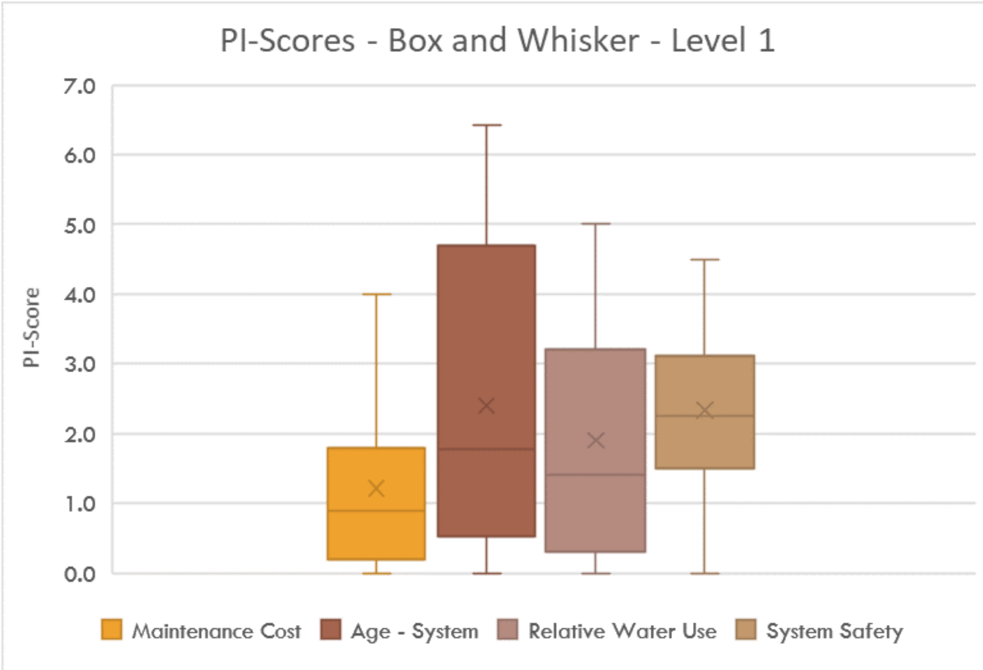


FIGURE 8 PI-SCORE STATISTICS AT ANALYSIS LEVEL 1 (BOX AND WHISKER PLOT)

TABLE 10 SCORE STATISTICS FOR 1ST LEVEL PERFORMANCE INDICATORS. PI-WEIGHTS IN BRACKETS REFER TO MINI-PARK SYSTEMS.

PI	PI-Code	PI-Weight	Level	Average Score	Median Score	Total Score	Max Score	Min Score
Maintenance Cost	C_1	4 (3)	I	1.2	0.9	56.2	4.0	0.0
Age - System	C_2	6 (7)	I	2.4	1.8	110.7	6.4	0.0
Relative Water Use	C_3	5	I	1.9	1.4	80.1	5.0	0.0
System Safety	C_4	5	I	2.3	2.3	107.5	4.5	0.0

Without distinguishing between park types (or acreages), System Age and System Safety contribute most to the SCI (PI-Score sum: 110.7 and 107.5 points respectively). Maintenance Cost and Relative Water use contribute significantly lower amounts, with a total sum of 56.2 and 80.7 each. Note that the variability is significantly different for each PIs as Figure 8 show. Most Systems have similar Maintenance cost and System Safety values whereas the distribution of Age and Relative Water Use values is much broader.

Figure 9 provides additional insights: Mini Parks consistently show the highest PI-Score average and median, except for C_3, where Community Parks have higher values. Neighborhood Parks perform (statistically) best in all fields, from Maintenance Cost to System Safety.

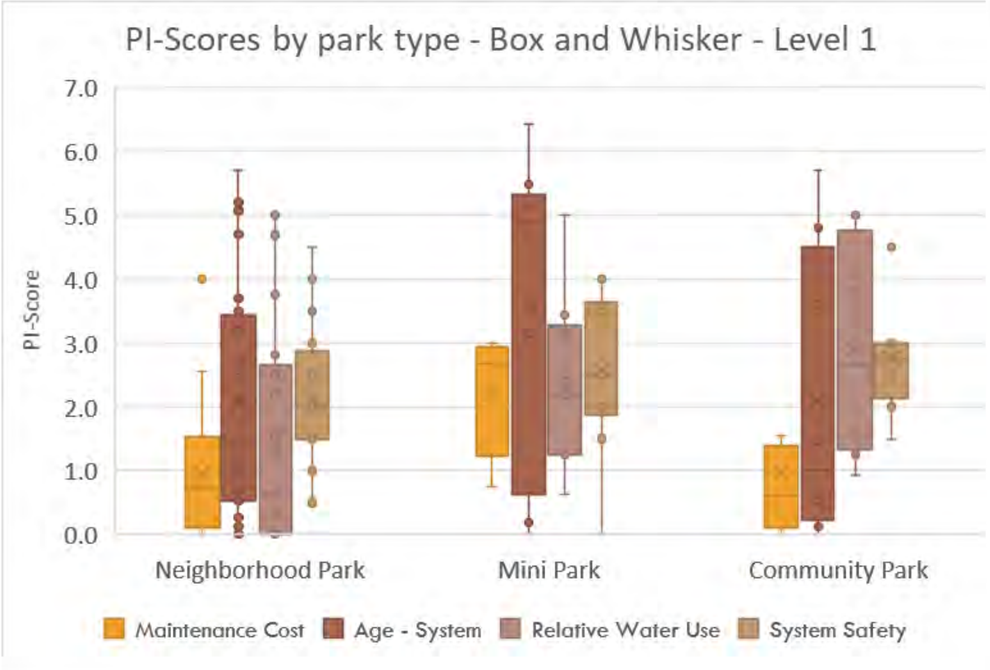


FIGURE 9 PI-SCORE BOX AND WHISKER DIAGRAM BY PARK TYPE

Within sub Performance Indicators, mainline and remote control valve ages contribute most to the SCI's. Overspraying onto hardscapes is the main reason for a high System Safety PI (see Table 11). Please note that the shares of each PI (Age-System and System Safety) sum up to 100% each.

TABLE 11 CONTRIBUTION OF SUB PERFORMANCE INDICATORS TO PI-SCORES

sPI	sPI-Code	PI-Score Sum	Contribution to PI
Age - Mainline	C_2.1	4.2	33%
Age - Controller	C_2.2	1.5	12%
Age - RCV's	C_2.3	4.4	35%
Age - Control Wire	C_2.4	2.4	19%
Auto-Shutdown Working	C_4.1	7.2	34%
Overspray	C_4.2	9.9	47%
Excessive Mainline Depth	C_4.3	2.8	13%
Old Griswold RCV's	C_4.4	1.3	6%

F.3.2 Level 2

The sample size at the second analysis level is 15 systems. Splitting this small sampling size into the three park types will introduce highly uncertain results and is therefore omitted. However, looking at the statistical parameters for PI-Scores in general, provides a good benchmark for each indicator.

While the median Maintenance Cost score increased from 0.9 to 2.6 points, there is at least one system that performs well in this category. Figure 10 shows that System Safety scores are no longer contributing as much as the Age factor at this analysis level (compare Figure 8).

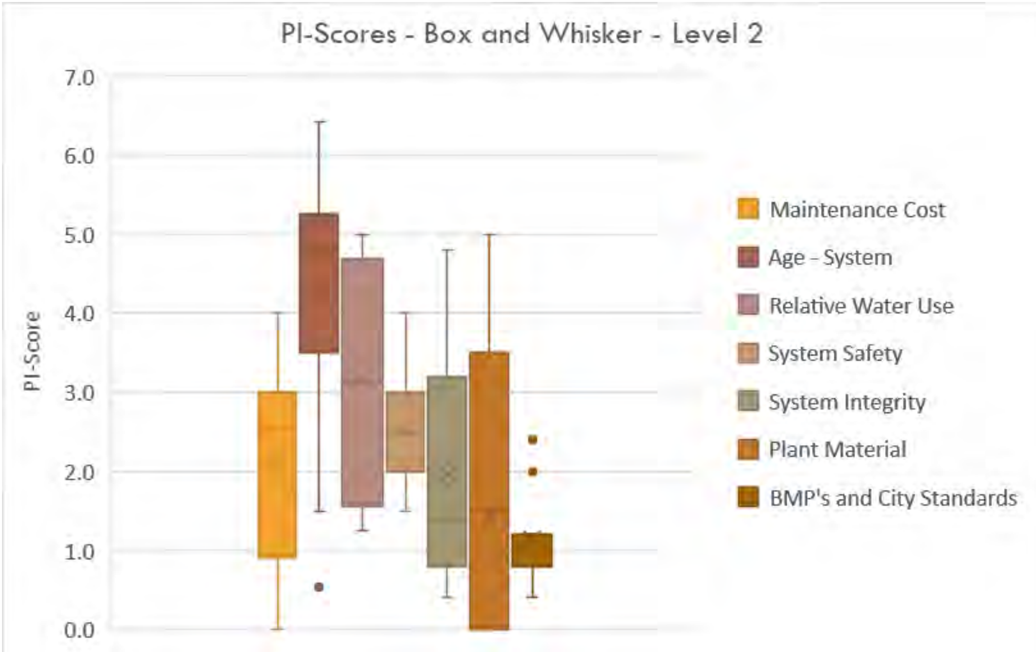


FIGURE 10 PI-SCORE STATISTICS AT ANALYSIS LEVEL 2 (BOX AND WHISKER PLOT)

From all second level PIs, System Integrity contributes the most to the total SCI. Note that this is true despite its weight being lower than the one for Plant Material (see Table 12 below). However, its low median indicates, that frequent breaks across all system components are an isolated issue and not common for all irrigation systems.

TABLE 12 SCORE STATISTICS FOR 1ST AND 2ND LEVEL PERFORMANCE INDICATORS. PI-WEIGHTS IN BRACKETS REFER TO MINI-PARK SYSTEMS.

PI	PI-Code	PI-Weight	Level	Average Score	Median Score	Total Score	Max Score	Min Score
Maintenance Cost	C_1	4 (3)	I	2.1	2.6	32.1	4.0	0.0
Age - System	C_2	6 (7)	I	4.3	4.8	64.8	6.4	0.5
Relative Water Use	C_3	5	I	3.2	3.1	47.5	5.0	1.3
System Safety	C_4	5	I	2.5	2.5	38.0	4.0	1.5
System Integrity	C_5	4	II	2.0	1.4	29.4	4.8	0.4
Plant Material	C_6	5	II	1.4	1.5	21.5	5.0	0.0
BMP's and City Standards	C_7	4	II	1.1	1.2	17.2	2.4	0.4

F.4 1st Level Analysis

The first level of the analysis process involves the following Performance Indicators. Two of the PIs are the result of four sub-Performance Indicators each:

- C_1: Maintenance Cost
- C_2: Age – System
  - C_2.1: Age - Mainline
  - C_2.2: Age - Controller
  - C_2.3: Age - RCV's
  - C_2.4: Age - Control Wire
- C_3: Relative Water Use
- C_4: System Safety
  - C_4.1: Auto-Shutdown Working
  - C_4.2: Overspray
  - C_4.3: Excessive Mainline Depth
  - C_4.4: Old Griswold RCV's

Following chapters look at individual irrigation systems and analyses their PI-Scores in more detail. Table 1 provides a reference framework for these PIs.

F.4.1 Ranking Table Results Level I

Table 24 lists Ranking Table results for the 1st level analysis. The table contains 46 irrigation systems with a SCI between 1 and 17.6. The SCI-threshold (see F.2.1.2) is 9.07 and 15 systems (33%) are marked for the next analysis level. Of these 15 systems, six are Mini Parks. Most of the top 15 Systems irrigate up to a few acres, but four systems irrigate community and neighborhood parks with more than 15 acres.

F.4.1.1 Top 5, Bottom 5 (unfiltered)

This section looks at the systems with the five highest SCI's in more detail. Most PI-Scores Table 13 shows are elevated, but there are a few exceptions: Maintenance Cost is at the PIs median value of 0.9 for Washington park. Beyond that, only System Safety of Spencer and Washington park are below the median value of this PI.

TABLE 13 1ST LEVEL ANALYSIS SYSTEM RANKING OF THE FIVE HIGHEST SCI (LOWER IS BETTER)

System	Location Type	Irrigated Area [ac.]	Maintenance Cost	Age - System	Relative Water Use	System Safety	SCI
Library Park - Irrig.Sys.	Neighborhood Park	3.59	4.0	4.7	5.0	4.0	17.7
Freedom Square Park - Irrig.Sys.	Mini Park	0.26	3.0	6.4	3.4	3.5	16.4
Romero Park - Irrig.Sys.	Mini Park	0.14	3.0	5.3	2.5	2.5	13.3
Spencer Park - Irrig.Sys.	Mini Park	0.47	2.8	5.3	3.1	2.0	13.1
Washington Park - Irrig.Sys.	Mini Park	2.56	0.9	5.1	5.0	2.0	13.1

The age related PI of all five top ranking irrigation systems is high and Freedom Square Park even shows this PIs maximum value of 6.4 points. The next sensible step is to validate that all "extreme" values are based on plausible input data.

Freedom Square Park has the highest age related PI-Score. All its irrigation components except the controller appear to be the same as installed originally in 1975. Its controller is currently 25 years old. It is rather unlikely that not a single RCV has been replaced over the course of 45 years, however, new valves where not indicated during the data collection (see F.2.3.2.2.1 System Data).

TABLE 14 TOP FIVE SCI SCORES ANT THEIR CONSTITUTING PIS AND SUB-PIS.

System	Maintenance Cost	Age - System	Age - Mainline	Age - Controller	Age - RCV's	Age - Control Wire	Relative Water Use	System Safety	Auto-Shutdown	Overspray	Excessive Mainline	Old Griswold RCV's	SCI
Library Park - Irrig.Sys.	4.0	4.7	0.4	0.0	0.2	0.2	5.0	4.0	0.4	0.3	0.0	0.1	17.7
Freedom Square Park - Irrig.Sys.	3.0	6.4	0.4	0.1	0.2	0.2	3.4	3.5	0.4	0.3	0.0	0.0	16.4
Romero Park - Irrig.Sys.	3.0	5.3	0.3	0.1	0.2	0.2	2.5	2.5	0.4	0.0	0.0	0.1	13.3
Spencer Park - Irrig.Sys.	2.8	5.3	0.3	0.1	0.2	0.2	3.1	2.0	0.4	0.0	0.0	0.0	13.1
Washington Park - Irrig.Sys.	0.9	5.1	0.3	0.0	0.2	0.2	5.0	2.0	0.4	0.0	0.0	0.0	13.1

Library Park has a System Safety score as high as four points. A detailed look at the sub-PIs reveals that this system, as well as Romero Park, still operate with old Griswold valves (see Table 14). This puts maintenance staff at risk as parts of these valves can pop off and turn into a projectile when adjusted under pressure.

Systems with low SCI values consistently show low PI-Scores (see Table 15). One exception to that rule is Indian Hills. Of the five lowest ranking systems, this is the only one to irrigate a Mini Park and it shows high maintenance cost. Drilling down in the analysis of this system reveals that all its components are from 2017, and maintenance expenses of previous years are exceptionally high. Even without knowing the more details one can conclude that maintenance cost will not continue to be as that high in the future.

TABLE 15 LEVEL 1 SYSTEM RANKING OF THE FIVE LOWEST SCI (LOWER IS BETTER)

System	Location Type	Irrigated Area [ac.]	Maintenance Cost	Age - System	Relative Water Use	System Safety	SCI
Soft Gold Park - Irrig.Sys.	Neighborhood Park	6.26	1.3	0.1	0.0	2.5	4.0
Rossborough Park - Irrig.Sys.	Neighborhood Park	14.4	0.8	2.6	0.0	0.5	3.8
Indian Hills Park - Irrig.Sys.	Mini Park	2	2.9	0.0	0.6	0.0	3.5
Radiant Park - Irrig.Sys.	Neighborhood Park	7.4	0.2	0.0	0.0	1.0	1.2
Crescent Park - Irrig.Sys.	Neighborhood Park	6	0.0	0.0	#N/A	1.0	1.0

Since no water use data is available for the Crescent Park irrigation system, the systems score can be higher. While unlikely, additional 5 points could catapult this system from the list of five systems with the lowest SCI. With a total score of 6 points it would be far from requiring additional analysis at the second level.

F.5 Tables and Figures

TABLE 16 COMPONENT TYPE DATA RECORDS

ID	Component Type Name	Useful Life Min	Useful Life Max
1	Pump System	15	25
2	Mainline Network	25	40
3	Controller	5	15
5	Remote Control Valves	20	25
6	Control Wire	25	40

TABLE 17 LOCATION TYPE DATA RECORDS

ID	LTypeName	LTypePriority
1	Community Park	0
2	Neighborhood Park	0
3	Mini Park	0

Table 18 Budget Type data records

ID	BudgetTypeName	Description	Unit
1	Water Budget	Externally calculated Water Budget for a given system	gal
2	Financial Budget	Not in use	$

Table 19 Plant Material data records

ID	MaterialName	LCoefficient	Description
1	Turf	0.8	NA
2	Seed	0.65	NA
3	Special Turf	0.7	Lower Crop Coefficient
4	Warm Season Grass	0.85	An even higher Crop Coeff.
6	Shrub Bed	0.55	Acceptable appearance
7	Unspecified	0.8	

TABLE 20 PINDICATOR DATA RECORDS

ID	PI-Label	PI-Desc	Question	Code	IsActive	IsIndependent	IsBenefit
1	Maintenance Cost	1029 - Overall La	How high whe	C_1	TRUE	FALSE	FALSE
3	Raw Water Use	This figure is req	How much raw	C_3.1	TRUE	FALSE	FALSE
4	Potable Water Use	This figure is req	How much pot	C_3.2	TRUE	FALSE	FALSE
8	O-Cost Power	NOT IN USE @ D	How much wh	C_8	TRUE	FALSE	FALSE
9	O-Cost Water	NOT IN USE @ D	How much wh	C_9	TRUE	FALSE	FALSE
10	Plants Lost	Indicates wethe	Did plants die	C_6.1	TRUE	FALSE	FALSE
11	Hand Watering	Indicates wheth	Within the ind	C_6.3	TRUE	FALSE	FALSE
12	Stressed Turf	Indicates if turf	Did an inadequ	C_6.2	TRUE	FALSE	FALSE
13	Watering Window	Indicates wethe	Is the current	C_7.1	TRUE	FALSE	TRUE
14	Controller To Standard	Indicates if syste	Is the controlle	C_7.2	TRUE	TRUE	TRUE
15	Auto-Shutdown Working	Indicates wethe	Does the syste	C_4.1	TRUE	TRUE	TRUE
16	Overspray	Indicates wethe	Does the irriga	C_4.2	TRUE	TRUE	FALSE
17	Excessive Mainline Depth	Indicates if large	Is the mainline	C_4.3	TRUE	TRUE	FALSE
18	Water Rental	For systems that	Was it necessa	C_7.3	TRUE	TRUE	FALSE
20	MCost-Mainline	The share of ma	How high whe	C_1.1	FALSE	FALSE	FALSE
21	MCost-Controller	The share of cos	How high whe	C_1.2	FALSE	FALSE	FALSE
22	MCost-RCV	The share of ma	How high whe	C_1.3	FALSE	FALSE	FALSE
23	MCost-LV Wire	The share of ma	How high whe	C_1.4	FALSE	FALSE	FALSE
24	Age - System	This performanc	N/A	C_2	FALSE	FALSE	FALSE
25	Age - Mainline	The age of the m	N/A	C_2.1	FALSE	FALSE	FALSE
26	Age - Controller	The age of the m	N/A	C_2.2	FALSE	FALSE	FALSE
27	Age - RCV's	The age of the sy	N/A	C_2.3	FALSE	FALSE	FALSE
28	Age - Control Wire	The age of the sy	N/A	C_2.4	FALSE	FALSE	FALSE
29	Relative Water Use	The relative wat	What is the qu	C_3	FALSE	FALSE	FALSE
30	System Safety	This indicator re	N/A	C_4	FALSE	FALSE	FALSE
31	System Integrity	Aims to assess t	N/A	C_5	FALSE	FALSE	FALSE
32	Integrity - RCV's	Percentage of R	What is the pe	C_5.9	TRUE	FALSE	FALSE
34	Plant Material	This PI comprise	N/A	C_6	FALSE	FALSE	FALSE
35	Pump Station	Assesses the ov	N/A	C_0	FALSE	FALSE	FALSE
36	MCost - Pump Station	Maintenance ex	How high whe	C_0.1	TRUE	FALSE	FALSE
38	Short Cycling	Short cycling of	Is the PMP turr	C_0.4	TRUE	FALSE	FALSE
41	Tripped Contactor/Fuses	Frequently tripp	Did pump stati	C_0.3	TRUE	FALSE	FALSE
42	Age - Pump Station	This performanc	N/A	C_0.2	FALSE	FALSE	FALSE
43	BMP's and City Standards		N/A	C_7	TRUE	FALSE	FALSE
44	Hydrozones	This indicator pr	Is the system c	C_7.4	TRUE	TRUE	TRUE
45	Flow Monitoring	This indicator pr	Can the flow b	C_7.5	TRUE	TRUE	TRUE
47	Integrity - Mainline Split	Reports that a sp	Did a split type	C_5.1	TRUE	FALSE	FALSE
50	Integrity - Fittings	Reports all types	Did fitting failu	C_5.2	TRUE	FALSE	FALSE
51	Integrity - Joint Failure	Reports all types	Did joint failur	C_5.3	TRUE	FALSE	FALSE
56	Integrity - Gaskets	Reports any failu	Did gasket failu	C_5.4	TRUE	FALSE	FALSE
57	Integrity - Low Voltage Wi	Reports issues w	Are valves com	C_5.5	TRUE	FALSE	FALSE
58	Integrity - Operations		Was it necessa	C_5.6	TRUE	FALSE	FALSE
59	Old Griswold RCV's	Certain old Grisv	Are old Griswo	C_4.4	TRUE	FALSE	FALSE

TABLE 21 META DATA TABLE RECORDS - STATUS FOR THE 2018 ANALYSIS

Table	Records	Source
ComponentType	5 records group system elements loosely by their function, but more importantly by their useful life.	Industry standards and expert knowledge. DST configuration and architecture
LocationType	50 records that allow to group or sort the analysis results by the park type. Every location (Park) references one of these records.	This data follows the park categorization the Parks Department uses. It is a direct copy of park type definitions in the department's RAMS.
BudgetType	1 record. The Current DST implementation and PI definition only requires one record in this table: The relative Water Use related PI-Function uses this information do group all water budget records for a given irrigation system and year. The record with the ID 2 is currently not is use.	DST configuration, architecture for functionality
PlantMaterial	6 records (one in use). Each Area references a plant material. These records include information about the plant water requirements and support the internal calculation of water budgets.	DST configuration, architecture for functionality
PIndicators	43 records that the DST uses for the WSM calculation and to link PI-Codes with labels. PI-Functions do currently not reference column IsBenefit. Distinguishing between benefit and harm criteria is integrated in their declarations (i.e. Excel functions). However, the PI-Functions do reference column IsIndependent to properly include or exclude historic data.	As the Project Report explains, the PI definition is an expert guided, stakeholder involving, and iterative process.

Table 22 Performance Indicator weight definitions

PI-Label	Performance Indicator	Community Park	Neighborhood Park	Mini Park
Pump Station	C_0	3.00	3.00	3.00
MCost - Pump Station	C_0.1	0.30	0.30	0.30
Age - Pump Station	C_0.2	0.30	0.30	0.30
Tripped Contactor/Fuses	C_0.3	0.20	0.20	0.20
Short Cycling	C_0.4	0.20	0.20	0.20
Maintenance Cost	C_1	4.00	4.00	3.00
Age - System	C_2	6.00	6.00	7.00
Age - Mainline	C_2.1	0.50	0.50	0.50
Age - Controller	C_2.2	0.05	0.05	0.05
Age - RCV's	C_2.3	0.20	0.20	0.20
Age - Control Wire	C_2.4	0.25	0.25	0.25
Relative Water Use	C_3	5.00	5.00	5.00
System Safety	C_4	5.00	5.00	5.00
Auto-Shutdown Working	C_4.1	0.40	0.40	0.40
Overspray	C_4.2	0.30	0.30	0.30
Excessive Mainline Depth	C_4.3	0.20	0.20	0.20
Old Griswold RCV's	C_4.4	0.10	0.10	0.10
System Integrity	C_5	4.00	4.00	4.00
Integrity - Mainline Split	C_5.1	0.30	0.30	0.30
Integrity - Fittings	C_5.2	0.15	0.15	0.15
Integrity - Joint Failure	C_5.3	0.15	0.15	0.15
Integrity - Gaskets	C_5.4	0.15	0.15	0.15
Integrity - Low Voltage Wiring	C_5.5	0.10	0.10	0.10
Integrity - Operations	C_5.6	0.05	0.05	0.05
Integrity - RCV's	C_5.9	0.10	0.10	0.10
Plant Material	C_6	5.00	5.00	5.00
Plants Lost	C_6.1	0.30	0.30	0.30
Stressed Turf	C_6.2	0.30	0.30	0.30
Hand Watering	C_6.3	0.40	0.40	0.40
BMP's and City Standards	C_7	4.00	4.00	4.00
Watering Window	C_7.1	0.30	0.30	0.30
Controller to Standard	C_7.2	0.10	0.10	0.10
Water Rental	C_7.3	0.30	0.30	0.30
Hydrozones	C_7.4	0.20	0.20	0.20
Flow Monitoring	C_7.5	0.10	0.10	0.10
O-Cost Power	C_8	1.00	1.00	1.00
O-Cost Water	C_9	3.00	3.00	3.00

TABLE 23 PERFORMANCE INDICATOR REQUIREMENT SETTINGS FOR ANALYSIS LEVELS 1, 2, AND 3.

PI	1	2	3	PI-Label
C_0	FALSE	FALSE	TRUE	Pump Station
C_0.1	FALSE	FALSE	TRUE	MCost - Pump Station
C_0.2	FALSE	FALSE	TRUE	Age - Pump Station
C_0.3	FALSE	FALSE	TRUE	Tripped Contactor/Fuses
C_0.4	FALSE	FALSE	TRUE	Short Cycling
C_1	TRUE	TRUE	TRUE	Maintenance Cost
C_2	TRUE	TRUE	TRUE	Age - System
C_2.1	TRUE	TRUE	TRUE	Age - Mainline
C_2.2	TRUE	TRUE	TRUE	Age - Controller
C_2.3	TRUE	TRUE	TRUE	Age - RCV's
C_2.4	TRUE	TRUE	TRUE	Age - Control Wire
C_3	TRUE	TRUE	TRUE	Relative Water Use
C_4	TRUE	TRUE	TRUE	System Safety
C_4.1	TRUE	TRUE	TRUE	Auto-Shutdown Working
C_4.2	TRUE	TRUE	TRUE	Overspray
C_4.3	TRUE	TRUE	TRUE	Excessive Mainline Depth
C_4.4	TRUE	TRUE	TRUE	Old Griswold RCV's
C_5	FALSE	TRUE	TRUE	System Integrity
C_5.1	FALSE	TRUE	TRUE	Integrity - Mainline Split
C_5.2	FALSE	TRUE	TRUE	Integrity - Fittings
C_5.3	FALSE	TRUE	TRUE	Integrity - Joint Failure
C_5.4	FALSE	TRUE	TRUE	Integrity - Gaskets
C_5.5	FALSE	TRUE	TRUE	Integrity - Low Voltage Wiring
C_5.6	FALSE	TRUE	TRUE	Integrity - Operations
C_5.9	FALSE	TRUE	TRUE	Integrity - RCV's
C_6	FALSE	TRUE	TRUE	Plant Material
C_6.1	FALSE	TRUE	TRUE	Plants Lost
C_6.2	FALSE	TRUE	TRUE	Stressed Turf
C_6.3	FALSE	TRUE	TRUE	Hand Watering
C_7	FALSE	TRUE	TRUE	BMP's and City Standards
C_7.1	FALSE	TRUE	TRUE	Watering Window
C_7.2	FALSE	TRUE	TRUE	Controller to Standard
C_7.3	FALSE	TRUE	TRUE	Water Rental
C_7.4	FALSE	TRUE	TRUE	Hydrozones
C_7.5	FALSE	TRUE	TRUE	Flow Monitoring
C_8	FALSE	FALSE	TRUE	O-Cost Power
C_9	FALSE	FALSE	TRUE	O-Cost Water

TABLE 24 1ST LEVEL ANALYSIS RESULTS (RANKING TABLE)

System	Location Type	Irrigated Area [ac.]	Maintenance Cost	Age - System	Relative Wat Use	System Safet	SCI
Library Park - Irrig.Sys.	Neighborhood Park	3.59	4.0	4.7	5.0	4.0	17.7
Freedom Square Park - Irrig.Sys.	Mini Park	0.26	3.0	6.4	3.4	3.5	16.4
Romero Park - Irrig.Sys.	Mini Park	0.14	3.0	5.3	2.5	2.5	13.3
Spencer Park - Irrig.Sys.	Mini Park	0.47	2.8	5.3	3.1	2.0	13.1
Washington Park - Irrig.Sys.	Mini Park	2.56	0.9	5.1	5.0	2.0	13.1
Leisure Park - Irrig.Sys.	Mini Park	0.56	2.6	4.7	1.3	4.0	12.5
Alta Vista Park - Irrig.Sys.	Mini Park	0.33	2.9	5.5	1.3	2.5	12.2
Civic Center Park - Irrig.Sys.	Community Park	1.25	4.0	0.5	5.0	2.0	11.5
Rolland Moore Park - Irrig.Sys.	Community Park	40.44	0.8	3.6	4.1	3.0	11.4
Buckingham Park - Irrig.Sys.	Neighborhood Park	3.28	2.3	5.1	2.5	1.5	11.4
Lee Martinez Park - Irrig.Sys.	Community Park	15.82	1.6	4.8	1.6	3.0	10.9
City Park - Irrig.Sys.	Community Park	48.98	0.1	5.7	1.6	3.0	10.4
Landings Park - Irrig.Sys.	Neighborhood Park	7.1	1.6	3.5	2.8	2.0	9.9
Troutman Park - Irrig.Sys.	Neighborhood Park	17.42	0.0	3.2	4.7	1.5	9.4
Old Ft. Collins Heritage Park/NACC - I	Neighborhood Park	4.9	2.6	1.5	3.8	1.5	9.3
Cottonwood Glen Park - Irrig.Sys.	Neighborhood Park	8.64	0.0	0.5	5.0	3.5	9.0
Creekside Park - Irrig.Sys.	Mini Park	2.44	1.8	3.2	2.2	1.5	8.7
Golden Meadows Park - Irrig.Sys.	Neighborhood Park	7.8	1.6	3.7	1.3	2.0	8.5
Blevins Park - Irrig.Sys.	Neighborhood Park	6.87	1.4	5.2	0.3	1.5	8.5
Fossil Creek Park - Irrig.Sys.	Community Park	37.36	0.9	0.5	3.8	2.5	7.7
Twin Silo Community Park - Irrig.Sys.	Community Park	30	0.0	0.0	5.0	2.5	7.5
Beattie Park - Irrig.Sys.	Neighborhood Park	7.89	1.1	5.7	0.0	0.5	7.3
Waters Way Park - Irrig.Sys.	Neighborhood Park	6.9	1.7	0.0	2.9	2.5	7.1
Warren Park - Irrig.Sys.	Neighborhood Park	21.26	0.0	4.7	0.3	2.0	7.0
Avery Park - Irrig.Sys.	Neighborhood Park	5.52	1.8	3.3	0.0	1.5	6.5
Rabbit Brush Park - Irrig.Sys.	Mini Park	1.52	1.3	0.2	1.3	3.5	6.3
Westfield Park - Irrig.Sys.	Neighborhood Park	9.95	0.1	1.0	1.3	3.5	5.8
Spring Canyon Community Park - Irrig	Community Park	50.6	0.1	0.1	0.9	4.5	5.7
Greenbriar Park - Irrig.Sys.	Neighborhood Park	18.08	0.6	1.5	0.6	3.0	5.6
Stewart Case Park - Irrig.Sys.	Neighborhood Park	11.5	0.3	0.7	#N/A	4.5	5.5
Eastside Park - Irrig.Sys.	Mini Park	2.7	0.8	0.8	#N/A	4.0	5.5
Overland Park - Irrig.Sys.	Neighborhood Park	11	0.4	2.7	0.3	1.5	5.0
Registry - Irrig.Sys.	Neighborhood Park	5.2	0.9	0.0	1.6	2.5	5.0
Spring Park - Irrig.Sys.	Neighborhood Park	14.07	0.7	2.7	0.0	1.5	4.9
Rogers Park - Irrig.Sys.	Neighborhood Park	6.5	1.1	2.1	0.0	1.5	4.7
Edora Park - Irrig.Sys.	Community Park	37.6	0.4	1.5	1.3	1.5	4.7
Ridgeview Park - Irrig.Sys.	Neighborhood Park	11.2	0.0	1.1	0.0	3.5	4.6
English Ranch Park - Irrig.Sys.	Neighborhood Park	12.66	0.3	0.5	2.2	1.5	4.6
Homestead Park - Irrig.Sys.	Neighborhood Park	7.15	1.4	0.3	0.3	2.5	4.5
Miramont Park - Irrig.Sys.	Neighborhood Park	9.5	0.1	0.7	1.6	2.0	4.4
Harmony Park - Irrig.Sys.	Neighborhood Park	11.4	0.0	0.6	#N/A	3.5	4.1
Soft Gold Park - Irrig.Sys.	Neighborhood Park	6.26	1.3	0.1	0.0	2.5	4.0
Rossborough Park - Irrig.Sys.	Neighborhood Park	14.4	0.8	2.6	0.0	0.5	3.8
Indian Hills Park - Irrig.Sys.	Mini Park	2	2.9	0.0	0.6	0.0	3.5
Radiant Park - Irrig.Sys.	Neighborhood Park	7.4	0.2	0.0	0.0	1.0	1.2
Crescent Park - Irrig.Sys.	Neighborhood Park	6	0.0	0.0	#N/A	1.0	1.0
AVERAGE			1.2	2.4	1.9	2.3	7.7

TABLE 25 2ND LEVEL ANALYSIS RESULTS (RANKING TABLE)

System	Location Type	Irrigated Area [ac.]	Maintenance Cost	Age - System	Relative Water Use	System Safety	System Integrity	Plant Material	BMP's and City Standards	SCI
Library Park - Irrig.Sys.	Neighborhood Park	3.59	4.0	4.7	5.0	4.0	3.6	1.5	1.2	24.0
Rolland Moore Park - Irrig.Sys.	Community Park	40.44	0.8	3.6	4.1	3.0	4.8	5.0	1.2	22.4
City Park - Irrig.Sys.	Community Park	48.98	0.1	5.7	1.6	3.0	3.2	3.5	2.0	19.1
Freedom Square Park - Irrig.Sys.	Mini Park	0.26	3.0	6.4	3.4	3.5	0.4	0.0	1.2	18.0
Washington Park - Irrig.Sys.	Mini Park	2.56	0.9	5.1	5.0	2.0	2.2	1.5	1.2	18.0
Buckingham Park - Irrig.Sys.	Neighborhood Park	3.28	2.3	5.1	2.5	1.5	4.2	1.5	0.8	17.9
Lee Martinez Park - Irrig.Sys.	Community Park	15.82	1.6	4.8	1.6	3.0	0.4	3.5	2.4	17.2
Troutman Park - Irrig.Sys.	Neighborhood Park	17.42	0.0	3.2	4.7	1.5	2.0	3.5	1.2	16.1
Spencer Park - Irrig.Sys.	Mini Park	0.47	2.8	5.3	3.1	2.0	1.0	0.0	1.2	15.3
Romero Park - Irrig.Sys.	Mini Park	0.14	3.0	5.3	2.5	2.5	0.8	0.0	1.2	15.3
Leisure Park - Irrig.Sys.	Mini Park	0.56	2.6	4.7	1.3	4.0	1.0	0.0	0.4	13.9
Alta Vista Park - Irrig.Sys.	Mini Park	0.33	2.9	5.5	1.3	2.5	0.4	0.0	1.2	13.8
Landings Park - Irrig.Sys.	Neighborhood Park	7.1	1.6	3.5	2.8	2.0	3.2	0.0	0.4	13.5
Old Ft. Collins Heritage Park/NACC - I	Neighborhood Park	4.9	2.6	1.5	3.8	1.5	1.4	1.5	1.2	13.4
Civic Center Park - Irrig.Sys.	Community Park	1.25	4.0	0.5	5.0	2.0	0.8	0.0	0.4	12.7
AVERAGE			1.2	2.4	1.9	2.3	0.0	0.0	0.0	11.8

Performance Questions - Level I

- ☐ Does the system have functioning auto-shutdown capabilities (i.e. master valve, flow sensor)?
- ☐ Does the irrigation system overspray hardscape?
- ☐ Is the mainline deeper than three feet?
- ☐ Are old Griswold RCV's used in this system?

Performance Questions - Level II

- ☐ Did a split type pipe failure occur?
- ☐ Did fitting failures occur?
- ☐ Did joint failures occur?
- ☐ Did gasket failures occur
- ☐ Are RCV's coming on as scheduled or on demand?
- ☐ Was it necessary to shut down the whole system for pipe network repairs?

◉ <10% replaced ○ 10% < fixing req. <= 15% ○ fixing req. > 15%	What is the percentage of RCV's where (partial) replacement was necessary?

- ☐ Did plants die due to an inadequate or failing irrigation system?
- ☐ Did an inadequate or failing irrigation system cause stressed turf?
- ☐ Was it necessary to hand water due to an inadequate or failing irrigation system?
- ☐ Is the watering window within current city standard limits?
- ☐ Is the controller in accordance with current city standards?
- ☐ Is the system design aligned with current hydrozones?
- ☐ Can the flow be monitored zone by zone?

Following performance indicators are only required if the system has a pump station

- ☐ Did pump station fuses or contactors trip or blow?
- ☐ Is the PMP turning on more than 6 times per hour?

FIGURE 11 USER FORM - LEVEL I AND LEVEL II CATEGORICAL PERFORMANCE VARIABLE COLLECTION

F.6 Individual System Reports

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:08 **Analysis Year:** 2018

1 General system information

System Name: Alta Vista Park - Irrig.Sys.

Location: Alta Vista Park

Component Count: 4

1.1 User comments

User comments from the data collection forms for a specific year:

No user notes available

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	0.33	100.00%
Grand Total			**0.33**	**100.00%**

2.2 System components:

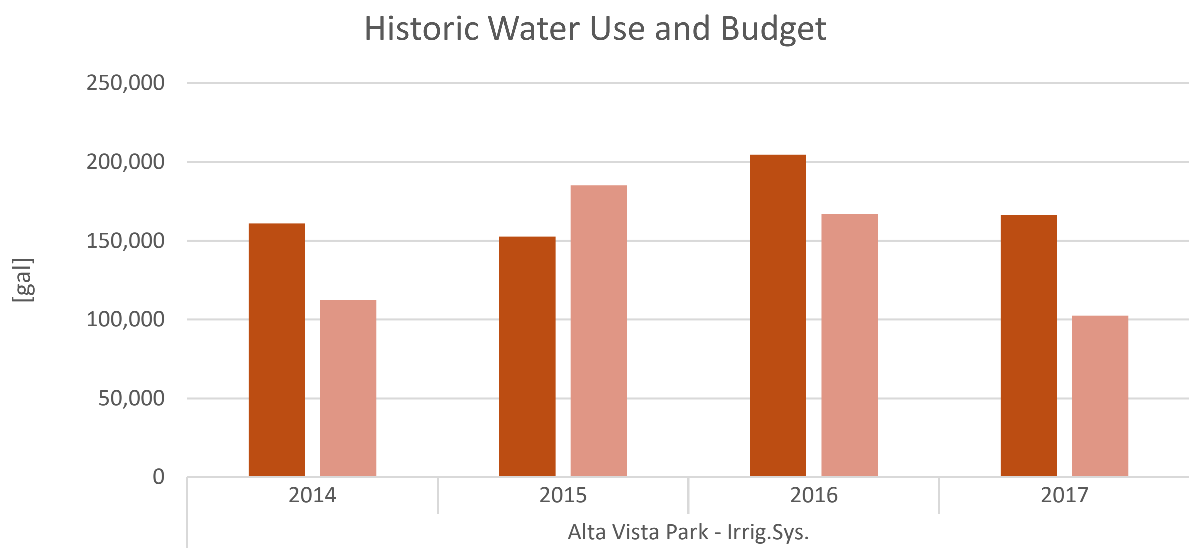
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
Domestic	Mainline Network	1978
Controller A	Controller	2017
RB RCVs	Remote Control Valves	1978
14 Gauge irri. Wires	Control Wire	1978

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



	2014	2015	2016	2017
Water Budget	160,893	152,694	204,667	166,180
Water Use	112,292	185,112	167,011	102,607

Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!ALTA VISTA	112,292
2014 Total		**112,292**
2015	Source: SW-NS-CEM Water Use.xls!ALTA VISTA	185,112
2015 Total		**185,112**
2016	Source: SW-NS-CEM Water Use.xls!ALTA VISTA	167,011
2016 Total		**167,011**
2017	Source: 2017 Northside water use reports.xlsx!ALTA VISTA	102,607
2017 Total		**102,607**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!ALTA VISTA	160,893
2014 Total		**160,893**
2015	Source: SW-NS-CEM Water Use.xls!ALTA VISTA	152,694
2015 Total		**152,694**
2016	Source: SW-NS-CEM Water Use.xls!ALTA VISTA	204,667
2016 Total		**204,667**
2017	Source: 2017 Northside water use reports.xlsx!ALTA VISTA	166,180
2017 Total		**166,180**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 1,247.06	$ 3,778.97
2014	$ 1,534.69	$ 4,650.57
2015	$ 2,298.80	$ 6,966.07
2016	$ 1,701.64	$ 5,156.50
2017	$ 1,484.27	$ 4,497.78
Total	**$ 8,266.46**	**$ 25,049.89**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018																					
2017																					
2016																					
2015																					
2014																					

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Power	2010	$ 23.24	$ 70.42
O-Cost Power	2011	$ 24.43	$ 74.03
O-Cost Power	2012	$ 27.85	$ 84.39
O-Cost Power	2013	$ 27.85	$ 84.39
O-Cost Power	2014	$ 31.87	$ 96.58
O-Cost Power	2015	$ 44.49	$ 134.82
O-Cost Power	2016	$ 28.38	$ 86.00
O-Cost Power	2017	$ 27.40	$ 83.03
O-Cost Power Total		**$ 235.51**	**$ 713.67**
O-Cost Water	2010	$ 444.03	$ 1,345.55
O-Cost Water	2011	$ 411.69	$ 1,247.55
O-Cost Water	2012	$ 499.23	$ 1,512.82
O-Cost Water	2013	$ 404.23	$ 1,224.94
O-Cost Water	2014	$ 445.24	$ 1,349.21
O-Cost Water	2015	$ 730.33	$ 2,213.12
O-Cost Water	2016	$ 555.14	$ 1,682.24
O-Cost Water	2017	$ 385.32	$ 1,167.64
O-Cost Water Total		**$ 3,875.21**	**$ 11,743.06**
Grand Total		**$ 4,110.72**	**$ 12,456.73**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:09 **Analysis Year:** 2018

1 General system information

System Name: Avery Park - Irrig.Sys.

Location: Avery Park

Component Count: 6

1.1 User comments

User comments from the data collection forms for a specific year:

Reporting Year	Note
2018	Avery park was estabelished in 1964. The oldest avialable irrigation design is from 1974 from Bath Landscaping. Some of the mainline and control wire is from the original installation. In 1982 The valves were upgraded to Weathermatic 3" valves which are still in use today for seven stations. In 2017 There was a major playground renovation along to upgrading the Booster pump to a Rainbird VFD, New Backflow and additonal valves for the updated side of the park. All new valves (Six 2" rainbird Scrubber and One 3/4" Rainbird Drip Assy.) are installed with Leemco Dictile fittings with 2" Spgot style isolation valves up-stream.

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	5.52	100.00%
Grand Total			**5.52**	**100.00%**

2.2 System components:

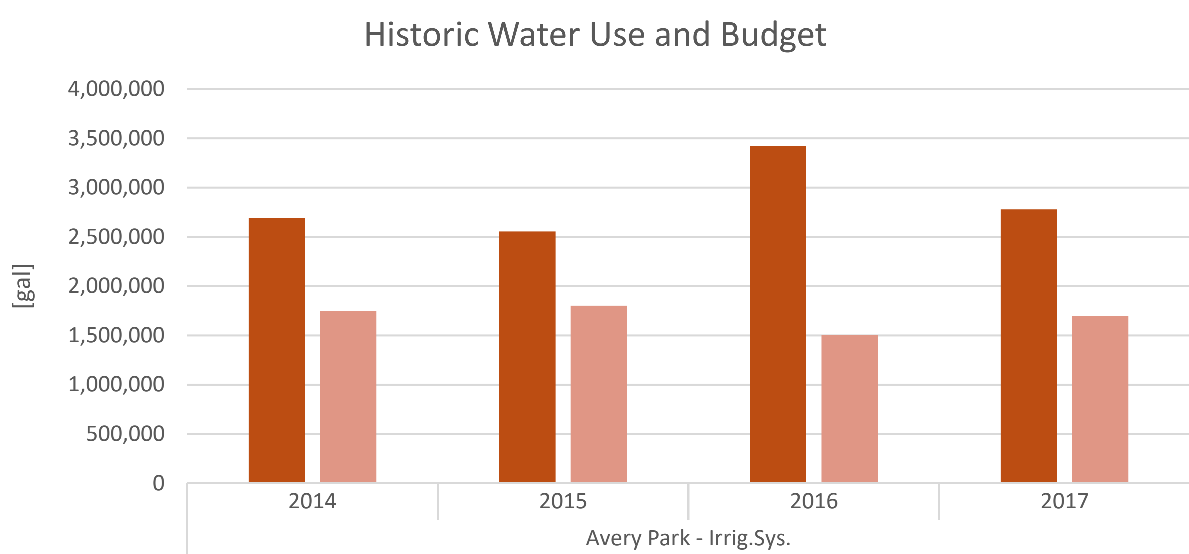
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	1974
Controller A	Controller	2017
Control Wire	Control Wire	2017
RCVs	Remote Control Valves	1982
RCV's	Remote Control Valves	2017
Inline Booster Pump	Pump System	1997

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



	2014	2015	2016	2017
Water Budget	2,691,301	2,554,150	3,423,521	2,779,737
Water Use	1,745,418	1,802,122	1,501,601	1,698,615

Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!AVERY	1,745,418
2014 Total		**1,745,418**
2015	Source: SW-NS-CEM Water Use.xls!AVERY	1,802,122
2015 Total		**1,802,122**
2016	Source: SW-NS-CEM Water Use.xls!AVERY	1,501,601
2016 Total		**1,501,601**
2017	Source: 2017 South West water use reports.xlsx!AVERY	1,698,615
2017 Total		**1,698,615**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!AVERY	2,691,301
2014 Total		**2,691,301**
2015	Source: SW-NS-CEM Water Use.xls!AVERY	2,554,150
2015 Total		**2,554,150**
2016	Source: SW-NS-CEM Water Use.xls!AVERY	3,423,521
2016 Total		**3,423,521**
2017	Source: 2017 South West water use reports.xlsx!AVERY	2,779,737
2017 Total		**2,779,737**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 11,027.11	$ 1,997.67
2014	$ 11,027.99	$ 1,997.82
2015	$ 15,169.94	$ 2,748.18
2016	$ 15,906.04	$ 2,881.53
2017	$ 20,385.17	$ 3,692.96
Total	**$ 73,516.24**	**$ 13,318.16**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018																					
2017																					
2016																					
2015																					
2014																					

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Power	2010	$ 575.36	$ 104.23
O-Cost Power	2011	$ 544.78	$ 98.69
O-Cost Power	2012	$ 782.33	$ 141.73
O-Cost Power	2013	$ 760.78	$ 137.82
O-Cost Power	2014	$ 803.75	$ 145.61
O-Cost Power	2015	$ 870.23	$ 157.65
O-Cost Power	2016	$ 928.77	$ 168.26
O-Cost Power	2017	$ 736.86	$ 133.49
O-Cost Power Total		**$ 6,002.86**	**$ 1,087.47**
O-Cost Water	2010	$ 6,477.35	$ 1,173.43
O-Cost Water	2011	$ 7,394.18	$ 1,339.53
O-Cost Water	2012	$ 7,884.82	$ 1,428.41
O-Cost Water	2013	$ 5,391.16	$ 976.66
O-Cost Water	2014	$ 7,029.02	$ 1,273.37
O-Cost Water	2015	$ 7,353.96	$ 1,332.24
O-Cost Water	2016	$ 7,374.72	$ 1,336.00
O-Cost Water	2017	$ 7,130.79	$ 1,291.81
O-Cost Water Total		**$ 56,036.00**	**$ 10,151.45**
Grand Total		**$ 62,038.86**	**$ 11,238.92**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:09 **Analysis Year:** 2018

1 General system information

System Name: Beattie Park - Irrig.Sys.

Location: Beattie Park

Component Count: 5

1.1 User comments

User comments from the data collection forms for a specific year:

No user notes available

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	7.89	100.00%
Grand Total			**7.89**	**100.00%**

2.2 System components:

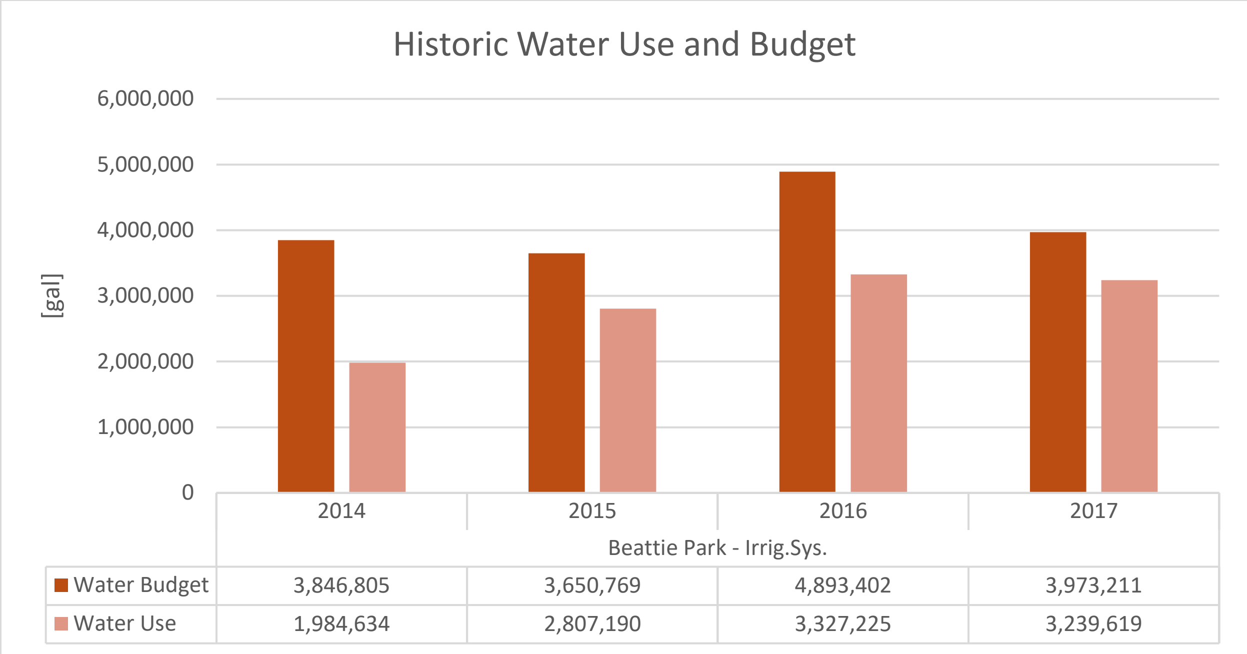
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	1973
Controller A	Controller	2017
Control Wire	Control Wire	1973
All RCVs	Remote Control Valves	1973
7.5HP Booster Pump	Pump System	1996

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!Beattie	1,984,634
2014 Total		**1,984,634**
2015	Source: SW-NS-CEM Water Use.xls!Beattie	2,807,190
2015 Total		**2,807,190**
2016	Source: SW-NS-CEM Water Use.xls!Beattie	3,327,225
2016 Total		**3,327,225**
2017	Source: 2017 South West water use reports.xlsx!Beattie	3,239,619
2017 Total		**3,239,619**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!Beattie	3,846,805
2014 Total		**3,846,805**
2015	Source: SW-NS-CEM Water Use.xls!Beattie	3,650,769
2015 Total		**3,650,769**
2016	Source: SW-NS-CEM Water Use.xls!Beattie	4,893,402
2016 Total		**4,893,402**
2017	Source: 2017 South West water use reports.xlsx!Beattie	3,973,211
2017 Total		**3,973,211**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 11,820.16	$ 1,498.12
2014	$ 12,252.87	$ 1,552.96
2015	$ 15,727.15	$ 1,993.30
2016	$ 15,726.24	$ 1,993.19
2017	$ 25,856.30	$ 3,277.10
Total	**$ 81,382.71**	**$ 10,314.67**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018																					
2017																					
2016																					
2015																					
2014																					

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Power	2010	$ 642.56	$ 81.44
O-Cost Power	2011	$ 547.45	$ 69.39
O-Cost Power	2012	$ 496.95	$ 62.98
O-Cost Power	2013	$ 730.44	$ 92.58
O-Cost Power	2014	$ 715.50	$ 90.68
O-Cost Power	2015	$ 818.33	$ 103.72
O-Cost Power	2016	$ 836.45	$ 106.01
O-Cost Power	2017	$ 779.73	$ 98.83
O-Cost Power Total		**$ 5,567.41**	**$ 705.63**
O-Cost Water	2010	$ 7,943.47	$ 1,006.78
O-Cost Water	2011	$ 7,254.66	$ 919.48
O-Cost Water	2012	$ 11,159.32	$ 1,414.36
O-Cost Water	2013	$ 6,068.08	$ 769.08
O-Cost Water	2014	$ 6,827.90	$ 865.39
O-Cost Water	2015	$ 9,451.49	$ 1,197.91
O-Cost Water	2016	$ 9,767.57	$ 1,237.97
O-Cost Water	2017	$ 10,446.68	$ 1,324.04
O-Cost Water Total		**$ 68,919.17**	**$ 8,735.00**
Grand Total		**$ 74,486.58**	**$ 9,440.63**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:09 **Analysis Year:** 2018

1 General system information

System Name: Blevins Park - Irrig.Sys.

Location: Blevins Park

Component Count: 5

1.1 User comments

User comments from the data collection forms for a specific year:

Reporting Year	Note
2018	Blevins park was open in 1974. The only avialable irrigation plans avialable have no dates on them so we are using 1974 as a standard. The controller was upgraded to WeatherTrak in 2017. All RCV's are original 3" Weathermatic Valves of which the majority of weep and have issues.

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	6.87	100.00%
Grand Total			**6.87**	**100.00%**

2.2 System components:

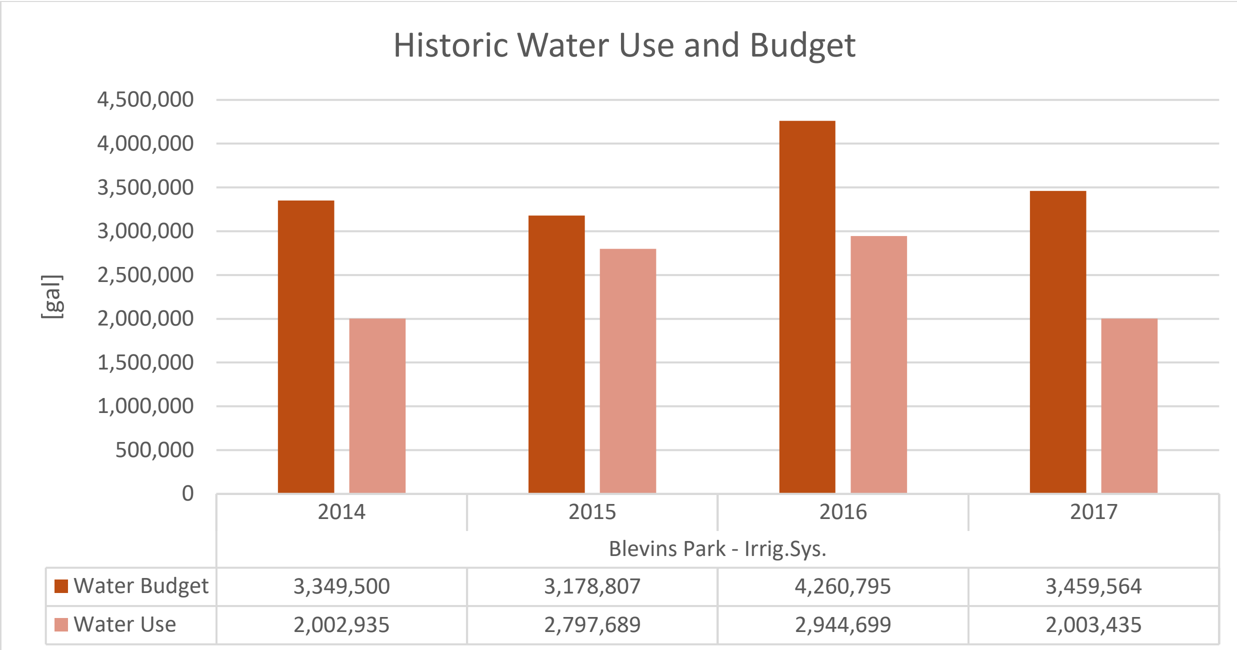
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	1974
Controller A	Controller	2017
Control Wire	Control Wire	1974
All RCVs	Remote Control Valves	1974
In-Line Booster Pump	Pump System	1976

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!BLEVINS	2,002,935
2014 Total		**2,002,935**
2015	Source: SW-NS-CEM Water Use.xls!BLEVINS	2,797,689
2015 Total		**2,797,689**
2016	Source: SW-NS-CEM Water Use.xls!BLEVINS	2,944,699
2016 Total		**2,944,699**
2017	Source: 2017 South West water use reports.xlsx!BLEVINS	2,003,435
2017 Total		**2,003,435**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!BLEVINS	3,349,500
2014 Total		**3,349,500**
2015	Source: SW-NS-CEM Water Use.xls!BLEVINS	3,178,807
2015 Total		**3,178,807**
2016	Source: SW-NS-CEM Water Use.xls!BLEVINS	4,260,795
2016 Total		**4,260,795**
2017	Source: 2017 South West water use reports.xlsx!BLEVINS	3,459,564
2017 Total		**3,459,564**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 13,567.06	$ 1,974.83
2014	$ 15,805.86	$ 2,300.71
2015	$ 17,458.60	$ 2,541.28
2016	$ 15,931.46	$ 2,318.99
2017	$ 19,119.02	$ 2,782.97
Total	**$ 81,882.01**	**$ 11,918.78**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018																					
2017																					
2016																					
2015																					
2014																					

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Power	2010	$ 312.64	$ 45.51
O-Cost Power	2011	$ 483.46	$ 70.37
O-Cost Power	2012	$ 312.26	$ 45.45
O-Cost Power	2013	$ 318.14	$ 46.31
O-Cost Power	2014	$ 533.31	$ 77.63
O-Cost Power	2015	$ 449.44	$ 65.42
O-Cost Power	2016	$ 674.09	$ 98.12
O-Cost Power	2017	$ 539.34	$ 78.51
O-Cost Power Total		**$ 3,622.68**	**$ 527.32**
O-Cost Water	2010	$ 6,022.72	$ 876.67
O-Cost Water	2011	$ 7,075.46	$ 1,029.91
O-Cost Water	2012	$ 9,143.70	$ 1,330.96
O-Cost Water	2013	$ 5,788.69	$ 842.60
O-Cost Water	2014	$ 6,830.65	$ 994.27
O-Cost Water	2015	$ 8,719.62	$ 1,269.23
O-Cost Water	2016	$ 9,713.23	$ 1,413.86
O-Cost Water	2017	$ 7,140.23	$ 1,039.33
O-Cost Water Total		**$ 60,434.30**	**$ 8,796.84**
Grand Total		**$ 64,056.98**	**$ 9,324.16**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:07 **Analysis Year:** 2018

1 General system information

System Name: Buckingham Park - Irrig.Sys.

Location: Buckingham Park

Component Count: 9

1.1 User comments

User comments from the data collection forms for a specific year:

Reporting Year	Note
2018	The southern border of the park and the controller were updated/renovated with the lincoln street improvement project in 2018

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	3.28	100.00%
Grand Total			**3.28**	**100.00%**

2.2 System components:

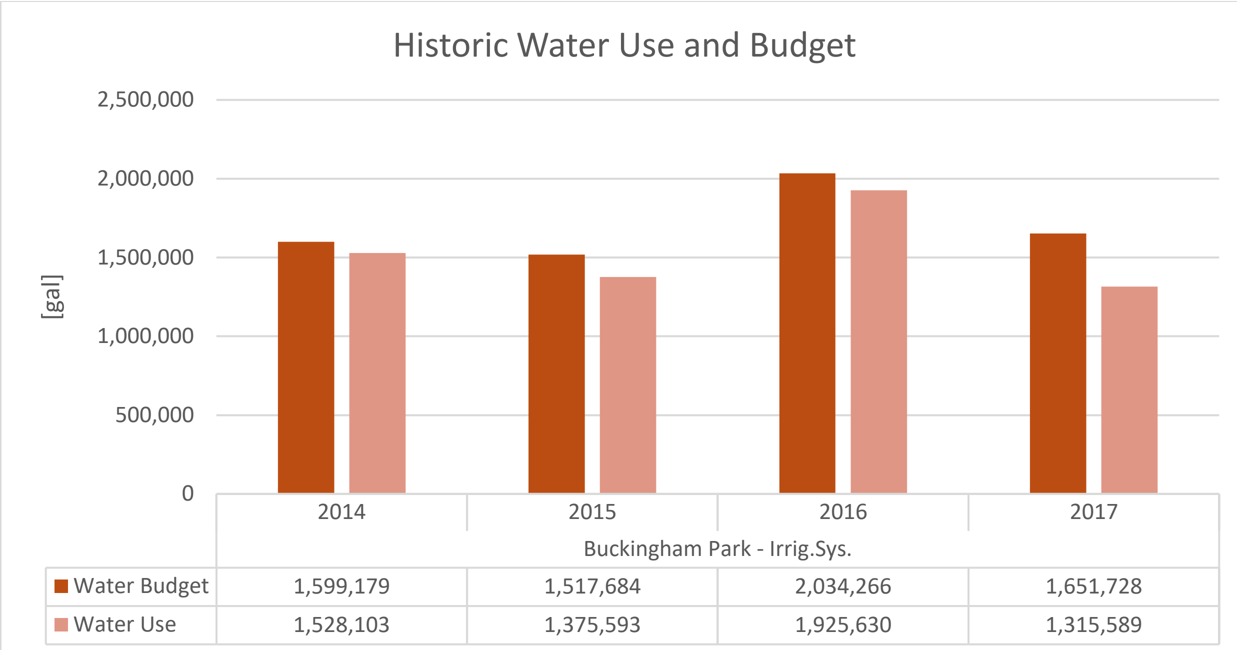
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	1974
Controller A	Controller	2018
Control Wire	Control Wire	1974
All RCVs	Remote Control Valves	1974
Domestic	Mainline Network	1967
Griswald RCVs	Remote Control Valves	1976
RB RCVs	Remote Control Valves	2018
Weathermatic RCVs	Remote Control Valves	1976
14 Gauge irri. Wires	Control Wire	1976

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!BUCKINGHAM	1,528,103
2014 Total		**1,528,103**
2015	Source: SW-NS-CEM Water Use.xls!BUCKINGHAM	1,375,593
2015 Total		**1,375,593**
2016	Source: SW-NS-CEM Water Use.xls!BUCKINGHAM	1,925,630
2016 Total		**1,925,630**
2017	Source: 2017 Northside water use reports.xlsx!BUCKINGHAM	1,315,589
2017 Total		**1,315,589**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!BUCKINGHAM	1,599,179
2014 Total		**1,599,179**
2015	Source: SW-NS-CEM Water Use.xls!BUCKINGHAM	1,517,684
2015 Total		**1,517,684**
2016	Source: SW-NS-CEM Water Use.xls!BUCKINGHAM	2,034,266
2016 Total		**2,034,266**
2017	Source: 2017 Northside water use reports.xlsx!BUCKINGHAM	1,651,728
2017 Total		**1,651,728**

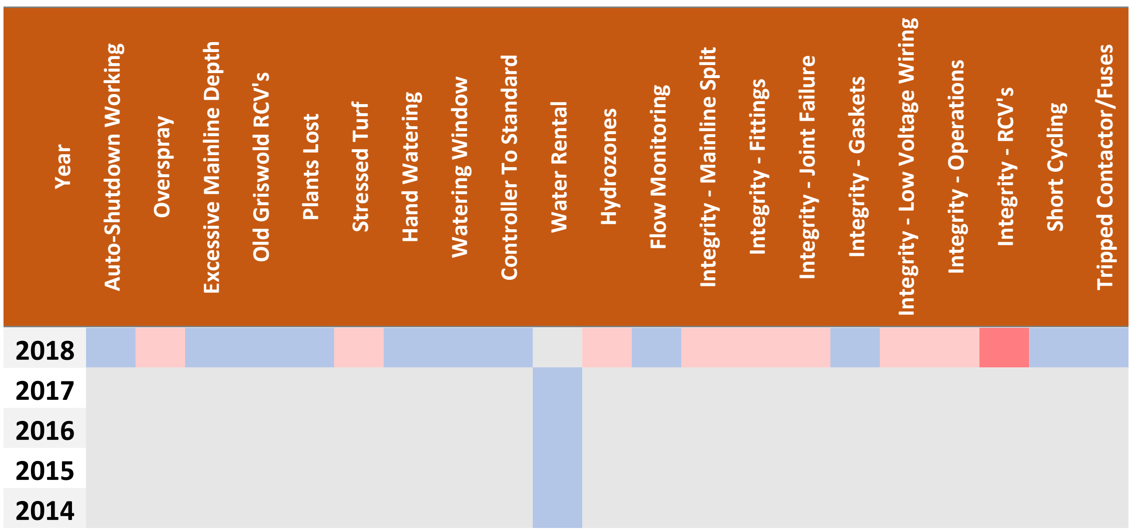
3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 8,797.87	$ 2,682.28
2014	$ 10,707.15	$ 3,264.38
2015	$ 10,387.40	$ 3,166.89
2016	$ 11,197.42	$ 3,413.85
2017	$ 10,842.73	$ 3,305.71
Total	**$ 51,932.57**	**$ 15,833.10**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):



3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Water	2010	$ 5,193.09	$ 1,583.26
O-Cost Water	2011	$ 5,291.61	$ 1,613.30
O-Cost Water	2012	$ 7,065.52	$ 2,154.12
O-Cost Water	2013	$ 5,714.08	$ 1,742.10
O-Cost Water	2014	$ 5,621.56	$ 1,713.89
O-Cost Water	2015	$ 5,506.90	$ 1,678.93
O-Cost Water	2016	$ 6,294.40	$ 1,919.02
O-Cost Water	2017	$ 5,935.02	$ 1,809.46
O-Cost Water Total		**$ 46,622.18**	**$ 14,214.08**
Grand Total		**$ 46,622.18**	**$ 14,214.08**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:07 **Analysis Year:** 2018

1 General system information

System Name: City Park - Irrig.Sys.

Location: City Park

Component Count: 7

1.1 User comments

User comments from the data collection forms for a specific year:

No user notes available

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	48.98	100.00%
Grand Total			**48.98**	**100.00%**

2.2 System components:

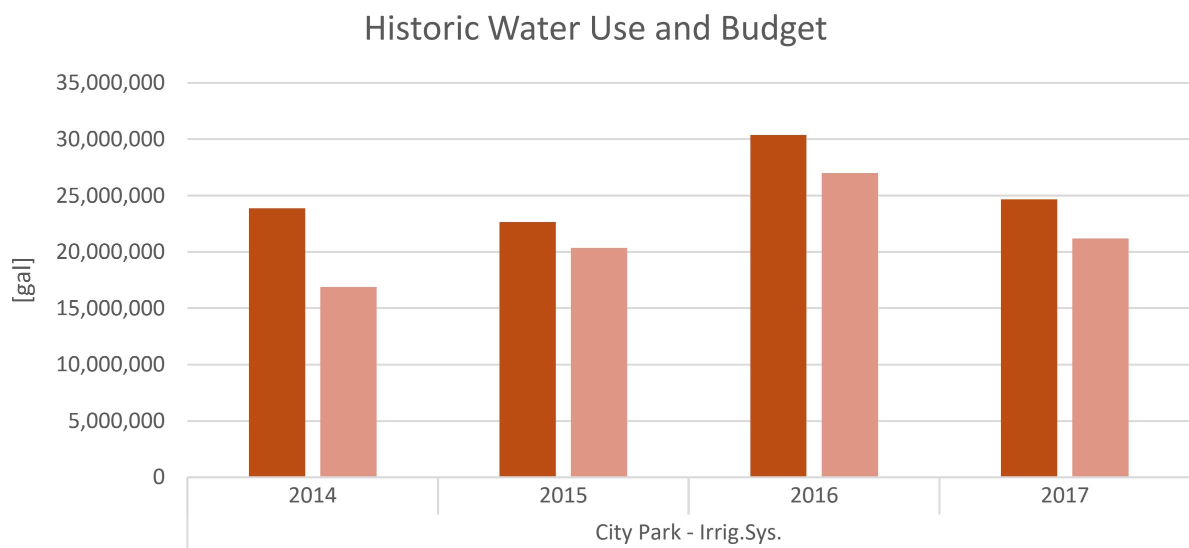
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
Pump station main	Mainline Network	1967
Controller A	Controller	2018
Control B	Controller	2018
RB RCVs	Remote Control Valves	1967
Griswald RCVs	Remote Control Valves	1967
Weathermatic RCVs	Remote Control Valves	1967
14 Gauge irri. Wires	Control Wire	1967

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



	2014	2015	2016	2017
Water Budget	23,880,422	22,663,458	30,377,546	24,665,131
Water Use	16,921,467	20,378,228	26,989,163	21,189,407

Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!CITY PARK	13,001,473
2014	Source: 2014 SW-NS-CEM Water Use.xls!CITY PARK ballfields	3,919,995
2014 Total		**16,921,467**
2015	Source: SW-NS-CEM Water Use.xls!CITY PARK	14,336,410
2015	Source: SW-NS-CEM Water Use.xls!CITY PARK ballfields	6,041,818
2015 Total		**20,378,228**
2016	Source: SW-NS-CEM Water Use.xls!CITY PARK ballfields	6,575,194
2016	Source: SW-NS-CEM Water Use.xls!CITY PARK Pump	20,413,969
2016 Total		**26,989,163**
2017	Source: 2017 Northside water use reports.xlsx!CITY PARK ballfields	5,208,352
2017	Source: 2017 Northside water use reports.xlsx!CITY PARK Pump	15,981,055
2017 Total		**21,189,407**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!CITY PARK	18,614,833
2014	Source: 2014 SW-NS-CEM Water Use.xls!CITY PARK ballfields	5,265,589
2014 Total		**23,880,422**
2015	Source: SW-NS-CEM Water Use.xls!CITY PARK	17,666,207
2015	Source: SW-NS-CEM Water Use.xls!CITY PARK ballfields	4,997,251
2015 Total		**22,663,458**
2016	Source: SW-NS-CEM Water Use.xls!CITY PARK ballfields	6,698,193
2016	Source: SW-NS-CEM Water Use.xls!CITY PARK Pump	23,679,353

2016 Total		**30,377,546**
2017	Source: 2017 Northside water use reports.xlsx!CITY PARK ballfields	5,438,616
2017	Source: 2017 Northside water use reports.xlsx!CITY PARK Pump	19,226,515
2017 Total		**24,665,131**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 65,829.10	$ 1,344.00
2014	$ 56,414.18	$ 1,151.78
2015	$ 51,226.60	$ 1,045.87
2016	$ 70,300.35	$ 1,435.29
2017	$ 55,376.70	$ 1,130.60
Total	**$ 299,146.94**	**$ 6,107.53**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018	blue	salmon	salmon	salmon	blue	salmon	salmon	blue	blue	grey	salmon	blue	salmon	salmon	salmon	blue	salmon	blue	salmon	salmon	blue
2017	grey	grey	grey	grey	grey	grey	grey	grey	grey	salmon	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2016	grey	grey	grey	grey	grey	grey	grey	grey	grey	salmon	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2015	grey	grey	grey	grey	grey	grey	grey	grey	grey	salmon	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2014	grey	grey	grey	grey	grey	grey	grey	grey	grey	salmon	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Power	2010	$ 4,783.27	$ 97.66
O-Cost Power	2011	$ 4,082.57	$ 83.35
O-Cost Power	2012	$ 4,374.34	$ 89.31
O-Cost Power	2013	$ 3,711.73	$ 75.78
O-Cost Power	2014	$ 4,278.84	$ 87.36
O-Cost Power	2015	$ 5,085.76	$ 103.83
O-Cost Power	2016	$ 5,550.17	$ 113.32
O-Cost Power	2017	$ 5,433.38	$ 110.93
O-Cost Power Total		**$ 37,300.06**	**$ 761.54**
O-Cost Water	2010	$ 3,874.70	$ 79.11
O-Cost Water	2011	$ 4,478.61	$ 91.44
O-Cost Water	2012	$ 7,922.78	$ 161.76
O-Cost Water	2013	$ 4,480.08	$ 91.47
O-Cost Water	2014	$ 4,882.06	$ 99.67
O-Cost Water	2015	$ 4,070.19	$ 83.10
O-Cost Water	2016	$ 5,343.63	$ 109.10
O-Cost Water	2017	$ 5,780.77	$ 118.02
O-Cost Water Total		**$ 40,832.82**	**$ 833.66**
Grand Total		**$ 78,132.88**	**$ 1,595.20**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:08 **Analysis Year:** 2018

1 General system information

System Name: Civic Center Park - Irrig.Sys.

Location: Civic Center Park

Component Count: 4

1.1 User comments

User comments from the data collection forms for a specific year:

No user notes available

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	1.25	100.00%
Grand Total			**1.25**	**100.00%**

2.2 System components:

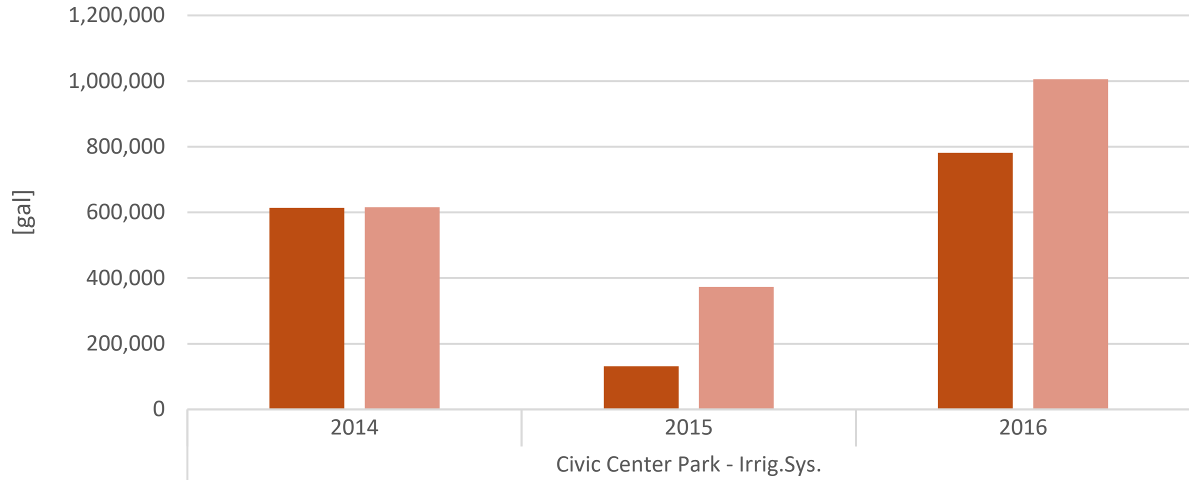
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	1999
Controller A	Controller	2017
Control Wire	Control Wire	1999
All RCVs	Remote Control Valves	1999

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



	2014	2015	2016
Water Budget	614,319	131,554	781,456
Water Use	615,642	373,025	1,006,068

Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 DaH-Fat Water Use.xls!Justice Center	615,642
2014 Total		**615,642**
2015	Source: DaH-Fat Water Use.xls!Justice Center	373,025
2015 Total		**373,025**
2016	Source: DaH-Fat Water Use.xls!Justice Center	1,006,068
2016 Total		**1,006,068**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 DaH-Fat Water Use.xls!Justice Center	614,319
2014 Total		**614,319**
2015	Source: DaH-Fat Water Use.xls!Justice Center	131,554
2015 Total		**131,554**
2016	Source: DaH-Fat Water Use.xls!Justice Center	781,456
2016 Total		**781,456**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 7,945.66	$ 6,356.53
2014	$ 10,374.74	$ 8,299.79

2015	$ 13,771.07	$ 11,016.86
2016	$ 10,928.66	$ 8,742.92
2017	$ 15,600.34	$ 12,480.27
Total	**$ 58,620.46**	**$ 46,896.37**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018																					
2017																					
2016																					
2015																					
2014																					

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Water	2010	$ 3,127.69	$ 2,502.15
O-Cost Water	2011	$ 3,369.59	$ 2,695.67
O-Cost Water	2012	$ 4,384.77	$ 3,507.82
O-Cost Water	2013	$ 3,065.88	$ 2,452.70
O-Cost Water	2014	$ 3,149.00	$ 2,519.20
O-Cost Water	2015	$ 3,399.58	$ 2,719.66
O-Cost Water	2016	$ 4,393.71	$ 3,514.97
O-Cost Water	2017	$ 3,059.86	$ 2,447.89
O-Cost Water Total		**$ 27,950.08**	**$ 22,360.06**
Grand Total		**$ 27,950.08**	**$ 22,360.06**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:08 **Analysis Year:** 2018

1 General system information

System Name: Cottonwood Glen Park - Irrig.Sys.

Location: Cottonwood Glen Park

Component Count: 5

1.1 User comments

User comments from the data collection forms for a specific year:

Reporting Year	Note
2018	Master Valve does not function.

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	8.64	100.00%
Grand Total			**8.64**	**100.00%**

2.2 System components:

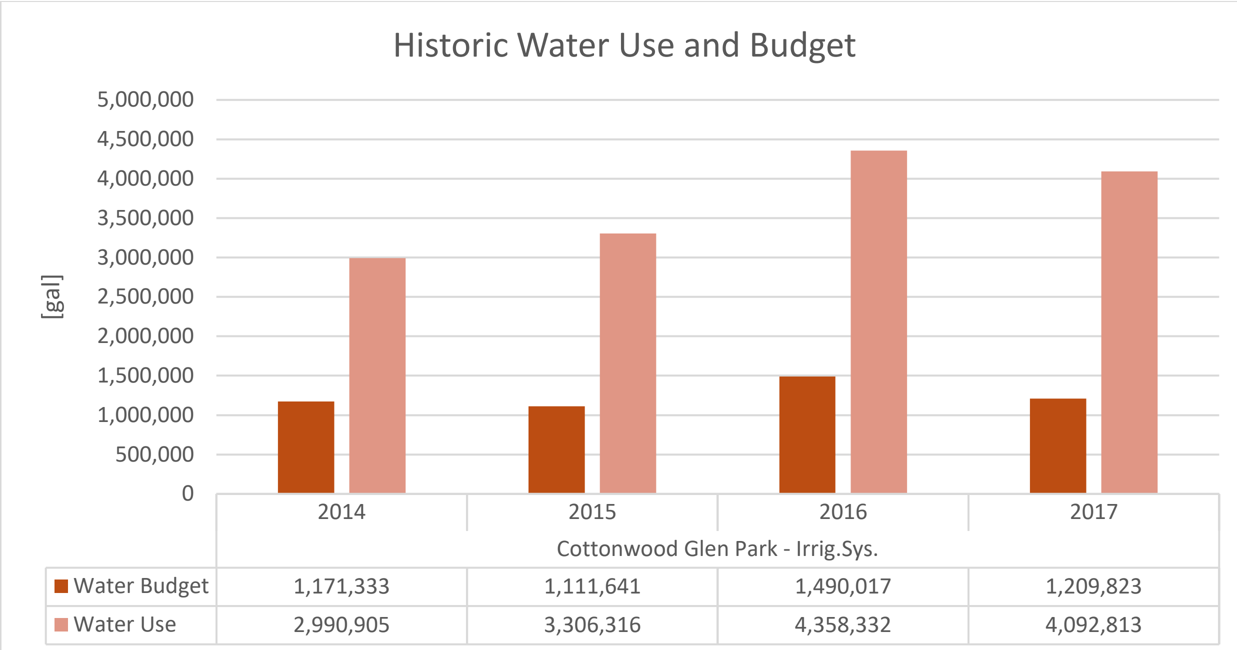
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	2000
Controller A	Controller	2007
Control Wire	Control Wire	2000
All RCVs	Remote Control Valves	2000
Pump (Add Name!)	Pump System	2006

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Acreage Based Calc from Spring Canyon Water Meter	2,990,905
2014 Total		**2,990,905**
2015	Acreage Based Calc from Spring Canyon Water Meter	3,306,316
2015 Total		**3,306,316**
2016	Acreage Based Calc from Spring Canyon Water Meter	4,358,332
2016 Total		**4,358,332**
2017	Acreage Based Calc from Spring Canyon Water Meter	4,092,813
2017 Total		**4,092,813**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Calc based on acreage	1,171,333
2014 Total		**1,171,333**
2015	Calc based on acreage	1,111,641
2015 Total		**1,111,641**
2016	Calc based on acreage	1,490,017
2016 Total		**1,490,017**
2017	Calc based on acreage	1,209,823
2017 Total		**1,209,823**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 2,696.11	$ 312.05
2014	$ 3,375.32	$ 390.66
2015	$ 5,535.76	$ 640.71
2016	$ 4,370.69	$ 505.87
2017	$ 11,727.17	$ 1,357.31
Total	**$ 27,705.05**	**$ 3,206.60**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018																					
2017																					
2016																					
2015																					
2014																					

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

No power or water expense data avialable

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:08 **Analysis Year:** 2018

1 General system information

System Name: Creekside Park - Irrig.Sys.

Location: Creekside Park

Component Count: 4

1.1 User comments

User comments from the data collection forms for a specific year:

No user notes available

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	2.44	100.00%
Grand Total			**2.44**	**100.00%**

2.2 System components:

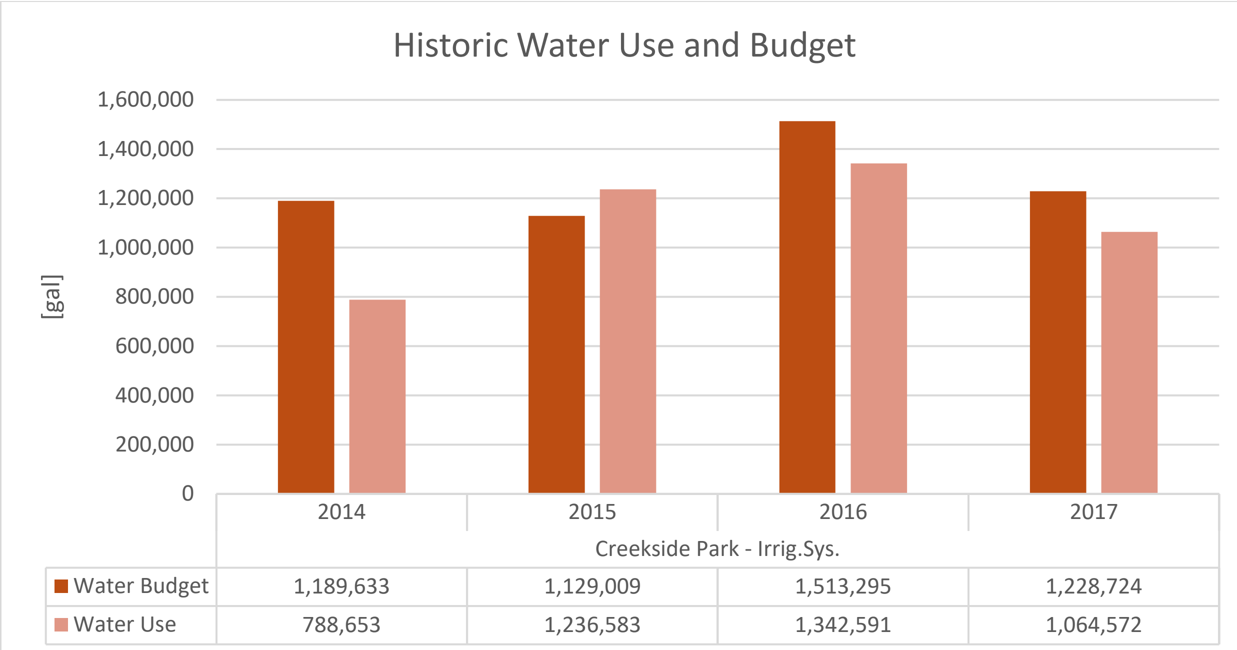
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	1989
Controller A	Controller	2017
Control Wire	Control Wire	1989
All RCVs	Remote Control Valves	1989

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 S-SE H2O Use.xls!CREEKSIDE	788,653
2014 Total		**788,653**
2015	Source: S-SE H2O Use.xls!CREEKSIDE	1,236,583
2015 Total		**1,236,583**
2016	Source: 2016 S-SE H2O Use.xls!CREEKSIDE	1,342,591
2016 Total		**1,342,591**
2017	Source: 2017 South East water use reports.xlsx!CREEKSIDE	1,064,572
2017 Total		**1,064,572**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 S-SE H2O Use.xls!CREEKSIDE	1,189,633
2014 Total		**1,189,633**
2015	Source: S-SE H2O Use.xls!CREEKSIDE	1,129,009
2015 Total		**1,129,009**
2016	Source: 2016 S-SE H2O Use.xls!CREEKSIDE	1,513,295
2016 Total		**1,513,295**
2017	Source: 2017 South East water use reports.xlsx!CREEKSIDE	1,228,724
2017 Total		**1,228,724**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 6,446.28	$ 2,641.92
2014	$ 6,645.24	$ 2,723.46
2015	$ 7,228.87	$ 2,962.65
2016	$ 10,823.58	$ 4,435.89
2017	$ 8,668.76	$ 3,552.77
Total	**$ 39,812.72**	**$ 16,316.69**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018	blue	salmon	blue	blue	blue	blue	blue	blue	blue	grey	blue	blue	blue	blue	blue	blue	salmon	salmon	salmon	blue	blue
2017	grey	grey	grey	grey	grey	grey	grey	grey	grey	blue	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2016	grey	grey	grey	grey	grey	grey	grey	grey	grey	blue	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2015	grey	grey	grey	grey	grey	grey	grey	grey	grey	blue	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2014	grey	grey	grey	grey	grey	grey	grey	grey	grey	blue	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Power	2010	$ 36.52	$ 14.97
O-Cost Power	2011	$ 41.88	$ 17.16
O-Cost Power	2012	$ 47.74	$ 19.57
O-Cost Power	2013	$ 47.70	$ 19.55
O-Cost Power	2014	$ 47.79	$ 19.59
O-Cost Power	2015	$ 197.12	$ 80.79
O-Cost Power Total		**$ 418.75**	**$ 171.62**
O-Cost Water	2010	$ 3,442.11	$ 1,410.70
O-Cost Water	2011	$ 3,088.95	$ 1,265.96
O-Cost Water	2012	$ 4,672.04	$ 1,914.77
O-Cost Water	2013	$ 2,836.40	$ 1,162.46
O-Cost Water	2014	$ 2,774.42	$ 1,137.06
O-Cost Water	2015	$ 3,804.64	$ 1,559.28
O-Cost Water	2016	$ 4,174.51	$ 1,710.86
O-Cost Water	2017	$ 3,430.31	$ 1,405.86
O-Cost Water Total		**$ 28,223.38**	**$ 11,566.96**
Grand Total		**$ 28,642.13**	**$ 11,738.58**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:11 **Analysis Year:** 2018

1 General system information

System Name: Crescent Park - Irrig.Sys.

Location: Crescent Park

Component Count: 5

1.1 User comments

User comments from the data collection forms for a specific year:

Reporting Year	Note
2018	Crescent Park is a new park as of 2018

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	6	100.00%
Grand Total			**6**	**100.00%**

2.2 System components:

Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
Pump station main	Mainline Network	2018
Controller A	Controller	2018
RB RCVs	Remote Control Valves	2018
14 Gauge irri. Wires	Control Wire	2018
Pump (Add Name!)	Pump System	2018

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:

Following water use performance records exist:
No Data Available

Following water budget records exist:
No Data Available

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2014	$ 509.49	$ 84.91
2016	$ 712.65	$ 118.77
2017	$ 934.78	$ 155.80
Total	**$ 2,156.92**	**$ 359.49**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018	blue	blue	salmon	blue	blue	blue	blue	blue	blue	grey	salmon	blue	blue	blue	blue	blue	salmon	blue	salmon	blue	blue
2017	grey	grey	grey	grey	grey	grey	grey	grey	grey	salmon	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2016	grey	grey	grey	grey	grey	grey	grey	grey	grey	salmon	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2015	grey	grey	grey	grey	grey	grey	grey	grey	grey	blue	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2014	grey	grey	grey	grey	grey	grey	grey	grey	grey	blue	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

No power or water expense data avialable

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:10 **Analysis Year:** 2018

1 General system information

System Name: Eastside Park - Irrig.Sys.

Location: Eastside Park

Component Count: 4

1.1 User comments

User comments from the data collection forms for a specific year:

Reporting Year	Note
2018	We need a flow sensor installed to monitor the water that we pull off of PSD's domestic mainline.

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	2.7	100.00%
Grand Total			**2.7**	**100.00%**

2.2 System components:

Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	1997
Controller A	Controller	2018
Control Wire	Control Wire	1997
All RCVs	Remote Control Valves	1997

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:

Following water use performance records exist:
No Data Available

Following water budget records exist:
No Data Available

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 3,484.72	$ 1,290.64
2014	$ 3,197.75	$ 1,184.35
2015	$ 4,179.11	$ 1,547.82
2016	$ 10,259.09	$ 3,799.66
2017	$ 5,888.78	$ 2,181.03
Total	**$ 27,009.45**	**$ 10,003.50**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018																					
2017																					
2016																					
2015																					
2014																					

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

No power or water expense data avialable

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:10 **Analysis Year:** 2018

1 General system information

System Name: Edora Park - Irrig.Sys.

Location: Edora Park

Component Count: 32

1.1 User comments

User comments from the data collection forms for a specific year:

Reporting Year	Note
2018	There are still old sections of mainline in Edora. Failing Isolation valves. We have watering issues due to the shared mainline with Riffenburg and EPIC. Do we need to install another large pump to better support the damans of the system? I would definatley like to meet with someone from to discuss possible options. We continue to add more acreage on a pump station that can not support the demands of the current irrigation system. We will be watering 24/7 with the Spring rehab project.

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	37.6	100.00%
Grand Total			**37.6**	**100.00%**

2.2 System components:

Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

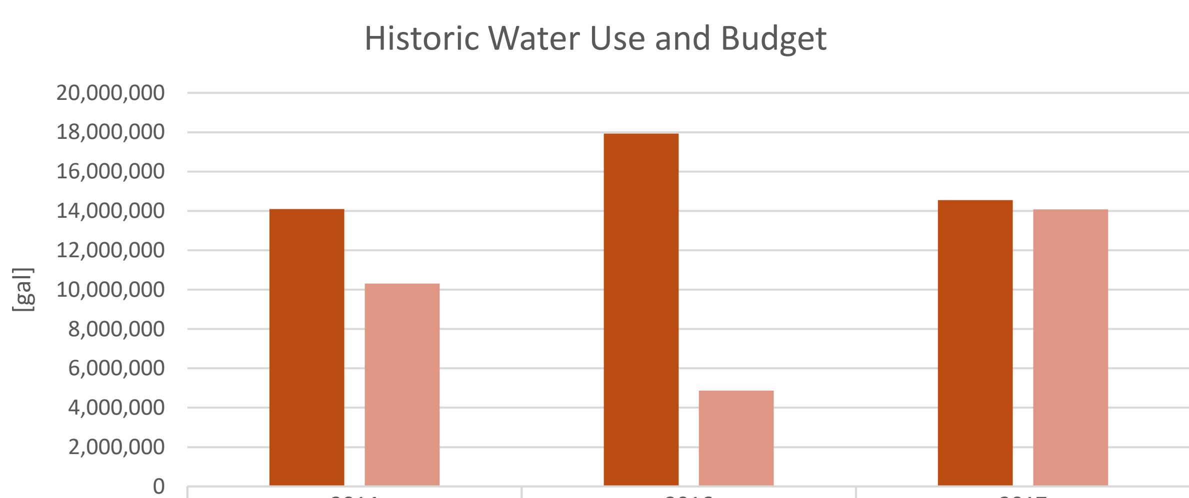
Component	Type	Built/Renovated
Mainline Edora	Mainline Network	1971
Controller 1 Pumphouse	Controller	1971
Control Wire Edora	Control Wire	1971
All RCVs Edora	Remote Control Valves	1971
Controller 2 Pumphouse	Controller	1971
Control Wire EPIC	Control Wire	1985
All RCVs EPIC	Remote Control Valves	1985
Controller 3 EPIC	Controller	1985
Mainline Ballfields	Mainline Network	1999
Control Wire Ballfields	Control Wire	1999

Ballfied RCVs	Remote Control Valves	1999
Mainline West of Ballfields	Mainline Network	2000
RCV's West of Ballfield	Remote Control Valves	2000
Control Wire West ofBallfields	Control Wire	2000
Mainline West Entrance	Mainline Network	2001
Control West Entrance	Control Wire	2001
RCV's West Entrance	Remote Control Valves	2001
Mainline North 40	Mainline Network	2002
Control Wire North 40	Control Wire	2002
RCV's North 40	Remote Control Valves	2002
Mainline Skate Park	Mainline Network	2002
RCV's Skate Park	Remote Control Valves	2002
Control Wire Skate Park	Controller	2002
RCV's BMX/Gardens	Remote Control Valves	2004
Controller 4 BMX	Controller	2004
Mainline Gardens BMX	Mainline Network	2004
Pump Station	Pump System	2006
Mainline EPIC	Mainline Network	2008
Controller 1	Controller	2017
Controller 2	Controller	2017
Controller 3	Controller	2017
Controller 4	Controller	2017

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



	2014	2016	2017
Water Budget	14,090,327	17,923,869	14,553,334
Water Use	10,304,521	4,866,950	14,071,448

Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 S-SE H2O Use.xls!EDORA	10,304,521
2014 Total		**10,304,521**
2016	Source: 2016 S-SE H2O Use.xls!EDORA	4,866,950
2016 Total		**4,866,950**
2017	Source: 2017 South East water use reports.xlsx!EDORA	14,071,448
2017 Total		**14,071,448**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 S-SE H2O Use.xls!EDORA	14,090,327
2014 Total		**14,090,327**
2015	Source: S-SE H2O Use.xls!EDORA	4,041,503
2015 Total		**4,041,503**
2016	Source: 2016 S-SE H2O Use.xls!EDORA	17,923,869
2016 Total		**17,923,869**
2017	Source: 2017 South East water use reports.xlsx!EDORA	14,553,334
2017 Total		**14,553,334**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 30,560.60	$ 812.78
2014	$ 36,461.44	$ 969.72
2015	$ 60,352.76	$ 1,605.13
2016	$ 49,420.04	$ 1,314.36
2017	$ 86,887.95	$ 2,310.85
Total	**$ 263,682.79**	**$ 7,012.84**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018																					
2017																					
2016																					
2015																					
2014																					

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Power	2010	$ 4,628.24	$ 123.09
O-Cost Power	2011	$ 5,278.10	$ 140.38
O-Cost Power	2012	$ 5,048.37	$ 134.27
O-Cost Power	2013	$ 4,503.25	$ 119.77
O-Cost Power	2014	$ 4,543.54	$ 120.84
O-Cost Power	2015	$ 4,512.16	$ 120.00
O-Cost Power	2016	$ 5,451.39	$ 144.98
O-Cost Power	2017	$ 6,212.75	$ 165.23
O-Cost Power Total		**$ 40,177.80**	**$ 1,068.56**
Grand Total		**$ 40,177.80**	**$ 1,068.56**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:10 **Analysis Year:** 2018

1 General system information

System Name: English Ranch Park - Irrig.Sys.

Location: English Ranch Park

Component Count: 6

1.1 User comments

User comments from the data collection forms for a specific year:

Reporting Year	Note
2018	Two Irritrol clocks were changed to one WeatherTrak clock in 2016.

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	12.66	100.00%
Grand Total			**12.66**	**100.00%**

2.2 System components:

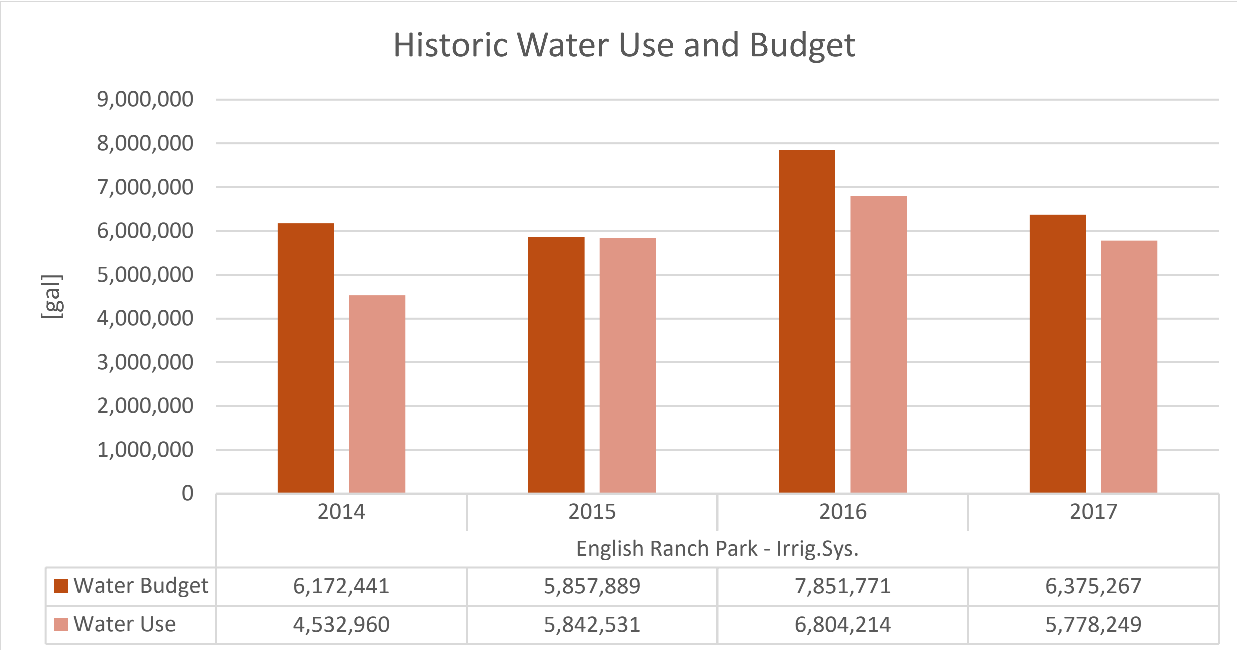
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	1999
Controller A	Controller	2016
Control Wire	Control Wire	1999
All RCVs	Remote Control Valves	1999
30HP Pump	Pump System	2013
5HP Pump	Pump System	2013

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 S-SE H2O Use.xls!ENGLISH RANCH	4,532,960
2014 Total		**4,532,960**
2015	Source: S-SE H2O Use.xls!ENGLISH RANCH	5,842,531
2015 Total		**5,842,531**
2016	Source: 2016 S-SE H2O Use.xls!ENGLISH RANCH	6,804,214
2016 Total		**6,804,214**
2017	Source: 2017 East water use reports.xlsx!ENGLISH RANCH	5,778,249
2017 Total		**5,778,249**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 S-SE H2O Use.xls!ENGLISH RANCH	6,172,441
2014 Total		**6,172,441**
2015	Source: S-SE H2O Use.xls!ENGLISH RANCH	5,857,889
2015 Total		**5,857,889**
2016	Source: 2016 S-SE H2O Use.xls!ENGLISH RANCH	7,851,771
2016 Total		**7,851,771**
2017	Source: 2017 East water use reports.xlsx!ENGLISH RANCH	6,375,267
2017 Total		**6,375,267**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 16,075.89	$ 1,269.82
2014	$ 18,385.59	$ 1,452.26
2015	$ 15,123.44	$ 1,194.58
2016	$ 21,777.76	$ 1,720.20
2017	$ 18,756.09	$ 1,481.52
Total	**$ 90,118.76**	**$ 7,118.39**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018																					
2017																					
2016																					
2015																					
2014																					

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Power	2010	$ 1,422.08	$ 112.33
O-Cost Power	2011	$ 2,021.81	$ 159.70
O-Cost Power	2012	$ 2,454.55	$ 193.88
O-Cost Power	2013	$ 2,311.93	$ 182.62
O-Cost Power	2014	$ 1,661.37	$ 131.23
O-Cost Power	2015	$ 1,693.68	$ 133.78
O-Cost Power	2016	$ 2,026.39	$ 160.06
O-Cost Power	2017	$ 2,636.89	$ 208.29
O-Cost Power Total		**$ 16,228.70**	**$ 1,281.89**
O-Cost Water	2010	$ 3,302.41	$ 260.85
O-Cost Water Total		**$ 3,302.41**	**$ 260.85**
Grand Total		**$ 19,531.11**	**$ 1,542.74**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:09 **Analysis Year:** 2018

1 General system information

System Name: Fossil Creek Park - Irrig.Sys.

Location: Fossil Creek Park

Component Count: 10

1.1 User comments

User comments from the data collection forms for a specific year:

Reporting Year	Note
2018	Isolation valve replacement program is in place and currently a total of 6 valves have been replaced, as purposly targeted, over the last 2 years. This is to alleviate need to shut down the system when any main line repairs are needed. Various valves are surrounded by large vault boxes for easy access/inspection. 2013 pump renovation with motors replaced ($32,455). A large part of irrigation failure is due to poor water quality. Turf quality reflects water and soil quality. Water is high in sodium content and soils are calcium deficient. There are cultural practices/programs in place for maximum growth.

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	37.36	100.00%
Grand Total			**37.36**	**100.00%**

2.2 System components:

Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

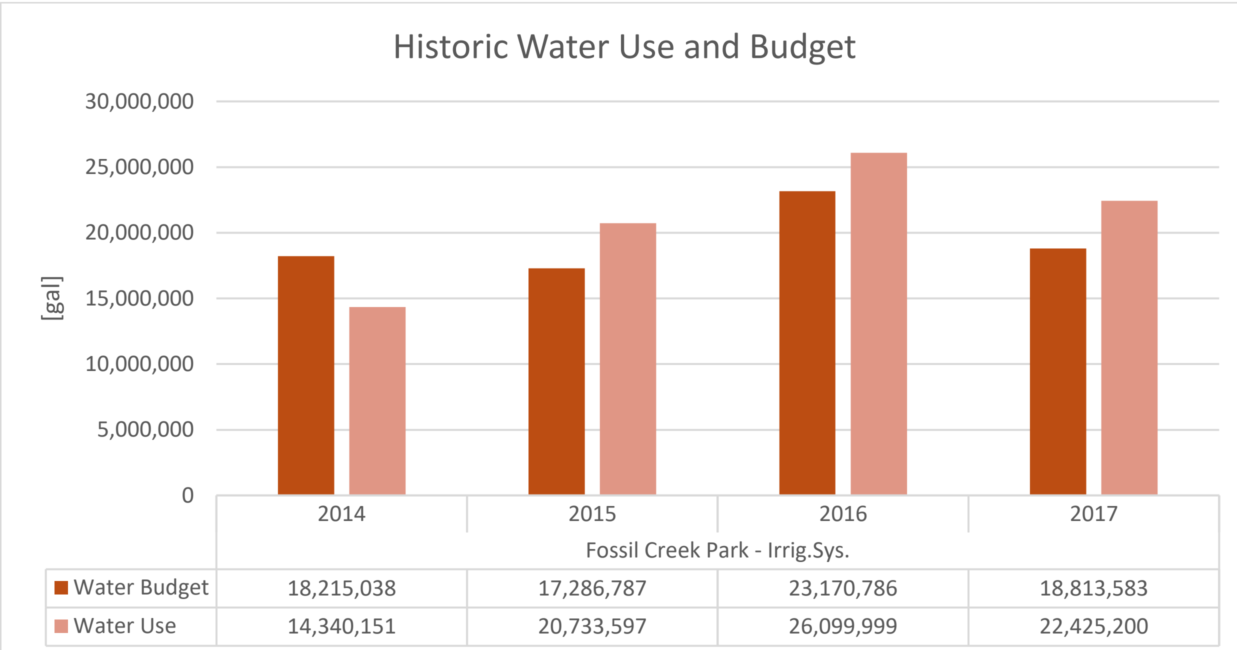
Component	Type	Built/Renovated
All Mainline	Mainline Network	2003
Controller 100	Controller	2003
Control Wire	Control Wire	2003
All RCVs	Remote Control Valves	2003
Dog Park Controller	Controller	2003
Oval Controller	Controller	2003
Water Feature	Controller	2003
Pump Station	Pump System	2003
Amiad Filtration unit	Pump System	2003

Ballfield controller	Controller	2003

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 S-SE H2O Use.xls!FOSSIL CREEK	12,675,839
2014	Source: 2014 S-SE H2O Use.xls!FOSSIL CREEK ballfields	1,664,312
2014 Total		**14,340,151**
2015	Source: S-SE H2O Use.xls!FOSSIL CREEK	19,341,603
2015	Source: S-SE H2O Use.xls!FOSSIL CREEK ballfields	1,391,994
2015 Total		**20,733,597**
2016	Source: 2016 S-SE H2O Use.xls!FOSSIL CREEK	24,081,363
2016	Source: 2016 S-SE H2O Use.xls!FOSSIL CREEK ballfields	2,018,636
2016 Total		**26,099,999**
2017	Source: 2017 South water use reports.xlsx!FOSSIL CREEK	20,610,778
2017	Source: 2017 South water use reports.xlsx!FOSSIL CREEK ballfields	1,814,423
2017 Total		**22,425,200**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 S-SE H2O Use.xls!FOSSIL CREEK	16,264,820
2014	Source: 2014 S-SE H2O Use.xls!FOSSIL CREEK ballfields	1,950,218

2014 Total		**18,215,038**
2015	Source: S-SE H2O Use.xls!FOSSIL CREEK	15,435,953
2015	Source: S-SE H2O Use.xls!FOSSIL CREEK ballfields	1,850,834
2015 Total		**17,286,787**
2016	Source: 2016 S-SE H2O Use.xls!FOSSIL CREEK	20,689,974
2016	Source: 2016 S-SE H2O Use.xls!FOSSIL CREEK ballfields	2,480,812
2016 Total		**23,170,786**
2017	Source: 2017 South water use reports.xlsx!FOSSIL CREEK	16,799,281
2017	Source: 2017 South water use reports.xlsx!FOSSIL CREEK ballfields	2,014,302
2017 Total		**18,813,583**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 67,210.60	$ 1,799.00
2014	$ 66,918.57	$ 1,791.18
2015	$ 68,901.60	$ 1,844.26
2016	$ 72,950.68	$ 1,952.64
2017	$ 85,715.57	$ 2,294.31
Total	**$ 361,697.03**	**$ 9,681.40**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Power	2010	$ 5,023.11	$ 134.45
O-Cost Power	2011	$ 5,688.07	$ 152.25
O-Cost Power	2012	$ 6,504.21	$ 174.10
O-Cost Power	2013	$ 4,702.71	$ 125.88
O-Cost Power	2014	$ 5,817.14	$ 155.71
O-Cost Power	2015	$ 5,580.78	$ 149.38
O-Cost Power	2016	$ 6,301.75	$ 168.68
O-Cost Power	2017	$ 6,609.92	$ 176.93
O-Cost Power Total		**$ 46,227.69**	**$ 1,237.36**
Grand Total		**$ 46,227.69**	**$ 1,237.36**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:07 **Analysis Year:** 2018

1 General system information

System Name: Freedom Square Park - Irrig.Sys.

Location: Freedom Square Park

Component Count: 4

1.1 User comments

User comments from the data collection forms for a specific year:

No user notes available

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	0.26	100.00%
Grand Total			**0.26**	**100.00%**

2.2 System components:

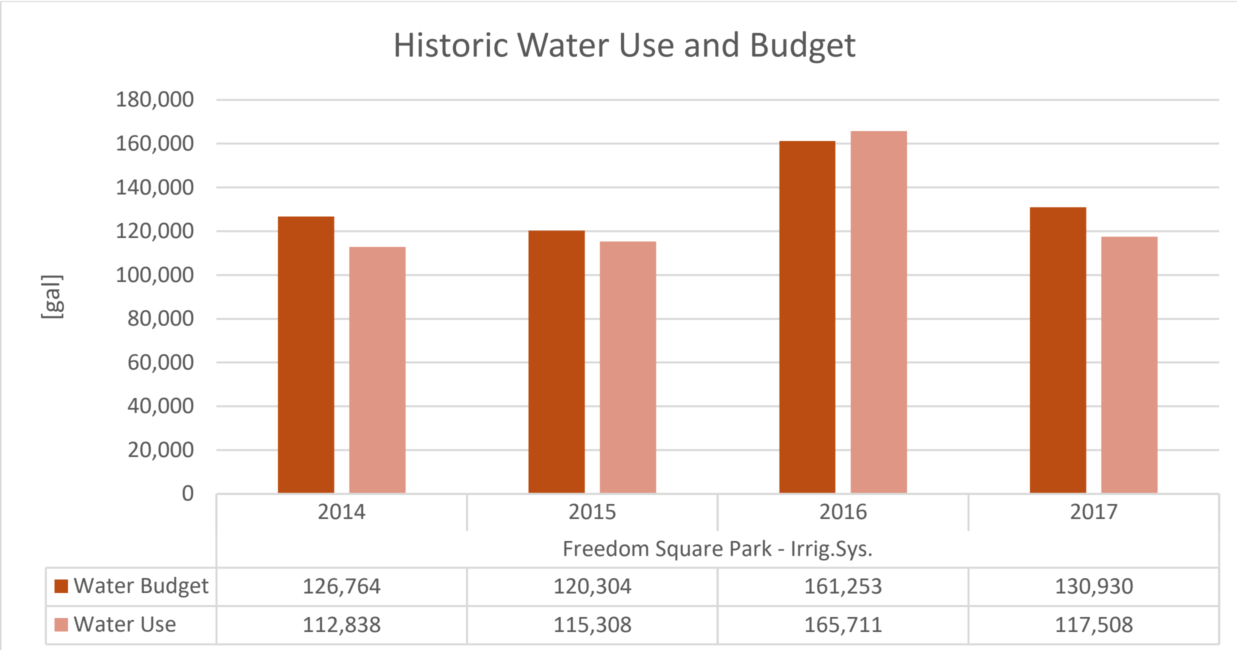
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
Domestic	Mainline Network	1975
Controller A	Controller	1995
Weathermatic RCVs	Remote Control Valves	1975
Trad 14gauge	Control Wire	1975

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!FREEDOM SQUARE	112,838
2014 Total		**112,838**
2015	Source: SW-NS-CEM Water Use.xls!FREEDOM SQUARE	115,308
2015 Total		**115,308**
2016	Source: SW-NS-CEM Water Use.xls!FREEDOM SQUARE	165,711
2016 Total		**165,711**
2017	Source: 2017 Northside water use reports.xlsx!FREEDOM SQUARE	117,508
2017 Total		**117,508**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!FREEDOM SQUARE	126,764
2014 Total		**126,764**
2015	Source: SW-NS-CEM Water Use.xls!FREEDOM SQUARE	120,304
2015 Total		**120,304**
2016	Source: SW-NS-CEM Water Use.xls!FREEDOM SQUARE	161,253
2016 Total		**161,253**
2017	Source: 2017 Northside water use reports.xlsx!FREEDOM SQUARE	130,930
2017 Total		**130,930**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 1,045.46	$ 4,020.99
2014	$ 2,050.67	$ 7,887.18
2015	$ 1,259.26	$ 4,843.30
2016	$ 1,322.38	$ 5,086.07
2017	$ 1,209.76	$ 4,652.92
Total	**$ 6,887.52**	**$ 26,490.45**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018																					
2017																					
2016																					
2015																					
2014																					

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Power	2010	$ 35.70	$ 137.31
O-Cost Power	2011	$ 41.30	$ 158.85
O-Cost Power	2012	$ 47.45	$ 182.50
O-Cost Power	2013	$ 45.03	$ 173.19
O-Cost Power	2014	$ 48.67	$ 187.19
O-Cost Power	2015	$ 63.37	$ 243.73
O-Cost Power	2016	$ 43.03	$ 165.50
O-Cost Power	2017	$ 47.15	$ 181.35
O-Cost Power Total		**$ 371.70**	**$ 1,429.62**
O-Cost Water	2010	$ 539.53	$ 2,075.12
O-Cost Water	2011	$ 566.85	$ 2,180.19
O-Cost Water	2012	$ 662.98	$ 2,549.92
O-Cost Water	2013	$ 453.43	$ 1,743.96
O-Cost Water	2014	$ 637.81	$ 2,453.12
O-Cost Water	2015	$ 548.13	$ 2,108.19
O-Cost Water	2016	$ 759.58	$ 2,921.46
O-Cost Water	2017	$ 589.57	$ 2,267.58
O-Cost Water Total		**$ 4,757.88**	**$ 18,299.54**
Grand Total		**$ 5,129.58**	**$ 19,729.15**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:09 **Analysis Year:** 2018

1 General system information

System Name: Golden Meadows Park - Irrig.Sys.

Location: Golden Meadows Park

Component Count: 5

1.1 User comments

User comments from the data collection forms for a specific year:

No user notes available

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	7.8	100.00%
Grand Total			**7.8**	**100.00%**

2.2 System components:

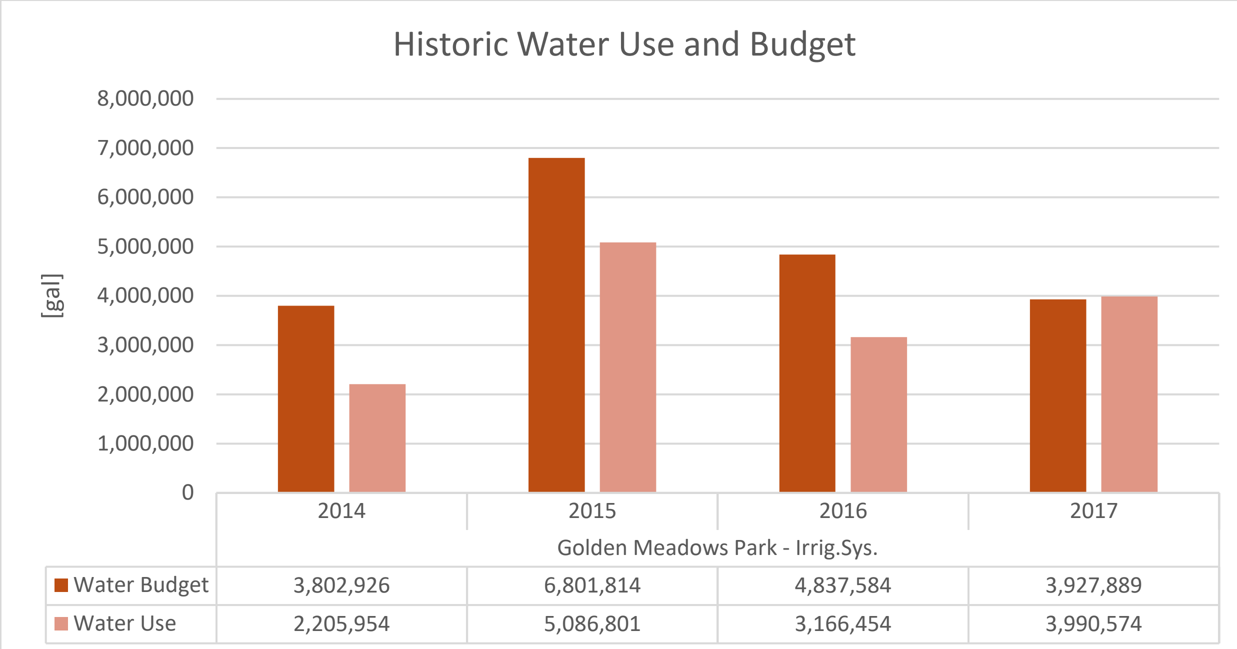
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	1985
Controller A	Controller	2017
Control Wire	Control Wire	1985
All RCVs	Remote Control Valves	1985
Pump Station	Pump System	2008

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 S-SE H2O Use.xls!GOLDEN MEADOWS	2,205,954
2014 Total		**2,205,954**
2015	Source: S-SE H2O Use.xls!GOLDEN MEADOWS	5,086,801
2015 Total		**5,086,801**
2016	Source: 2016 S-SE H2O Use.xls!GOLDEN MEADOWS	3,166,454
2016 Total		**3,166,454**
2017	Source: 2017 South East water use reports.xlsx!GOLDEN MEADOWS	3,990,574
2017 Total		**3,990,574**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 S-SE H2O Use.xls!GOLDEN MEADOWS	3,802,926
2014 Total		**3,802,926**
2015	Source: S-SE H2O Use.xls!GOLDEN MEADOWS	6,801,814
2015 Total		**6,801,814**
2016	Source: 2016 S-SE H2O Use.xls!GOLDEN MEADOWS	4,837,584
2016 Total		**4,837,584**
2017	Source: 2017 South East water use reports.xlsx!GOLDEN MEADOWS	3,927,889
2017 Total		**3,927,889**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 14,063.77	$ 1,803.05
2014	$ 30,224.82	$ 3,874.98
2015	$ 9,956.71	$ 1,276.50
2016	$ 20,682.74	$ 2,651.63
2017	$ 17,696.14	$ 2,268.74
Total	**$ 92,624.19**	**$ 11,874.90**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Power	2010	$ 1,751.54	$ 224.56
O-Cost Power	2011	$ 2,154.69	$ 276.24
O-Cost Power	2012	$ 1,516.95	$ 194.48
O-Cost Power	2013	$ 2,079.22	$ 266.57
O-Cost Power	2014	$ 1,821.78	$ 233.56
O-Cost Power	2015	$ 2,327.93	$ 298.45
O-Cost Power	2016	$ 2,742.96	$ 351.66
O-Cost Power	2017	$ 2,690.09	$ 344.88
O-Cost Power Total		**$ 17,085.16**	**$ 2,190.41**
O-Cost Water	2014	$ 4,749.65	$ 608.93
O-Cost Water Total		**$ 4,749.65**	**$ 608.93**
Grand Total		**$ 21,834.81**	**$ 2,799.33**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:09 **Analysis Year:** 2018

1 General system information

System Name: Greenbriar Park - Irrig.Sys.

Location: Greenbriar Park

Component Count: 6

1.1 User comments

User comments from the data collection forms for a specific year:

No user notes available

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	18.08	100.00%
Grand Total			**18.08**	**100.00%**

2.2 System components:

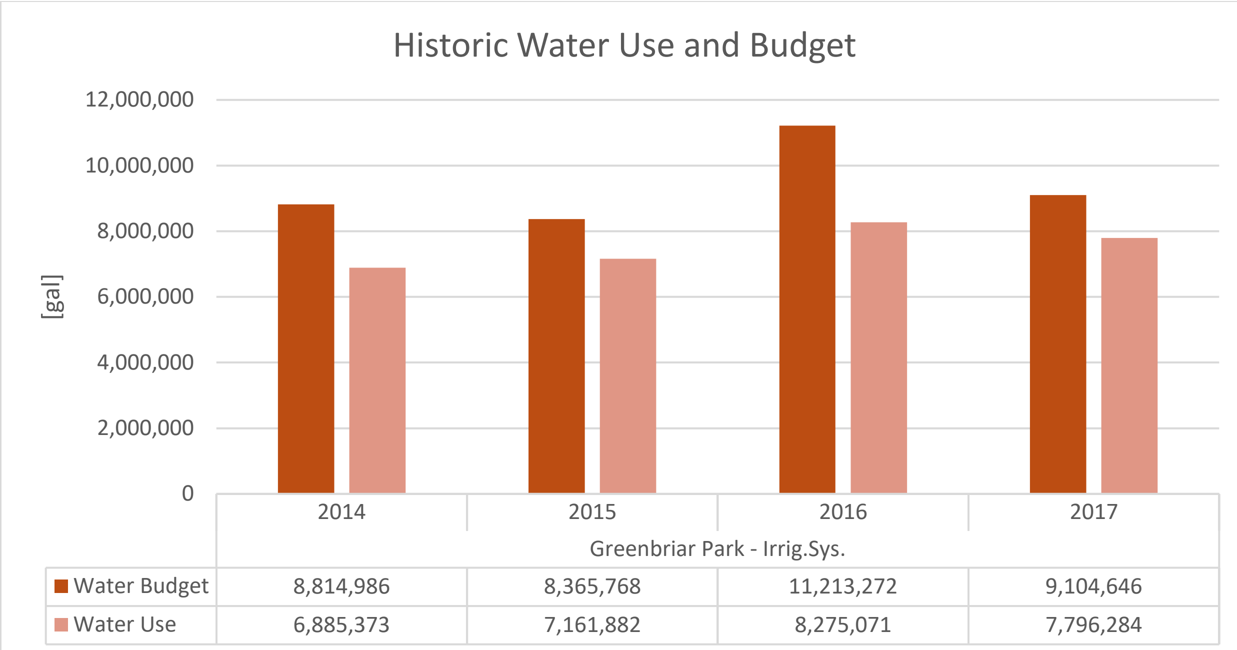
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
Pump station main	Mainline Network	1993
Controller A	Controller	2013
RB RCVs	Remote Control Valves	2017
Griswald RCVs	Remote Control Valves	1993
14 Gauge irri. Wires	Control Wire	1993
Pump (Add Name!)	Pump System	2005

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!GREENBRIAR	6,885,373
2014 Total		**6,885,373**
2015	Source: SW-NS-CEM Water Use.xls!GREENBRIAR	7,161,882
2015 Total		**7,161,882**
2016	Source: SW-NS-CEM Water Use.xls!GREENBRIAR	8,275,071
2016 Total		**8,275,071**
2017	Source: 2017 Northside water use reports.xlsx!GREENBRIAR	7,796,284
2017 Total		**7,796,284**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!GREENBRIAR	8,814,986
2014 Total		**8,814,986**
2015	Source: SW-NS-CEM Water Use.xls!GREENBRIAR	8,365,768
2015 Total		**8,365,768**
2016	Source: SW-NS-CEM Water Use.xls!GREENBRIAR	11,213,272
2016 Total		**11,213,272**
2017	Source: 2017 Northside water use reports.xlsx!GREENBRIAR	9,104,646
2017 Total		**9,104,646**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 31,814.66	$ 1,759.66
2014	$ 30,272.92	$ 1,674.39
2015	$ 29,883.20	$ 1,652.83
2016	$ 27,424.96	$ 1,516.87
2017	$ 34,463.46	$ 1,906.16
Total	**$ 153,859.21**	**$ 8,509.91**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018																					
2017																					
2016																					
2015																					
2014																					

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Power	2010	$ 4,853.85	$ 268.47
O-Cost Power	2011	$ 1,947.83	$ 107.73
O-Cost Power	2012	$ 1,713.15	$ 94.75
O-Cost Power	2013	$ 1,828.50	$ 101.13
O-Cost Power	2014	$ 1,759.22	$ 97.30
O-Cost Power	2015	$ 1,382.64	$ 76.47
O-Cost Power	2016	$ 1,314.17	$ 72.69
O-Cost Power	2017	$ 1,611.36	$ 89.12
O-Cost Power Total		**$ 16,410.72**	**$ 907.67**
O-Cost Water	2010	$ 3,049.63	$ 168.67
O-Cost Water	2011	$ 11,642.41	$ 643.94
O-Cost Water	2012	$ 8,493.11	$ 469.75
O-Cost Water	2013	$ 3,957.48	$ 218.89
O-Cost Water	2014	$ 6,930.82	$ 383.34
O-Cost Water	2015	$ 11,924.66	$ 659.55
O-Cost Water	2016	$ 7,029.48	$ 388.80
O-Cost Water	2017	$ 7,743.57	$ 428.29
O-Cost Water Total		**$ 60,771.16**	**$ 3,361.24**
Grand Total		**$ 77,181.88**	**$ 4,268.91**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:11 **Analysis Year:** 2018

1 General system information

System Name: Harmony Park - Irrig.Sys.

Location: Harmony Park

Component Count: 5

1.1 User comments

User comments from the data collection forms for a specific year:

Reporting Year	Note
2018	harmony Park irrigation is run by pump owned and operated by P.S.D…it has 2 Irritrol clocks

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	11.4	100.00%
Grand Total			**11.4**	**100.00%**

2.2 System components:

Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	2002
Controller A	Controller	2002
Control Wire	Control Wire	2002
All RCVs	Remote Control Valves	2002
Vertical Turbine Pump	Pump System	2002

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:

Following water use performance records exist:
No Data Available

Following water budget records exist:
No Data Available

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 8,158.11	$ 715.62
2014	$ 7,514.17	$ 659.14
2015	$ 6,819.53	$ 598.20
2016	$ 5,717.46	$ 501.53
2017	$ 9,993.07	$ 876.58
Total	**$ 38,202.34**	**$ 3,351.08**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018																					
2017																					
2016																					
2015																					
2014																					

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

No power or water expense data avialable

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:10 **Analysis Year:** 2018

1 General system information

System Name: Homestead Park - Irrig.Sys.

Location: Homestead Park

Component Count: 5

1.1 User comments

User comments from the data collection forms for a specific year:

Reporting Year	Note
2018	Booster pump had an electrical failure. A new lcd screen was installed.

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	7.15	100.00%
Grand Total			**7.15**	**100.00%**

2.2 System components:

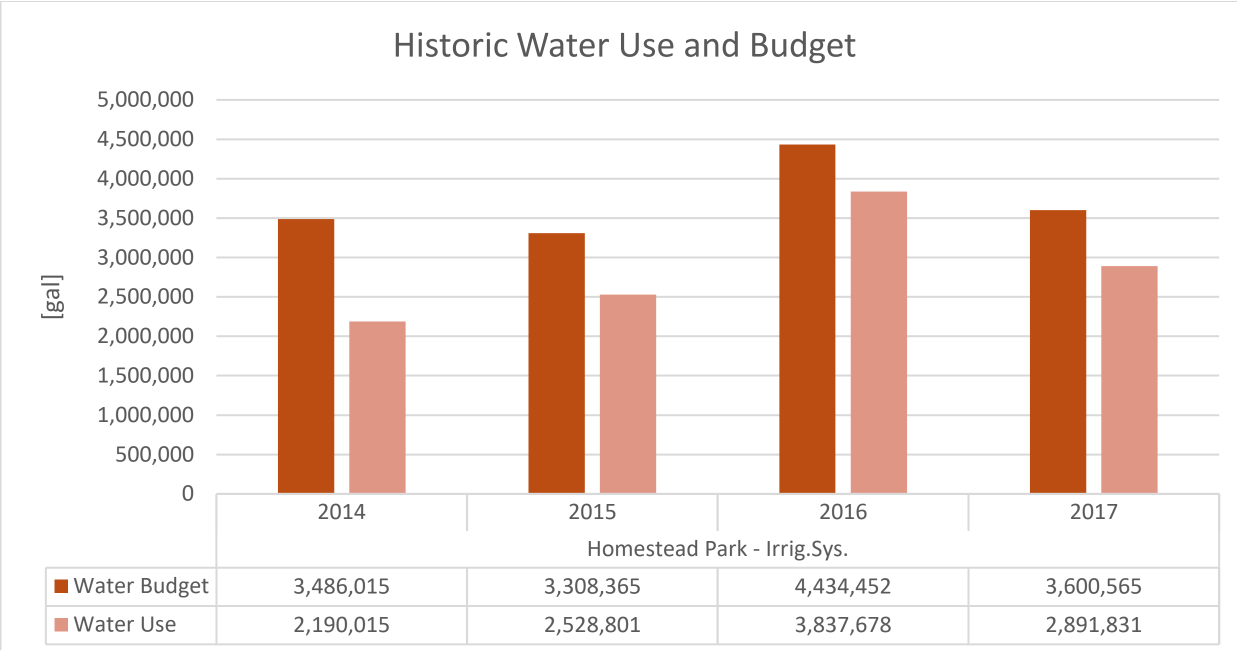
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	2003
Controller A	Controller	2018
Control Wire	Control Wire	2003
All RCVs	Remote Control Valves	2003
Booster Pump	Pump System	2003

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 S-SE H2O Use.xls!HOMESTEAD	2,190,015
2014 Total		**2,190,015**
2015	Source: S-SE H2O Use.xls!HOMESTEAD	2,528,801
2015 Total		**2,528,801**
2016	Source: 2016 S-SE H2O Use.xls!HOMESTEAD	3,837,678
2016 Total		**3,837,678**
2017	Source: 2017 South water use reports.xlsx!HOMESTEAD	2,891,831
2017 Total		**2,891,831**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 S-SE H2O Use.xls!HOMESTEAD	3,486,015
2014 Total		**3,486,015**
2015	Source: S-SE H2O Use.xls!HOMESTEAD	3,308,365
2015 Total		**3,308,365**
2016	Source: 2016 S-SE H2O Use.xls!HOMESTEAD	4,434,452
2016 Total		**4,434,452**
2017	Source: 2017 South water use reports.xlsx!HOMESTEAD	3,600,565
2017 Total		**3,600,565**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 13,164.33	$ 1,841.17
2014	$ 18,937.62	$ 2,648.62
2015	$ 13,068.85	$ 1,827.81
2016	$ 14,529.84	$ 2,032.15
2017	$ 24,244.74	$ 3,390.87
Total	**$ 83,945.38**	**$ 11,740.61**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018																					
2017																					
2016																					
2015																					
2014																					

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Water	2010	$ 5,513.28	$ 771.09
O-Cost Water	2011	$ 4,913.01	$ 687.13
O-Cost Water	2012	$ 6,254.11	$ 874.70
O-Cost Water	2013	$ 6,097.97	$ 852.86
O-Cost Water	2014	$ 7,951.66	$ 1,112.12
O-Cost Water	2015	$ 7,824.28	$ 1,094.30
O-Cost Water	2016	$ 10,093.77	$ 1,411.72
O-Cost Water	2017	$ 8,674.01	$ 1,213.15
O-Cost Water Total		**$ 57,322.09**	**$ 8,017.08**
Grand Total		**$ 57,322.09**	**$ 8,017.08**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:11 **Analysis Year:** 2018

1 General system information

System Name: Indian Hills Park - Irrig.Sys.

Location: Indian Hills Park

Component Count: 4

1.1 User comments

User comments from the data collection forms for a specific year:

No user notes available

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	2	100.00%
Grand Total			**2**	**100.00%**

2.2 System components:

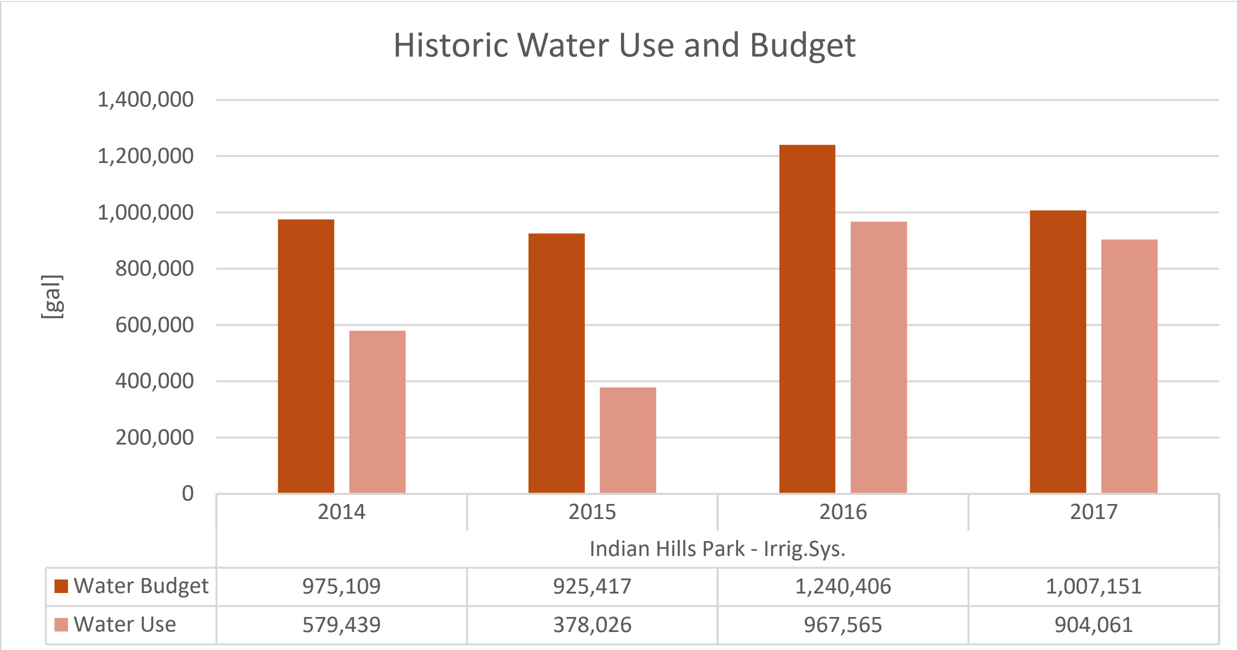
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	2017
Controller A	Controller	2017
Control Wire	Control Wire	2017
All RCVs	Remote Control Valves	2017

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 S-SE H2O Use.xls!Indian Hills	579,439
2014 Total		**579,439**
2015	Source: S-SE H2O Use.xls!Indian Hills	378,026
2015 Total		**378,026**
2016	Source: 2016 S-SE H2O Use.xls!Indian Hills	967,565
2016 Total		**967,565**
2017	Source: 2017 South East water use reports.xlsx!Indian Hills	904,061
2017 Total		**904,061**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 S-SE H2O Use.xls!Indian Hills	975,109
2014 Total		**975,109**
2015	Source: S-SE H2O Use.xls!Indian Hills	925,417
2015 Total		**925,417**
2016	Source: 2016 S-SE H2O Use.xls!Indian Hills	1,240,406
2016 Total		**1,240,406**
2017	Source: 2017 South East water use reports.xlsx!Indian Hills	1,007,151
2017 Total		**1,007,151**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 5,045.05	$ 2,522.52
2014	$ 10,738.19	$ 5,369.09
2015	$ 31,468.58	$ 15,734.29
2016	$ 14,091.50	$ 7,045.75
2017	$ 9,016.57	$ 4,508.28
Total	**$ 70,359.88**	**$ 35,179.94**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018																					
2017																					
2016																					
2015																					
2014																					

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Water	2010	$ 2,351.57	$ 1,175.79
O-Cost Water	2011	$ 2,943.58	$ 1,471.79
O-Cost Water	2012	$ 3,733.00	$ 1,866.50
O-Cost Water	2013	$ 2,604.77	$ 1,302.39
O-Cost Water	2014	$ 2,501.31	$ 1,250.66
O-Cost Water	2015	$ 1,684.55	$ 842.28
O-Cost Water	2016	$ 3,571.79	$ 1,785.90
O-Cost Water	2017	$ 3,712.17	$ 1,856.09
O-Cost Water Total		**$ 23,102.74**	**$ 11,551.37**
Grand Total		**$ 23,102.74**	**$ 11,551.37**

IRRIGATION SYSTEM REPORT

Report Date:	10/7/2019 -- 17:08	**Analysis Year:**	2018

1 General system information

System Name: Landings Park - Irrig.Sys.

Location: Landings Park

Component Count: 4

1.1 User comments

User comments from the data collection forms for a specific year:

Reporting Year	Note
2018	Domestic System with a backflow replacement in 2017. Meter valves need to be replaced and the curb stop weeps.

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	7.1	100.00%
Grand Total			**7.1**	**100.00%**

2.2 System components:

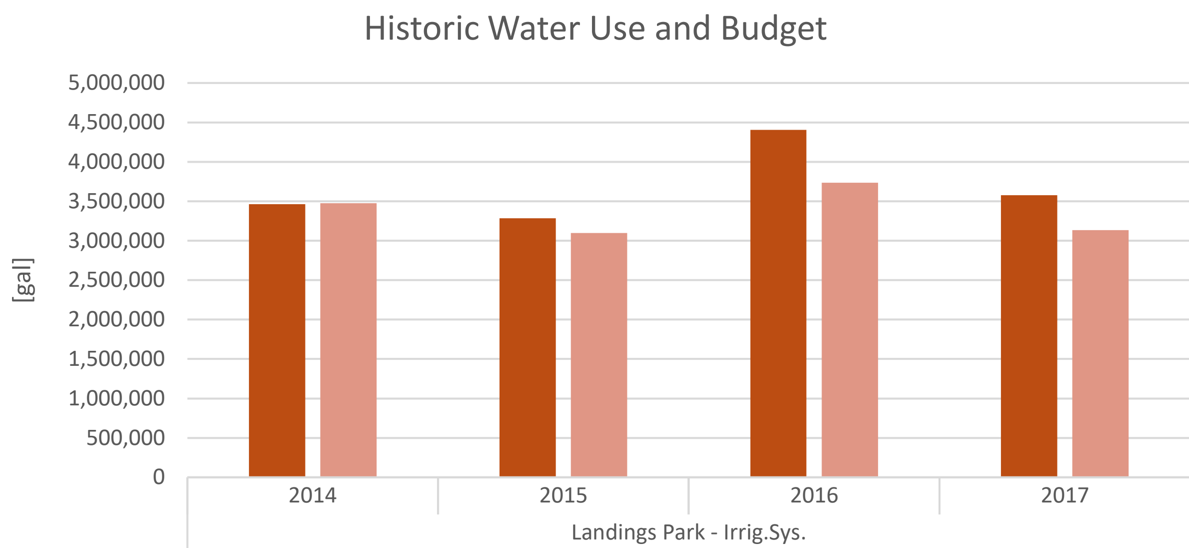
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	1986
Controller A	Controller	1986
Control Wire	Control Wire	1986
All RCVs	Remote Control Valves	1986

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



	2014	2015	2016	2017
Water Budget	3,461,637	3,285,230	4,403,442	3,575,387
Water Use	3,475,535	3,098,939	3,733,752	3,135,712

Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 S-SE H2O Use.xls!LANDINGS	3,475,535
2014 Total		**3,475,535**
2015	Source: S-SE H2O Use.xls!LANDINGS	3,098,939
2015 Total		**3,098,939**
2016	Source: 2016 S-SE H2O Use.xls!LANDINGS	3,733,752
2016 Total		**3,733,752**
2017	Source: 2017 South water use reports.xlsx!LANDINGS	3,135,712
2017 Total		**3,135,712**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 S-SE H2O Use.xls!LANDINGS	3,461,637
2014 Total		**3,461,637**
2015	Source: S-SE H2O Use.xls!LANDINGS	3,285,230
2015 Total		**3,285,230**
2016	Source: 2016 S-SE H2O Use.xls!LANDINGS	4,403,442
2016 Total		**4,403,442**
2017	Source: 2017 South water use reports.xlsx!LANDINGS	3,575,387
2017 Total		**3,575,387**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 20,121.74	$ 2,834.05
2014	$ 19,897.71	$ 2,802.49
2015	$ 14,275.82	$ 2,010.68
2016	$ 16,521.13	$ 2,326.92
2017	$ 21,504.56	$ 3,028.81
Total	**$ 92,320.97**	**$ 13,002.95**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018																					
2017																					
2016																					
2015																					
2014																					

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Water	2010	$ 8,229.88	$ 1,159.14
O-Cost Water	2011	$ 8,040.26	$ 1,132.43
O-Cost Water	2012	$ 17,287.20	$ 2,434.82
O-Cost Water	2013	$ 9,320.49	$ 1,312.75
O-Cost Water	2014	$ 13,432.13	$ 1,891.85
O-Cost Water	2015	$ 9,797.59	$ 1,379.94
O-Cost Water	2016	$ 12,152.79	$ 1,711.66
O-Cost Water	2017	$ 11,475.15	$ 1,616.22
O-Cost Water Total		**$ 89,735.49**	**$ 12,638.80**
Grand Total		**$ 89,735.49**	**$ 12,638.80**

IRRIGATION SYSTEM REPORT

Report Date:	10/7/2019 -- 17:08	**Analysis Year:**	2018

1 General system information

System Name:	Lee Martinez Park - Irrig.Sys.
Location:	Lee Martinez Park
Component Count:	7

1.1 User comments

User comments from the data collection forms for a specific year:

Reporting Year	Note
2018	East mainline near tree henge and Discovery Center and mainline south along retaining wall were installed later than 1976.

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	15.82	100.00%
Grand Total			**15.82**	**100.00%**

2.2 System components:

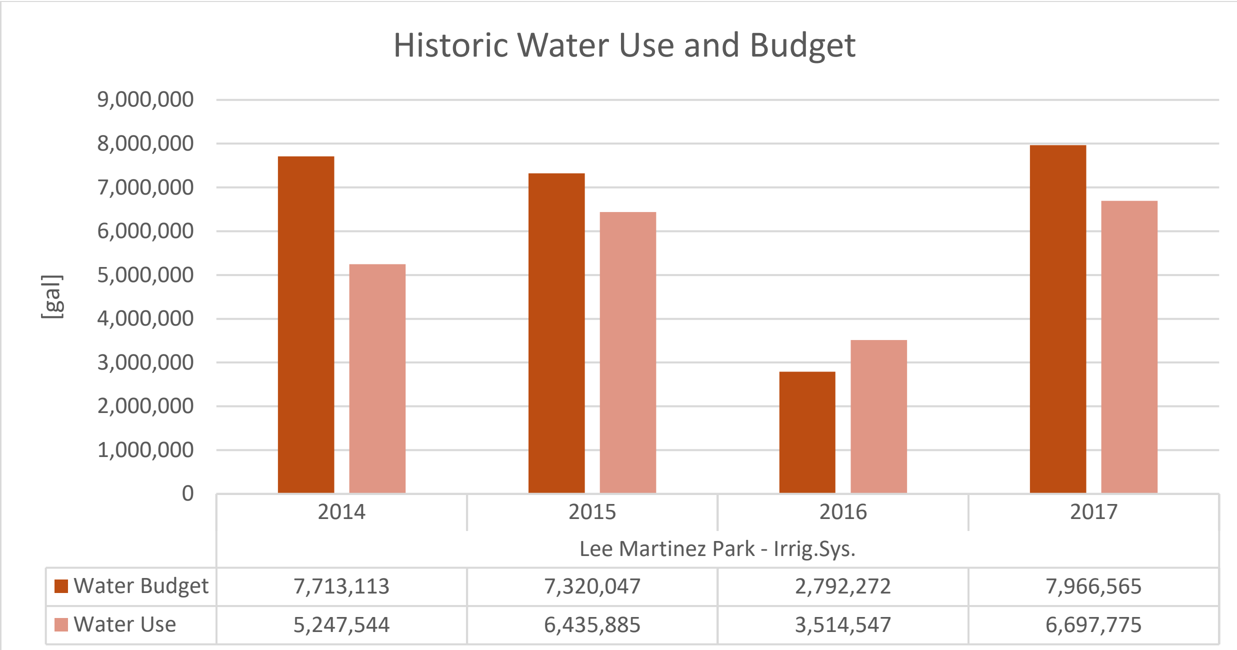
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
Domestic	Mainline Network	1976
Controller A	Controller	2018
Control B	Controller	2018
RB RCVs	Remote Control Valves	2014
Griswald RCVs	Remote Control Valves	1976
Weathermatic RCVs	Remote Control Valves	1976
14 Gauge irri. Wires	Control Wire	1976

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!MARTINEZ	5,247,544
2014 Total		**5,247,544**
2015	Source: SW-NS-CEM Water Use.xls!MARTINEZ	6,435,885
2015 Total		**6,435,885**
2016	Source: SW-NS-CEM Water Use.xls!MARTINEZ	3,514,547
2016 Total		**3,514,547**
2017	Source: 2017 Northside water use reports.xlsx!MARTINEZ	6,697,775
2017 Total		**6,697,775**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!MARTINEZ	7,713,113
2014 Total		**7,713,113**
2015	Source: SW-NS-CEM Water Use.xls!MARTINEZ	7,320,047
2015 Total		**7,320,047**
2016	Source: SW-NS-CEM Water Use.xls!MARTINEZ	2,792,272
2016 Total		**2,792,272**
2017	Source: 2017 Northside water use reports.xlsx!MARTINEZ	7,966,565
2017 Total		**7,966,565**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 43,965.87	$ 2,779.13
2014	$ 30,362.71	$ 1,919.26
2015	$ 32,136.23	$ 2,031.37
2016	$ 60,603.52	$ 3,830.82
2017	$ 40,329.40	$ 2,549.27
Total	**$ 207,397.73**	**$ 13,109.84**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018	blue	salmon	salmon	salmon	blue	salmon	salmon	salmon	salmon	grey	salmon	blue	blue	blue	blue	blue	blue	blue	salmon	blue	blue
2017	grey	grey	grey	grey	grey	grey	grey	grey	grey	blue	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2016	grey	grey	grey	grey	grey	grey	grey	grey	grey	blue	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2015	grey	grey	grey	grey	grey	grey	grey	grey	grey	blue	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2014	grey	grey	grey	grey	grey	grey	grey	grey	grey	blue	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Water	2010	$ 18,862.99	$ 1,192.35
O-Cost Water	2011	$ 19,436.87	$ 1,228.63
O-Cost Water	2012	$ 28,205.18	$ 1,782.88
O-Cost Water	2013	$ 19,353.93	$ 1,223.38
O-Cost Water	2014	$ 18,144.52	$ 1,146.94
O-Cost Water	2015	$ 21,881.38	$ 1,383.15
O-Cost Water	2016	$ 31,633.20	$ 1,999.57
O-Cost Water	2017	$ 22,581.60	$ 1,427.41
O-Cost Water Total		**$ 180,099.67**	**$ 11,384.30**
Grand Total		**$ 180,099.67**	**$ 11,384.30**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:08 **Analysis Year:** 2018

1 General system information

System Name: Leisure Park - Irrig.Sys.

Location: Leisure Park

Component Count: 4

1.1 User comments

User comments from the data collection forms for a specific year:

No user notes available

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	0.56	100.00%
Grand Total			**0.56**	**100.00%**

2.2 System components:

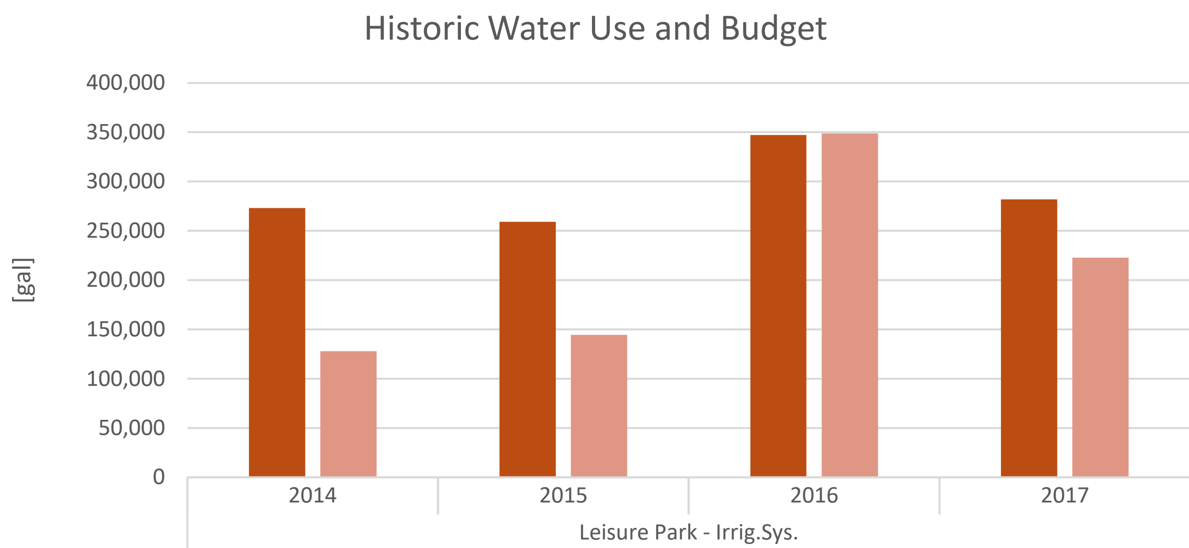
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI’s

Component	Type	Built/Renovated
All Mainline	Mainline Network	1984
Controller A	Controller	1984
Control Wire	Control Wire	1984
All RCVs	Remote Control Valves	1984

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



	2014	2015	2016	2017
Water Budget	273,031	259,117	347,314	282,002
Water Use	127,989	144,660	349,024	222,915

Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 S-SE H2O Use.xls!Leisure	127,989
2014 Total		**127,989**
2015	Source: S-SE H2O Use.xls!Leisure	144,660
2015 Total		**144,660**
2016	Source: 2016 S-SE H2O Use.xls!Leisure	349,024
2016 Total		**349,024**
2017	Source: 2017 South East water use reports.xlsx!Leisure	222,915
2017 Total		**222,915**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 S-SE H2O Use.xls!Leisure	273,031
2014 Total		**273,031**
2015	Source: S-SE H2O Use.xls!Leisure	259,117
2015 Total		**259,117**
2016	Source: 2016 S-SE H2O Use.xls!Leisure	347,314
2016 Total		**347,314**
2017	Source: 2017 South East water use reports.xlsx!Leisure	282,002
2017 Total		**282,002**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 1,707.49	$ 3,049.09
2014	$ 3,234.93	$ 5,776.66
2015	$ 1,617.90	$ 2,889.10
2016	$ 7,867.50	$ 14,049.10
2017	$ 5,964.15	$ 10,650.26
Total	**$ 20,391.96**	**$ 36,414.22**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018																					
2017																					
2016																					
2015																					
2014																					

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Power	2010	$ 23.24	$ 41.50
O-Cost Power	2011	$ 24.43	$ 43.63
O-Cost Power	2012	$ 31.82	$ 56.82
O-Cost Power	2013	$ 19.91	$ 35.55
O-Cost Power	2014	$ 27.89	$ 49.80
O-Cost Power	2015	$ 33.85	$ 60.45
O-Cost Power	2016	$ 24.84	$ 44.36
O-Cost Power	2017	$ 23.49	$ 41.95
O-Cost Power Total		**$ 209.47**	**$ 374.05**
O-Cost Water	2010	$ 703.01	$ 1,255.38
O-Cost Water	2011	$ 734.07	$ 1,310.84
O-Cost Water	2012	$ 1,292.03	$ 2,307.20
O-Cost Water	2013	$ 546.83	$ 976.48
O-Cost Water	2014	$ 592.27	$ 1,057.63
O-Cost Water	2015	$ 503.92	$ 899.86
O-Cost Water	2016	$ 1,159.01	$ 2,069.66
O-Cost Water	2017	$ 826.54	$ 1,475.96
O-Cost Water Total		**$ 6,357.68**	**$ 11,353.00**
Grand Total		**$ 6,567.15**	**$ 11,727.05**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:07 **Analysis Year:** 2018

1 General system information

System Name: Library Park - Irrig.Sys.

Location: Library Park

Component Count: 6

1.1 User comments

User comments from the data collection forms for a specific year:

Reporting Year	Note
2018	Library Park, Front of Library, Carnegie Courtyard

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	3.59	100.00%
Grand Total			**3.59**	**100.00%**

2.2 System components:

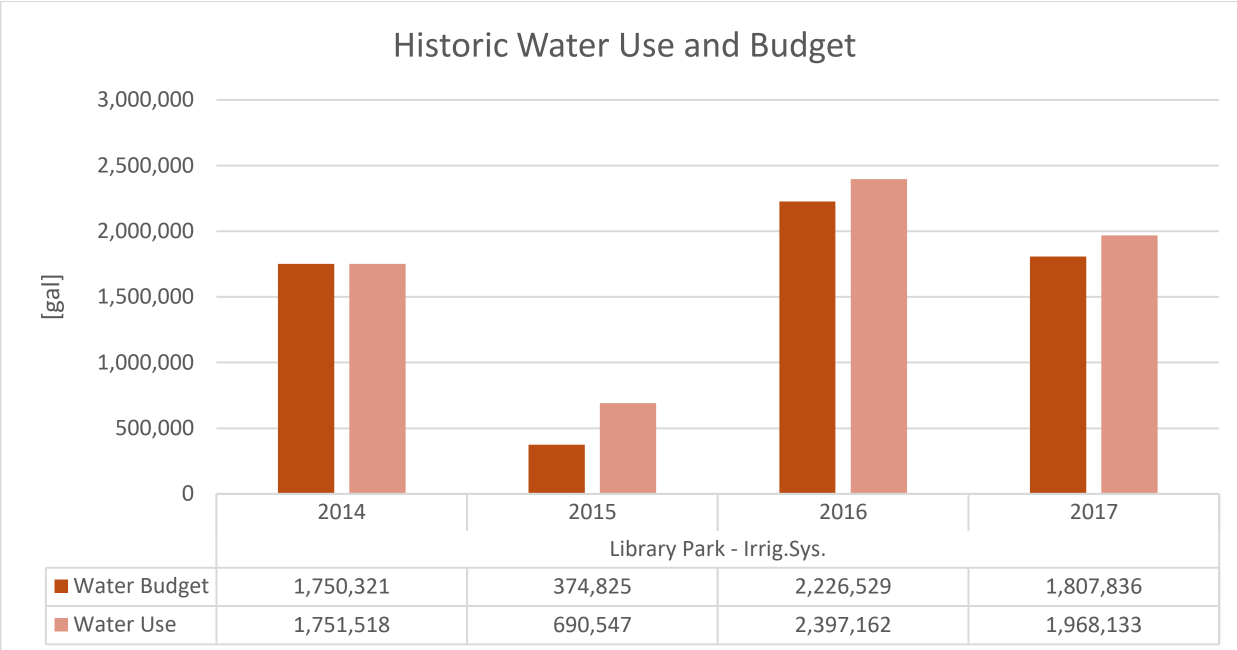
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	1977
Controller A	Controller	2011
Control Wire	Control Wire	1977
All RCVs	Remote Control Valves	1977
Controller B	Controller	2013
Controller C	Controller	2013

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 DaH-Fat Water Use.xls!LIBRARY	1,751,518
2014 Total		**1,751,518**
2015	Source: DaH-Fat Water Use.xls!LIBRARY	690,547
2015 Total		**690,547**
2016	Source: DaH-Fat Water Use.xls!LIBRARY	2,397,162
2016 Total		**2,397,162**
2017	Source: 2017 Facilities water use reports.xlsx!LIBRARY	1,968,133
2017 Total		**1,968,133**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 DaH-Fat Water Use.xls!LIBRARY	1,750,321
2014 Total		**1,750,321**
2015	Source: DaH-Fat Water Use.xls!LIBRARY	374,825
2015 Total		**374,825**
2016	Source: DaH-Fat Water Use.xls!LIBRARY	2,226,529
2016 Total		**2,226,529**
2017	Source: 2017 Facilities water use reports.xlsx!LIBRARY	1,807,836
2017 Total		**1,807,836**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 19,331.80	$ 5,384.90
2014	$ 19,604.75	$ 5,460.93
2015	$ 18,274.28	$ 5,090.33
2016	$ 17,167.49	$ 4,782.03
2017	$ 19,787.48	$ 5,511.83
Total	**$ 94,165.80**	**$ 26,230.03**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018																					
2017																					
2016																					
2015																					
2014																					

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Power	2010	$ 43.55	$ 12.13
O-Cost Power	2011	$ 49.37	$ 13.75
O-Cost Power	2012	$ 47.14	$ 13.13
O-Cost Power	2013	$ 51.50	$ 14.35
O-Cost Power	2014	$ 51.63	$ 14.38
O-Cost Power	2015	$ 50.56	$ 14.08
O-Cost Power	2016	$ 42.92	$ 11.96
O-Cost Power	2017	$ 51.33	$ 14.30
O-Cost Power Total		**$ 388.00**	**$ 108.08**
O-Cost Water	2010	$ 7,071.48	$ 1,969.77
O-Cost Water	2011	$ 6,629.76	$ 1,846.73
O-Cost Water	2012	$ 9,917.11	$ 2,762.43
O-Cost Water	2013	$ 6,969.85	$ 1,941.46
O-Cost Water	2014	$ 9,179.64	$ 2,557.00
O-Cost Water	2015	$ 7,656.62	$ 2,132.76
O-Cost Water	2016	$ 9,958.10	$ 2,773.84
O-Cost Water	2017	$ 6,414.12	$ 1,786.66
O-Cost Water Total		**$ 63,796.68**	**$ 17,770.66**
Grand Total		**$ 64,184.68**	**$ 17,878.74**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:10 **Analysis Year:** 2018

1 General system information

System Name: Miramont Park - Irrig.Sys.

Location: Miramont Park

Component Count: 6

1.1 User comments

User comments from the data collection forms for a specific year:

Reporting Year	Note
2018	Replacing/Updating outdated valves AND updating controller to smart style ET controller.

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	9.5	100.00%
Grand Total			**9.5**	**100.00%**

2.2 System components:

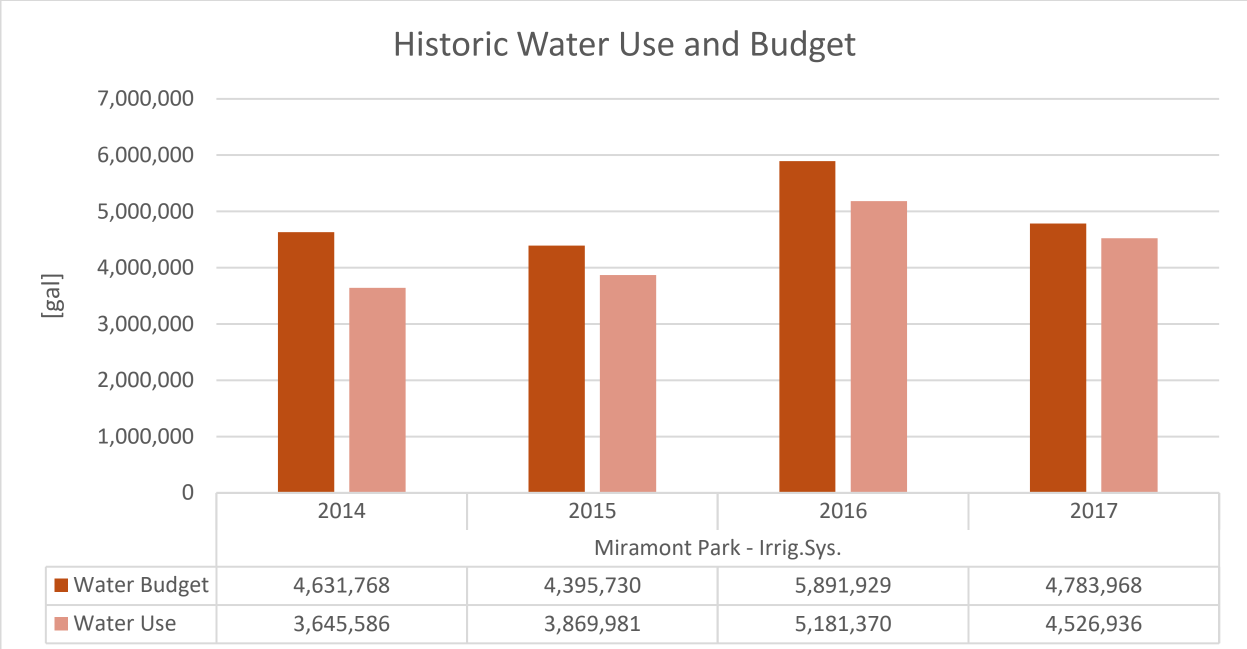
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	2000
Controller A	Controller	2000
Control Wire	Control Wire	2000
All RCVs	Remote Control Valves	2000
Controller B	Controller	2000
Pump Station	Pump System	1998

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 S-SE H2O Use.xls!MIRAMONT	3,645,586
2014 Total		**3,645,586**
2015	Source: S-SE H2O Use.xls!MIRAMONT	3,869,981
2015 Total		**3,869,981**
2016	Source: 2016 S-SE H2O Use.xls!MIRAMONT	5,181,370
2016 Total		**5,181,370**
2017	Source: 2017 South water use reports.xlsx!MIRAMONT	4,526,936
2017 Total		**4,526,936**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 S-SE H2O Use.xls!MIRAMONT	4,631,768
2014 Total		**4,631,768**
2015	Source: S-SE H2O Use.xls!MIRAMONT	4,395,730
2015 Total		**4,395,730**
2016	Source: 2016 S-SE H2O Use.xls!MIRAMONT	5,891,929
2016 Total		**5,891,929**
2017	Source: 2017 South water use reports.xlsx!MIRAMONT	4,783,968
2017 Total		**4,783,968**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 16,271.93	$ 1,712.83
2014	$ 17,030.68	$ 1,792.70
2015	$ 9,341.60	$ 983.33
2016	$ 7,940.67	$ 835.86
2017	$ 6,858.59	$ 721.96
Total	**$ 57,443.47**	**$ 6,046.68**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018	salmon	blue	blue	blue	blue	blue	blue	blue	blue	grey	blue	blue	blue	salmon	salmon	blue	salmon	blue	salmon	blue	blue
2017	grey	grey	grey	grey	grey	grey	grey	grey	grey	salmon	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2016	grey	grey	grey	grey	grey	grey	grey	grey	grey	salmon	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2015	grey	grey	grey	grey	grey	grey	grey	grey	grey	salmon	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2014	grey	grey	grey	grey	grey	grey	grey	grey	grey	salmon	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Power	2010	$ 2,302.23	$ 242.34
O-Cost Power	2011	$ 3,105.80	$ 326.93
O-Cost Power	2012	$ 2,260.79	$ 237.98
O-Cost Power	2013	$ 3,013.60	$ 317.22
O-Cost Power	2014	$ 2,834.09	$ 298.33
O-Cost Power	2015	$ 2,834.56	$ 298.37
O-Cost Power	2016	$ 2,466.48	$ 259.63
O-Cost Power	2017	$ 2,276.17	$ 239.60
O-Cost Power Total		**$ 21,093.72**	**$ 2,220.39**
O-Cost Water	2010	$ 3,541.82	$ 372.82
O-Cost Water	2011	$ 1,716.27	$ 180.66
O-Cost Water	2012	$ 3,805.94	$ 400.63
O-Cost Water	2013	$ 1,165.78	$ 122.71
O-Cost Water	2014	$ 2,396.89	$ 252.30
O-Cost Water Total		**$ 12,626.70**	**$ 1,329.13**
Grand Total		**$ 33,720.42**	**$ 3,549.52**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:08 **Analysis Year:** 2018

1 General system information

System Name: Old Fort Collins Heritage Park - Irrig.Sys.

Location: Old Fort Collins Heritage Park

Component Count: 6

1.1 User comments

User comments from the data collection forms for a specific year:

Reporting Year	Note
2018	3 different aged irrigation systems have been combined

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	4.9	100.00%
Grand Total			**4.9**	**100.00%**

2.2 System components:

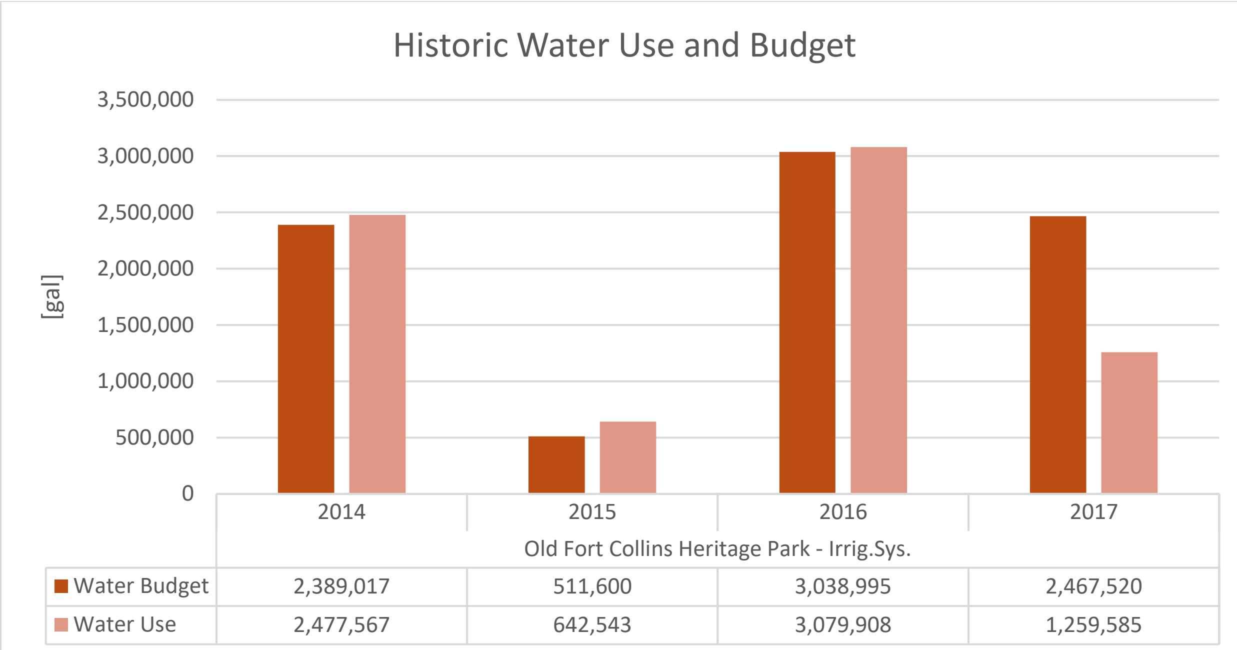
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	2006
Controller A	Controller	2015
All RCVs	Remote Control Valves	2006
Mainline	Mainline Network	1980
New control wire	Control Wire	2006
old control wire	Control Wire	1980

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 DaH-Fat Water Use.xls!NORTHSIDE	2,477,567
2014 Total		**2,477,567**
2015	Source: DaH-Fat Water Use.xls!NORTHSIDE	642,543
2015 Total		**642,543**
2016	Source: DaH-Fat Water Use.xls!NORTHSIDE	3,079,908
2016 Total		**3,079,908**
2017	Source: 2017 Facilities water use reports.xlsx!NORTHSIDE	1,259,585
2017 Total		**1,259,585**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 DaH-Fat Water Use.xls!NORTHSIDE	2,389,017
2014 Total		**2,389,017**
2015	Source: DaH-Fat Water Use.xls!NORTHSIDE	511,600
2015 Total		**511,600**
2016	Source: DaH-Fat Water Use.xls!NORTHSIDE	3,038,995
2016 Total		**3,038,995**
2017	Source: 2017 Facilities water use reports.xlsx!NORTHSIDE	2,467,520
2017 Total		**2,467,520**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 15,158.03	$ 3,093.47
2014	$ 16,520.02	$ 3,371.43
2015	$ 18,458.57	$ 3,767.06
2016	$ 16,440.13	$ 3,355.13
2017	$ 20,478.14	$ 4,179.21
Total	**$ 87,054.88**	**$ 17,766.30**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018																					
2017																					
2016																					
2015																					
2014																					

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Water	2010	$ 9,193.72	$ 1,876.27
O-Cost Water	2011	$ 6,833.60	$ 1,394.61
O-Cost Water	2012	$ 10,363.85	$ 2,115.07
O-Cost Water	2013	$ 6,764.79	$ 1,380.57
O-Cost Water	2014	$ 8,604.00	$ 1,755.92
O-Cost Water	2015	$ 7,441.73	$ 1,518.72
O-Cost Water	2016	$ 9,675.40	$ 1,974.57
O-Cost Water	2017	$ 8,266.55	$ 1,687.05
O-Cost Water Total		**$ 67,143.64**	**$ 13,702.78**
Grand Total		**$ 67,143.64**	**$ 13,702.78**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:10 **Analysis Year:** 2018

1 General system information

System Name: Overland Park - Irrig.Sys.

Location: Overland Park

Component Count: 5

1.1 User comments

User comments from the data collection forms for a specific year:

No user notes available

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	11	100.00%
Grand Total			**11**	**100.00%**

2.2 System components:

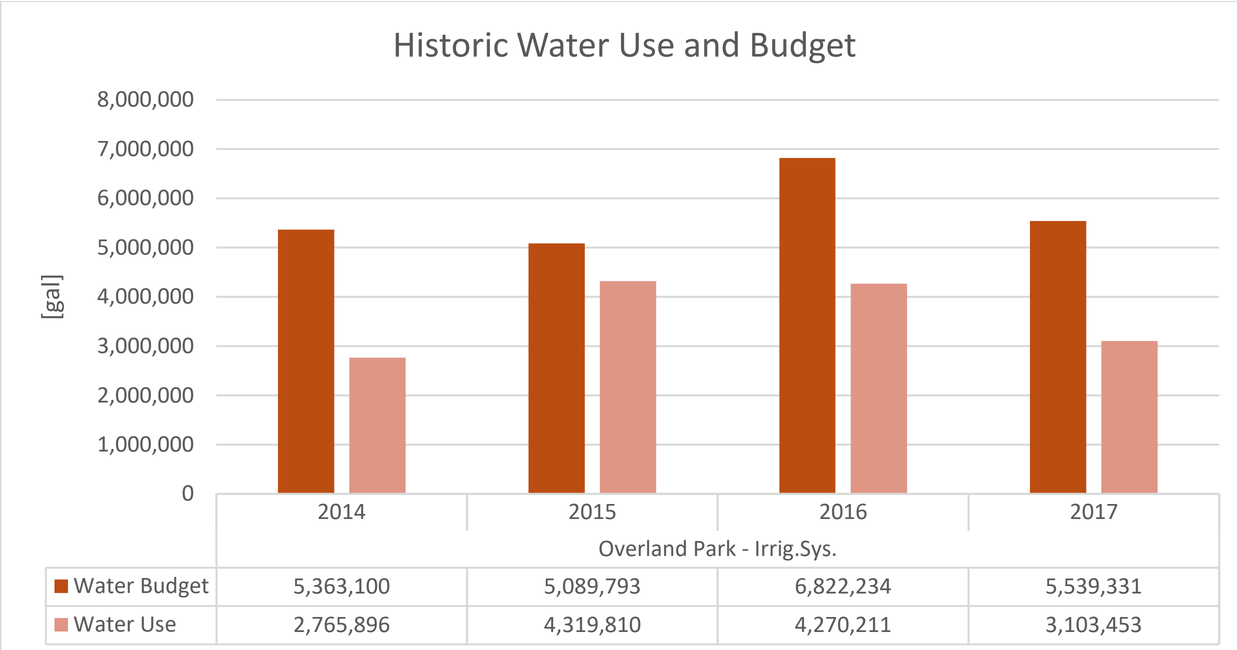
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	1988
Controller A	Controller	2016
Control Wire	Control Wire	1988
All RCVs	Remote Control Valves	1988
Pump (Add Name!)	Pump System	2013

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!OVERLAND	2,765,896
2014 Total		**2,765,896**
2015	Source: SW-NS-CEM Water Use.xls!OVERLAND	4,319,810
2015 Total		**4,319,810**
2016	Source: SW-NS-CEM Water Use.xls!OVERLAND	4,270,211
2016 Total		**4,270,211**
2017	Source: 2017 South West water use reports.xlsx!OVERLAND	3,103,453
2017 Total		**3,103,453**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!OVERLAND	5,363,100
2014 Total		**5,363,100**
2015	Source: SW-NS-CEM Water Use.xls!OVERLAND	5,089,793
2015 Total		**5,089,793**
2016	Source: SW-NS-CEM Water Use.xls!OVERLAND	6,822,234
2016 Total		**6,822,234**
2017	Source: 2017 South West water use reports.xlsx!OVERLAND	5,539,331
2017 Total		**5,539,331**

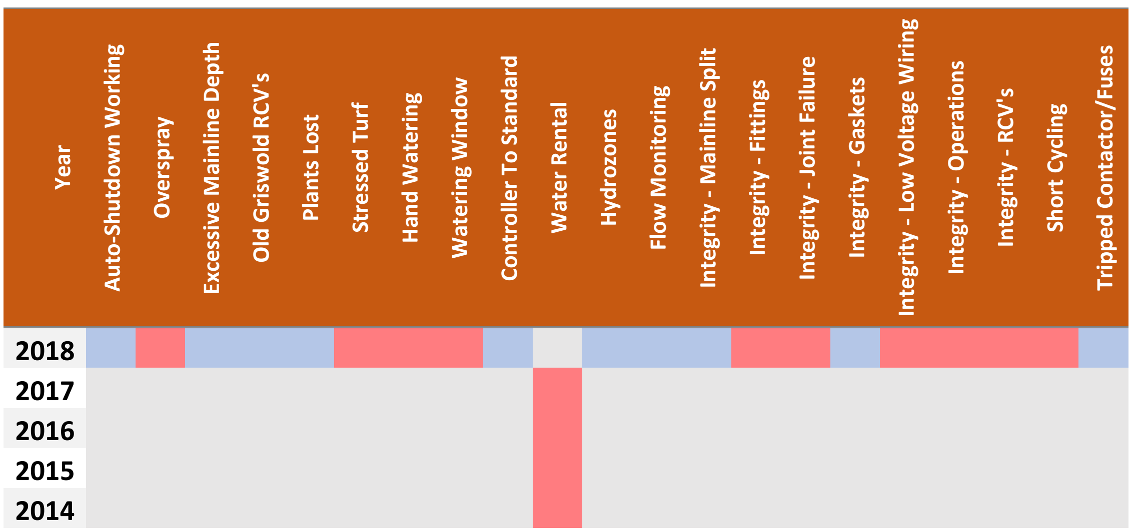
3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 18,843.65	$ 1,713.06
2014	$ 27,922.78	$ 2,538.43
2015	$ 10,735.01	$ 975.91
2016	$ 14,305.30	$ 1,300.48
2017	$ 18,234.02	$ 1,657.64
Total	**$ 90,040.75**	**$ 8,185.52**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):



3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Power	2010	$ 1,464.12	$ 133.10
O-Cost Power	2011	$ 1,600.27	$ 145.48
O-Cost Power	2012	$ 1,280.77	$ 116.43
O-Cost Power	2013	$ 1,283.14	$ 116.65
O-Cost Power	2014	$ 1,277.52	$ 116.14
O-Cost Power	2015	$ 1,518.25	$ 138.02
O-Cost Power	2016	$ 1,529.19	$ 139.02
O-Cost Power	2017	$ 1,624.29	$ 147.66
O-Cost Power Total		**$ 11,577.55**	**$ 1,052.50**
Grand Total		**$ 11,577.55**	**$ 1,052.50**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:09 **Analysis Year:** 2018

1 General system information

System Name: Rabbit Brush Park - Irrig.Sys.

Location: Rabbit Brush Park

Component Count: 4

1.1 User comments

User comments from the data collection forms for a specific year:

Reporting Year	Note
2018	Rabbit Brush has a few issues, mainly just old valves, and terrible DU. If we ran a water audit, I bet it would fail.

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	1.52	100.00%
Grand Total			**1.52**	**100.00%**

2.2 System components:

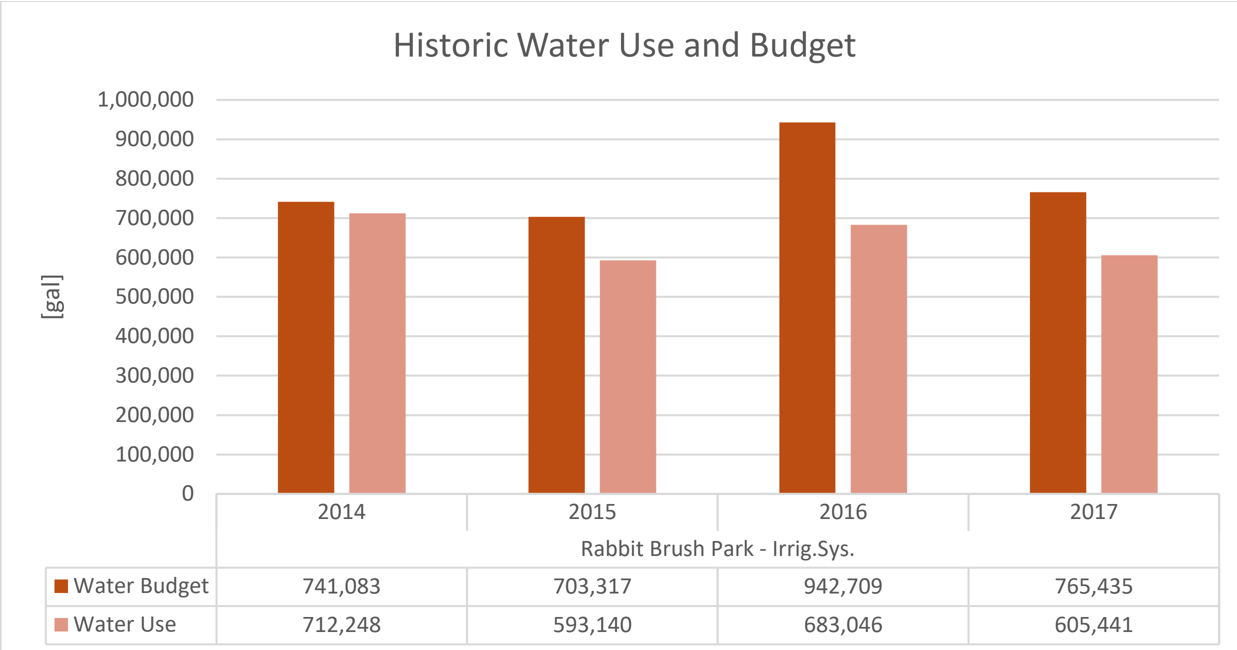
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
Domestic	Mainline Network	2006
Controller A	Controller	2006
RB RCVs	Remote Control Valves	2006
14 Gauge irri. Wires	Control Wire	2006

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!Rabbit Brush	712,248
2014 Total		**712,248**
2015	Source: SW-NS-CEM Water Use.xls!Rabbit Brush	593,140
2015 Total		**593,140**
2016	Source: SW-NS-CEM Water Use.xls!Rabbit Brush	683,046
2016 Total		**683,046**
2017	Source: 2017 Northside water use reports.xlsx!Rabbit Brush	605,441
2017 Total		**605,441**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!Rabbit Brush	741,083
2014 Total		**741,083**
2015	Source: SW-NS-CEM Water Use.xls!Rabbit Brush	703,317
2015 Total		**703,317**
2016	Source: SW-NS-CEM Water Use.xls!Rabbit Brush	942,709
2016 Total		**942,709**
2017	Source: 2017 Northside water use reports.xlsx!Rabbit Brush	765,435
2017 Total		**765,435**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 2,830.62	$ 1,862.25
2014	$ 4,874.63	$ 3,206.99
2015	$ 6,285.23	$ 4,135.02
2016	$ 2,984.61	$ 1,963.56
2017	$ 2,785.77	$ 1,832.74
Total	**$ 19,760.86**	**$ 13,000.57**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018																					
2017																					
2016																					
2015																					
2014																					

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Power	2010	$ 36.52	$ 24.03
O-Cost Power	2011	$ 45.20	$ 29.74
O-Cost Power	2012	$ 43.78	$ 28.80
O-Cost Power	2013	$ 47.70	$ 31.38
O-Cost Power	2014	$ 147.02	$ 96.72
O-Cost Power	2015	$ (53.15)	$ (34.97)
O-Cost Power	2016	$ 39.00	$ 25.66
O-Cost Power	2017	$ 46.95	$ 30.89
O-Cost Power Total		**$ 353.02**	**$ 232.25**
O-Cost Water	2010	$ 2,094.59	$ 1,378.02
O-Cost Water	2011	$ 2,180.03	$ 1,434.23
O-Cost Water	2012	$ 2,325.06	$ 1,529.64
O-Cost Water	2013	$ 626.10	$ 411.91
O-Cost Water	2014	$ 2,445.52	$ 1,608.89
O-Cost Water	2015	$ 2,138.08	$ 1,406.63
O-Cost Water	2016	$ 2,068.70	$ 1,360.99
O-Cost Water	2017	$ 2,018.42	$ 1,327.91
O-Cost Water Total		**$ 15,896.50**	**$ 10,458.22**
Grand Total		**$ 16,249.52**	**$ 10,690.47**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:11 **Analysis Year:** 2018

1 General system information

System Name: Radiant Park - Irrig.Sys.

Location: Radiant Park

Component Count: 9

1.1 User comments

User comments from the data collection forms for a specific year:

No user notes available

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	7.4	100.00%
Grand Total			**7.4**	**100.00%**

2.2 System components:

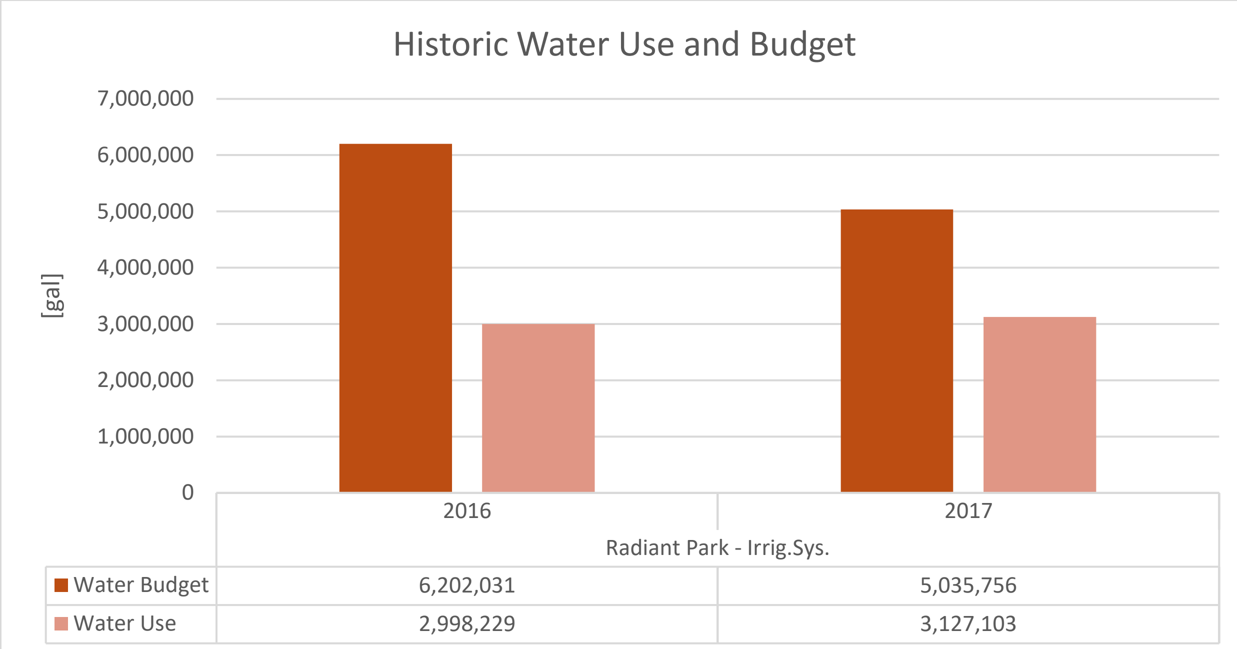
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	2013
Ph 1-Controller A	Controller	2013
2-wire	Control Wire	2013
All RCVs	Remote Control Valves	2013
Master Valve	Mainline Network	2013
Flow Sensor	Mainline Network	2013
Pump Station	Pump System	2003
Ph 2- Controller A	Controller	2016
2-wire	Control Wire	2016

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2016	Source: 2016 S-SE H2O Use.xls!RADIANT	2,998,229
2016 Total		**2,998,229**
2017	Source: 2017 East water use reports.xlsx!RADIANT	3,127,103
2017 Total		**3,127,103**

Following water budget records exist:

Year	Description	Water Budget [gal]
2016	Source: 2016 S-SE H2O Use.xls!RADIANT	6,202,031
2016 Total		**6,202,031**
2017	Source: 2017 East water use reports.xlsx!RADIANT	5,035,756
2017 Total		**5,035,756**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 4,291.23	$ 579.90
2014	$ 12,003.16	$ 1,622.05
2015	$ 12,119.92	$ 1,637.83
2016	$ 9,822.57	$ 1,327.37
2017	$ 4,609.88	$ 622.96
Total	**$ 42,846.76**	**$ 5,790.10**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018																					
2017																					
2016																					
2015																					
2014																					

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

No power or water expense data avialable

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:10 **Analysis Year:** 2018

1 General system information

System Name: Registry Park - Irrig.Sys.

Location: Registry Park

Component Count: 4

1.1 User comments

User comments from the data collection forms for a specific year:

No user notes available

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	5.2	100.00%
Grand Total			**5.2**	**100.00%**

2.2 System components:

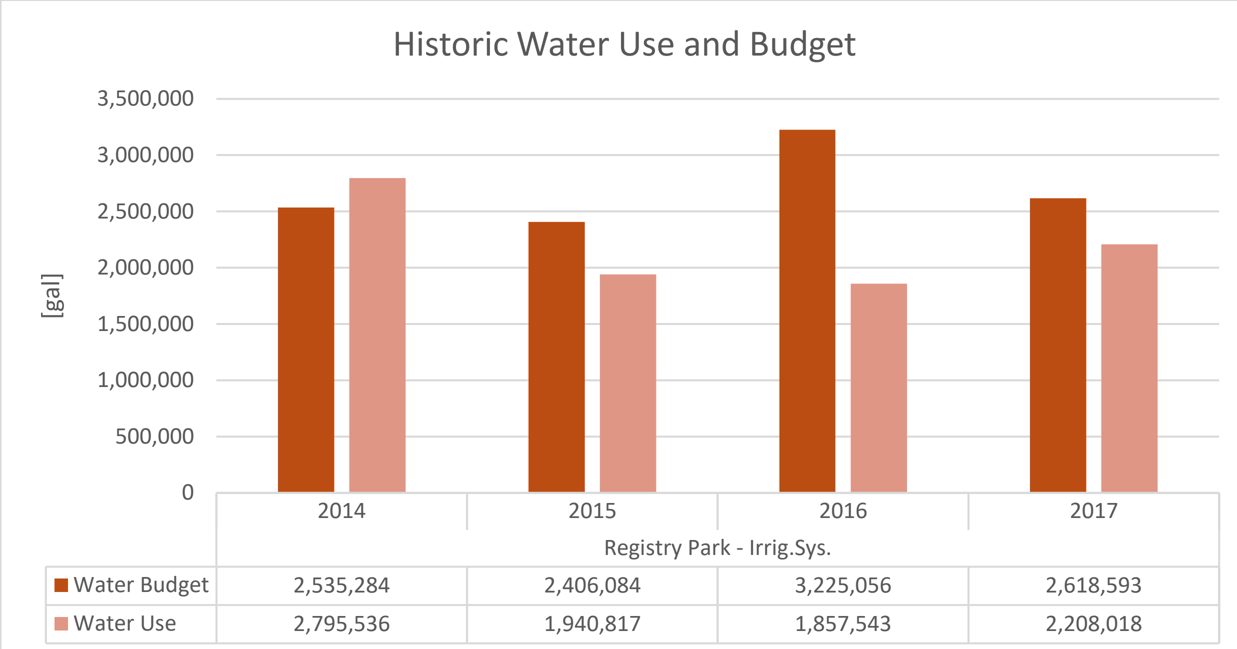
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	2012
Controller A	Controller	2012
Control Wire	Control Wire	2012
All RCVs	Remote Control Valves	2012

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 S-SE H2O Use.xls!Registry	2,795,536
2014 Total		**2,795,536**
2015	Source: S-SE H2O Use.xls!Registry	1,940,817
2015 Total		**1,940,817**
2016	Source: 2016 S-SE H2O Use.xls!REGISTRY	1,857,543
2016 Total		**1,857,543**
2017	Source: 2017 South water use reports.xlsx!REGISTRY	2,208,018
2017 Total		**2,208,018**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 S-SE H2O Use.xls!Registry	2,535,284
2014 Total		**2,535,284**
2015	Source: S-SE H2O Use.xls!Registry	2,406,084
2015 Total		**2,406,084**
2016	Source: 2016 S-SE H2O Use.xls!REGISTRY	3,225,056
2016 Total		**3,225,056**
2017	Source: 2017 South water use reports.xlsx!REGISTRY	2,618,593
2017 Total		**2,618,593**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 6,013.81	$ 1,156.50
2014	$ 10,822.76	$ 2,081.30
2015	$ 7,918.27	$ 1,522.74
2016	$ 12,300.43	$ 2,365.47
2017	$ 11,047.84	$ 2,124.59
Total	**$ 48,103.11**	**$ 9,250.60**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018	blue	salmon	salmon	blue	blue	blue	blue	blue	blue	grey	blue	blue	blue	blue	blue	blue	salmon	blue	salmon	blue	blue
2017	grey	grey	grey	grey	grey	grey	grey	grey	grey	blue	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2016	grey	grey	grey	grey	grey	grey	grey	grey	grey	blue	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2015	grey	grey	grey	grey	grey	grey	grey	grey	grey	blue	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2014	grey	grey	grey	grey	grey	grey	grey	grey	grey	blue	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Water	2016	$ 1,502.68	$ 288.98
O-Cost Water Total		**$ 1,502.68**	**$ 288.98**
Grand Total		**$ 1,502.68**	**$ 288.98**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:10 **Analysis Year:** 2018

1 General system information

System Name: Ridgeview Park - Irrig.Sys.

Location: Ridgeview Park

Component Count: 7

1.1 User comments

User comments from the data collection forms for a specific year:

Reporting Year	Note
2018	Irrigation desing flaw outfield 1st base. New pump motor 2018. Pump Station rebuilt with amiad addition in 2015/2016? Site is shared with PSD who supplies domestic when needed with a 2" supply line. When running off their supply only 1 valve can be run at a time. Meter must be flipped to get water from them.

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	11.2	100.00%
Grand Total			**11.2**	**100.00%**

2.2 System components:

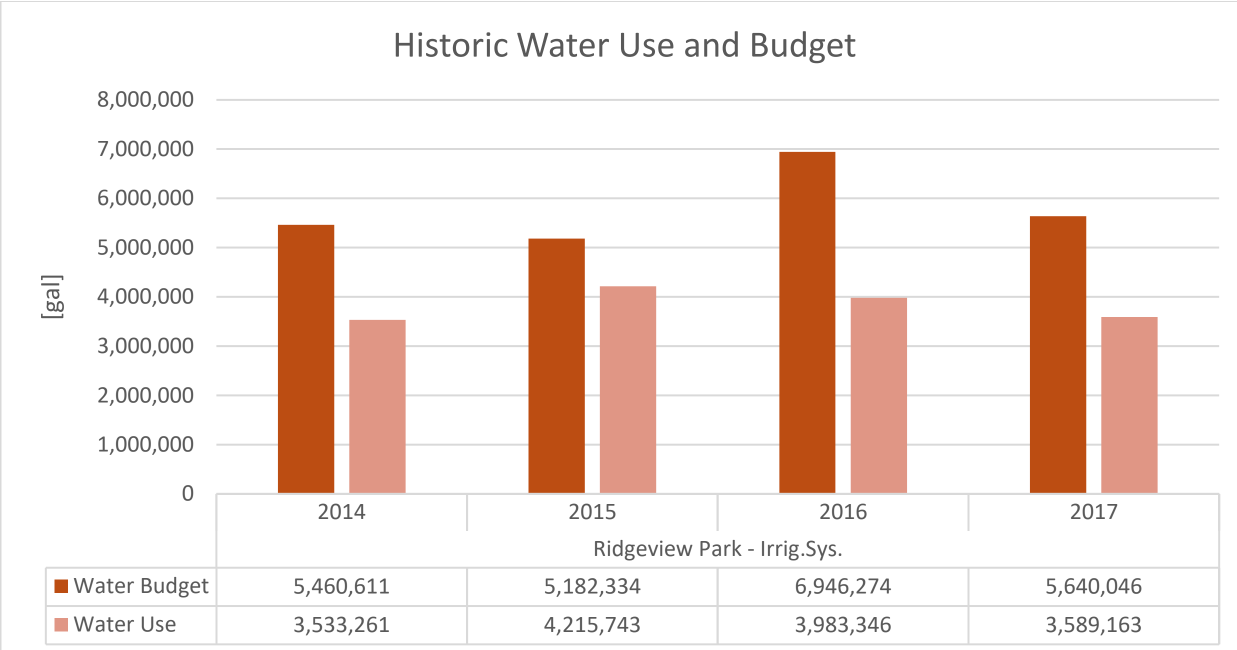
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
Mainline PH 1	Mainline Network	1996
Controller A	Controller	2012
Control Wire	Control Wire	1996
All RCVs	Remote Control Valves	1996
Mainline PH 2	Mainline Network	1998
Controller B	Controller	2012
Pump System	Pump System	2018

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 S-SE H2O Use.xls!RIDGEVIEW	3,533,261
2014 Total		**3,533,261**
2015	Source: S-SE H2O Use.xls!RIDGEVIEW	4,215,743
2015 Total		**4,215,743**
2016	Source: 2016 S-SE H2O Use.xls!RIDGEVIEW	3,983,346
2016 Total		**3,983,346**
2017	Source: 2017 South water use reports.xlsx!RIDGEVIEW	3,589,163
2017 Total		**3,589,163**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 S-SE H2O Use.xls!RIDGEVIEW	5,460,611
2014 Total		**5,460,611**
2015	Source: S-SE H2O Use.xls!RIDGEVIEW	5,182,334
2015 Total		**5,182,334**
2016	Source: 2016 S-SE H2O Use.xls!RIDGEVIEW	6,946,274
2016 Total		**6,946,274**
2017	Source: 2017 South water use reports.xlsx!RIDGEVIEW	5,640,046
2017 Total		**5,640,046**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 16,168.62	$ 1,443.63
2014	$ 11,176.58	$ 997.91
2015	$ 9,128.81	$ 815.07
2016	$ 10,714.59	$ 956.66
2017	$ 10,786.64	$ 963.09
Total	**$ 57,975.25**	**$ 5,176.36**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018	salmon	salmon	blue	blue	blue	salmon	salmon	blue	blue	grey	salmon	salmon	blue	blue	blue	blue	salmon	blue	salmon	blue	blue
2017	grey	grey	grey	grey	grey	grey	grey	grey	grey	salmon	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2016	grey	grey	grey	grey	grey	grey	grey	grey	grey	salmon	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2015	grey	grey	grey	grey	grey	grey	grey	grey	grey	salmon	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2014	grey	grey	grey	grey	grey	grey	grey	grey	grey	salmon	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Power	2010	$ 1,429.81	$ 127.66
O-Cost Power	2011	$ 1,681.59	$ 150.14
O-Cost Power	2012	$ 1,686.48	$ 150.58
O-Cost Power	2013	$ 1,905.92	$ 170.17
O-Cost Power	2014	$ 1,697.80	$ 151.59
O-Cost Power	2015	$ 1,490.82	$ 133.11
O-Cost Power	2016	$ 1,578.11	$ 140.90
O-Cost Power	2017	$ 1,446.63	$ 129.16
O-Cost Power Total		**$ 12,917.16**	**$ 1,153.32**
Grand Total		**$ 12,917.16**	**$ 1,153.32**

IRRIGATION SYSTEM REPORT

Report Date:	10/7/2019 -- 17:10	**Analysis Year:**	2018

1 General system information

System Name: Rogers Park - Irrig.Sys.

Location: Rogers Park

Component Count: 4

1.1 User comments

User comments from the data collection forms for a specific year:

Reporting Year	Note
2018	Rogers Park irrigation is mostly original with the exception of heads. Most time in maintenance is spent doing zone checks and head replacement/ adjusting. The controller was upgraded to WeatherTrak and a hydrometer/mastervalve was added in 2017.

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	6.5	100.00%
Grand Total			**6.5**	**100.00%**

2.2 System components:

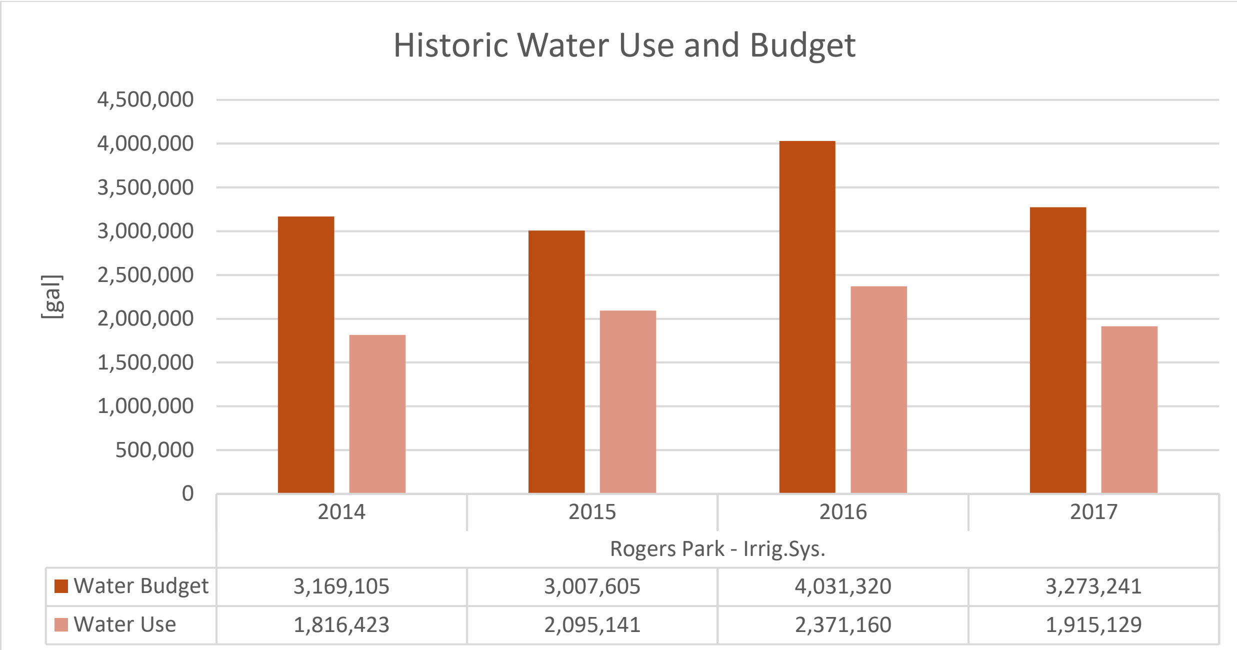
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	1991
Controller A	Controller	2017
Control Wire	Control Wire	1991
All RCVs	Remote Control Valves	1991

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!ROGERS	1,816,423
2014 Total		**1,816,423**
2015	Source: SW-NS-CEM Water Use.xls!ROGERS	2,095,141
2015 Total		**2,095,141**
2016	Source: SW-NS-CEM Water Use.xls!ROGERS	2,371,160
2016 Total		**2,371,160**
2017	Source: 2017 South West water use reports.xlsx!ROGERS	1,915,129
2017 Total		**1,915,129**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!ROGERS	3,169,105
2014 Total		**3,169,105**
2015	Source: SW-NS-CEM Water Use.xls!ROGERS	3,007,605
2015 Total		**3,007,605**
2016	Source: SW-NS-CEM Water Use.xls!ROGERS	4,031,320
2016 Total		**4,031,320**
2017	Source: 2017 South West water use reports.xlsx!ROGERS	3,273,241
2017 Total		**3,273,241**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 16,504.51	$ 2,539.16
2014	$ 11,021.64	$ 1,695.64
2015	$ 12,876.60	$ 1,981.02
2016	$ 15,543.84	$ 2,391.36
2017	$ 18,819.05	$ 2,895.24
Total	**$ 74,765.64**	**$ 11,502.41**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018																					
2017																					
2016																					
2015																					
2014																					

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]		Expense [$/ac.]	
O-Cost Power	2010	$	952.29	$	146.51
O-Cost Power	2011	$	676.54	$	104.08
O-Cost Power	2012	$	648.28	$	99.74
O-Cost Power	2013	$	669.20	$	102.95
O-Cost Power	2014	$	608.02	$	93.54
O-Cost Power	2015	$	568.00	$	87.38
O-Cost Power	2016	$	794.96	$	122.30
O-Cost Power	2017	$	884.62	$	136.10
O-Cost Power Total		**$**	**5,801.91**	**$**	**892.60**
O-Cost Water	2010	$	6,088.96	$	936.76
O-Cost Water	2011	$	6,504.74	$	1,000.73
O-Cost Water	2012	$	7,893.65	$	1,214.41
O-Cost Water	2013	$	5,638.95	$	867.53
O-Cost Water	2014	$	6,054.71	$	931.49
O-Cost Water	2015	$	7,222.83	$	1,111.20
O-Cost Water	2016	$	8,072.24	$	1,241.88
O-Cost Water	2017	$	6,518.94	$	1,002.91
O-Cost Water Total		**$**	**53,995.02**	**$**	**8,306.93**
Grand Total		**$**	**59,796.93**	**$**	**9,199.53**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:07 **Analysis Year:** 2018

1 General system information

System Name: Rolland Moore Park - Irrig.Sys.

Location: Rolland Moore Park

Component Count: 7

1.1 User comments

User comments from the data collection forms for a specific year:

Reporting Year	Note
2018	Rolland Moore's irrigation system contains aging mainline fittings and tees that are failing at an expontential rate. These components are rusting and developing various size leaks. On average, 4-5 valves and Tees are repaired every year. Repairs tend to take 3-5 days in trouble-shooting, digging and repair. Cost of repairs range from $500-$1200. Signifcant turf damage can occur and events can be cancelled for this range of time.

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	40.44	100.00%
Grand Total			**40.44**	**100.00%**

2.2 System components:

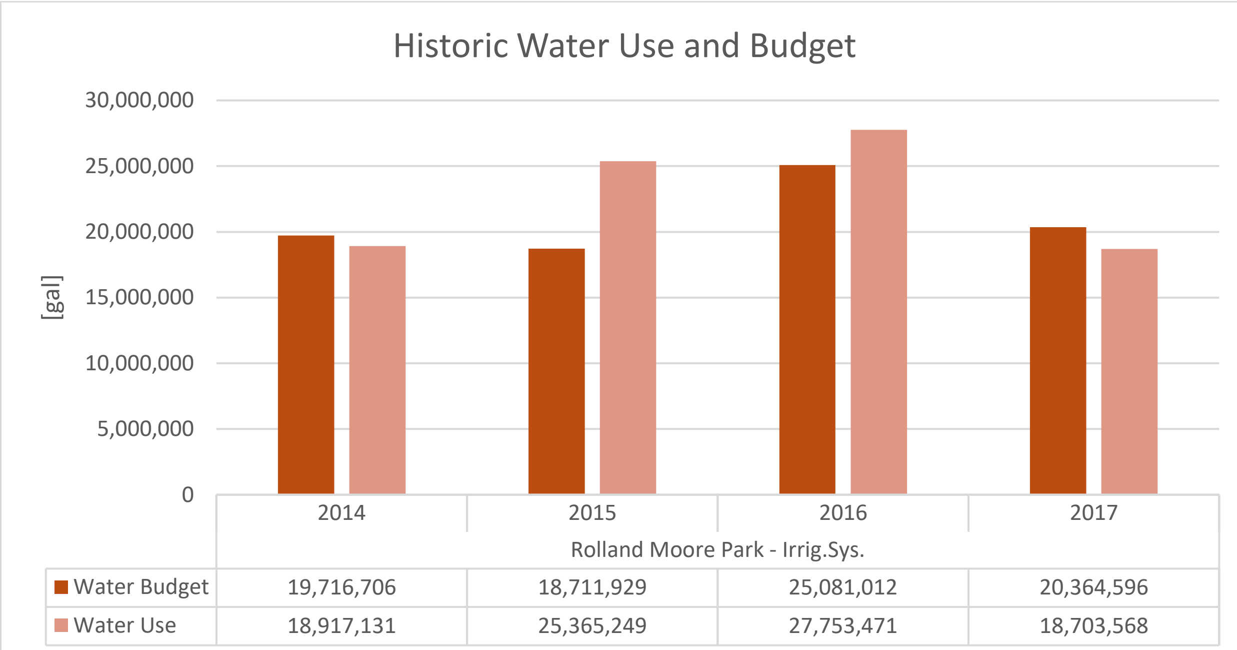
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	1981
PMP	Pump System	2018
Controller A, B, C	Controller	2018
Control Wire	Control Wire	1981
Griswold Valves	Remote Control Valves	1981
Rainbird Scrubber Valves	Remote Control Valves	2018
Vertical Turbine Pump	Pump System	2014

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!MOORE	18,917,131
2014 Total		**18,917,131**
2015	Source: SW-NS-CEM Water Use.xls!MOORE	25,365,249
2015 Total		**25,365,249**
2016	Source: SW-NS-CEM Water Use.xls!MOORE	27,753,471
2016 Total		**27,753,471**
2017	Source: 2017 South West water use reports.xlsx!MOORE	18,703,568
2017 Total		**18,703,568**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!MOORE	19,716,706
2014 Total		**19,716,706**
2015	Source: SW-NS-CEM Water Use.xls!MOORE	18,711,929
2015 Total		**18,711,929**
2016	Source: SW-NS-CEM Water Use.xls!MOORE	25,081,012
2016 Total		**25,081,012**
2017	Source: 2017 South West water use reports.xlsx!MOORE	20,364,596
2017 Total		**20,364,596**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 60,935.99	$ 1,506.82
2014	$ 73,657.88	$ 1,821.41
2015	$ 73,680.10	$ 1,821.96
2016	$ 66,967.25	$ 1,655.97
2017	$ 84,122.85	$ 2,080.19
Total	**$ 359,364.07**	**$ 8,886.35**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018																					
2017																					
2016																					
2015																					
2014																					

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Power	2010	$ 4,950.97	$ 122.43
O-Cost Power	2011	$ 4,613.60	$ 114.09
O-Cost Power	2012	$ 5,691.95	$ 140.75
O-Cost Power	2013	$ 4,828.39	$ 119.40
O-Cost Power	2014	$ 5,226.97	$ 129.25
O-Cost Power	2015	$ 5,169.44	$ 127.83
O-Cost Power	2016	$ 5,279.09	$ 130.54
O-Cost Power	2017	$ 4,910.06	$ 121.42
O-Cost Power Total		**$ 40,670.47**	**$ 1,005.70**
O-Cost Water	2010	$ 438.04	$ 10.83
O-Cost Water	2011	$ 561.50	$ 13.88
O-Cost Water	2012	$ 763.46	$ 18.88
O-Cost Water	2013	$ 788.80	$ 19.51
O-Cost Water	2014	$ 853.06	$ 21.09
O-Cost Water	2015	$ 2,307.83	$ 57.07
O-Cost Water	2016	$ 807.03	$ 19.96
O-Cost Water	2017	$ 913.58	$ 22.59
O-Cost Water Total		**$ 7,433.30**	**$ 183.81**
Grand Total		**$ 48,103.77**	**$ 1,189.51**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:08 **Analysis Year:** 2018

1 General system information

System Name: Romero Park - Irrig.Sys.

Location: Romero Park

Component Count: 6

1.1 User comments

User comments from the data collection forms for a specific year:

No user notes available

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	0.14	100.00%
Grand Total			**0.14**	**100.00%**

2.2 System components:

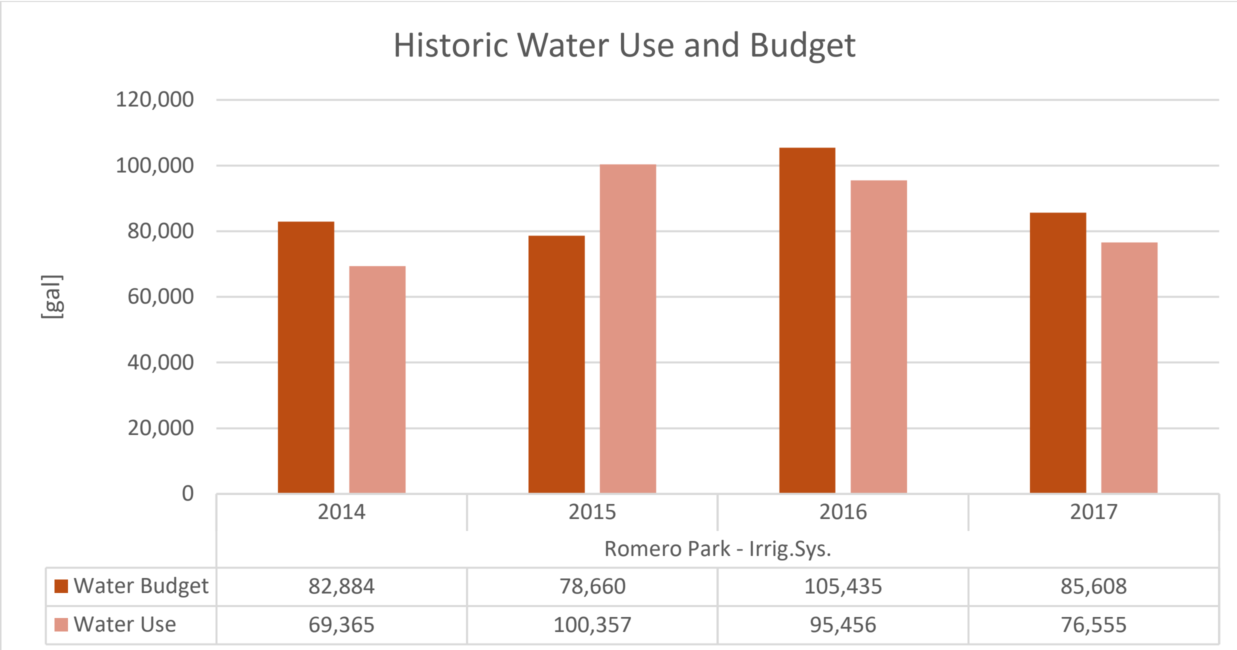
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
Domestic	Mainline Network	1982
Controller A	Controller	1982
Control B	Controller	1982
RB RCVs	Remote Control Valves	1982
Electro-Valve	Remote Control Valves	1982
14 Gauge irri. Wires	Control Wire	1982

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!ROMERO	69,365
2014 Total		**69,365**
2015	Source: SW-NS-CEM Water Use.xls!ROMERO	100,357
2015 Total		**100,357**
2016	Source: SW-NS-CEM Water Use.xls!ROMERO	95,456
2016 Total		**95,456**
2017	Source: 2017 Northside water use reports.xlsx!ROMERO	76,555
2017 Total		**76,555**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!ROMERO	82,884
2014 Total		**82,884**
2015	Source: SW-NS-CEM Water Use.xls!ROMERO	78,660
2015 Total		**78,660**
2016	Source: SW-NS-CEM Water Use.xls!ROMERO	105,435
2016 Total		**105,435**
2017	Source: 2017 Northside water use reports.xlsx!ROMERO	85,608
2017 Total		**85,608**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 2,944.40	$ 21,031.44
2014	$ 2,873.68	$ 20,526.27
2015	$ 2,145.66	$ 15,326.15
2016	$ 1,257.19	$ 8,979.93
2017	$ 1,168.37	$ 8,345.52
Total	**$ 10,389.30**	**$ 74,209.30**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018	salmon	blue	blue	salmon	blue	blue	blue	blue	blue	grey	salmon	salmon	blue	blue	blue	blue	salmon	blue	salmon	blue	blue
2017	grey	grey	grey	grey	grey	grey	grey	grey	grey	blue	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2016	grey	grey	grey	grey	grey	grey	grey	grey	grey	blue	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2015	grey	grey	grey	grey	grey	grey	grey	grey	grey	blue	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2014	grey	grey	grey	grey	grey	grey	grey	grey	grey	blue	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Power	2010	$ 23.24	$ 166.00
O-Cost Power	2011	$ 24.43	$ 174.50
O-Cost Power	2012	$ 31.83	$ 227.36
O-Cost Power	2013	$ 19.91	$ 142.21
O-Cost Power	2014	$ 31.87	$ 227.64
O-Cost Power	2015	$ 48.03	$ 343.07
O-Cost Power	2016	$ 21.28	$ 152.00
O-Cost Power	2017	$ 27.40	$ 195.71
O-Cost Power Total		**$ 227.99**	**$ 1,628.50**
O-Cost Water	2010	$ 201.22	$ 1,437.29
O-Cost Water	2011	$ 246.49	$ 1,760.64
O-Cost Water	2012	$ 292.28	$ 2,087.71
O-Cost Water	2013	$ 232.91	$ 1,663.64
O-Cost Water	2014	$ 313.23	$ 2,237.36
O-Cost Water	2015	$ 458.13	$ 3,272.36
O-Cost Water	2016	$ 310.86	$ 2,220.43
O-Cost Water	2017	$ 315.90	$ 2,256.43
O-Cost Water Total		**$ 2,371.02**	**$ 16,935.86**
Grand Total		**$ 2,599.01**	**$ 18,564.36**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:11 **Analysis Year:** 2018

1 General system information

System Name: Rossborough Park - Irrig.Sys.

Location: Rossborough Park

Component Count: 4

1.1 User comments

User comments from the data collection forms for a specific year:

No user notes available

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	14.4	100.00%
Grand Total			**14.4**	**100.00%**

2.2 System components:

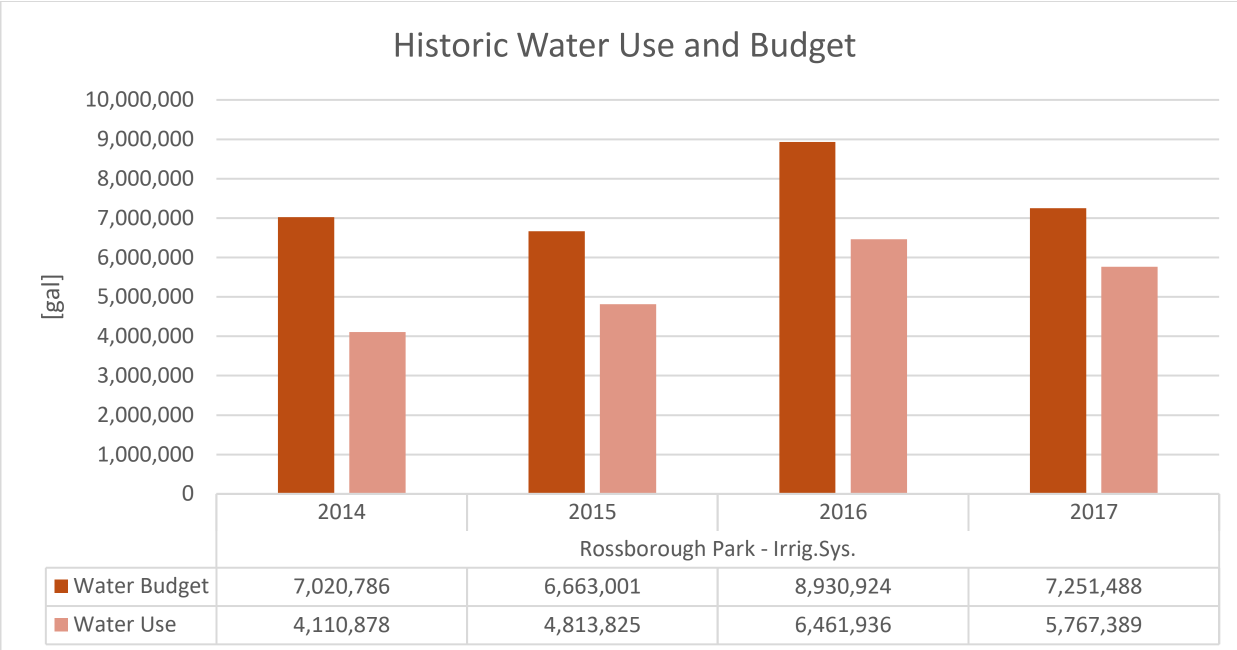
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	1990
Controller A	Controller	2017
Control Wire	Control Wire	1990
All RCVs	Remote Control Valves	1991

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!ROSSBOROUGH	4,110,878
2014 Total		**4,110,878**
2015	Source: SW-NS-CEM Water Use.xls!ROSSBOROUGH	4,813,825
2015 Total		**4,813,825**
2016	Source: SW-NS-CEM Water Use.xls!ROSSBOROUGH	6,461,936
2016 Total		**6,461,936**
2017	Source: 2017 South West water use reports.xlsx!ROSSBOROUGH	5,767,389
2017 Total		**5,767,389**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!ROSSBOROUGH	7,020,786
2014 Total		**7,020,786**
2015	Source: SW-NS-CEM Water Use.xls!ROSSBOROUGH	6,663,001
2015 Total		**6,663,001**
2016	Source: SW-NS-CEM Water Use.xls!ROSSBOROUGH	8,930,924
2016 Total		**8,930,924**
2017	Source: 2017 South West water use reports.xlsx!ROSSBOROUGH	7,251,488
2017 Total		**7,251,488**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 13,866.02	$ 962.92
2014	$ 17,667.90	$ 1,226.94
2015	$ 22,127.48	$ 1,536.63
2016	$ 28,949.04	$ 2,010.35
2017	$ 37,935.81	$ 2,634.43
Total	**$ 120,546.24**	**$ 8,371.27**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018																					
2017																					
2016																					
2015																					
2014																					

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Power	2010	$ 334.22	$ 23.21
O-Cost Power	2011	$ 294.92	$ 20.48
O-Cost Power	2012	$ 276.17	$ 19.18
O-Cost Power	2013	$ 330.10	$ 22.92
O-Cost Power	2014	$ 351.76	$ 24.43
O-Cost Power	2015	$ 352.28	$ 24.46
O-Cost Power	2016	$ 343.08	$ 23.83
O-Cost Power	2017	$ 365.75	$ 25.40
O-Cost Power Total		**$ 2,648.28**	**$ 183.91**
O-Cost Water	2010	$ 13,840.33	$ 961.13
O-Cost Water	2011	$ 13,464.66	$ 935.05
O-Cost Water	2012	$ 20,379.42	$ 1,415.24
O-Cost Water	2013	$ 9,324.47	$ 647.53
O-Cost Water	2014	$ 12,396.95	$ 860.90
O-Cost Water	2015	$ 14,891.89	$ 1,034.16
O-Cost Water	2016	$ 22,426.52	$ 1,557.40
O-Cost Water	2017	$ 24,994.78	$ 1,735.75
O-Cost Water Total		**$ 131,719.02**	**$ 9,147.15**
Grand Total		**$ 134,367.30**	**$ 9,331.06**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:11 **Analysis Year:** 2018

1 General system information

System Name: Soft Gold Park - Irrig.Sys.

Location: Soft Gold Park

Component Count: 4

1.1 User comments

User comments from the data collection forms for a specific year:

No user notes available

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	6.26	100.00%
Grand Total			**6.26**	**100.00%**

2.2 System components:

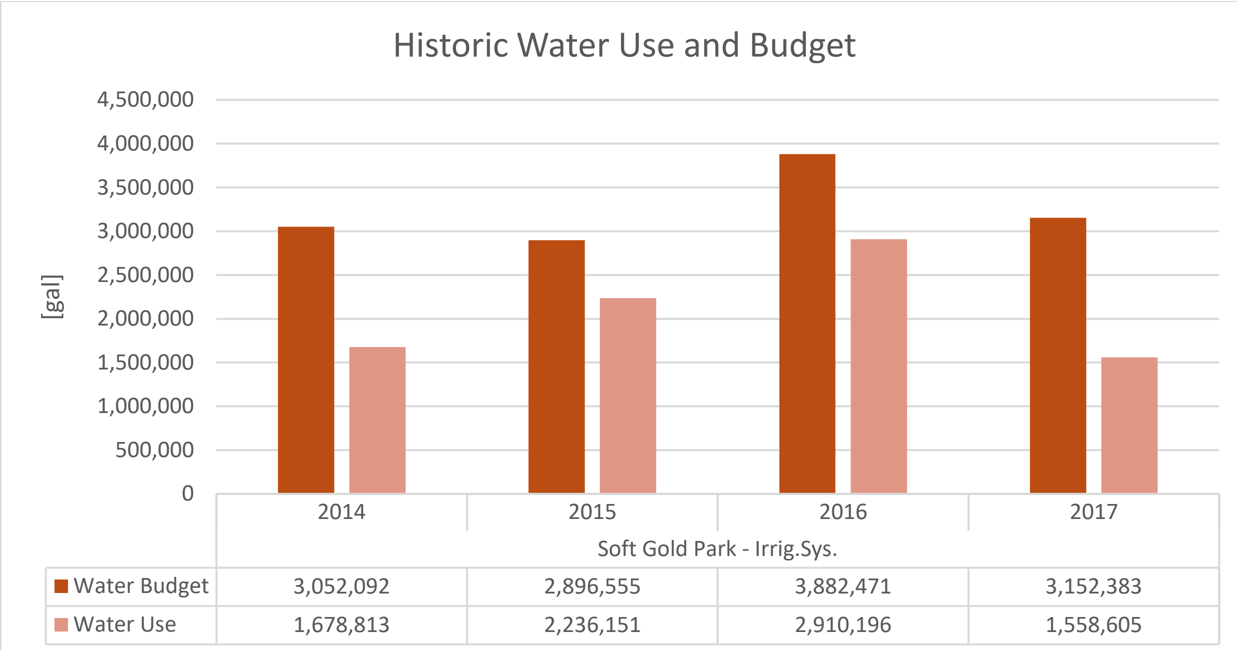
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
Controller A	Controller	2017
Mainline	Mainline Network	2004
Trad 14ga	Control Wire	2004
Rainbird	Remote Control Valves	2004

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!SoftGold	1,678,813
2014 Total		**1,678,813**
2015	Source: SW-NS-CEM Water Use.xls!SoftGold	2,236,151
2015 Total		**2,236,151**
2016	Source: SW-NS-CEM Water Use.xls!SoftGold	2,910,196
2016 Total		**2,910,196**
2017	Source: 2017 Northside water use reports.xlsx!SoftGold	1,558,605
2017 Total		**1,558,605**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!SoftGold	3,052,092
2014 Total		**3,052,092**
2015	Source: SW-NS-CEM Water Use.xls!SoftGold	2,896,555
2015 Total		**2,896,555**
2016	Source: SW-NS-CEM Water Use.xls!SoftGold	3,882,471
2016 Total		**3,882,471**
2017	Source: 2017 Northside water use reports.xlsx!SoftGold	3,152,383
2017 Total		**3,152,383**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 12,945.05	$ 2,067.90
2014	$ 15,733.86	$ 2,513.40
2015	$ 12,940.09	$ 2,067.11
2016	$ 18,945.70	$ 3,026.47
2017	$ 13,436.42	$ 2,146.39
Total	**$ 74,001.12**	**$ 11,821.26**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Water	2010	$ 6,168.63	$ 985.40
O-Cost Water	2011	$ 5,260.33	$ 840.31
O-Cost Water	2012	$ 7,322.80	$ 1,169.78
O-Cost Water	2013	$ 7,113.50	$ 1,136.34
O-Cost Water	2014	$ 5,320.61	$ 849.94
O-Cost Water	2015	$ 7,411.63	$ 1,183.97
O-Cost Water	2016	$ 8,797.03	$ 1,405.28
O-Cost Water	2017	$ 5,412.29	$ 864.58
O-Cost Water Total		**$ 52,806.82**	**$ 8,435.59**
Grand Total		**$ 52,806.82**	**$ 8,435.59**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:08 **Analysis Year:** 2018

1 General system information

System Name: Spencer Park - Irrig.Sys.

Location: Spencer Park

Component Count: 4

1.1 User comments

User comments from the data collection forms for a specific year:

No user notes available

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	0.47	100.00%
Grand Total			**0.47**	**100.00%**

2.2 System components:

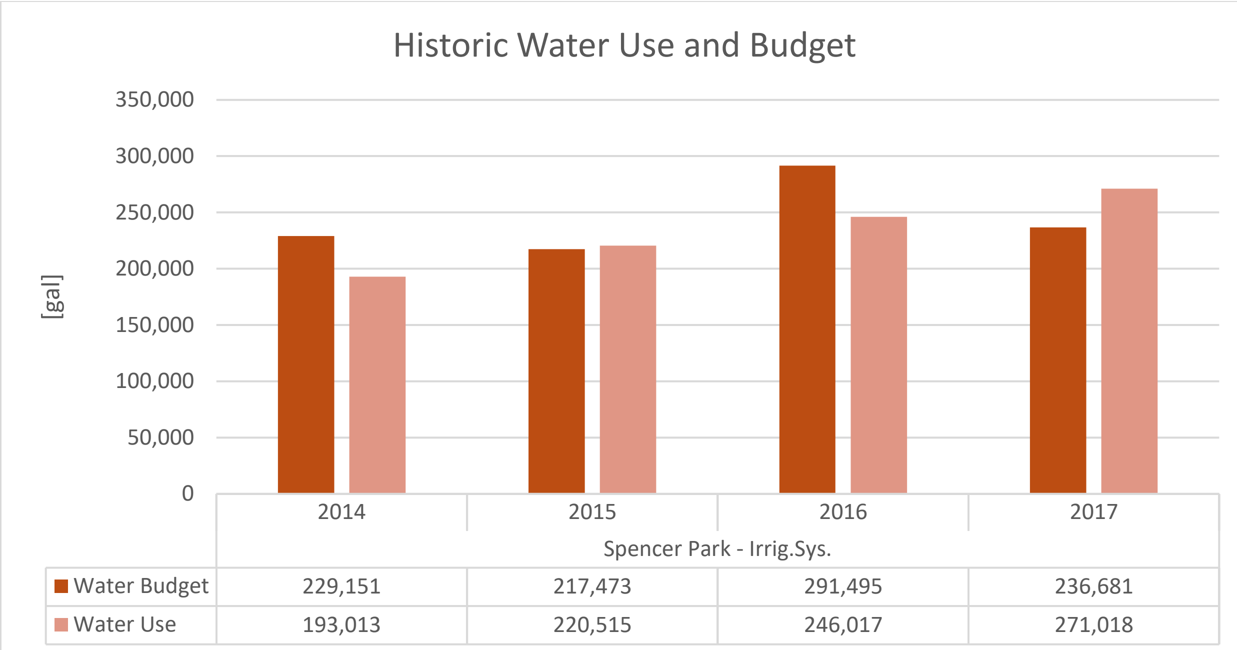
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	1981
Controller A	Controller	1981
Control Wire	Control Wire	1981
All RCVs	Remote Control Valves	1981

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 S-SE H2O Use.xls!Spencer	193,013
2014 Total		**193,013**
2015	Source: S-SE H2O Use.xls!Spencer	220,515
2015 Total		**220,515**
2016	Source: 2016 S-SE H2O Use.xls!Spencer	246,017
2016 Total		**246,017**
2017	Source: 2017 South East water use reports.xlsx!Spencer	271,018
2017 Total		**271,018**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 S-SE H2O Use.xls!Spencer	229,151
2014 Total		**229,151**
2015	Source: S-SE H2O Use.xls!Spencer	217,473
2015 Total		**217,473**
2016	Source: 2016 S-SE H2O Use.xls!Spencer	291,495
2016 Total		**291,495**
2017	Source: 2017 South East water use reports.xlsx!Spencer	236,681
2017 Total		**236,681**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 2,622.70	$ 5,580.21
2014	$ 2,157.57	$ 4,590.58
2015	$ 1,959.91	$ 4,170.02
2016	$ 2,585.91	$ 5,501.93
2017	$ 4,125.11	$ 8,776.83
Total	**$ 13,451.20**	**$ 28,619.57**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018																					
2017																					
2016																					
2015																					
2014																					

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Power	2010	$ 41.55	$ 88.40
O-Cost Power	2011	$ 44.70	$ 95.11
O-Cost Power	2012	$ 42.97	$ 91.43
O-Cost Power	2013	$ 46.96	$ 99.91
O-Cost Power	2014	$ 42.99	$ 91.47
O-Cost Power	2015	$ 36.95	$ 78.62
O-Cost Power	2016	$ 31.14	$ 66.26
O-Cost Power	2017	$ 37.84	$ 80.51
O-Cost Power Total		**$ 325.10**	**$ 691.70**
O-Cost Water	2010	$ 1,115.62	$ 2,373.66
O-Cost Water	2011	$ 1,158.04	$ 2,463.91
O-Cost Water	2012	$ 1,500.45	$ 3,192.45
O-Cost Water	2013	$ 1,069.31	$ 2,275.13
O-Cost Water	2014	$ 1,169.84	$ 2,489.02
O-Cost Water	2015	$ 968.28	$ 2,060.17
O-Cost Water	2016	$ 1,576.99	$ 3,355.30
O-Cost Water	2017	$ 1,909.16	$ 4,062.04
O-Cost Water Total		**$ 10,467.69**	**$ 22,271.68**
Grand Total		**$ 10,792.79**	**$ 22,963.38**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:09 **Analysis Year:** 2018

1 General system information

System Name: Spring Canyon Community Park - Irrig.Sys.

Location: Spring Canyon Community Park

Component Count: 4

1.1 User comments

User comments from the data collection forms for a specific year:

Reporting Year	Note
2018	Master Valve does not work. Hand watering of zones were due to a failing master and slave clock. Clock C. They was sent to LL Johnson and repaired in 2018.

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	50.6	100.00%
Grand Total			**50.6**	**100.00%**

2.2 System components:

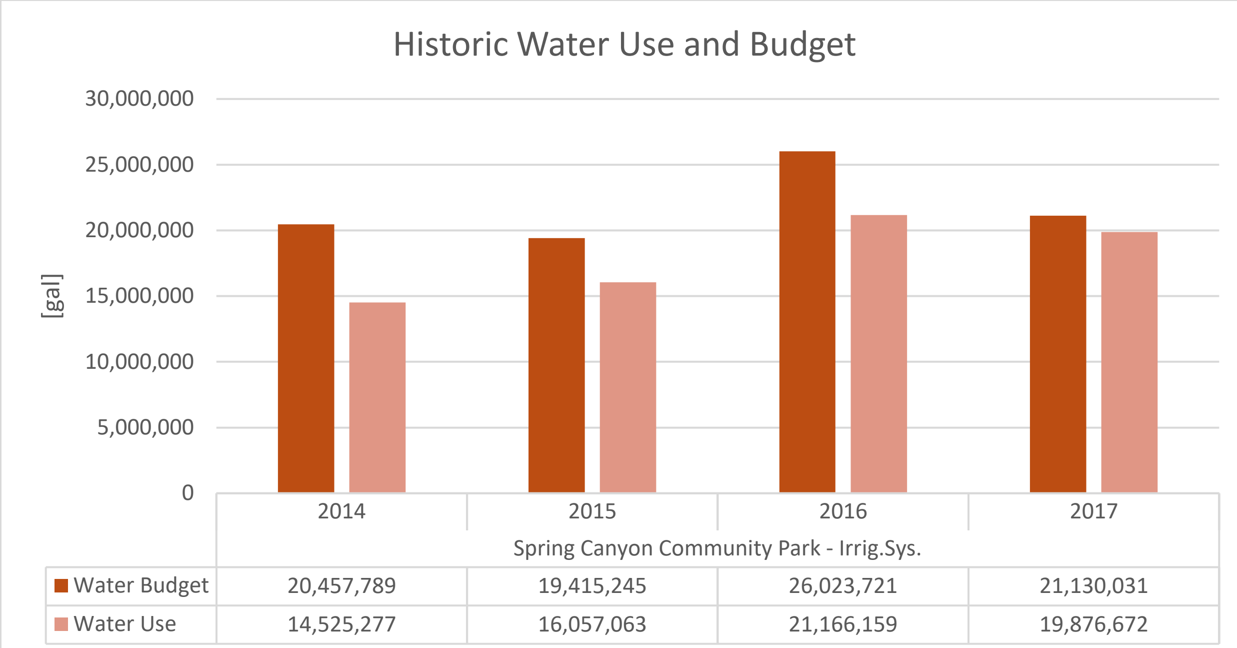
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	2007
Controller A	Controller	2007
Control Wire	Control Wire	2007
All RCVs	Remote Control Valves	2007

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!Spring Canyon	14,525,277
2014 Total		**14,525,277**
2015	Source: SW-NS-CEM Water Use.xls!Spring Canyon	16,057,063
2015 Total		**16,057,063**
2016	Source: SW-NS-CEM Water Use.xls!Spring Canyon	21,166,159
2016 Total		**21,166,159**
2017	Source: 2017 Spring Canyon water use reports.xlsx!Spring Canyon	19,876,672
2017 Total		**19,876,672**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!Spring Canyon	20,457,789
2014 Total		**20,457,789**
2015	Source: SW-NS-CEM Water Use.xls!Spring Canyon	19,415,245
2015 Total		**19,415,245**
2016	Source: SW-NS-CEM Water Use.xls!Spring Canyon	26,023,721
2016 Total		**26,023,721**
2017	Source: 2017 Spring Canyon water use reports.xlsx!Spring Canyon	21,130,031
2017 Total		**21,130,031**

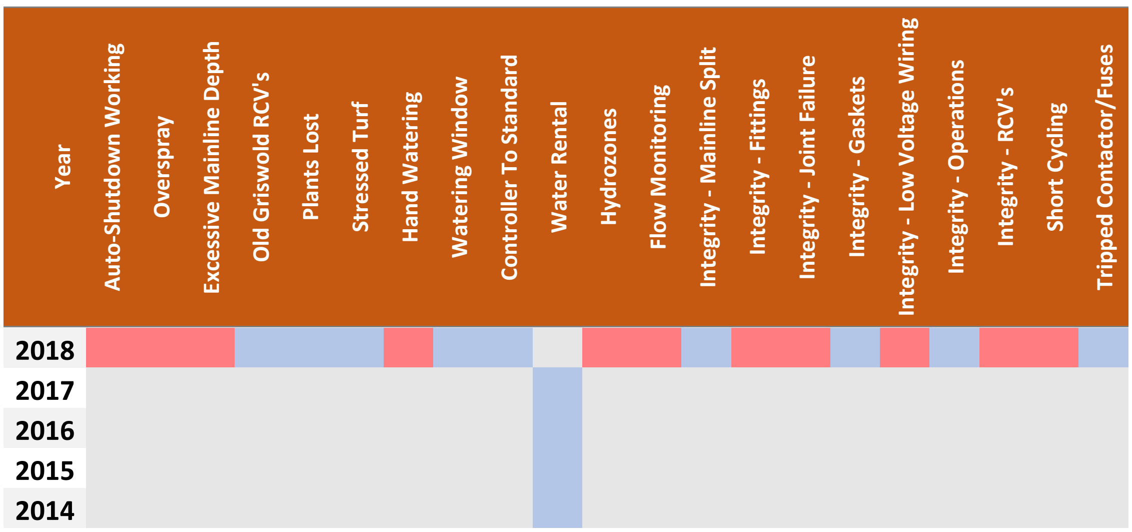
3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 33,232.53	$ 656.77
2014	$ 32,961.10	$ 651.41
2015	$ 69,910.88	$ 1,381.64
2016	$ 47,892.07	$ 946.48
2017	$ 84,456.25	$ 1,669.10
Total	**$ 268,452.83**	**$ 5,305.39**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):



3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Power	2010	$ 7,533.92	$ 148.89
O-Cost Power	2011	$ 7,045.52	$ 139.24
O-Cost Power	2012	$ 6,753.69	$ 133.47
O-Cost Power	2013	$ 5,343.61	$ 105.60
O-Cost Power	2014	$ 7,412.76	$ 146.50
O-Cost Power	2015	$ 7,513.69	$ 148.49
O-Cost Power	2016	$ 7,997.54	$ 158.05
O-Cost Power	2017	$ 9,515.33	$ 188.05
O-Cost Power Total		**$ 59,116.06**	**$ 1,168.30**
Grand Total		**$ 59,116.06**	**$ 1,168.30**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:10 **Analysis Year:** 2018

1 General system information

System Name: Spring Park - Irrig.Sys.

Location: Spring Park

Component Count: 6

1.1 User comments

User comments from the data collection forms for a specific year:

No user notes available

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	14.07	100.00%
Grand Total			**14.07**	**100.00%**

2.2 System components:

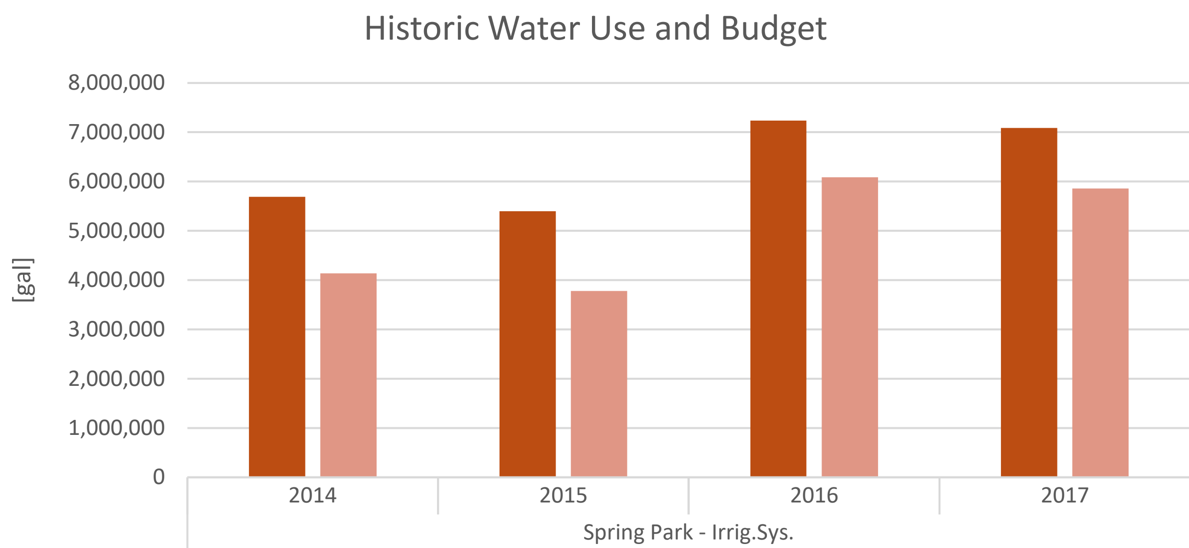
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	1989
Controller A	Controller	2017
Control Wire	Control Wire	1989
All RCVs	Remote Control Valves	1989
Pump	Pump System	2008
Pump House	Pump System	1995

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



	2014	2015	2016	2017
Water Budget	5,688,559	5,398,666	7,236,240	7,085,308
Water Use	4,136,370	3,782,531	6,085,936	5,858,450

Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 S-SE H2O Use.xls!SPRING	4,136,370
2014 Total		**4,136,370**
2015	Source: S-SE H2O Use.xls!SPRING	3,782,531
2015 Total		**3,782,531**
2016	Source: 2016 S-SE H2O Use.xls!SPRING	6,085,936
2016 Total		**6,085,936**
2017	Source: 2017 South East water use reports.xlsx!SPRING	5,858,450
2017 Total		**5,858,450**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 S-SE H2O Use.xls!SPRING	5,688,559
2014 Total		**5,688,559**
2015	Source: S-SE H2O Use.xls!SPRING	5,398,666
2015 Total		**5,398,666**
2016	Source: 2016 S-SE H2O Use.xls!SPRING	7,236,240
2016 Total		**7,236,240**
2017	Source: 2017 South East water use reports.xlsx!SPRING	7,085,308
2017 Total		**7,085,308**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 15,918.55	$ 1,131.38
2014	$ 18,866.10	$ 1,340.87
2015	$ 30,170.40	$ 2,144.31
2016	$ 16,512.69	$ 1,173.61
2017	$ 37,730.76	$ 2,681.65
Total	**$ 119,198.50**	**$ 8,471.82**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018																					
2017																					
2016																					
2015																					
2014																					

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Power	2010	$ 1,589.13	$ 112.94
O-Cost Power	2011	$ 2,282.47	$ 162.22
O-Cost Power	2012	$ 1,950.92	$ 138.66
O-Cost Power	2013	$ 2,205.62	$ 156.76
O-Cost Power	2014	$ 2,047.50	$ 145.52
O-Cost Power	2015	$ 2,298.72	$ 163.38
O-Cost Power	2016	$ 1,875.79	$ 133.32
O-Cost Power	2017	$ 2,478.36	$ 176.14
O-Cost Power Total		**$ 16,728.51**	**$ 1,188.95**
O-Cost Water	2010	$ 5,411.66	$ 384.62
O-Cost Water	2011	$ 796.96	$ 56.64
O-Cost Water	2012	$ 13,667.91	$ 971.42
O-Cost Water	2013	$ 3,838.93	$ 272.85
O-Cost Water	2014	$ 448.30	$ 31.86
O-Cost Water	2015	$ 4,059.85	$ 288.55
O-Cost Water Total		**$ 28,223.61**	**$ 2,005.94**
Grand Total		**$ 44,952.12**	**$ 3,194.89**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:10 **Analysis Year:** 2018

1 General system information

System Name: Stewart Case Park - Irrig.Sys.

Location: Stew Case Park

Component Count: 5

1.1 User comments

User comments from the data collection forms for a specific year:

Reporting Year	Note
2018	Stewart Case Park irrigation is run by pump station owned and operated by P.S.D...It has 3 Irritrol clocks

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	11.5	100.00%
Grand Total			**11.5**	**100.00%**

2.2 System components:

Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	2000
Controller A	Controller	2000
Control Wire	Control Wire	2000
All RCVs	Remote Control Valves	2000
Vertical Turbine Pump	Pump System	2000

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:

Following water use performance records exist:
No Data Available

Following water budget records exist:
No Data Available

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 16,751.98	$ 1,456.69
2014	$ 16,464.45	$ 1,431.69
2015	$ 22,544.14	$ 1,960.36
2016	$ 15,927.40	$ 1,384.99
2017	$ 11,696.90	$ 1,017.12
Total	**$ 83,384.87**	**$ 7,250.86**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018																					
2017																					
2016																					
2015																					
2014																					

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Water	2013	$ 2,958.24	$ 257.24
O-Cost Water	2014	$ 632.90	$ 55.03
O-Cost Water	2015	$ 3,369.07	$ 292.96
O-Cost Water	2016	$ 197.78	$ 17.20
O-Cost Water Total		**$ 7,157.99**	**$ 622.43**
Grand Total		**$ 7,157.99**	**$ 622.43**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:08 **Analysis Year:** 2018

1 General system information

System Name: Troutman Park - Irrig.Sys.

Location: Troutman Park

Component Count: 5

1.1 User comments

User comments from the data collection forms for a specific year:

Reporting Year	Note
2018	Leak in Z Pipe, due for replacement winter 2019. Needs meter valves replaced. Zone 20 abandoned which is used for pump start now. Zone around tennis is new 2018.

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	17.42	100.00%
Grand Total			**17.42**	**100.00%**

2.2 System components:

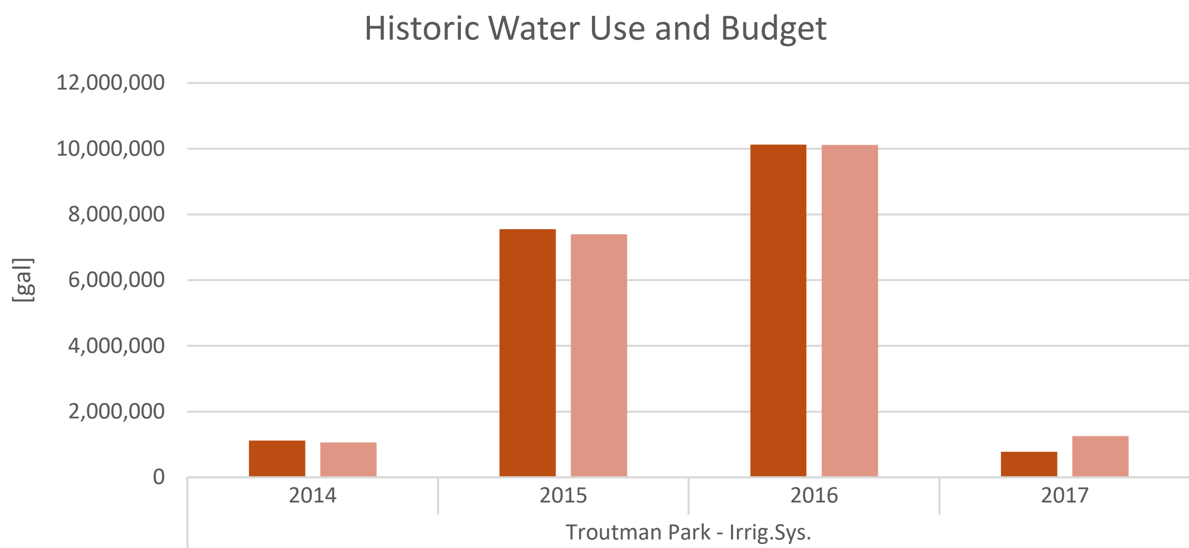
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	1986
Controller A	Controller	2018
Control Wire	Control Wire	1986
All RCVs	Remote Control Valves	1986
Pump Station	Pump System	2008

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



	2014	2015	2016	2017
Water Budget	1,118,709	7,551,401	10,121,714	781,160
Water Use	1,060,714	7,391,828	10,115,497	1,256,350

Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!TROUTMAN	1,060,714
2014 Total		**1,060,714**
2015	Source: SW-NS-CEM Water Use.xls!TROUTMAN	7,391,828
2015 Total		**7,391,828**
2016	Source: SW-NS-CEM Water Use.xls!TROUTMAN	10,115,497
2016 Total		**10,115,497**
2017	Source: 2017 South water use reports.xlsx!TROUTMAN	1,256,350
2017 Total		**1,256,350**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!TROUTMAN	1,118,709
2014 Total		**1,118,709**
2015	Source: SW-NS-CEM Water Use.xls!TROUTMAN	7,551,401
2015 Total		**7,551,401**
2016	Source: SW-NS-CEM Water Use.xls!TROUTMAN	10,121,714
2016 Total		**10,121,714**
2017	Source: 2017 South water use reports.xlsx!TROUTMAN	781,160
2017 Total		**781,160**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 14,675.55	$ 842.45
2014	$ 16,414.64	$ 942.29
2015	$ 15,661.56	$ 899.06
2016	$ 15,390.65	$ 883.50
2017	$ 17,668.31	$ 1,014.25
Total	**$ 79,810.70**	**$ 4,581.56**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018																					
2017																					
2016																					
2015																					
2014																					

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Power	2010	$ 1,633.53	$ 93.77
O-Cost Power	2011	$ 1,881.64	$ 108.02
O-Cost Power	2012	$ 1,604.79	$ 92.12
O-Cost Power	2013	$ 1,441.77	$ 82.77
O-Cost Power	2014	$ 1,488.88	$ 85.47
O-Cost Power	2015	$ 1,768.95	$ 101.55
O-Cost Power	2016	$ 1,901.45	$ 109.15
O-Cost Power	2017	$ 1,992.32	$ 114.37
O-Cost Power Total		**$ 13,713.33**	**$ 787.22**
O-Cost Water	2011	$ 3,772.35	$ 216.55
O-Cost Water	2012	$ 2,094.40	$ 120.23
O-Cost Water	2015	$ 415.56	$ 23.86
O-Cost Water Total		**$ 6,282.31**	**$ 360.64**
Grand Total		**$ 19,995.64**	**$ 1,147.86**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:09 **Analysis Year:** 2018

1 General system information

System Name: Twin Silo Community Park - Irrig.Sys.

Location: Twin Silo Community Park

Component Count: 9

1.1 User comments

User comments from the data collection forms for a specific year:

No user notes available

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	30	100.00%
Grand Total			**30**	**100.00%**

2.2 System components:

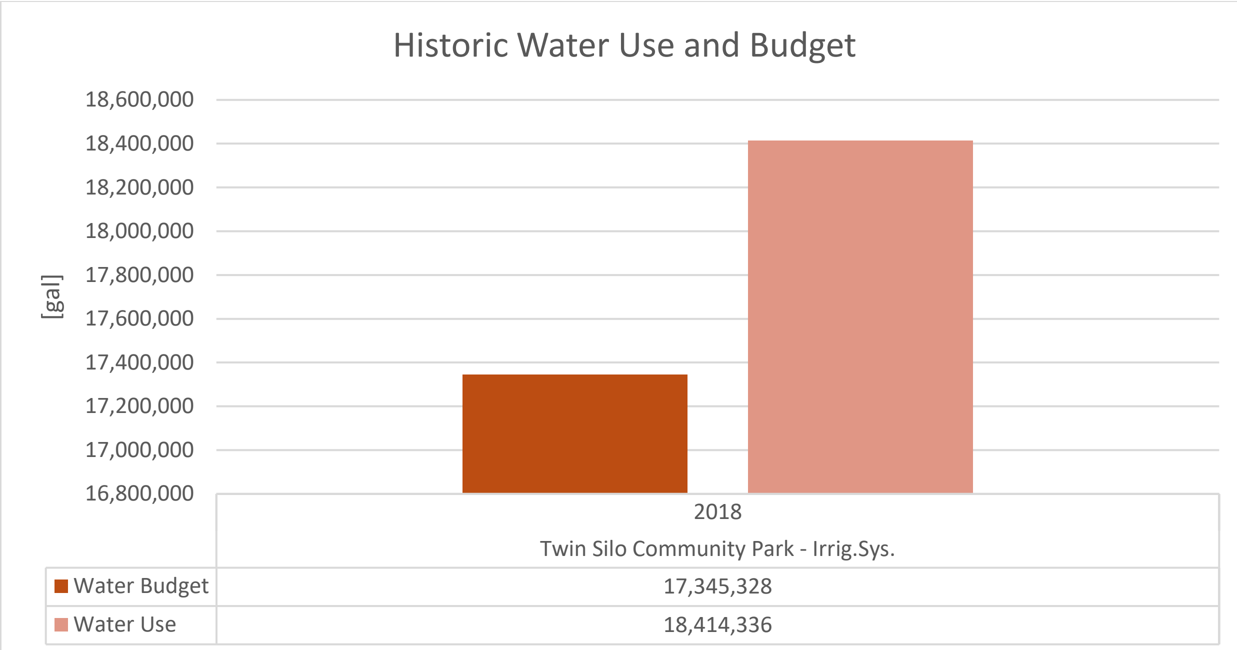
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	2017
Controller A (slave)	Controller	2017
2-wire	Control Wire	2017
All RCVs	Remote Control Valves	2017
Controller B (Master)	Controller	2017
2-wire	Controller	2017
Flow Sensor	Mainline Network	2017
Master Valve	Mainline Network	2003
Pump Station	Pump System	2003

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2018	2018 Water Use Spreadsheet	18,414,336
2018 Total		**18,414,336**

Following water budget records exist:

Year	Description	Water Budget [gal]
2018	Calc based on acreage	17,345,328
2018 Total		**17,345,328**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 636.22	$ 21.21
2014	$ 158.13	$ 5.27
2015	$ 459.92	$ 15.33
2016	$ 12,583.68	$ 419.46
2017	$ 12,710.67	$ 423.69
Total	**$ 26,548.62**	**$ 884.95**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018	blue	salmon	salmon	blue	blue	blue	blue	blue	blue	grey	blue	blue	blue	salmon	blue	blue	blue	blue	salmon	blue	salmon
2017	grey	grey	grey	grey	grey	grey	grey	grey	grey	salmon	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2016	grey	grey	grey	grey	grey	grey	grey	grey	grey	blue	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2015	grey	grey	grey	grey	grey	grey	grey	grey	grey	blue	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2014	grey	grey	grey	grey	grey	grey	grey	grey	grey	blue	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

No power or water expense data avialable

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:09 **Analysis Year:** 2018

1 General system information

System Name: Warren Park - Irrig.Sys.

Location: Warren Park

Component Count: 5

1.1 User comments

User comments from the data collection forms for a specific year:

No user notes available

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	21.26	100.00%
Grand Total			**21.26**	**100.00%**

2.2 System components:

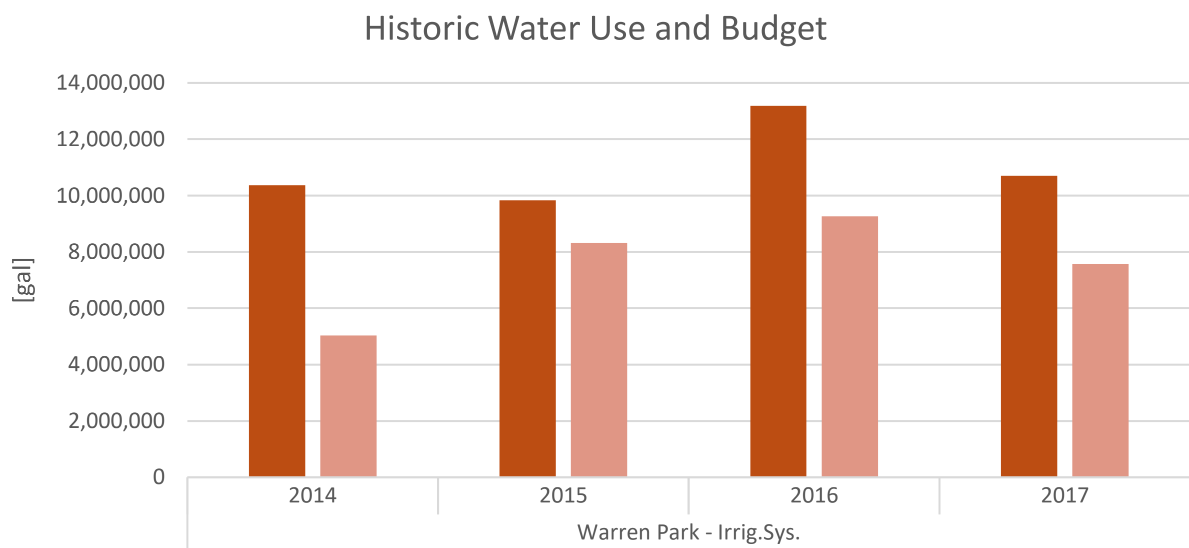
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	1978
Controller A	Controller	2017
Control Wire	Control Wire	1978
All RCVs	Remote Control Valves	1978
Pump Station	Pump System	2006

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



	2014	2015	2016	2017
Water Budget	10,365,410	9,837,181	13,185,517	10,706,017
Water Use	5,037,762	8,324,366	9,259,723	7,576,548

Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 S-SE H2O Use.xls!WARREN	5,037,762
2014 Total		**5,037,762**
2015	Source: S-SE H2O Use.xls!WARREN	8,324,366
2015 Total		**8,324,366**
2016	Source: 2016 S-SE H2O Use.xls!WARREN	9,259,723
2016 Total		**9,259,723**
2017	Source: 2017 South East water use reports.xlsx!WARREN	7,576,548
2017 Total		**7,576,548**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 S-SE H2O Use.xls!WARREN	10,365,410
2014 Total		**10,365,410**
2015	Source: S-SE H2O Use.xls!WARREN	9,837,181
2015 Total		**9,837,181**
2016	Source: 2016 S-SE H2O Use.xls!WARREN	13,185,517
2016 Total		**13,185,517**
2017	Source: 2017 South East water use reports.xlsx!WARREN	10,706,017
2017 Total		**10,706,017**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 25,849.30	$ 1,215.87
2014	$ 23,287.70	$ 1,095.38
2015	$ 24,198.74	$ 1,138.23
2016	$ 25,135.54	$ 1,182.29
2017	$ 25,296.15	$ 1,189.85
Total	**$ 123,767.44**	**$ 5,821.61**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018																					
2017																					
2016																					
2015																					
2014																					

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Power	2010	$ 3,196.29	$ 150.34
O-Cost Power	2011	$ 4,274.69	$ 201.07
O-Cost Power	2012	$ 3,736.44	$ 175.75
O-Cost Power	2013	$ 4,164.29	$ 195.87
O-Cost Power	2014	$ 3,885.98	$ 182.78
O-Cost Power	2015	$ 3,544.42	$ 166.72
O-Cost Power	2016	$ 3,869.50	$ 182.01
O-Cost Power	2017	$ 4,395.03	$ 206.73
O-Cost Power Total		**$ 31,066.64**	**$ 1,461.27**
O-Cost Water	2010	$ 3,108.01	$ 146.19
O-Cost Water	2011	$ 149.41	$ 7.03
O-Cost Water	2012	$ 1,439.41	$ 67.71
O-Cost Water Total		**$ 4,696.83**	**$ 220.92**
Grand Total		**$ 35,763.47**	**$ 1,682.20**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:08 **Analysis Year:** 2018

1 General system information

System Name: Washington Park - Irrig.Sys.

Location: Washington Park

Component Count: 6

1.1 User comments

User comments from the data collection forms for a specific year:

Reporting Year	Note
2018	High water use, poly pipe at Operations Services fails often

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	2.56	100.00%
Grand Total			**2.56**	**100.00%**

2.2 System components:

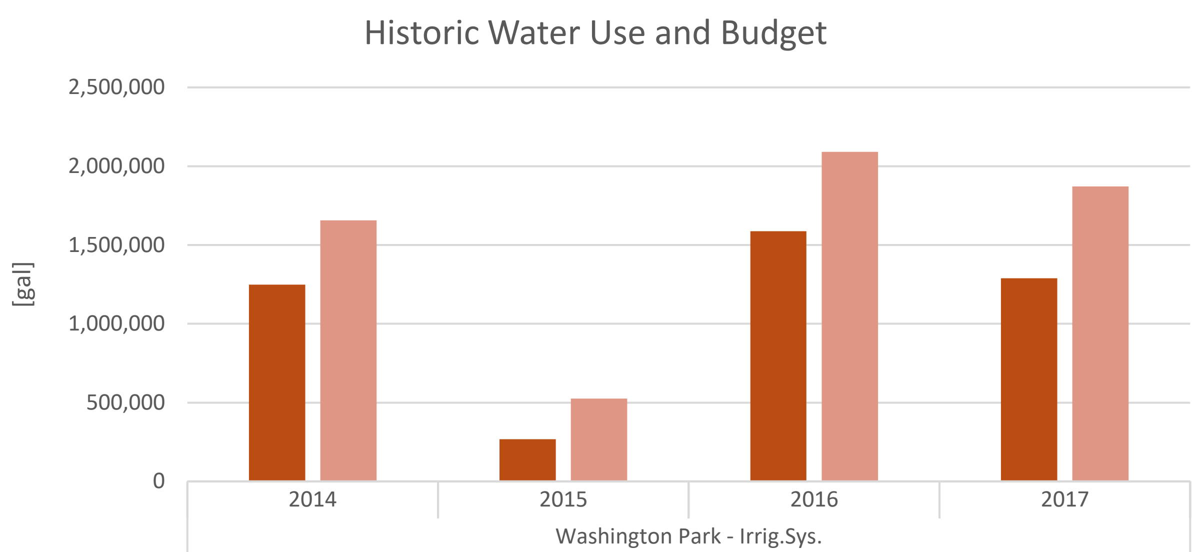
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	1980
Control Wire	Control Wire	1980
All RCVs	Remote Control Valves	1980
Washington Park Controller	Controller	1990
Operation Services Controller	Controller	2000
Xeriscape Garden controller	Controller	2016

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



	2014	2015	2016	2017
Water Budget	1,248,140	267,285	1,587,720	1,289,153
Water Use	1,655,612	525,035	2,090,091	1,872,126

Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 DaH-Fat Water Use.xls!WASHINGTON	1,655,612
2014 Total		**1,655,612**
2015	Source: DaH-Fat Water Use.xls!City hall-WASHINGTON	525,035
2015 Total		**525,035**
2016	Source: DaH-Fat Water Use.xls!City hall-WASHINGTON	2,090,091
2016 Total		**2,090,091**
2017	Source: 2017 Facilities water use reports.xlsx!City hall-WASHINGTON	1,872,126
2017 Total		**1,872,126**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 DaH-Fat Water Use.xls!WASHINGTON	1,248,140
2014 Total		**1,248,140**
2015	Source: DaH-Fat Water Use.xls!City hall-WASHINGTON	267,285
2015 Total		**267,285**
2016	Source: DaH-Fat Water Use.xls!City hall-WASHINGTON	1,587,720
2016 Total		**1,587,720**
2017	Source: 2017 Facilities water use reports.xlsx!City hall-WASHINGTON	1,289,153
2017 Total		**1,289,153**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 3,843.03	$ 1,501.18
2014	$ 8,151.03	$ 3,184.00
2015	$ 6,153.32	$ 2,403.64
2016	$ 4,729.71	$ 1,847.54
2017	$ 3,749.38	$ 1,464.60
Total	**$ 26,626.48**	**$ 10,400.97**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018																					
2017																					
2016																					
2015																					
2014																					

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Water	2010	$ 2,139.80	$ 835.86
O-Cost Water	2011	$ 2,171.60	$ 848.28
O-Cost Water	2012	$ 3,148.08	$ 1,229.72
O-Cost Water	2013	$ 2,216.19	$ 865.70
O-Cost Water	2014	$ 2,729.03	$ 1,066.03
O-Cost Water	2015	$ 2,746.47	$ 1,072.84
O-Cost Water	2016	$ 2,844.92	$ 1,111.30
O-Cost Water	2017	$ 2,742.95	$ 1,071.46
O-Cost Water Total		**$ 20,739.04**	**$ 8,101.19**
Grand Total		**$ 20,739.04**	**$ 8,101.19**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:09 **Analysis Year:** 2018

1 General system information

System Name: Waters Way Park - Irrig.Sys.

Location: Waters Way Park

Component Count: 5

1.1 User comments

User comments from the data collection forms for a specific year:

Reporting Year	Note
2018	Pump station had an issue contactors and a reverse filter. Charlie Bruger made mechanical adjustments that fixed the issue. Nothing was replaced.

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	6.9	100.00%
Grand Total			**6.9**	**100.00%**

2.2 System components:

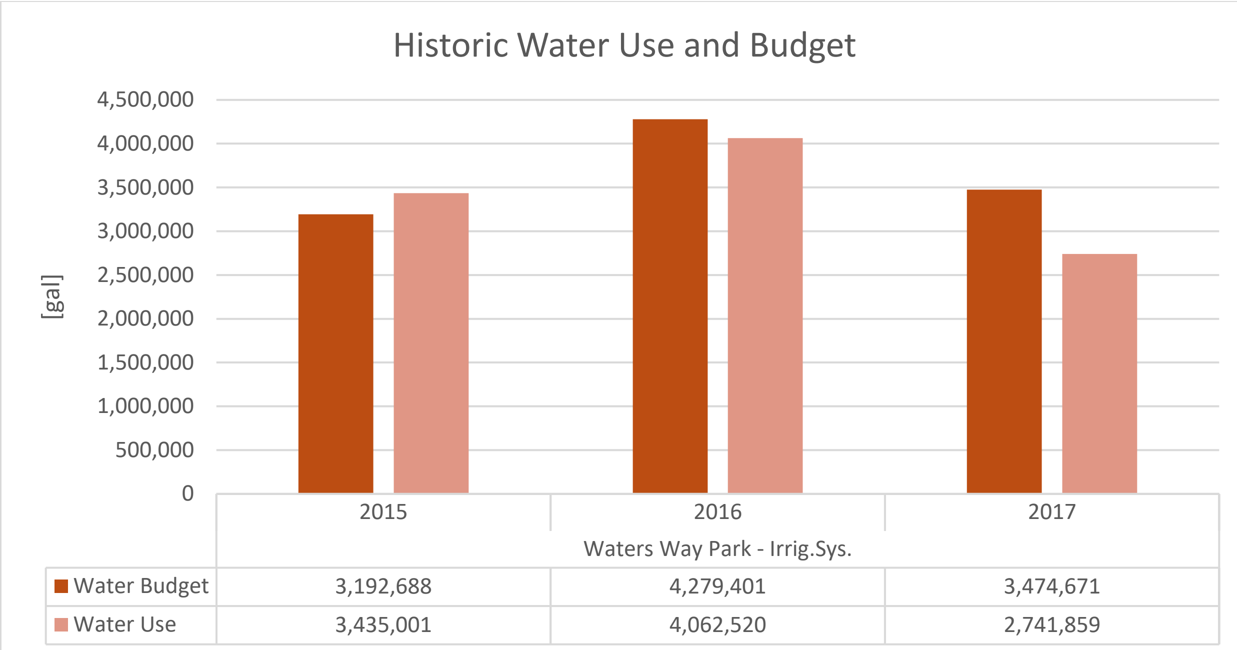
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	2012
Controller A	Controller	2018
Control Wire	Control Wire	2012
All RCVs	Remote Control Valves	2012
Booster Pump	Pump System	2012

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



Following water use performance records exist:

Year	Description	Water Use [gal]
2015	Source: S-SE H2O Use.xls!Waters Way	3,435,001
2015 Total		**3,435,001**
2016	Source: 2016 S-SE H2O Use.xls!WATERS WAY	4,062,520
2016 Total		**4,062,520**
2017	Source: 2017 South water use reports.xlsx!WATERS WAY	2,741,859
2017 Total		**2,741,859**

Following water budget records exist:

Year	Description	Water Budget [gal]
2015	Source: S-SE H2O Use.xls!Waters Way	3,192,688
2015 Total		**3,192,688**
2016	Source: 2016 S-SE H2O Use.xls!WATERS WAY	4,279,401
2016 Total		**4,279,401**
2017	Source: 2017 South water use reports.xlsx!WATERS WAY	3,474,671
2017 Total		**3,474,671**

3.2 Maintenance Cost:

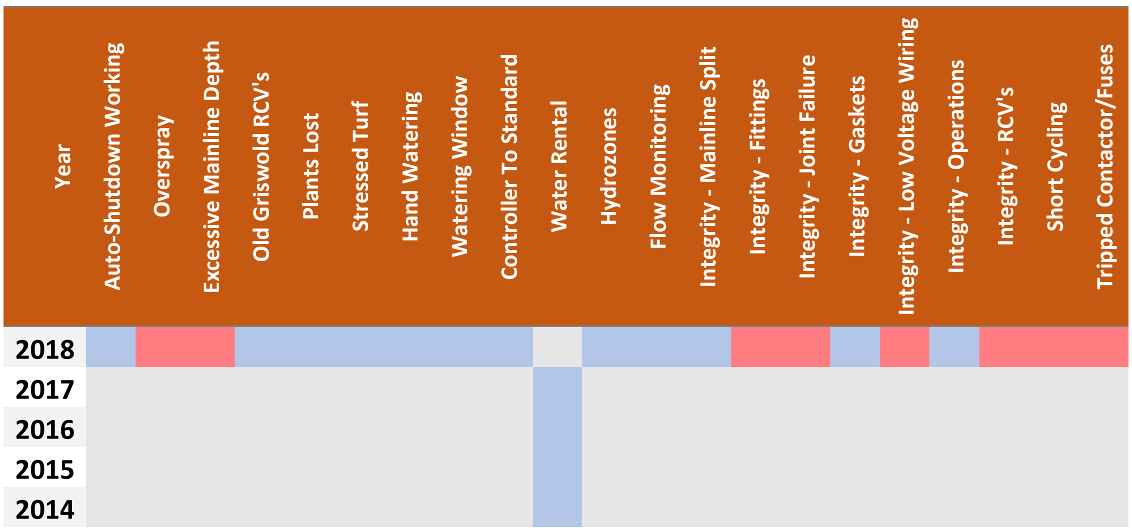
The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 7,647.63	$ 1,108.35
2014	$ 8,824.19	$ 1,278.87

2015	$ 21,549.64	$ 3,123.14
2016	$ 19,639.07	$ 2,846.24
2017	$ 24,034.21	$ 3,483.22
Total	**$ 81,694.74**	**$ 11,839.82**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):



3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Power	2015	$ 8,584.58	$ 1,244.14
O-Cost Power	2016	$ 2,551.31	$ 369.76
O-Cost Power	2017	$ 1,939.72	$ 281.12
O-Cost Power Total		**$ 13,075.61**	**$ 1,895.02**
O-Cost Water	2017	$ 1,100.00	$ 159.42
O-Cost Water Total		**$ 1,100.00**	**$ 159.42**
Grand Total		**$ 14,175.61**	**$ 2,054.44**

IRRIGATION SYSTEM REPORT

Report Date: 10/7/2019 -- 17:09 **Analysis Year:** 2018

1 General system information

System Name: Westfield Park - Irrig.Sys.

Location: Westfield Park

Component Count: 5

1.1 User comments

User comments from the data collection forms for a specific year:

Reporting Year	Note
2018	Westfield is all I 25 heads and has horrible coverage. There are a lot of zones that have full and part circle heads together.

2 System Data

2.1 Irrigated areas:

Following table lists all areas this irrigation system irrigates. This information is relevant for calculating several important metrics, including specific water use and expense related Performance Indicators.

Name	Plant Material	Crop Coefficient	Acreage [ac.]	Share
Total Irrigated Area	Unspecified	0.8	9.95	100.00%
Grand Total			**9.95**	**100.00%**

2.2 System components:

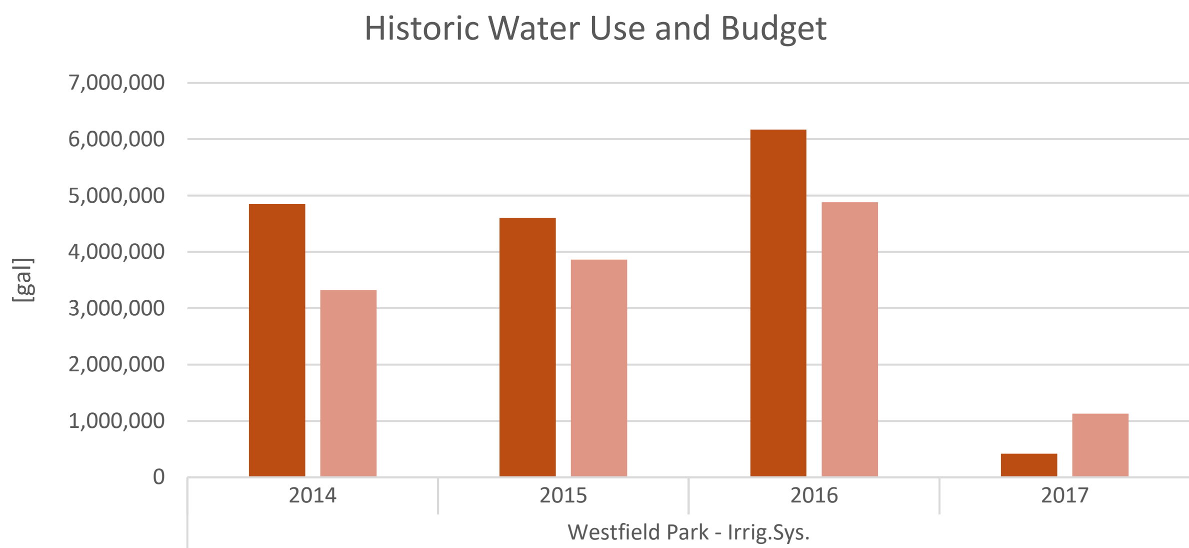
Following table lists all components that are defined for this irrigation system. Make sure it does not list any outdated and abandoned items. Listing decommissioned components affects age related PI's

Component	Type	Built/Renovated
All Mainline	Mainline Network	1997
Controller A	Controller	1997
Control Wire	Control Wire	1997
All RCVs	Remote Control Valves	1997
Pump (Add Name!)	Pump System	2013

3 Performance related information

3.1 Water Use

Following chart provides compares historic water budgets with the actual water use:



	2014	2015	2016	2017
Water Budget	4,851,168	4,603,949	6,171,021	420,137
Water Use	3,322,724	3,866,661	4,882,030	1,129,976

Following water use performance records exist:

Year	Description	Water Use [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!Westfield	3,322,724
2014 Total		**3,322,724**
2015	Source: SW-NS-CEM Water Use.xls!Westfield	3,866,661
2015 Total		**3,866,661**
2016	Source: SW-NS-CEM Water Use.xls!Westfield	4,882,030
2016 Total		**4,882,030**
2017	Source: 2017 South West water use reports.xlsx!Westfield	1,129,976
2017 Total		**1,129,976**

Following water budget records exist:

Year	Description	Water Budget [gal]
2014	Source: 2014 SW-NS-CEM Water Use.xls!Westfield	4,851,168
2014 Total		**4,851,168**
2015	Source: SW-NS-CEM Water Use.xls!Westfield	4,603,949
2015 Total		**4,603,949**
2016	Source: SW-NS-CEM Water Use.xls!Westfield	6,171,021
2016 Total		**6,171,021**
2017	Source: 2017 South West water use reports.xlsx!Westfield	420,137
2017 Total		**420,137**

3.2 Maintenance Cost:

The following table lists the expenses that occurred within specific years.

Year	Maintenance Cost [$]	Maintenance Cost [$/ac.]
2013	$ 11,989.95	$ 1,205.02
2014	$ 7,849.01	$ 788.85
2015	$ 13,085.52	$ 1,315.13
2016	$ 11,967.10	$ 1,202.72
2017	$ 14,167.76	$ 1,423.90
Total	**$ 59,059.35**	**$ 5,935.61**

3.3 Categorical Performance Indicators:

Following matrix shows if a categorical PI indicated good or bad system performance for a given year. (blue=good performance, salmon = poor performance, grey = no data):

Year	Auto-Shutdown Working	Overspray	Excessive Mainline Depth	Old Griswold RCV's	Plants Lost	Stressed Turf	Hand Watering	Watering Window	Controller To Standard	Water Rental	Hydrozones	Flow Monitoring	Integrity - Mainline Split	Integrity - Fittings	Integrity - Joint Failure	Integrity - Gaskets	Integrity - Low Voltage Wiring	Integrity - Operations	Integrity - RCV's	Short Cycling	Tripped Contactor/Fuses
2018	salmon	salmon	blue	blue	blue	blue	blue	blue	blue	grey	salmon	salmon	blue	salmon	blue	blue	blue	blue	salmon	blue	blue
2017	grey	grey	grey	grey	grey	grey	grey	grey	grey	salmon	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2016	grey	grey	grey	grey	grey	grey	grey	grey	grey	salmon	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2015	grey	grey	grey	grey	grey	grey	grey	grey	grey	salmon	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey
2014	grey	grey	grey	grey	grey	grey	grey	grey	grey	salmon	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey	grey

3.4 Other Operating Cost (Level 3):

This is relevant if a reinvestment would reduce these expenses (Power, Water)

PI-Label	PYear	Expense [$]	Expense [$/ac.]
O-Cost Power	2010	$ 1,332.58	$ 133.93
O-Cost Power	2011	$ 1,440.13	$ 144.74
O-Cost Power	2012	$ 1,414.07	$ 142.12
O-Cost Power	2013	$ 1,497.24	$ 150.48
O-Cost Power	2014	$ 1,203.02	$ 120.91
O-Cost Power	2015	$ 1,548.05	$ 155.58
O-Cost Power	2016	$ 1,578.49	$ 158.64
O-Cost Power	2017	$ 1,967.48	$ 197.74
O-Cost Power Total		**$ 11,981.06**	**$ 1,204.13**
O-Cost Water	2017	$ 1,532.66	$ 154.04
O-Cost Water Total		**$ 1,532.66**	**$ 154.04**
Grand Total		**$ 13,513.72**	**$ 1,358.16**

FORT COLLINS IRRIGATION SYSTEM PLANNING TOOLBOX

Project Report

Contents

A Introduction

The City of Fort Collins Parks Department strives to implement a proactive and data driven irrigation infrastructure management approach. Economic, social, and environmental reasons suggest the development of an irrigation system master plan. In September 2018, the Department contracted with Aqua Engineering, Inc. to provide a set of tools to facilitate the master plan design and execution.

Close collaboration with the Parks Department, experience with irrigation system design and management, and extensive research led the project team to define the following tools to support the implementation of the master plan:

A. A formalized decision making process.

B. A set of priority defining Performance Indicators (PIs) with associated weights as part of the MDCA.

C. A decision support tool (DST) that implements a Multiple Criteria Decision Analysis (MDCA) approach.

D. Updated Irrigation System Standards including: Design Guidelines, Equipment, Installation Details, and Specifications.

The first three elements of this toolbox are widely adopted by decision makers to prioritize infrastructure projects. These concepts are also suitable for irrigation system infrastructure. Element D logically complements the toolbox as it is closely connected to the preferences and priorities element B lays out.

Aqua Engineering developed the planning toolbox over the course of several months. The project started with a rough definition and successive refinement of a tiered decision process (element A, see B.4.1). Since assessing a system's condition depends on the expectations for the system, defining said expectations was the next step: Aqua engineering guided work sessions to evaluate the priorities and preferences of several City employee stakeholder groups. Analyzing work sessions results, existing data, and the attainability of indicator variables subsequently lead to the definition of PIs (element B, see section B.4.2).

Another outcome of this project, the DST, uses the PI definitions to support parts of the decision making process. The DST is an Excel based tool that stores irrigation system and irrigation system performance data, implements all aspects of the MDCA, and provides features to analyze the results [1(sec.C)].

Using these tools, Aqua Engineering worked with the Parks Department to collect all necessary data for a first assessment of infrastructure that irrigates approximately 540 acres of park landscapes. The result is a ranked list of irrigation systems, highlighting the conditions of systems with respect to the City of Fort Collins set of priorities and preferences. A separate document describes the findings of the assessment process and highlights irrigation systems that require infrastructure investments.

This document describes the project's development process, it's goals, and the scope of work. The report explains what methods led to the development of toolbox components and how the components are valuable tools in infrastructure decision making. Further information is available through the DST Documentation, the 2018 System Analysis Report, and the updated Irrigation Standards documentation. Figure 1illustrates these documents and the tools they describe.

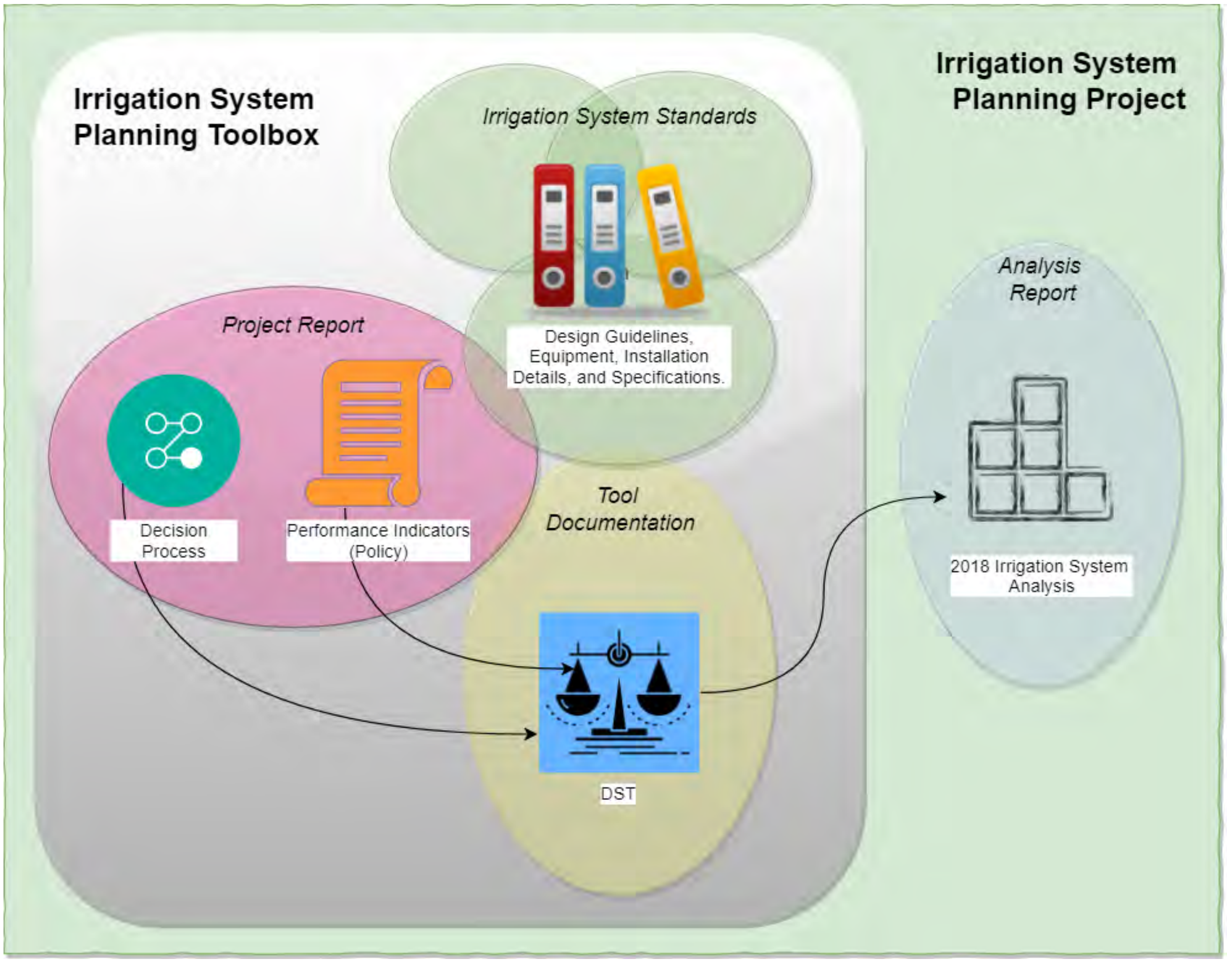


FIGURE 1 PROJECT OUTCOMES: TOOLS, DOCUMENTATION, AND REPORTS.

A.1 Terminology and Acronyms

Below is a list of acronyms and terms that are important in the context of the Irrigation System Planning Toolbox.

Acronym or Term	Description
Decision Criteria	In decision theory, criteria values are the consequences of the decisions we make. In the context of the DST, performance indicators are the cause for a decision being more or less favorable. The terms describe the cause or the result of decisions and can be used interchangeable.
Decision Process	One of the tools of the Irrigation System Planning Toolbox. A flowchart that defines several processes and if-then statements to rank and filter investment alternatives.
DST	Decision Support Tool, in this context, it refers to the MS Excel based tool to calculate SCI's
FK	Foreign Key. A (often integer) database field used to reference parent table records.
GIS	Geographic Information System

Inventory	A data structure and its content that describes irrigation system infrastructure, and the infrastructure environment. The inventory forms the basis for system assessments.
MDCA	Multiple Criteria Decision Analysis
PI	Performance Indicator.
PI-Code	A code defined for each PI and sub-PI. It follows a distinct pattern that allows grouping sub-PIs.
PI-Function	A function that uses performance input variables and outputs a PI-Score.
PI-Label	A name tag for PIs
PI-Score	The score or numeric value for a specific PI and system.
PI-Weight	The importance that a PI has in the overall assessment of a system
PI-Variable	Input data for PI-Functions. Examples are system age, maintenance cost, or if the system has automatic shutdown capabilities.
PK	Primary Key. A (integer) database field with unique values used to identify table records.
RAMS	Resource Allocation Measurement System: A accounting database that the City of Fort Collins Parks department uses to track expenses and more.
***Ranking* Table**	The Ranking Table (found at the DST Ranking Analysis Worksheet) displays the result of the DST system analysis process. It lists all irrigation systems that are under investigation at the current analysis level and shows PI-scores and SCI's for each system.
SCI	System Condition Index. A calculated indicator that aims to describe the overall condition of an irrigation system.
System	In the context of this documentation, the term system refers to an irrigation system. It comprises the physical infrastructure required to irrigate landscaped areas.
UserForms	Documents used for data collection. To collect 2018 irrigation system (master and performance) data, an excel spreadsheet that allows user input has been developed.
***WaterUse* workbook**	*An* Excel workbook with a distinct layout used by the Parks Department to collect and store water consumption data.

A.2 Context, Goals and Scope

A.2.1 Context

The City of Fort Collins Parks Department maintains and operates more than 150 irrigation systems. The total irrigated area exceeds 600 acres, even without accounting for irrigation systems that irrigate facility landscapes (e.g. at City Hall or the Laporte Buildings). Assuming unit implementation cost for irrigation systems to be between $1.50 and $2.00 per square foot, the total value of park and streetscape irrigation infrastructure exceeds $40 million (see Table 1).

According to a Parks Department report, total lifecycle replacement spending on existing park irrigation infrastructure amounts to $ 870,000 between 1993 and 2014. More than 75% of these expenses where used to update pump equipment, the remainder of about $200,000 was spent on the replacement (acquisition) of other irrigation components (i.e. pipe network, controller). Compared to the annual depreciation of 1.15 million dollar per year[a], the actual capital expenditures of roughly 10,000 dollars (200,000 dollars over 20 years) are startingly low. This holds true even when sprinkler, drip emission and valve replacements are often part of the corrective maintenance budget. These numbers and the annual maintenance spending of $1.1 to $1.4 million[2(p34)] for the years 2014 to 2017 underline the importance of sound maintenance and investment planning.

Although operating at a larger geographic and financial scale, Utilities or Streets are examples of other departments within the City that maintain and operate infrastructure assets. Both, their Water and Wastewater Master Plan and the Streets Maintenance Program, are examples of proactive strategies to increase the cost effectiveness of maintenance and reinvestment funding. Both approaches include standardized and computer aided tools that support infrastructure investment decisions. Transparent tools are essential in achieving long term financial sustainability as governmental accountability is increasingly relevant to the public. These tools are common parts of established infrastructure asset management strategies. Amongst these strategies, life cycle planning (LCP) enables an agency to:

- "Establish a long-term focus for improving and preserving the system.
- Develop maintenance strategies that consider long-term investment needs.
- …
- Provide objective data to support investment decisions.
- Eliminate existing performance gaps.
- Demonstrate good stewardship to internal and external stakeholders."[3]

The irrigation system planning toolbox considers all these planning objectives and aims to provide tools that facilitate certain asset management and LCP tasks.

A.2.1.1 Irrigation Infrastructure

The Parks Department maintains and operates different types of irrigation infrastructure. These system categories are different from each other as they operate in contrasting environments, or because of different financial responsibilities. Table 1 lists the two system types that are within the scope of the first phase of the Fort Collins Irrigation Masterplan (not necessarily this project), Parks and Streetscapes.

Table 1 Irrigation Infrastructure Capital Cost

Type	System Count	Total Irrig. Acreage [Ac.]	Capital Unit Cost [$/ft^2]	Total Capital Cost [$]
Parks	46	540	1.50	35,283,600
Streetscapes	124+	60	2.00	5,269,736
Facilities	≈30	#N/A	#N/A	#N/A
Total	**200**	**600**		**40,553,336**

Facility type irrigation systems irrigate e.g. landscaped areas at the City Hall or Utility buildings. Beyond that, systems that irrigate cemetery and golf course areas may become relevant in the future.

[a] 35 million dollars acquisition cost (see Table 1) divided by 30 years of assumed overall useful life. This is theoretically required to keep the average age at the current status.

A.2.1.1.1 PARKS

As of the beginning of 2019, the Parks Department maintains and operates 57 park sites. Figure 3 below highlights all Community-, Neighborhood and Mini-Parks. Since not all parks have irrigated landscapes, this number deviates from the system record count in the DST-Inventory at the time of writing this report.

Irrigation system component characteristics vary from site to site. 21 parks have a raw water source and use a pump system to pressurize the irrigation system. Of the systems that use potable water as their source for irrigation, some require the use of booster pumps to achieve adequate pressure.

The age of irrigation equipment that is currently in use varies drastically: While Crescent Park was installed in 2018, some of the irrigation components that are in use on other sites date back to 1967. In some cases, the age of irrigation system components indicates a wide range within a single site. Rolland Moore Park, for example, is comprised of components from 1981 as well as from 2018.

According to reports from the Parks Department, the original built date of irrigation infrastructure lies on average 30 years in the past (in 2019). Figure 2 below provides insights in the current age distribution of irrigation system components. The boxes reach from the lower to the upper quartile and are divided by the median line. The cross represents the average age. For example, 75 percent of all mainline components are older than 16 years and the average mainline age is about 25 years.

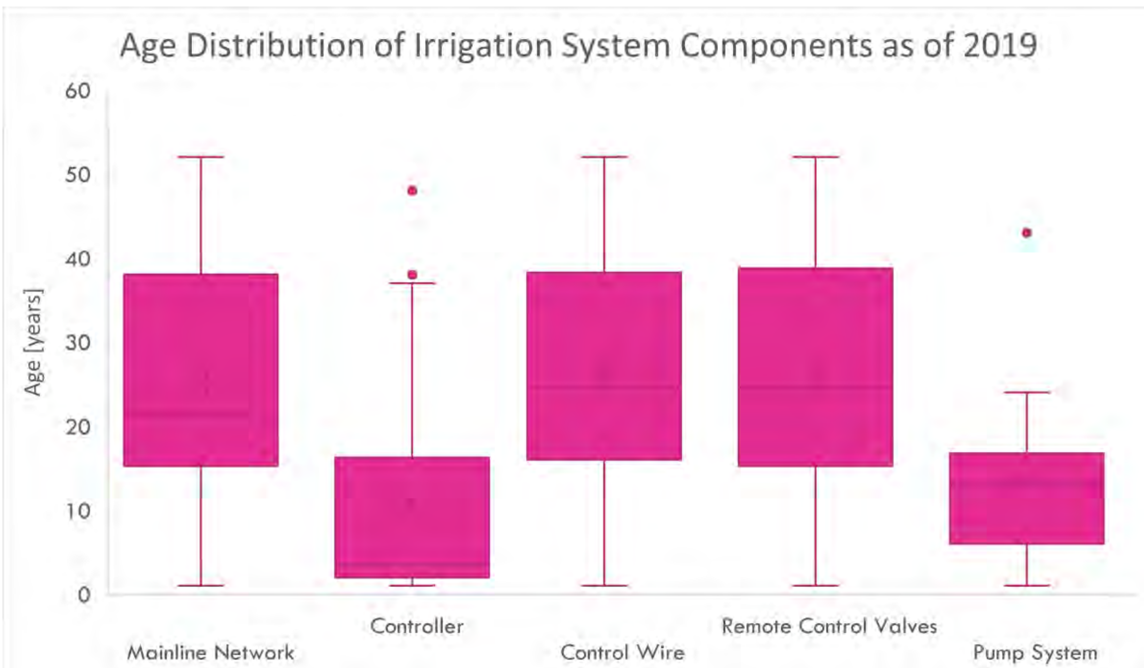


FIGURE 2 BOX AND WHISKER CHART SOWING THE AGE OF DIFFERENT IRRIGATION SYSTEM COMPONENTS AS OF 2019

The project team selected two parks as "proof of concept" sites. All decision process, DST, and Performance Indicator developments where guided by, and tested with, the irrigation systems at Rolland Moore and English Ranch Park.

A.2.1.1.2 STREETSCAPES

Beyond parks, other City owned and operated facilities and especially the landscaped parts of streetscapes rely on irrigation infrastructure. Streetscape environments are significantly different from parks. A different microclimate, environmental aspects such as the application of anti-icing chemicals, the typical geometric shapes of landscaped areas and the location close to moving traffic have an impact on both, irrigation system design/specification and all aspects of maintenance.

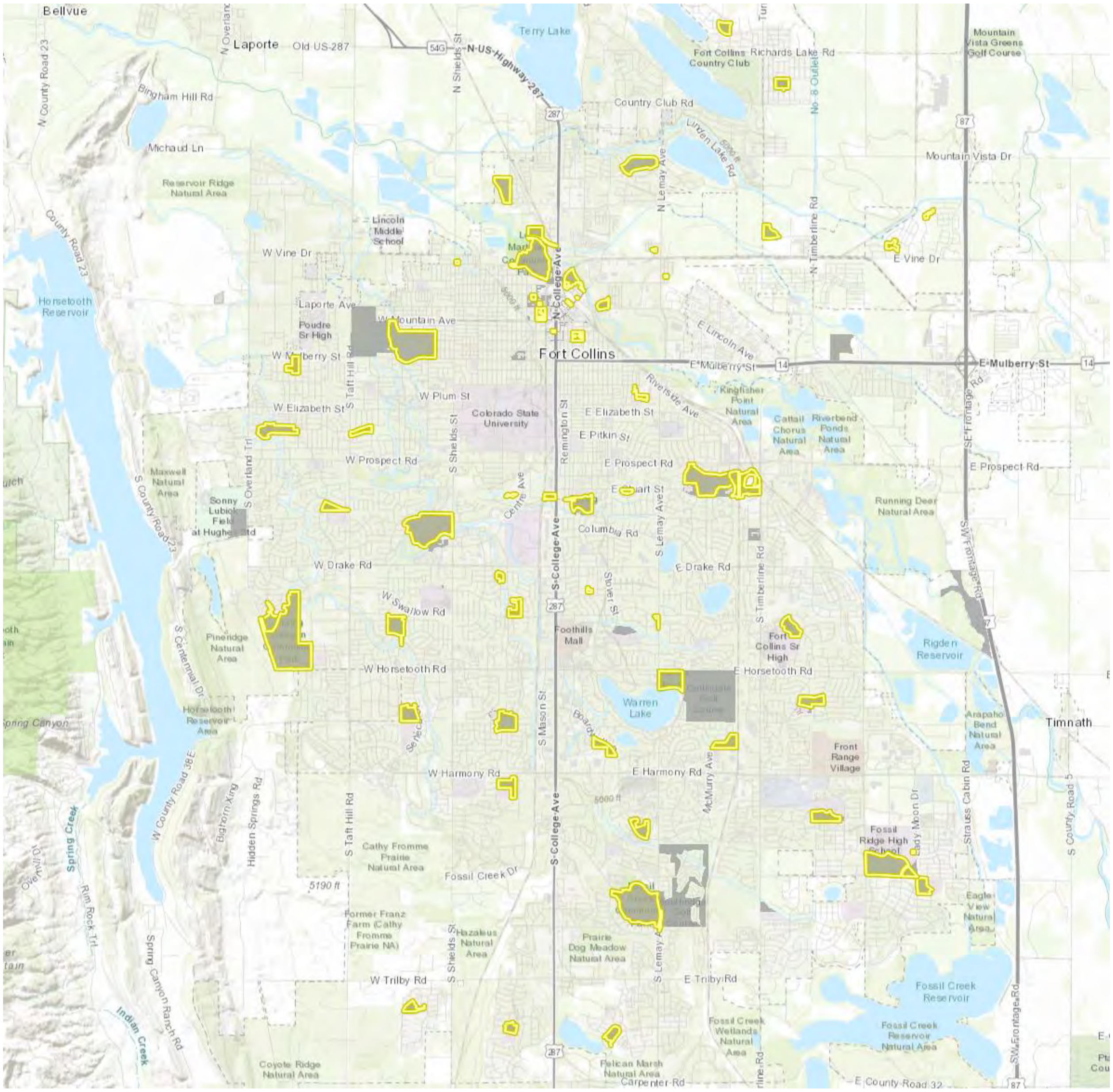


FIGURE 3 CITY OF FORT COLLINS PARKS MAP

The Parks Department's GIS currently lists 815 irrigated and non-irrigated streetscapes objects (see Figure 4), however a single irrigated streetscape may consist of several of these objects. From a total of 60 acres (see Table 1), roughly 43 acres are managed by external contractors. This is important to note, as it affects data collection efforts that are integrated in regular maintenance tasks.

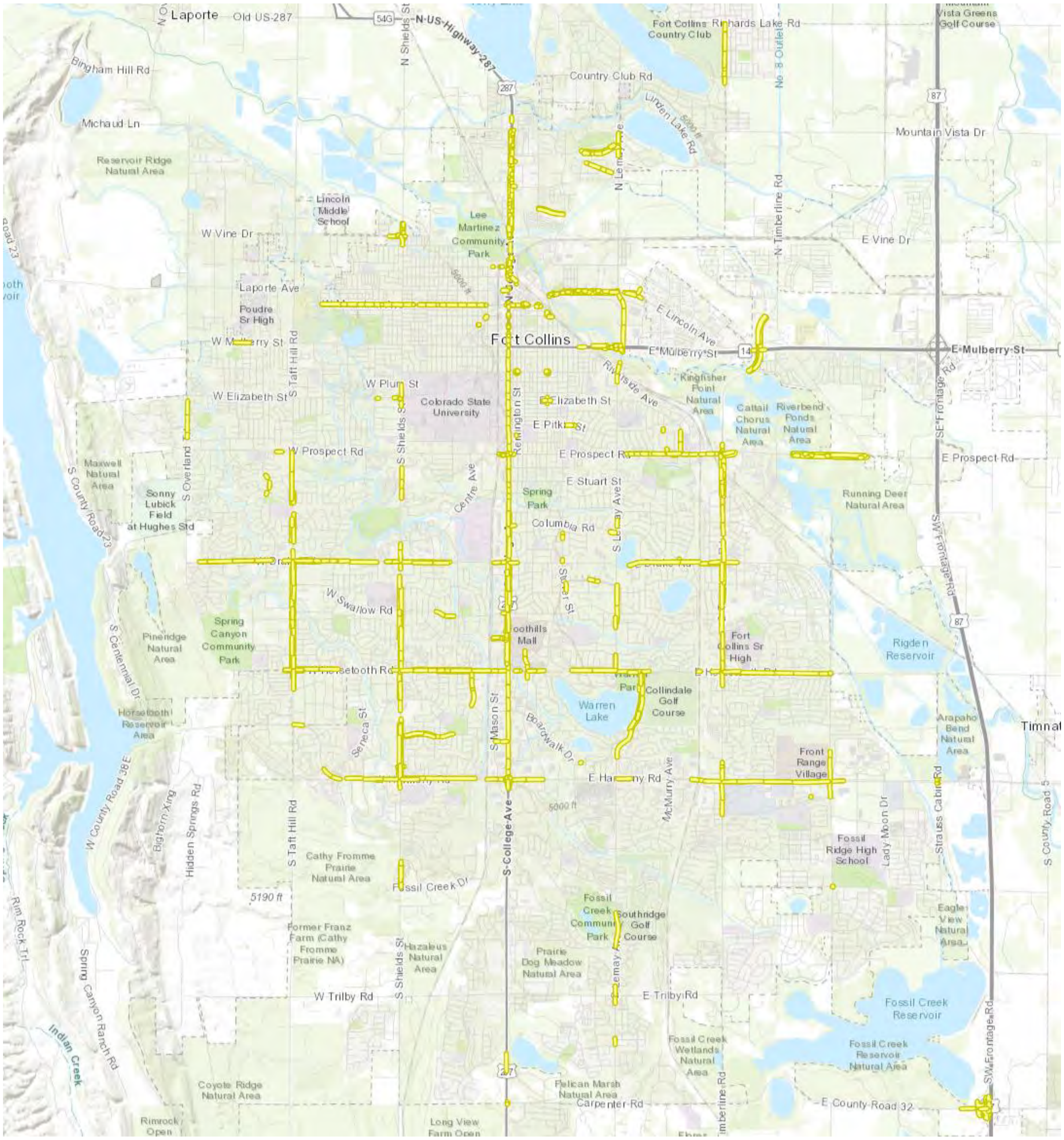


FIGURE 4 CITY OF FORT COLLINS STREETSCAPES MAP.

A.2.1.2 Stakeholders

The effects of irrigation infrastructure planning go beyond the Parks Department's management team and maintenance crews. Groups such as the City's Environmental Services, Economic Health, and Water Conservation have an interest in the implementation of proper planning tools and policy. The following section as well as the sections under B.2 explain the stakeholder relationships in more detail.

A.2.1.3 Other Plans and Programs

Irrigation systems allow Fort Collins to maintain green public spaces and built environment. Cost effective and resource conserving operation relies on proper system design and faultless performance of all components. Fostering the ability to maintain landscaped areas, conserve resources, and improve economic sustainability are desired outcomes of the Irrigation System Planning Toolbox. Besides that, proactive irrigation system planning can have positive effects on a broader parks programming level: reinvestments in irrigation infrastructure always bare the opportunity of adjusting the landscapes to align better with current standards and goals.

The impact on following items is even higher considering these opportunities. Improving efficiencies within the City's irrigation systems supports several of the organization's climate and water goals, including:

- The strategic objective to "place priority on maintaining and repairing our infrastructure of parks, recreation centers, trails and cultural facilities."[4(p19)]
- 2015 Climate Action Plan goals of reducing greenhouse gas emissions from 2005 levels 20% by 2020, 80% by 2030, and to be carbon neutral by 2050. Water-related emissions represent 0.33% of community-wide emissions and conserving water plays a role in reducing this portion of the community's carbon footprint.[5]
- To lead by example, municipal greenhouse gas reduction goals mirror the targets set for the community of 20x20, 80x30 and carbon neutral by 2050, as outlined in the 2019 Municipal Sustainability and Adaptation Plan (MSAP).
    - Per 2017's municipal carbon inventory, water treatment represents 5% of the municipal organization's greenhouse gas emissions.
- Water efficiency and conservation objectives are also outlined in the MSAP as part of the We Are Water Smart goal. Tools for "water wise" decision-making are supported by objective 3.1.3. "Convert and create landscapes that are drought-tolerant, water wise, and appropriate for our climate" in this plan.
- The City of Fort Collins Water Efficiency Plan describes the commitments made with the 2015 Climate Action Plan regarding water and resource conservation as well. It specifically mentions the goal "to reduce municipal operations in water irrigation and increase efficiency per acre."[6(p25)]

A.2.2 Goals

This project seeks to provide the City of Fort Collins Parks Department with a tool set that enables informed irrigation system planning and decision making. The toolbox shall support the Department's efforts of irrigation infrastructure maintenance and reinvestment planning. Requirements for successful public infrastructure planning include:

- Maximize the effectiveness of infrastructure investments through data driven decision making.
- Minimize the risk of bad infrastructure investment decisions.
- Increase transparency through formalized planning and decision making processes.
- Minimize the need for resources in the planning process.

A.2.3 Scope

Following tasks have been laid out as contributors to achieving the project's goals:

- Review and assemble information on life cycle analysis or examples of irrigation system replacement criteria from:
    - City of Fort Collins Streets Department, Utilities
    - Green Industry Sources such as Irrigation Association, distributors, manufacturers, etc.
- Review and/or analyze existing data provided by City of Fort Collins including, but not limited to:
    - Water use
    - Water cost
    - Maintenance/labor time
    - Maintenance/labor cost

  - Climate Action Plan
  - Water Conservation Plans
  - Drought Response Plan
- Review past irrigation design criteria/standards and provide recommendations for how to update based on current industry standards or technology.
- Attend, facilitate and analyze input and feedback from various stakeholder committees
  - Prepare documentation/format for meeting with and obtaining information from different committees.
  - Prior to each meeting, prepare the methodology for evaluation such that committee members can provide responses.
  - Attend up to 10 meetings
- Develop an irrigation prioritization evaluation method/process.
- Test prioritization evaluation method/process.
- Conduct up to four site visits as necessary to observe the irrigation systems in operation and identify things that may be important in developing and/or testing the methodology/process.
- Prepare a report describing the proposed methodology/process. Report to include an executive summary that could be used for public presentations.

B Methods

This section describes the toolbox development in more detail. It covers decision making theory, the process of irrigation system ranking, and describes the nature of Performance Indicators and how guided stakeholder meetings formed the basis for their definition. It further describes how PI-Variables feed into the calculation of PI-Scores and how the DST uses a weighted sum model to calculate a single figure for irrigation system ranking.

B.1 Project Outline and Development

The Irrigation System Planning Tool project was conducted between September 2018 and June 2019. In the initial phase of the project, collaboration with the Client, experience with irrigation system design and management, and extensive research led the project team to define following concrete tasks:

A. Develop a formalized decision making process.

B. Define a set of Performance Indicators (PIs) and associated weights as part of the MDCA.

C. Implement a DST that uses a Multiple Criteria Decision Analysis (MDCA) approach.

D. Update Irrigation System Standards and provide: Design Guidelines, Equipment, Installation Details, and Specifications.

E. Collect and analyze irrigation system data for park areas.

Figure 5 illustrates following process, the development of list elements A, B, and C, in more detail: Aqua Engineering initially introduced a rough concept for the standardized and computer aided assessment of irrigation infrastructure (i.e. decision process and criteria). Simultaneously, a MS Excel prototype version of the DST was designed. In regular client meetings both, the decision process and the tool where geared towards the Client's needs.

Knowledge about industry practices, screening of available data, and six guided stakeholder work sessions subsequently led to an initial definition of PIs. In several cycles of discussion, assessment, and redefinition, PIs had to prove that they are not only ascertainable, but also capable of predicting irrigation system qualities (see B.4.2). After incorporating a final set of indicators in the DST, the next project phase focused on the implementation of a DST production version, data collection, and quality control. The final project phase included the first irrigation system analysis, the re-adjustment of PIs, and the completion of toolbox documentation and analysis reports.

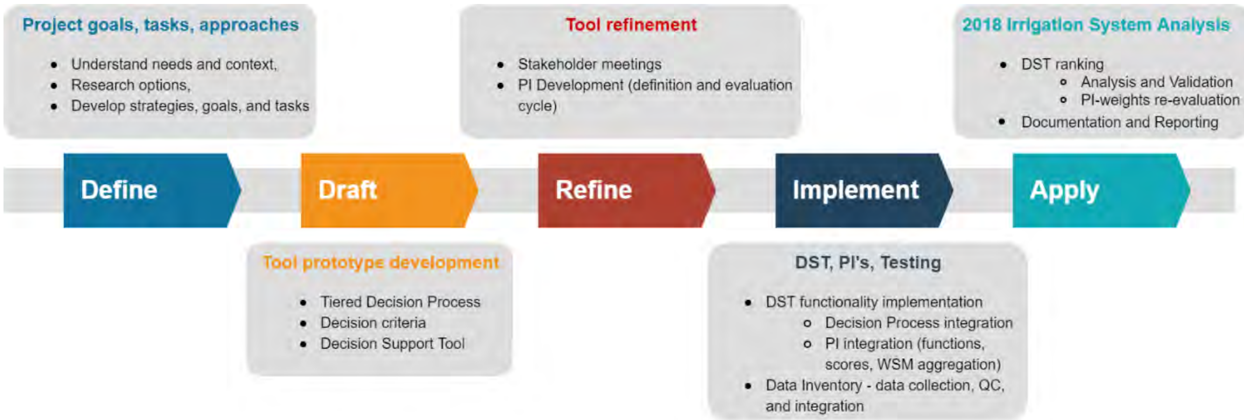


FIGURE 5 PROJECT ROADMAP: DECISION PROCESS, POLICY (PI), AND SUPPORT TOOL DEVELOPMENT

The definition of PIs and their weight in calculating a single measure for a system's condition assessment, reveals much about the values an organization has towards said system. This information formed the basis for the development of updated Irrigation System Standards.

B.2 Stakeholder Meetings

Meetings with several groups from the City of Fort Collins staff took place between October 17 and November 5, 2018. The intention was to gain an understanding for irrigation related value systems that exist at different areas and levels of the organization. Only a thorough understanding of these value systems allowed the project team to identify:

- Which indicators are important to the stakeholders (City of Fort Collins)?.
- Which indicators, in the Client's opinion, show that action (i.e. improvement) is required?

Group exercises were the tool of choice to answer these questions at several of these meetings: Each group was provided with a list of decision criteria and with a decision process in the form of flow chart (See Figure 9). Following 20 decision criteria were presented as easy to understand and short phrases on sticky notes:

TABLE 2 DECISION CRITERIA FOR STAKEHOLDER GROUP EXERCISES.

• Maintenance Cost (Time and Material)	• Opportunity for Water Conservation
• Cost of Water	• Site Visibility/Use
• Cost of Electricity	• Revenue Generation
• Integrity of Mainline Pipe Network	• Actual Water Use vs. Budget/Target Water Use
• Integrity of Lateral Pipe/Sprinklers	• Quality of Plant Material
• Integrity of Remote Control Valves	• Age
• Integrity of Control Valve Wiring	• ROI
• Integrity of Power Source	• Refresh/Park Programming
• Human Safety (Occupational/Visitor)	• Risk - Appropriate Shut Down Capabilities
• BMP's	• City Standards

B.2.1 Crew Chiefs

The project team met with the parks crew chiefs on October 17, 2018. Two groups took part in the work exercise. One group suggested a flow chart adjustment: Add the decision “Ability to phase renovation” that, if true, would lead to Process III before the decision over making a minor upgrade is made. If false, the decision leads back to the normal maintenance cycle. Figure 12 and Figure 13 show the outcome of this work session.

B.2.2 Technicians

The project team met with the park technicians on October 30, 2018. Figure 14, Figure 15, and Figure 16 depict the results of this group work session.

B.2.3 Water Conservation and Sustainability

The project team met with Water Conservation (Utilities) and Sustainability Services staff on October 22, 2018. Figure 18 and Figure 19 show the results of this work session. The discussions included resiliency aspects of (irrigated) park landscapes.

B.2.4 Forestry

The project team met with the Forestry Department staff on October 22, 2018. While no group exercise was conducted, the need for valuation of trees was stressed. Both, replacing dead trees and the need for hand watering has significant cost implications. Both issues can be the result of failing irrigation infrastructure.

B.2.5 Streetscapes

The project team met with the Parks Department streetscapes staff on October 26, 2018. The group work session (see Figure 17) resulted in many changes to the decision criteria from Table 2. This showed how different the priorities are for irrigated streetscape areas compared to park areas.

The meeting also made clear that several factors also lead to different data collection challenges:

- The use of external contractors.
- Water service lines that are shared with other entities.
- Water supply contracts with the East Larimer County and the Fort Collins Loveland Water District.
- …

It became clear that, due to these differences, an individual set of PIs is required for each system type (i.e. Park and Streetscape Irrigation System). Although the DST is flexible enough to include data and PIs of both system types within one file, the project team decided to remove the PI definition and data collection process for streetscapes from this project.

B.2.6 Economic Health

The project team met with Rachel Rogers (Sr Specialist, Economic Health) staff on November 05, 2018. The toolbox’ methods and their applicability to a holistic asset management process was discussed.

B.2.7 Other Meetings

The project team met with Matt Fater (Special Projects Manager, Utilities) on November 23, 2018. The Water Distribution and Wastewater Collection Master Plan, focus of this meeting, implements a GIS-based decision support tool that analyses seven decision criteria to support informed project planning.

Another meeting was conducted with Tim Campbell (Information Technology Department) on January 28, 2019. This meeting gauged the challenges and opportunities of using centralized relational databases as an inventory backend and GIS integration.

B.3 Site Visits

The project team conducted site visits at the Rolland Moore (S1) and English Ranch (S2) Park on October 9 and October 10, 2018 respectively. While the Rolland Moore irrigation system was originally installed in 1983, the English Ranch system was installed more recently in 1999.

Annual maintenance expenses for S1 are about 25% higher than for S2 ($1,780 vs. $1,420 per acre) and conversations with technicians on site revealed interesting insights: Frequent failures of components, excessive mainline depth and the abundance of groundwater are factors that make repairs difficult (and expensive). Several issues are related to the design, installation practices, and material of the respective eras. Examples are

- improperly poured thrust blocks,
- regular low voltage electrical failures,
- the lack and leakage of isolation gate valves,
- the lack of ball valves at the remote control valve assemblies, or
- insufficient PVC pipe material standards.

B.4 Infrastructure Asset Management

Many municipal organizations apply asset management strategies to tackle an aging infrastructure, the public demands for high levels of service, liability issues and limited financial resources. Asset management provides transparent, rational, and accountable cost-effective management of municipal infrastructure. It provides best value for money and saves unnecessary cost [7]. Typical applications are potable water, storm and wastewater, municipal roads or transit systems.

While proactive asset management has several advantages over reactive approaches to manage municipal infrastructure, its implementation requires personnel, information, and technology (i.e. additional meters, controllers, etc). The need to consider multiple social, environmental, and economic aspects make infrastructure management decisions a complex task. The results of this project meet several key requirements of a holistic asset management approach and the outcomes reduce the need for client-resources by providing insights, data, and tools that

- facilitate performance measurement and evaluation,
- form the basis for infrastructure value assessment, and
- facilitate data driven life cycle management.

Various approaches for prioritization and decision making exist in the infrastructure management domain. Marcelo et. al. name, for example, the (social) cost benefit analysis (CBA) as a 'competitor' to the MDCA presented here. However, the directness of incorporating both monetary and non-monetary objectives in MDCA is one of its key benefits over the CBA approach. This is especially useful when information or analytical resources are limited.[8(p6 pp.)]

In decision theory MCDA is a tool for evaluating a number of alternatives in terms of a number of decision criteria or Performance Indicators. More specifically, the planning toolset seeks to solve *multiple-criteria evaluation problems* since a finite number of alternatives, the rehabilitation of irrigation systems, is explicitly known in advance[9]. To provide a transparent evaluation, the MDCA incorporates a set of policies in the form of PIs. It is therefore a formalized approach to transform factual data (i.e. measurements, questionnaire results) into ranking scores, using a set of policies (i.e. PI definitions and their associated weights). Please refer to subsequent chapters for more information about this process.

The DST implements a simple form of MCDA, the weighted sum model (WSM). The performance matrix defines m alternatives and n Performance Indicators. As mentioned earlier, the term alternative describes the action of rehabilitating or replacing a specific irrigation system. Figure 6 shows how the DST arranges irrigation systems and PIs in the ranking table. It is important to note that the PI-Scores in this table are already weighted. PI-Weights are not displayed. Please refer to subsequent sections as well as to online resources[10] for additional information.

To manually disable a Performance Indicator (e.g. to compare Systems based on a sub-set of their components), double-click on the Performance Indicator Labels to the right. This has no impact if a PI is not included due to the analysis level.

PI's (Decision Criteria, [n]): Maintenance Cost, Age - System, Relative Water Use, System Safety, System Integrity, Plant Material, BMP's and City Standards

Systems (Alternatives, [m]) — Filter Criteria (Not part of basic MCDA) — PI-Scores [m, n] — SCI [m]

System	Type	Irrigated Area	C_1	C_2	C_3	C_4	C_5	C_6	C_7	Result
Rolland Moore Park - Irrig.Sys.	Community Park	40.44	0.6	2.6	3.1	3.0	4.8	5.0	1.2	20.2
Library Park - Irrig.Sys.	Neighborhood [illegible]rk	3.59	1.7	3.2	3.8	4.0	3.6	1.5	1.2	18.9
Stewart Case Park - Irrig.Sys.	Neighborhood [illegible]rk	11.5	0.1	1.2	#N/A	4.5	4.8	3.5	4.0	18.1
Harmony Park - Irrig.Sys.	Neighborhood [illegible]rk	11.4	0.0	3.6	#N/A	3.5	2.6	3.5	4.0	17.2
Washington Park - Irrig.Sys.	Mini Park	2.56	0.4	3.9	5.0	2.0	2.8	1.5	1.2	16.8
Edora Park - Irrig.Sys.	Community Pa	37.6	0.3	2.7	0.4	1.5	3.8	3.5	2.4	14.6
Lee Martinez Park - Irrig.Sys.	Community Pa	15.82	0.7	2.8	1.3	3.0	0.4	3.5	2.4	14.0
Buckingham Park - Irrig.Sys.	Neighborhood [illegible]rk	3.28	1.1	3.9	0.6	1.5	4.2	1.5	0.8	13.7
Troutman Park - Irrig.Sys.	Neighborhood [illegible]rk	17.42	0.0	2.2	2.8	1.5	2.0	3.5	1.2	1[illegible]
Romero Park - Irrig.Sys.	Mini Park	0.14	3.1	4.1	[illegible]	[illegible]	[illegible]	0.0	1.2	1[illegible]
Blevins Park - Irrig.Sys.	Neighborhood [illegible]rk	6.87	0.6	4.1	0.0	1.5	4.2	1.5	0.8	1[illegible]
Freedom Square Park - Irrig.Sys.	Mini Park	0.26	1.4	5.0	0.9	3.5	0.5	0.0	1.2	12.6
Overland Park - Irrig.Sys.	Neighborhood [illegible]rk	11	0.3	2.2	0.0	1.5	2.2	3.5	2.4	12.1
Fossil Creek Park - Irrig.Sys.	Community Pa	47.36	0.1	0.5	3.8	2.5	2.4	1.5	1.2	11.9
Old Ft. Collins Heritage Park/NACC - I	Neighborhood [illegible]rk	4.9	1.1	1.4	3.8	1.5	1.4	1.5	1.2	11.8
Spencer Park - Irrig.Sys.	Mini Park	0.47	1.3	4.1	1.9	2.0	1.3	0.0	1.2	11.7
Leisure Park - Irrig.Sys.	Mini Park	0.56	2.0	3.1	0.6	4.0	1.3	0.0	0.4	11.4
Civic Center Park - Irrig.Sys.	Community Pa	1.25	3.3	0.3	4.2	2.0	0.8	0.0	0.4	11.0
English Ranch Park - Irrig.Sys.	Neighborhood Park	12.66	0.1	0.3	0.6	1.5	3.6	3.5	1.2	10.9

FIGURE 6 THE DST DECISION MATRIX IMPLEMENTATION.

B.4.1 Decision Process

The DST attempts to answer, which irrigation system investment decision creates the most favorable outcomes. In other words: Which investment will remedy the most unpleasant situations or pains. Pains take various shapes or forms and therefore infrastructure decision making takes numerous factors into consideration. Much information is necessary to decide if a whole system or specific system components need maintenance or replacement. Gathering this information is tedious and cost intensive.

The toolbox' decision process mitigates this by implementing several analysis levels. The process reduces data acquisition requirements by screening all systems in a first step or 1st level analysis. At this level, the tool takes only the most impactful and easily accessible PIs into consideration. Additional data input is required for those systems, where investing in infrastructure replacement is, according to the 1st level analysis, a favorable decision. The 2nd level analysis is a more detailed screening process and it takes place once the required data is available. The third level analysis is a very detailed analysis of those systems where investments are likely to have the greatest impact.

The DST calculates a SCI for each irrigation system that is under consideration at a given analysis level (i.e. all systems at level 1, fewer systems at level 2, ...). Section B.4.2.4 contains additional information about this process. At this point it is important to note that a high SCI shows that an irrigation system would benefit highly from rehabilitation measures.

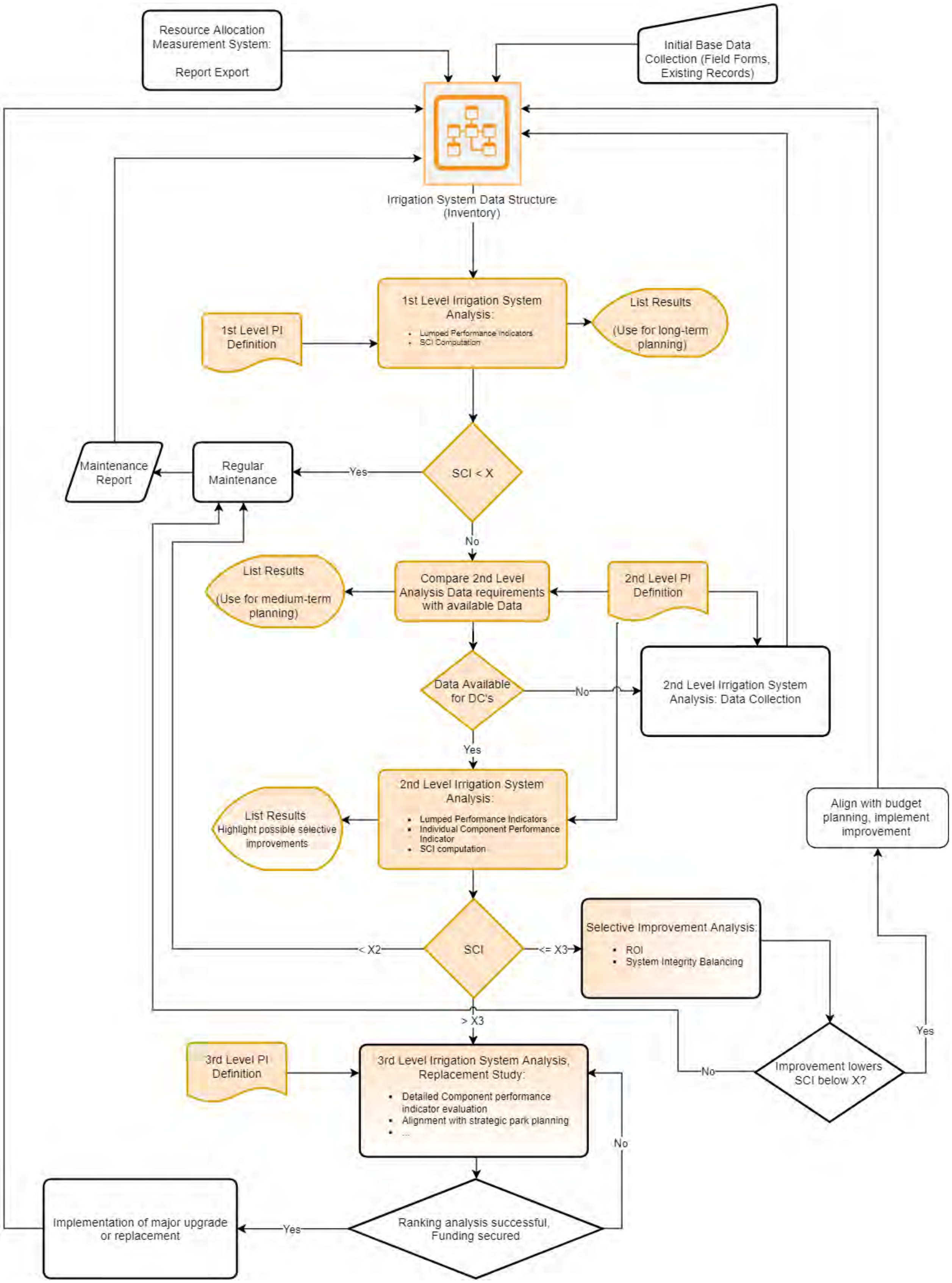


FIGURE 7 THE ALTERNATIVE RANKING AND DECISION MAKING PROCESS

Figure 7 illustrates the decision making process as a flow chart. Elements that the DST incorporates have a salmon colored background. Process, decision, or input symbols that have no background color are not computer aided. The four central processes are:

- **1st level irrigation system analysis:** The DST can fully automate this process. It uses the PI-definitions (see section B.4.2) and information about priorities (see B.4.2.4) to calculate a SCI for each system.
- **Compare 2nd Level data requirements with available data:** The tool incorporates a definition of all PIs that are relevant at each level. It automatically highlights missing data and the user can update this information.
- **2nd level irrigation system analysis:** See 1st level analysis.
- **3rd level irrigation system analysis:** The investigations necessary at this level go beyond the DST capabilities. In fact, the diversity of required investigations makes absolute automation difficult. Instead, a user needs to calculate the SCI as the sum of the DST result and the scores of additional studies. Example are:
    - ROI-Study
    - Alignment with strategic park planning
    - Additional criteria evaluation (e.g. visibility and visitor count, events, etc.)

B.4.2 Performance Indicators

The DST uses PI'-scores as signals for the degree of inconvenience irrigation systems causes in economic, social, or environmental fields. Section B.2 explains the approach to evaluate what the most pressing pains are for the City of Fort Collins in more detail. The current list of PIs in the DST (see Table 4) is a refined result of gauging the stakeholder's priorities. The term PI encompasses

- input data for PI-Score computation (PI-Variables, e.g. water use measurements or questionnaire answers),
- the mathematical function to calculate the PI-Score (see section B.4.2.3), and
- the PI-Score that the DST uses for the SCI calculation.

Careful consideration is important when defining PIs. Beyond policy aspirations, other relevant aspects are:

- Data availability or if it is possible to collect the data.
- The cost of data collection in the form of labor or new metering equipment.
- The correlation between a PI and the stakeholder priorities.
- Data quality: Unambiguity, repeatability, etc.

This project required several cycles of PI definition and PI' suitability evaluation. During this process it became clear, that for some PIs to reflect the stakeholder's priorities several questions need to be answered. Section B.4.3 explains in more detail how the DST solves this issue.

B.4.2.1 Data Availability

Data collection is a significant cost factor in the implementation of infrastructure asset management programs. Utilize data that is already available is a logical step to reduce the need for new data collection systems. Following resources have been identified to be attainable, of adequate quality, and relevant for the decision process. Please refer to section B.4.2 for more information on the PI calculation and see Table 4 in the Appendix as a reference for PI-Codes:

- Existing Resource Allocation Measurement System (RAMS) data:
    - Explanation: The Parks Department logs payroll and non-payroll expenses in the RAMS software. Periodical data export and report generation leads to the RAMS Report. RAMS

tables and other exports form the basis for the data analysis.
Account sequences for categorization and resource allocation reflect the department's organizational and service structure. Data processing uses following account sequence elements:
    - Business Unit: Distinguish Parks, Medians, and Downtown Expenses
    - Object: Service and commodity types (e.g. Expenses for Repairs, Water, Electricity, Raw Water Rental)
    - Areas: Geographic distinct areas (i.e. Parks, Facilities)
    - Program: Codes to distinguish Parks Department programs (e.g. Pumphouse, Water Mngmt/Repair, Lifecycle – Irrigation, Tennis, Football, Trash/Litter)
  - Use:
    - System data (see B.5)
    - Performance:
      - Payroll and non-payroll expense information are the source for the maintenance cost related PI (C_1).
      - An invoice report (Water Billings) is available to extract expenses for electrical power and potable water (C_8, C_9). It also allows to answer if it was necessary to rent raw water for a given year (C_7.3).
    - Data quality control: Past pump station expenses indicate that this component exists on a site. A pump station component definition must exist in the DST Inventory as well.
- Water Use Spreadsheets
  - Explanation: The Parks Department collects water use data on an annual basis. Each district (Downtown, East, Northside, Southeast, South, and Southwest[b]) saves a copy of an Excel workbook per year. The Workbooks store meter readings on separate worksheets, one for each park. These worksheets also contain the irrigated acreage, precipitation data for the irrigation season, and calculations that evaluate the total seasonal water use and budget.
  - Use:
    - Performance: The DST uses this data to calculate PI *Relative Water Use* (C_3)
    - Budget: The DST can use this data to calculate PI *Relative Water Use* (C_3).

B.4.2.2 Performance Indicator Categories

Variables for the calculation of PIs are either continuous numerical (e.g. use of resources in a specific time period) or categorical (i.e. dichotomous or polytomous). Dichotomous (binary) variables are either true or false, stored as the number 1 or 0 respectively. Values of polytomous variables are defined as sets of value-label pairs. One can frequently find this variable type in questionnaires where possible answers are e.g. never (value = 0), sometimes (value = 1), often (value =2) or always (value = 3).

Another way to categorize Performance Indicators is to look at the correlation between the PI-Variable values and its impact: Positively correlated PIs have a high value when there is a high need for improvement of the irrigation system. Negative correlation variables have a high value when the system is in good shape. At the time of writing this report, most of the DST PIs have a positive correlation (harm criteria) while only a few benefit criteria exist. Examples:

- Positive correlation:
  - Maintenance cost: High cost indicate a high need for renovation or replacement

[b] With the introduction of GIS and related data collection, some district names have changed. The names given above have been used historically to label the water use spreadsheets.

  - Requirement of Hand Watering: TRUE (1) indicates that the system inadequately irrigates certain areas or plants. Renovation, replacement or other improvements are needed.
- Negative correlation:
  - Automatic shutdown capabilities in working order: If this is TRUE (1) improvements are not necessary

The third way to categorize PIs is to look at the independence of their input variables. Just like in probability theory the value of an independent variable does not affect the value adjacent measurements. Independence is an indicator for the relevance of historic data. For example, the PI "Controller to Standard" is dependent. For this year's system assessment, it does not matter if last year the controller was in accordance with the city standards. The most recent measurement is the only one that is relevant. Maintenance cost, on the other hand, are the result from numerous factors. If maintenance cost for a given system are high in one year, it is likely that they are high in another year as well. In this case it is beneficial to average several measurements as part of the PI-function.

B.4.2.3 PI-functions

The DST implements PI-functions for every PI. They are required to relativize and render input variables into unitless PIs. PI-functions may also assure that benefit criteria do not increase the SCI. In fact, the PI-functions for several categorical variables only do that: they negate the input variable.

For continuous numeric variables the DST uses a simple classification or grading function. Similar to forming a histogram, variable values fall into one of several bins. Each bin has an associated grade (e.g. 0, ½, and 1). While bin's have the same range, the total range of all bins depends on the variable in question. To define the total range and the number of bins, understanding variable characteristics and expert knowledge is necessary. All current PI-Functions that apply this kind of grading yield PI-Scores between 0 and 1. Figure 8 illustrates how a grading function leads to a unitless classification of a numeric input variable.

PI-functions that calculate the score from independent variables must only take the most recent record into consideration. Functions for dependent variables form the average from several measurements.

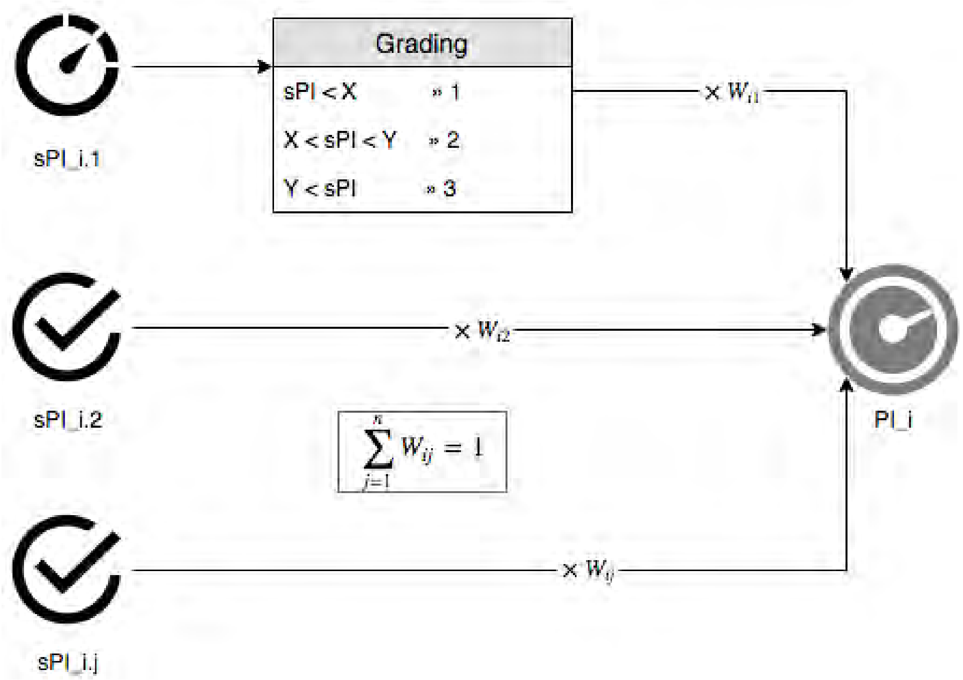


FIGURE 8 COMBINATION OF SUB-PIS TO A SINGLE PI

B.4.2.4 Performance Indicator Weighting

Beyond the selection of PIs, assigning weights to these criteria is the second policy choice of any MCDA[8(p8)]. Several strategies to assign weights exist, most notably equal weighing or negotiated expert guidance. The DST allows a user to quickly change weight settings and at the time of writing this report, weights are set by Aqua Engineering with consideration of stakeholder work session results. Table 3 guided the weighting definition. Refer to a recent Analysis Report and the DST User Manual for exemplary PI-Weight definitions [1(secD.6.1.1),11(secF.1.1)].

B.4.3 Organizing Performance Indicators

To assess a specific aspect of irrigation systems, it can be necessary to ask several questions. Every question that one needs to ask is called a sub-Performance Indicator (sub-PI). PIs that describe the aspects of irrigation systems are subsequently computed using the values from the sub-PIs.

For example, it is possible assess the risk to people or property that comes with the operation of an irrigation system (**C_4**) by asking following questions:

- **C_4.1:** Is the system auto-shutdown capable and is the auto-shutdown feature in working order?
- **C_4.2:** Is the irrigation system overspraying sidewalks, potentially creating icy and slippery surfaces?
- **C_4.3:** Are large portions of the mainline deeper that three feet?
- **C_4.4:** Are electrical installations up to national electric code, local laws and regulations?

These sub-PIs don't necessarily all have the same significance when it comes to computing a value for C_4. A weighted average operation helps resolve this issue. In contrast to calculating a PI by summing up its sub-PIs, the weighted average allows for using as many sub-PIs as required without changing the significance of the resulting PI. Figure 8 illustrates how a weighted average of several sub-PIs result in a single PI. It is important to note that the sum of all weights of a sub-PI-Set equals 1. This assures that the significance of the resulting PI-Score is only affected by its own weight (and not by any of the sub-PI-Weights).

B.4.4 SCI Calculation and Ranking

The DST calculates a WSM to assess the condition of all systems under consideration at each analysis level. As the previous section describes, the PI-Function vector for the WSM changes with each analysis level.

To accommodate the concept of PIs and sub-PIs, the DST implements a nested form of the weighted sum model. Following notation shows, how a PI is the result of summing up the total number (o) weighted sub-PI-Scores ($w_{jk}a_{ik}$) or a single PI-Score (a_{ik}). If a PI does not consist of sub-PIs, then o and w_{jk}equals 1:

$$A_i^{SCI} = \sum_{j=1}^{n} w_j * \sum_{k=1}^{o} w_{jk} a_{ik} \text{, for } i = 1, 2, 3.., m$$

with $m =$ *number of systems*

$n =$ *number of PIs*

$o =$ *number of subPIs a for a* PI_j

$w_j, w_{jk} =$ *PI and sub-PI-Weights*

and $\sum_{k=1}^{o} w_{jk} = 1$

This hierarchical design allows one to group sub-PIs into categories such as *System Safety* or (overall) *Age*. It also allows one to group all sub-PIs that are relevant to assess the status of e.g. a pump station or any other component separately.

B.5 Irrigation System Inventory and Analysis Configuration Data

The DST uses different types of information to a) define the data analysis process (Meta Data) and b) derive information necessary to conduct the analysis process (System or Data)[c]. The current DST implementation includes and references tables of both types.

B.5.1 Metadata Definitions

Meta Data is an integral part of the DST and the DST uses it as a descriptor or configuration of the analysis. The data results from an understanding of the analysis process, the irrigation system environment, and a client's priorities and preferences (PIs). It is unique for the current implementation and allows to adjust the analysis process if, for example, a different irrigation system type is under investigation (e.g. streetscape irrigation). Following DST-Tables tables contain Metadata Records:

- LocationType
- PlantMaterial
- PIndicator
- Component Type
- BudgetType

[c] Section D.5.2 of the DST Documentation describes boty data categories and their contents in more detail.[1]

B.5.2 Inventory Data Collection

System Data is information about irrigation systems. It encompasses data that describes a system's physical components and environment (Master Data), and its performance (Performance Data). Following sections describe the System Data collection process.

B.5.2.1 Existing Data

As section B.4.2.1describes, the Parks Department's RAMS system contains valuable information. The RAMS's configuration reflects the department's organizational and service structure. The DST's System Inventory contains location data that is a direct copy of all RAMS *Area* records (Parks), that reference irrigation program related expenses. This location data also forms the basis for user forms (see below).

Other system- and performance-data (irrigated acreages, historic water use, and budget) stem from water use spreadsheets. Irrigation system names in these records are inconsistent with RAMS data and manual matching is necessary. MS Excel spreadsheets are available to document and repeat the necessary processing steps.

B.5.2.2 User Generated Data

System Master- and Performance Data that was not available through existing sources required User Data Collection. A macro enabled and protected MS Excel workbook was therefore sent to Parks Department staff. Crew chiefs and technicians where asked to fill out the form and save a separate file for each park. Aqua Engineering subsequently collected all returned documents and incorporated their content in the DST Irrigation System Inventory.

While the User form had some data validation features, additional automated screening during the inventory import was necessary to assure good data quality. It was necessary to repeat that data collection process for several irrigation systems.

Figure 10 shows the top section of this form, which allowed the input of a system's name, irrigated acreage, and components. The form contained check-boxes and displayed questions (see Table 4) for the collection of data for categorical PIs. It was also possible for users to leave a general note.

B.6 Irrigation System Standards

These documents aim to alleviate the design process. They also ensure that new irrigation systems (or sections) are built in a consistent quality and fashion across multiple projects. The standards consist of following three elements:

- Design Guidelines: Beyond design considerations, this document includes a list of standard equipment.
- Specifications: As part of the construction documents, the specifications detail the work and workmanship needed to complete an irrigation system construction project.
- Details: Detail drawings and schematics of several components of an irrigation system

Existing standards form the basis for the new documents. Knowledge and analysis of state of the art technology and close collaboration between stakeholders further shape all three documents.

C Results & Conclusion

The results of this project follow following categorization and structure:

- Toolbox
    - The formalization of irrigation system infrastructure investment prioritization.

    - The identification of main priorities regarding the operation and management of irrigation systems
    - The development of a flexible tool for the computer aided assessment of irrigation systems (DST). The tool considers, but is not limited to, the resulting priorities.
- A first analysis of all parks irrigation systems.
    - Includes Master- and 2018 Performance Data Collection
- Updated Irrigation System Standards including: Design Guidelines, Equipment, Installation Details, and Specifications.

Additional reports exist for the documentation of the DST, the irrigation system analysis, and for the Irrigation System Standards. Following sections provide an overview of these documents.

Performance Indicators: Table 4 lists the PIs that the current DST-version implements. They are the result of an elaborate selection process as described in sections B.4.2 and B.2. The DST (see below) defines the PI-functions. Beyond PI-Functions, specific questions are available for every PI that relies on data input from stakeholders. These questions are an essential part of the 2018 data collection form, an MS Excel workbook that allows semi-automated user data collection.

DST: One of the outcomes of this project is the DST. Based on MS Office (Excel, Word) and VBA, this tool incorporates following components:

- Data Inventory (Stores system information, PI-definitions, and PI-function inputs)
- Analysis Logic (Data compilation and PI-functions; see B.4.2)
- Ranking Analysis (see B.4.4)
- Reporting

Please refer to the DST Tool Documentation for a detailed explanation of these core components.

System Analysis: Please refer to the corresponding documents for further information.

Standards and Specifications: Please refer to the corresponding documents for further information.

D Current Limitations and Outlook

The DST can use several years of historic data. It's scalable and flexible design as well as the MS Excel based implementation allows for easy adjustments to future needs. The tool is able to connect to a centralized data backend, which would ensure high data quality and improved user friendliness.

Changes to the current work order system would improve the resolution and usability of irrigation system analysis. The DST in its current version can analyze multiple economic PIs, each representing the expenses made for specific irrigation system components. However, at the time of writing this report work orders are lumped within the programs Pumphouse, Lifecycle – Irrigation, and WaterMngmt/Repair. The latter may be split up into

- Repair – Controller
- Repair – Mainline Network
- Repair – Remote Control Valves
- Repair – Control Wire

GIS based work order systems facilitate the allocation of expenses to specific components. This would substitute the need for a more detailed work order categorization in the current RAMS.

Additional features such as online user forms for continued data collection could significantly reduce the need for data management efforts, improve user experience, and enhance data quality control. Data collection and may even be integrated and accessible through the City's GIS platform. This platform already stores irrigation system infrastructure data. Extending this geodatabase to accommodate the current DST inventory could enhance data quality, analysis resolution (components), and usability. Using this data may also resolve one of the limitations of the DST: Since the component definitions do not quantify the material, the current PI-function for component age assessment considers every component definition with the same weight: The system grade 100 feet of 50 year old main line and 2000 feet of 10 year old main line as a 30 year old main line component. It is the user's responsibility to e.g. omit defining the old piece of mainline. Only significantly higher data collection efforts, as being done to improve the GIS database, can resolve this issue.

The current DST implementation allows a user to define any number of irrigation system components. Due to the limitations of a spreadsheet based PI-function definition for the age assessment, the DST takes only 36 components into account when calculating the age PI-Scores for each component type. This is adequate if the user pre-consolidates the available information about components: Instead of defining each individual valve, it is necessary to lump all valves that have the same age. While this is a good solution at the time of writing this report, future data availability (GIS) might require and allow improving of the PI-Score calculation.

E References

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F List of Figures

G List of Tables

H Appendix

H.1 Tables

Table 3 Count and ranking of decision criteria from stakeholder meetings

Votes for Performance Indicators at different levels of analysis

Performance Indicator	Level 1	Level 2	Level 3	Sum
Actual Water Use vs. Budget/Target Water Use	3	3	2	8
Age	4	2	1	7
City Standards	2	1	4	7
Quality of Plant Material	3	3	1	7
Cost of Water	2	3	2	7
ROI	1	3	3	7
BMP's	3	1	2	6
Maintenance Cost (Time and Material)	4	2		6
Risk - Appropriate Shut Down Capabilities	1	3	2	6
Integrity of Mainline Pipe Network		4	2	6
Integrity of Remote Control Valves		4	2	6
Integrity of Control Valve Wiring		5	1	6
Integrity of Lateral Pipe/Sprinklers		5	1	6
Site Visibility/Use	2	2	1	5
Human Safety (Occupational/Visitor)	4		1	5
Integrity of Power Source		4	1	5
Opportunity for Water Conservation		2	3	5
Refresh/Park Programming		2	2	4
Revenue Generation			4	4
Cost of Electricity		1	2	3
Quality of Water		2	1	3
Total	29	52	38	119

TABLE 4 PERFORMANCE INDICATORS THE DST IMPLEMENTS

PI-Label	Description	Question	PI-Code	IsInde-pendent	IsBene-fit
Pump Station	Assesses the overall performance of the pump station	N/A	C_0	FALSE	FALSE
MCost - Pump Station	Maintenance expenses associated with the pump station. Source: RAMS	How high where the expenses for pump station maintenance in the reporting period?	C_0.1	FALSE	FALSE
Age - Pump Station	This Performance Indicator is the calculated result of the age of a system's components. Source: Form - System Property Data	N/A	C_0.2	FALSE	FALSE
Tripped Contactor / Fuses	Frequently tripping fuses or blown contactors are indicate a failing electrical system. Source: Form - Annual Report	Did pump station fuses or contactors trip or blow during the reporting period?	C_0.3	FALSE	FALSE
Short Cycling	Short cycling of a pump can have various reasons. While it can be an indicator for issues with the pipe network served, issues with the pump station itself can be the cause as well. Make sure to investigate the actual source of this effect. Source: User Form - Annual Report (or electrical load time series data)	Is the PMP turning on more than 6 times per hour?	C_0.4	FALSE	FALSE
Maintenance Cost	1029 - Overall Labor and Material Source: RAMS	How high where the expenses for system maintenance in the reporting period?	C_1	FALSE	FALSE
MCost-Mainline	The share of maintenance cost attributable to the mainline network. Source: RAMS	How high where the expenses for mainline network maintenance in the reporting period?	C_1.1	FALSE	FALSE
MCost-Controller	The share of cost attributable to controller maintenance. Source: RAMS	How high where the expenses for controller maintenance in the reporting period?	C_1.2	FALSE	FALSE
MCost-RCV	The share of maintenance cost attributable to remote control valves. Source: RAMS	How high where the expenses for remote control valve maintenance and replacement in the reporting period?	C_1.3	FALSE	FALSE
MCost-LV Wire	The share of maintenance cost attributable to control wire issues. Source: RAMS	How high where the expenses for control wire repairs in the reporting period?	C_1.4	FALSE	FALSE
Age - System	This Performance Indicator is the calculated result of the age of a system's components. Source: Form - System Property Data	N/A	C_2	FALSE	FALSE

Age - Mainline	The age of the mainline pipe network. It is derived from component definitions and uses either one of the "year built" or "year renovated" fields. Source: Form - System Property Data	N/A	C_2.1	FALSE	FALSE
Age - Controller	The age of the mainline pipe network. It is derived from component definitions and uses either one of the "year built" or "year renovated" fields. Source: Form - System Property Data	N/A	C_2.2	FALSE	FALSE
Age - RCV's	The age of the system's remote control valves. It is derived from component definitions and uses either one of the "year built" or "year renovated" fields. Source: Form - System Property Data	N/A	C_2.3	FALSE	FALSE
Age - Control Wire	The age of the system's remote control valves. It is derived from component definitions and uses either one of the "year built" or "year renovated" fields. Source: Form - System Property Data	N/A	C_2.4	FALSE	FALSE
Relative Water Use	The relative water use is the quotient of total and budgeted water use. It comprises both potable and raw water sub-PIs. Source: RAMS	What is the quotient of total and budgeted water use?	C_3	FALSE	FALSE
Raw Water Use	This figure is required to calculate the ratio between used and budgeted water. While achieving the budgeted goal depends on several Infrastructure-unrelated factors such as management or the correct calculation of the goal, it can also indicate an inadequate irrigation system (design, technology), water loss through breaks, leaks, failing valves or similar. Source: RAMS	How much raw water was used during the reporting period?	C_3.1	FALSE	FALSE
Potable Water Use	This figure is required to calculate the ratio between used and budgeted water. While achieving the budgeted goal depends on several Infrastructure-unrelated factors such as management or the correct calculation of the goal, it can also indicate an inadequate irrigation system (design, technology), water loss through breaks, leaks, failing valves or similar. Source: RAMS	How much potable water was used during the reporting period?	C_3.2	FALSE	FALSE
System Safety	This indicator represents the risk that arises from the operation of the irrigation system. Adverse effects include those harmful to human health and to goods and property as well. The PI comprises three sub-Indicators.	N/A	C_4	FALSE	FALSE

Auto-Shutdown Working	Indicates whether the System has automatic shutdown capabilities for high flow events (Mainline break) and if that system is working. Breaks can cause serious damage due to flooding. Source: Form - Annual Report	Does the system have functioning auto-shutdown capabilities (i.e. master valve, flow sensor)?	C_4.1	TRUE	TRUE
Overspray	Indicates whether the system oversprays hardscape. This is commonly the case when the system is rather old (design standards) or sidewalks where installed without adjusting the sprinkler layout. As a result, sidewalks and other paved areas can become slippery and pose a hazard to visitors and staff. Source: Form - Annual Report	Does the irrigation system overspray hardscape?	C_4.2	TRUE	FALSE
Excessive Mainline Depth	Indicates if large parts (>30%) of the mainline network is deeper than 3 ft (soil surface to top of pipe). Trench collapse, or cave-ins, pose a great risk to worker's lives. Source: Form - System Property Data	Is the mainline deeper than three feet?	C_4.3	TRUE	FALSE
Old Griswold RCV's	Certain old Griswold valve models pose a risk to maintenance staff. Source: Form - Annual Report	Are old Griswold RCV's used in this system?	C_4.4	FALSE	FALSE
System Integrity	Aims to assess the overall integrity of the irrigation system. This PI comprises several sub-PIs, each aiming to cover accessible integrity data points. Source: Form - Annual Report	N/A	C_5	FALSE	FALSE
Integrity - Mainline Split	Reports that a split type failure mode occurred. Source: Form - Annual Report	Did a split type pipe failure occur within the reporting period?	C_5.1	FALSE	FALSE
Integrity - Fittings	Reports all types of fitting failures (pinhole, burst, etc.) Source: Form - Annual Report	Did fitting failures occur within the reporting period?	C_5.2	FALSE	FALSE
Integrity - Joint Failure	Reports all types joint failures as a result from inadequate thrust block design or failing mechanical restraints. Source: Form - Annual Report	Did joint failures occur within the reporting period?	C_5.3	FALSE	FALSE
Integrity - Gaskets	Reports any failure of pipe gaskets. Source: Form - Annual Report	Did gasket failures occur within the reporting period	C_5.4	FALSE	FALSE
Integrity - Low Voltage Wiring	Reports issues with the low voltage wiring. Source: Form - Annual Report	Are valves coming on as scheduled or on demand?	C_5.5	FALSE	FALSE
Integrity - Operations	This indicator aims to answer whether isolation gate valves exist and if they are operational. Source: User Form - Annual Report	Was it necessary to shut down the whole system for pipe network repairs?	C_5.6	FALSE	FALSE

Integrity - RCV's	Percentage of RCV's that needed partial or complete replacement. Source: Form - Annual Report	What is the percentage of RCV's where (partial) replacement was necessary during the reporting period?	C_5.9	FALSE	FALSE
Plant Material	This PI comprises three sub-PIs that describe the effects of an improperly working irrigation system on the plant material. Replacing plants can be costly, especially if they are old or large growing. These cost are directly related to the irrigation system but are often excluded from asset management considerations.	N/A	C_6	FALSE	FALSE
Plants Lost	Indicates whether plants died as a result of a failing irrigation system or one of it's components. Source: Form - Annual Report	Did plants die due to an inadequate or failing irrigation system?	C_6.1	FALSE	FALSE
Stressed Turf	Indicates if turf was stressed due to an inadequate, poorly designed, or failing irrigation system. Source: Form - Annual Report	Did an inadequate or failing irrigation system cause stressed turf?	C_6.2	FALSE	FALSE
Hand Watering	Indicates whether hand watering was required due to an inadequate automated irrigation system. Source: Form - Annual Report	Within the indicated period, was it necessary to hand water due to an inadequate or failing irrigation system?	C_6.3	FALSE	FALSE
BMP's and City Standards	Indicates if the system design, implementation, and operation is according to best management practices and city standards.	N/A	C_7	FALSE	TRUE
Watering Window	Indicates whether an irrigation system can apply the required water within the watering window the city standards state. "Quote Watering Window City Standards here" Source: Form - Annual Report	Is the current watering window within city standard limits?	C_7.1	FALSE	TRUE
Controller To Standard	Indicates if system's controller is up to city standards or not. Source: Form - Annual Report/System Property Data	Is the controller in accordance with city standards?	C_7.2	TRUE	TRUE
Water Rental	For systems that are using non-potable water, the need to rent water on a regular basis may be an indicator that water savings exist or that a redesign of the system could improve the use of existing water rights through a change of storage capacity or the implementation of BMP's. Source: RAMS	Was it necessary to acquire water within the reporting period?	C_7.3	TRUE	FALSE

Hydrozones	This indicator provides insights into the design quality of a system. It is a BMP to correlate the irrigation zones with the different hydro zones (Clusters of plants with similar water requirements) Source: Form - System Property Data	Is the system design aligned with current hydro zones?	C_7.4	TRUE	TRUE
Flow Monitoring	This indicator provides insights into the design quality of a system. It is a BMP to correlate the irrigation zones with the different hydro zones (Clusters of plants with similar water requirements) Source: Form - System Property Data	Can the flow be monitored zone by zone?	C_7.5	TRUE	TRUE
O-Cost Power	Expenses for electrical energy.	How much where the expenses for electrical power in the reporting period?	C_8	FALSE	FALSE
O-Cost Water	Expenses for water.	How much where the expenses for water in the reporting period?	C_9	FALSE	FALSE

Table 5 Area and Program codes in the department's RAMS System. Green highlighted areas are part of the 2018 DST-Inventory data. Orange indicates programs relevant to this project. Lifecycle cost are not part of the automated analysis, they are relevant information for decision making.

	AREA/Subsidiary		AREA/Subsidiary		AREA/Subsidiary		PROGRAM/Subledger
6001	Leave	6057	Creekside Park	6109	Whitewater Park	1028	Dog Parks
6003	Oak Street Plaza	6058	Eastside Park	6110	Side Hill Park Site	1029	Water Mngmt/Repair
6007	Old Town Square	6059	Edora Park	6111	Lind - Undeveloped	1030	Snow Removal
6008	City Office Bldg	6060	English Ranch Park	6112	Trail Head Park Site	1031	Ice/Skate Rinks
6009	Carnegie Bldg (Old Museu	6061	Fossil Creek Park	6114	Bacon Park Site	1032	Turf Care
6010	Lee Martinez Farm	6062	Freedom Square Park	6115	Streets Facilities Park Site	1033	Equipment Repair
6011	Linc Ctr/Indoor Pool	6063	Golden Meadows Park	6116	East Community Park Site	1034	Trash/Litter
6012	Downtown/Linden	6064	Greenbriar Park	6150	Carbarn Block 33	1035	Maintenance Facilities
6013	City Hall & Op Svcs Bldg	6065	USE PSD - 6046 (huideko	6154	Dis Science Ctr/Museum	1036	Misc Infrastructure Maint
6014	EPIC	6066	Harmony Park	6155	Willow & Linden Plaza	1037	Snow RemovalAFTER HOURS
6015	Avery House	6067	Soft Gold Park	6157	Safe House	1038	Community Gardens
6016	Park Shop	6068	Grdns on Spg Ck / Lilac P	6160	Montezuma Alley	1039	Holiday Lighting/Decorations
6017	Senior Center	6069	Indian Hills Park	6161	Old Firehouse Alley	1040	Vandalism
6018	Police Building	6070	NOT BEING USED	6162	Alley Cat Alley (Dazell)	1041	Recycling/Compost
6019	Other Facilities	6071	Landings Park	6163	West Mountain Alley	1042	Emergency Response Cleanu
6020	Showmobile	6072	Lee Martinez Park	6164	Seckner Alley	1043	Volunteers
6021	4th of July	6073	Legacy Park	6170	Mall Underpass	1044	Special Projects (Billable)
6022	I25 & Highway 392	6074	Leisure Park	6171	CSU/Shields Underpass	1045	Living Wall
6023	222 LaPorte (Utility Bldg)	6075	Library Park	*6197*	*Undist Tools/Supp*	1046	Power Washing
6024	Enhanced Medians	6076	Miramont Park		**PROGRAM/Subledger**	1047	Veteran Sites
6025	Median/Parkwy - Contract	6077	NACC / Old FtC Heritage	1000	No Specific Prog	1048	CP South Ballfield
6026	281 North College Ave	6078	Overland Park	1002	Conf/Training/Committees	1049	Memorial Benches
6027	Aggie Greens Disc Golf	6079	Ridgeview Park	1003	Lacross	1050	Events / Event Prep
6028	Archery Range	6080	Rogers Park	1004	Rugby	1051	Native Areas in Parks
6030	Trail - Power	6081	Rolland Moore Park	1005	Project Management	1052	Ponds/Ditches/Reservoirs
6031	Trail - Rendezvous	6082	Romero Park	1006	Pumphouse	1070	Routine Patrols
6032	Trail - Long View	6083	Rossborough Park	1007	BMX / Bike Course	1071	Directed Patrols
6036	Trail - Poudre	6084	Spring Canyon Park	1008	Basketball	1072	Community Policing/Problem Solving
6037	Trail - Spring	6085	Spencer Park	1009	Disc Golf	1073	Park Ranger Miscellaneous
6038	Trail - Fossil	6086	Spring Park	1010	Baseball/Softball	1074	Homeless/Transient Issues
6039	Trails - Other	6087	Stewart Case Park	1012	Softball/Baseball Tournies	1075	Animal Management
6040	Cemeteries	6088	Troutman Park	1013	Football	1076	Abandoned Property
6043	Golf	6089	Warren Park	1014	Soccer	1080	Lifecycle - Admin
6044	Forestry	6090	Washington Park	1015	Tennis	1081	Lifecycle - Asphalt
6045	DBA / DDA	6091	Westfield Park	1016	Horseshoes	1082	Lifecycle - Buildings
6046	PSD	6092	Woodwest Park	1017	Pickleball	1083	Lifecycle - Courts
6047	Dixon Reservoir	6093	Homestead Park	1018	Volleyball	1085	Lifecycle - Fields
6048	Non-City Agency	6094	Iron Horse Park Site	1019	Skateboard/In Line	1086	Lifecycle - Irrigation
6049	Other Depts	6095	Rabbit Brush Park	1020	Restrooms	1087	Lifecycle - Medians
6050	Alta Vista Park	6096	Civic Ctr Park / Blk 31	1021	Playgrounds	1088	Lifecycle - Playgrounds
6051	Avery Park	6103	Waters Way Park	1022	Shelters	1089	Lifecycle - Structures
6052	Beattie Park	6104	Richard's Lake Park Site	1023	Kickball	1090	Lifecycle - Trails
6053	Blevins Park	6105	Twin Silo Park	1024	Botanical	1091	Lifecycle - Water
6054	Buckingham Park	6106	Registry Park	1025	Parking Lots	1092	Lifecycle - Other
6055	City Park	6107	Radiant Park	1026	Décor water features		**Subledger Type**
6056	Cottonwood Park	6108	Crescent Park	1027	Trail Repairs	A	Address Book Number

H.2 Figures

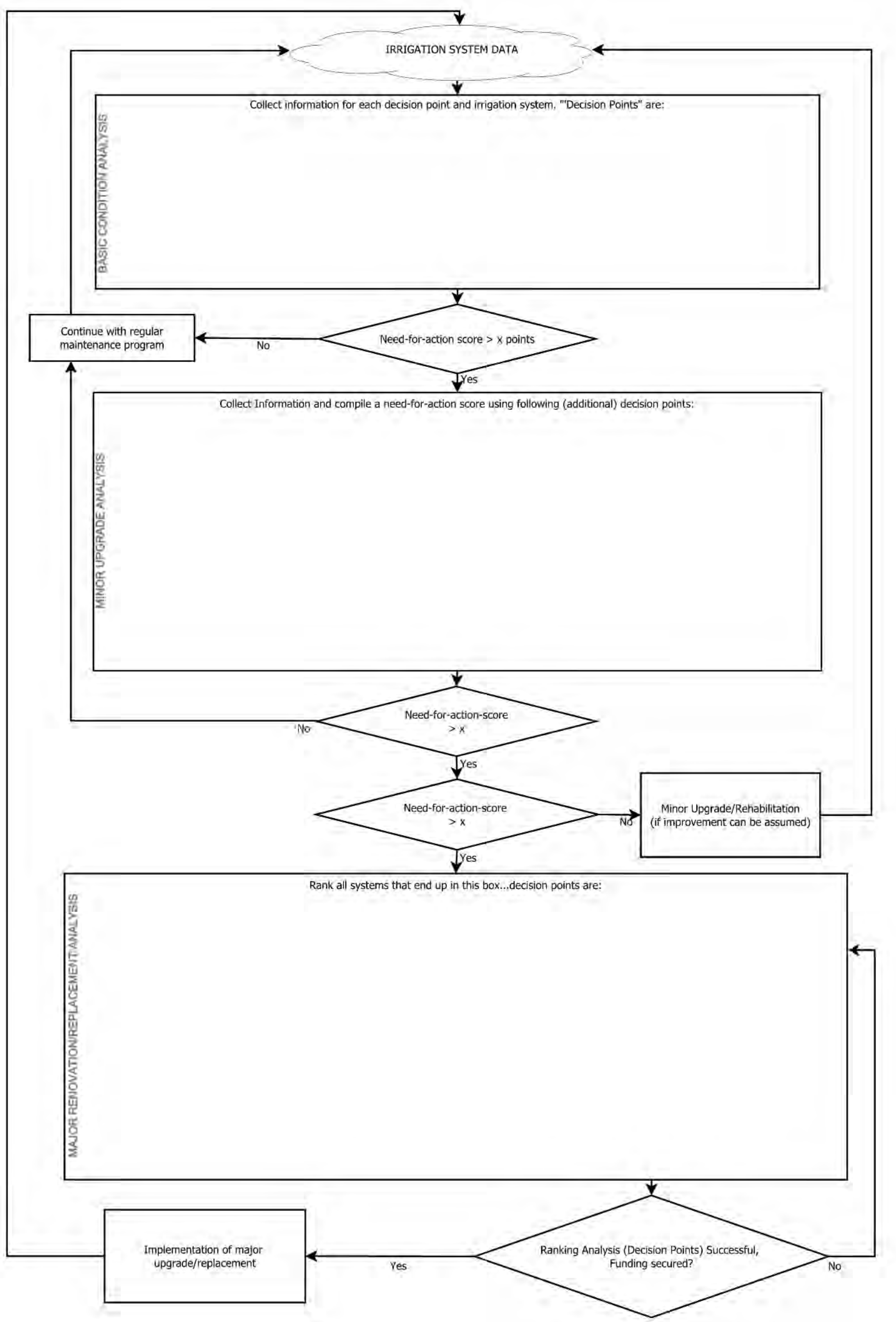
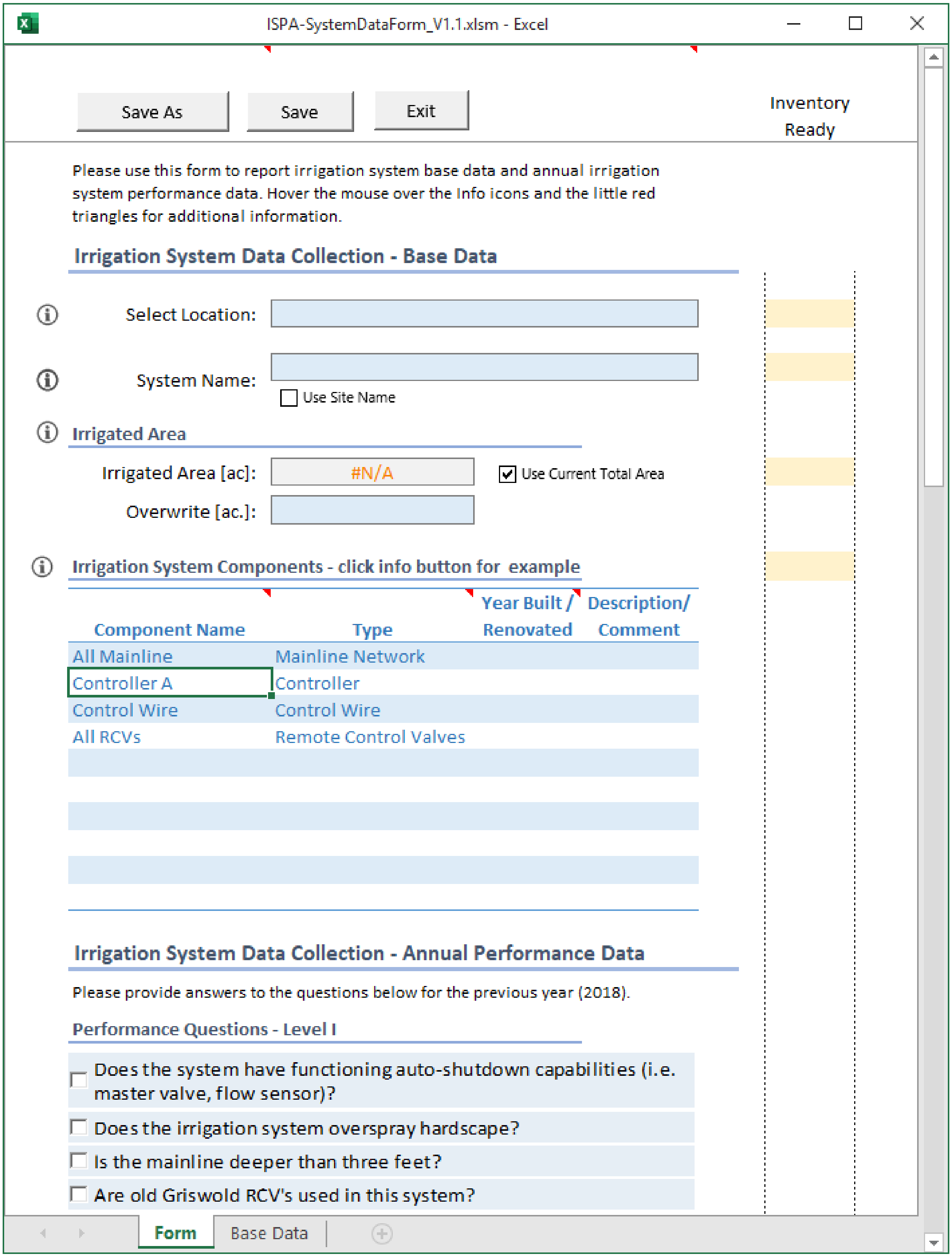


Figure 9 The irrigation system decision process for stakeholder group exercises



ISPA-SystemDataForm_V1.1.xlsm - Excel

Save As | Save | Exit

Inventory Ready

Please use this form to report irrigation system base data and annual irrigation system performance data. Hover the mouse over the Info icons and the little red triangles for additional information.

Irrigation System Data Collection - Base Data

Select Location:

System Name:

Use Site Name

Irrigated Area

Irrigated Area [ac]: #N/A

Use Current Total Area

Overwrite [ac.]:

Irrigation System Components - click info button for example

Component Name	Type	Year Built / Renovated	Description/ Comment
All Mainline	Mainline Network		
Controller A	Controller		
Control Wire	Control Wire		
All RCVs	Remote Control Valves		

Irrigation System Data Collection - Annual Performance Data

Please provide answers to the questions below for the previous year (2018).

Performance Questions - Level I

- Does the system have functioning auto-shutdown capabilities (i.e. master valve, flow sensor)?
- Does the irrigation system overspray hardscape?
- Is the mainline deeper than three feet?
- Are old Griswold RCV's used in this system?

Form | Base Data

FIGURE 10 USER FORM FOR MASTER DATA COLLECTION

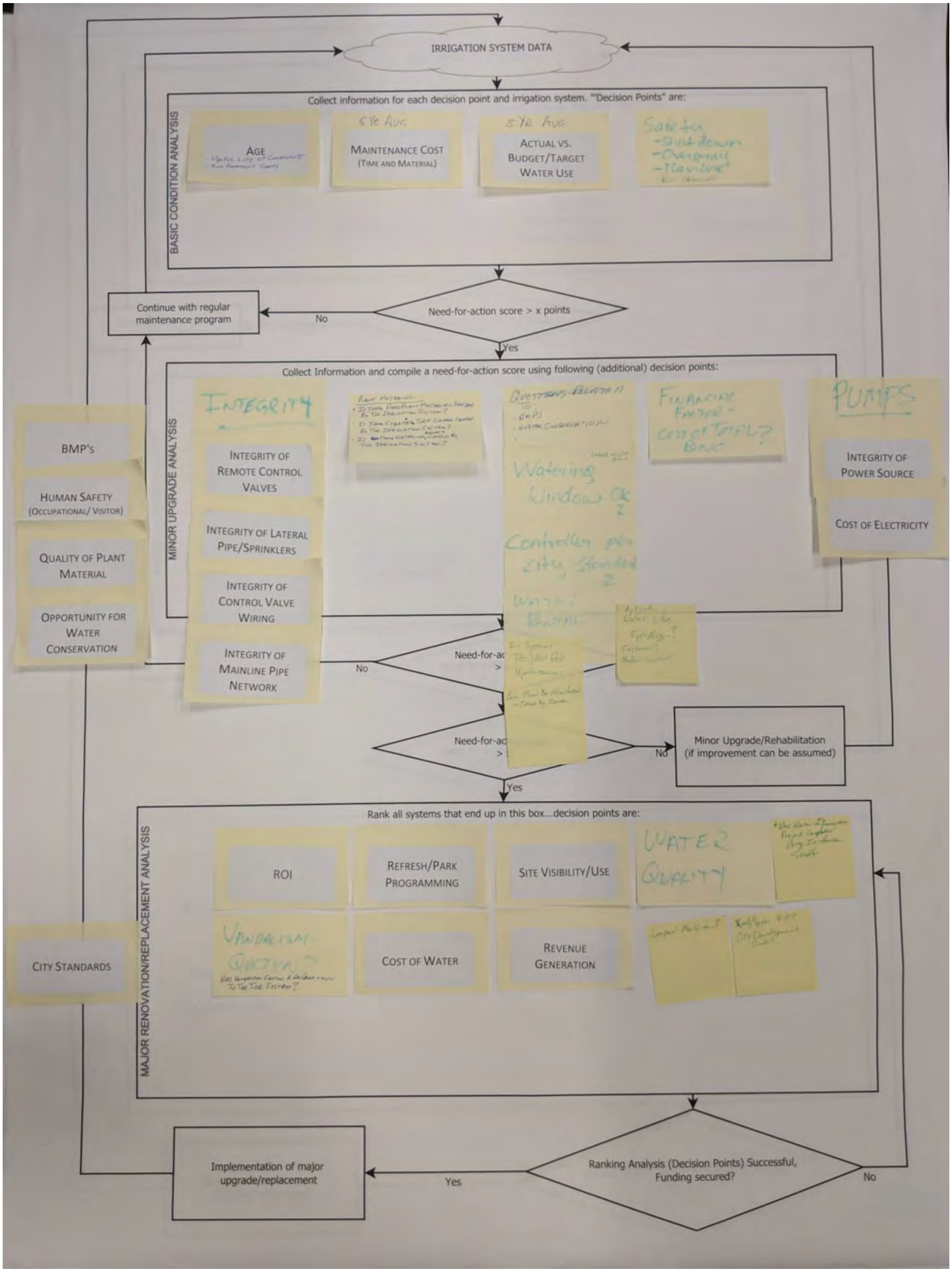


FIGURE 11 FINAL PERFORMANCE INDICATOR WORK SESSION RESULT.

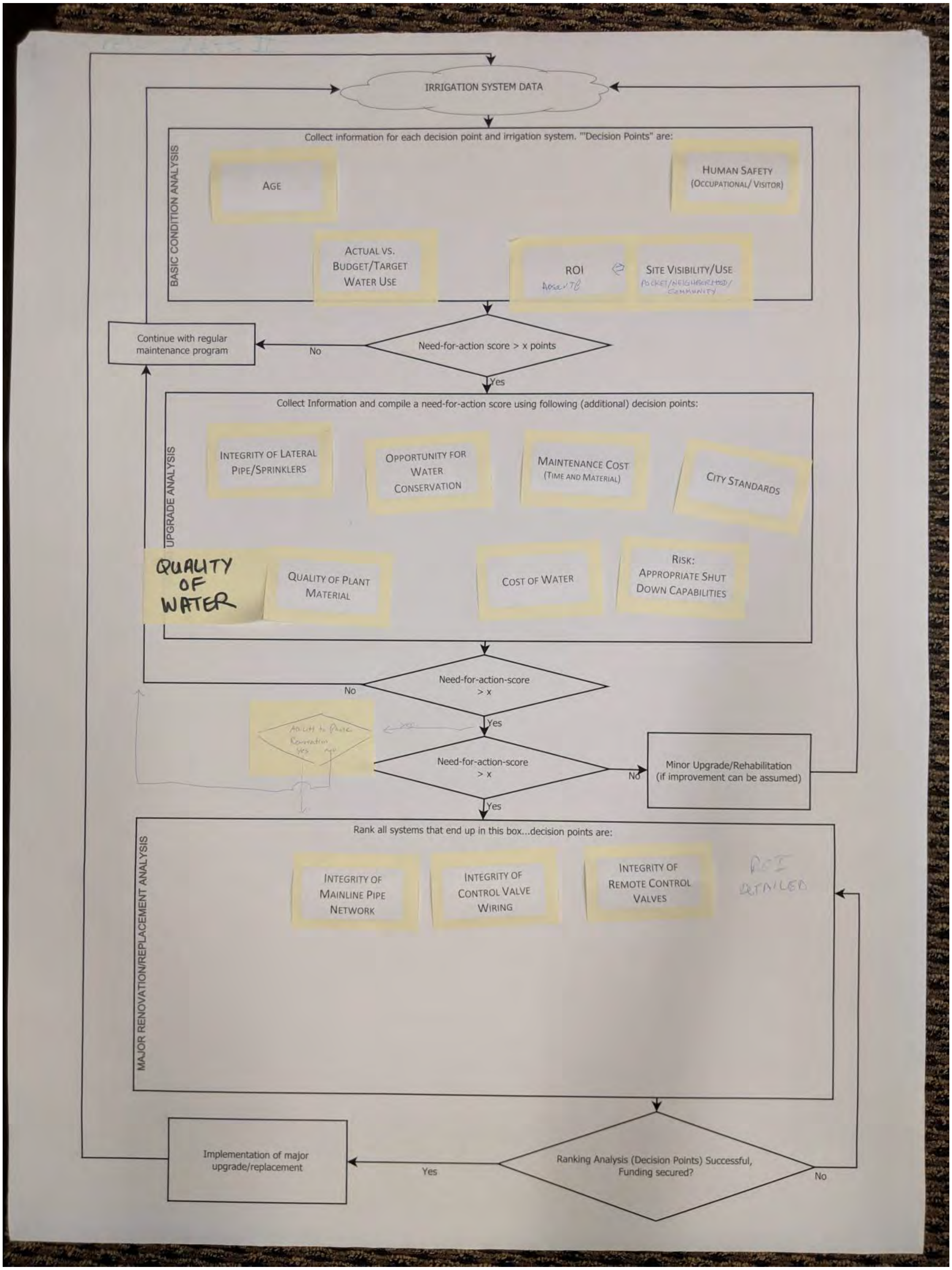


FIGURE 12 GROUP EXERCISE RESULTS - CREW CHIEFS I

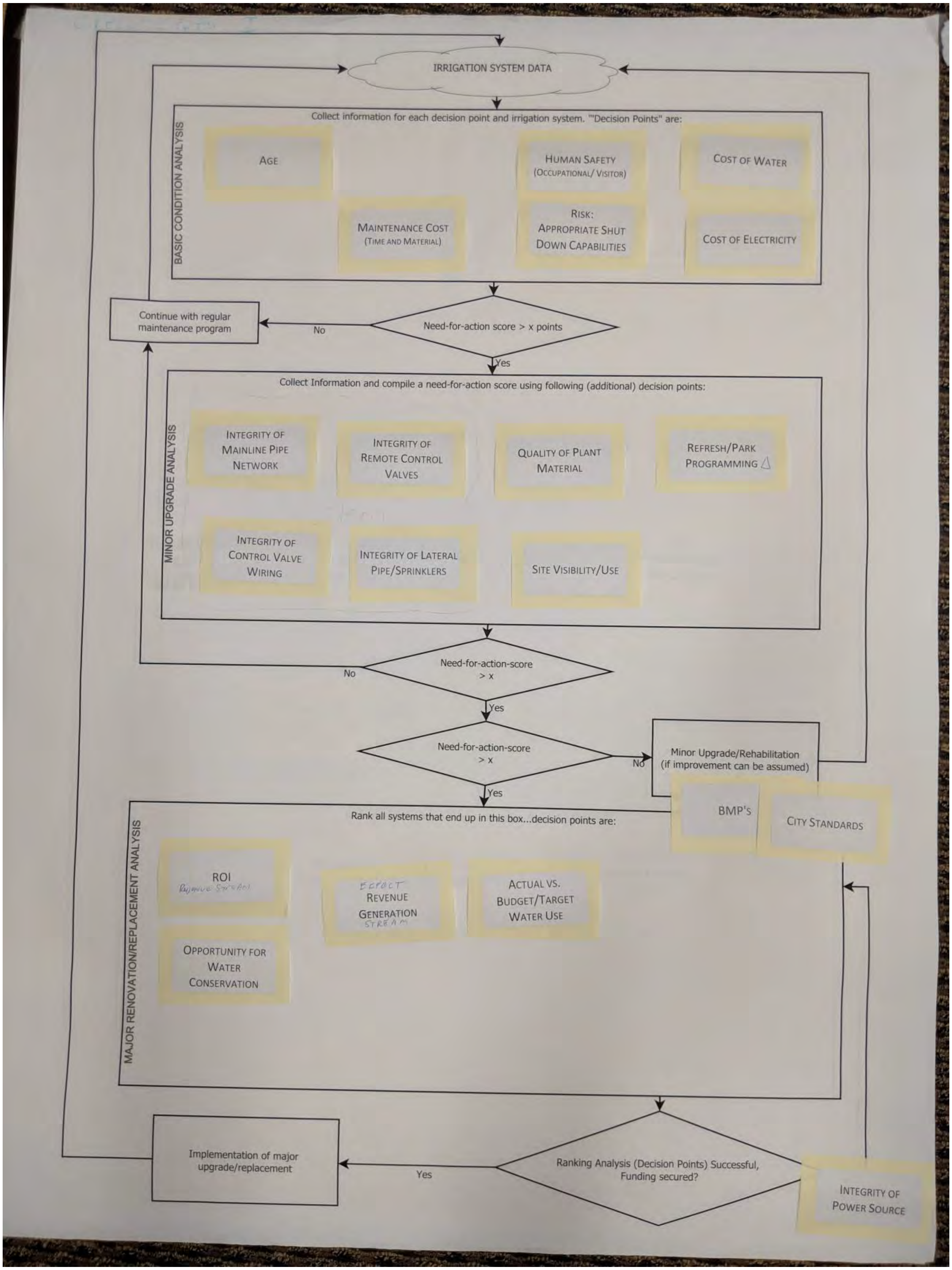


FIGURE 13 GROUP EXERCISE RESULTS - CREW CHIEFS II

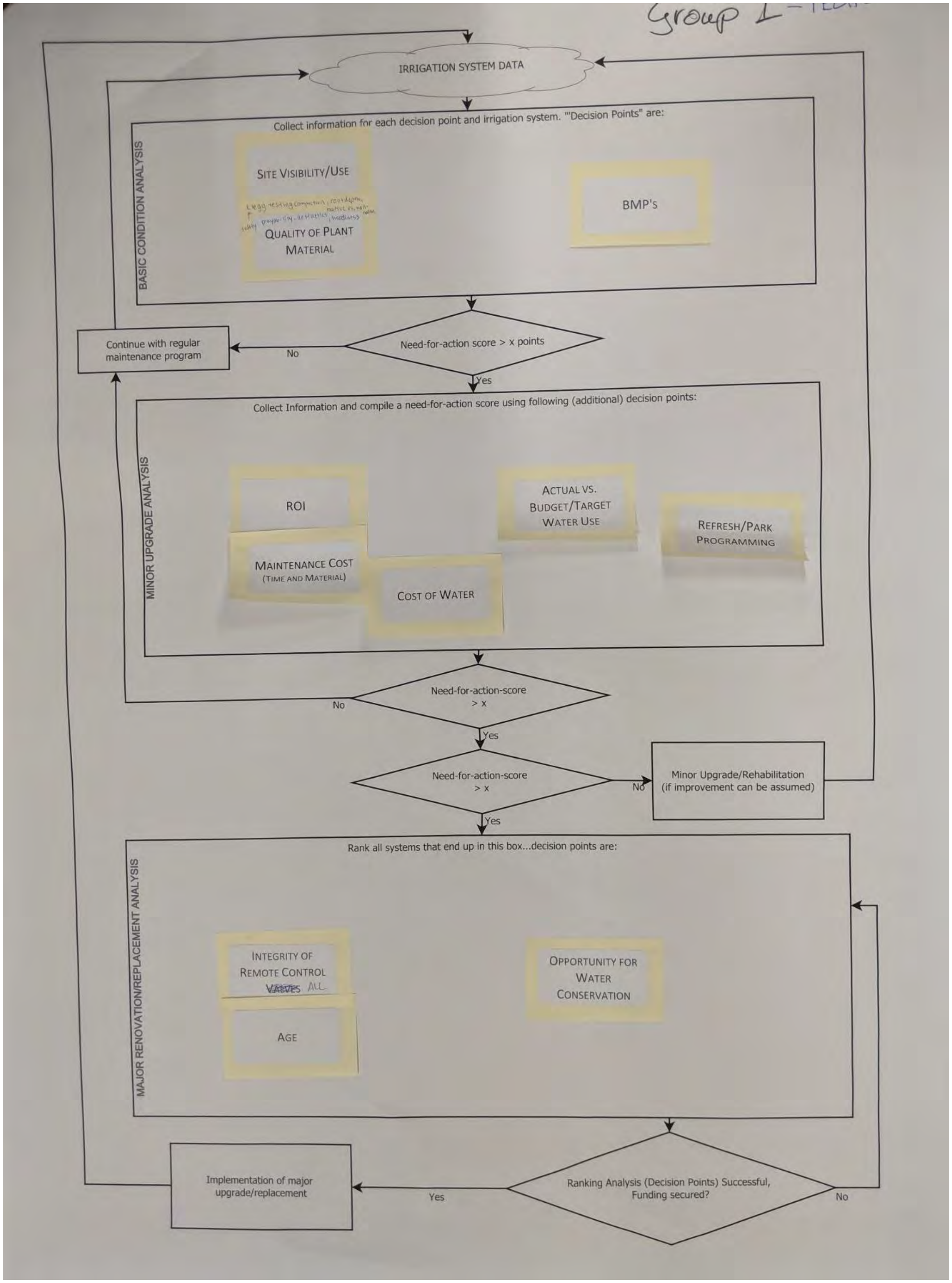


FIGURE 14 GROUP EXERCISE RESULTS - PARK TECHNICIANS I

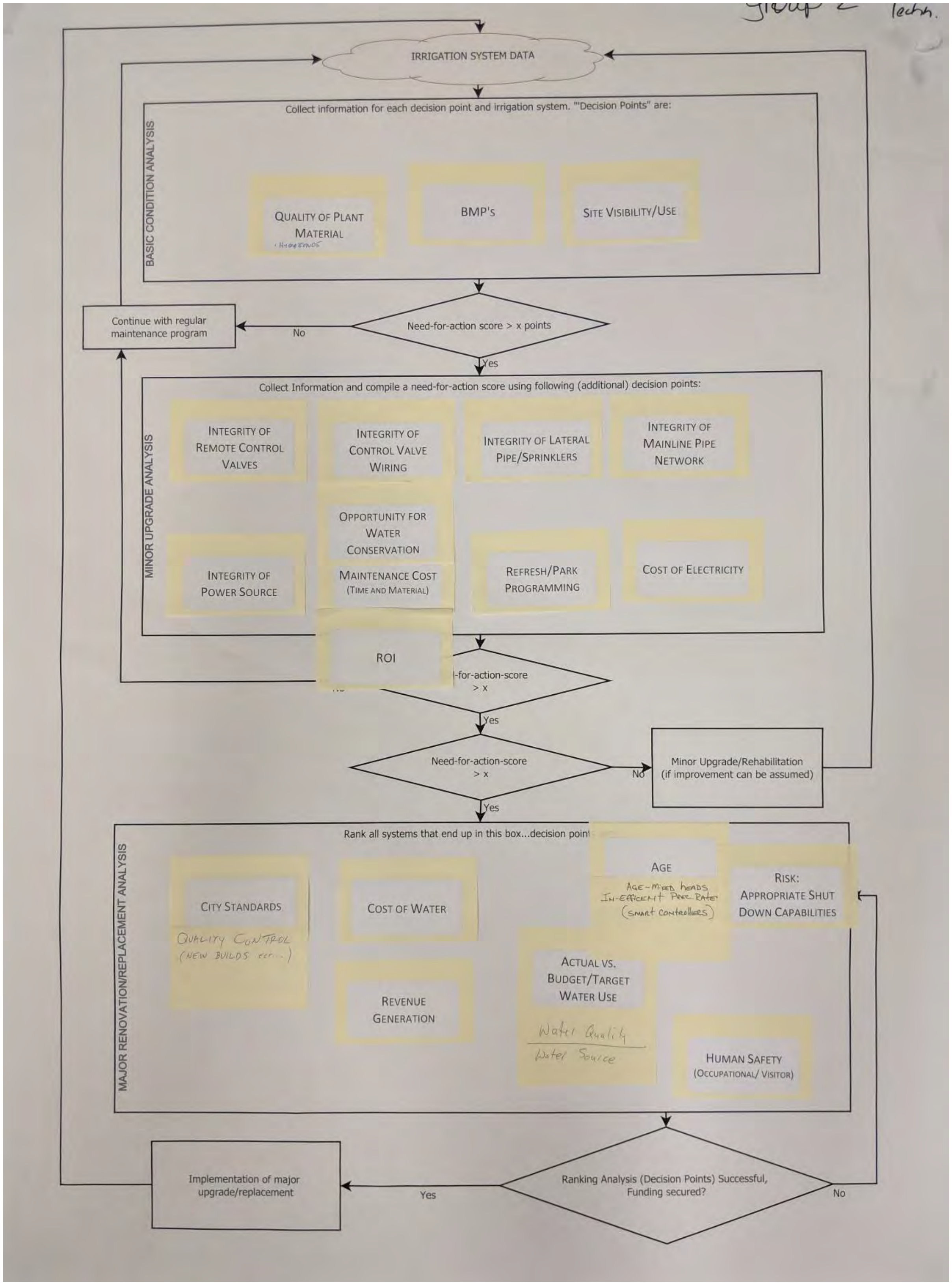


Figure 15 Group exercise results - Park Technicians II

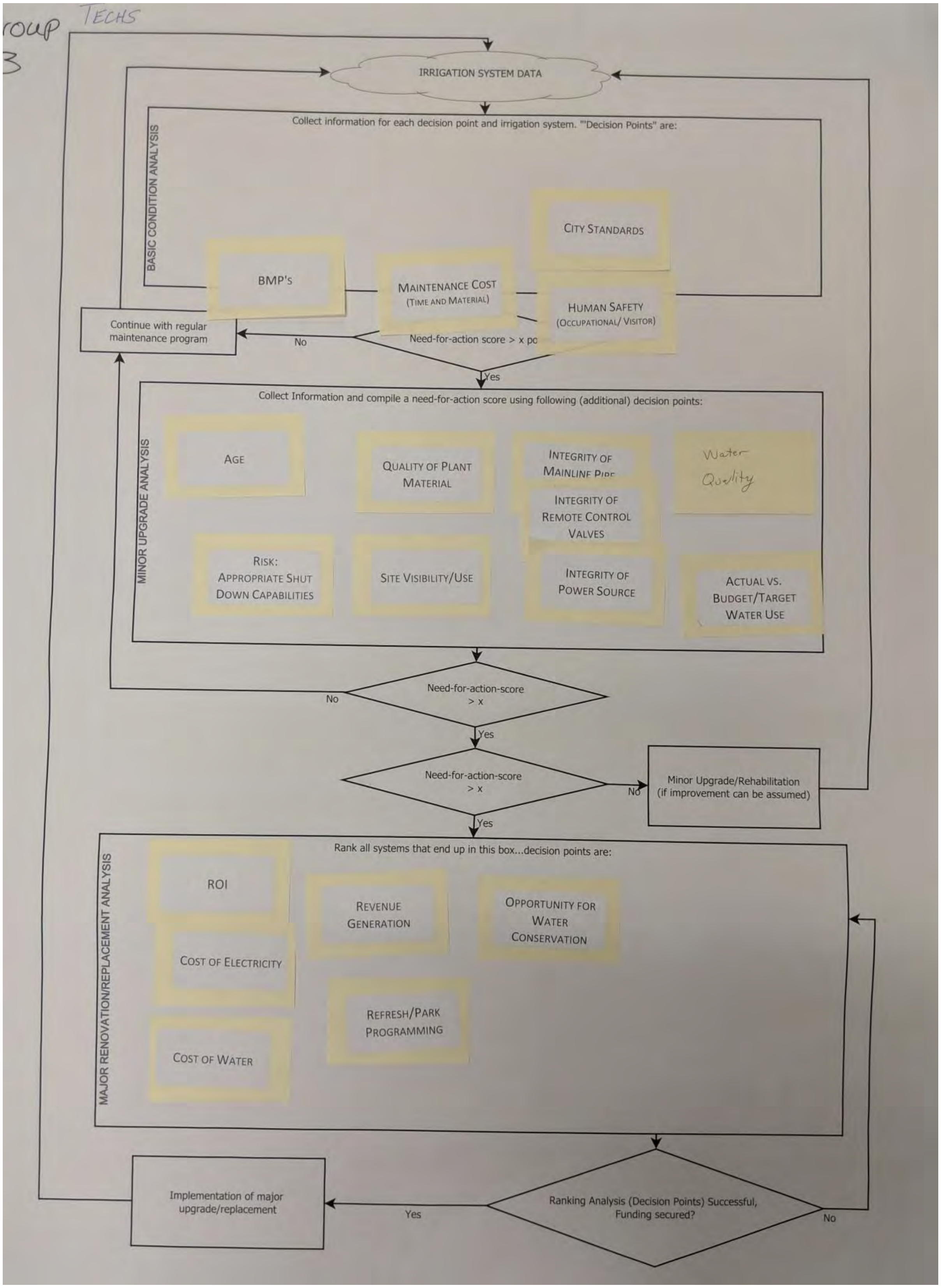


FIGURE 16 GROUP EXERCISE RESULTS - PARK TECHNICIANS III

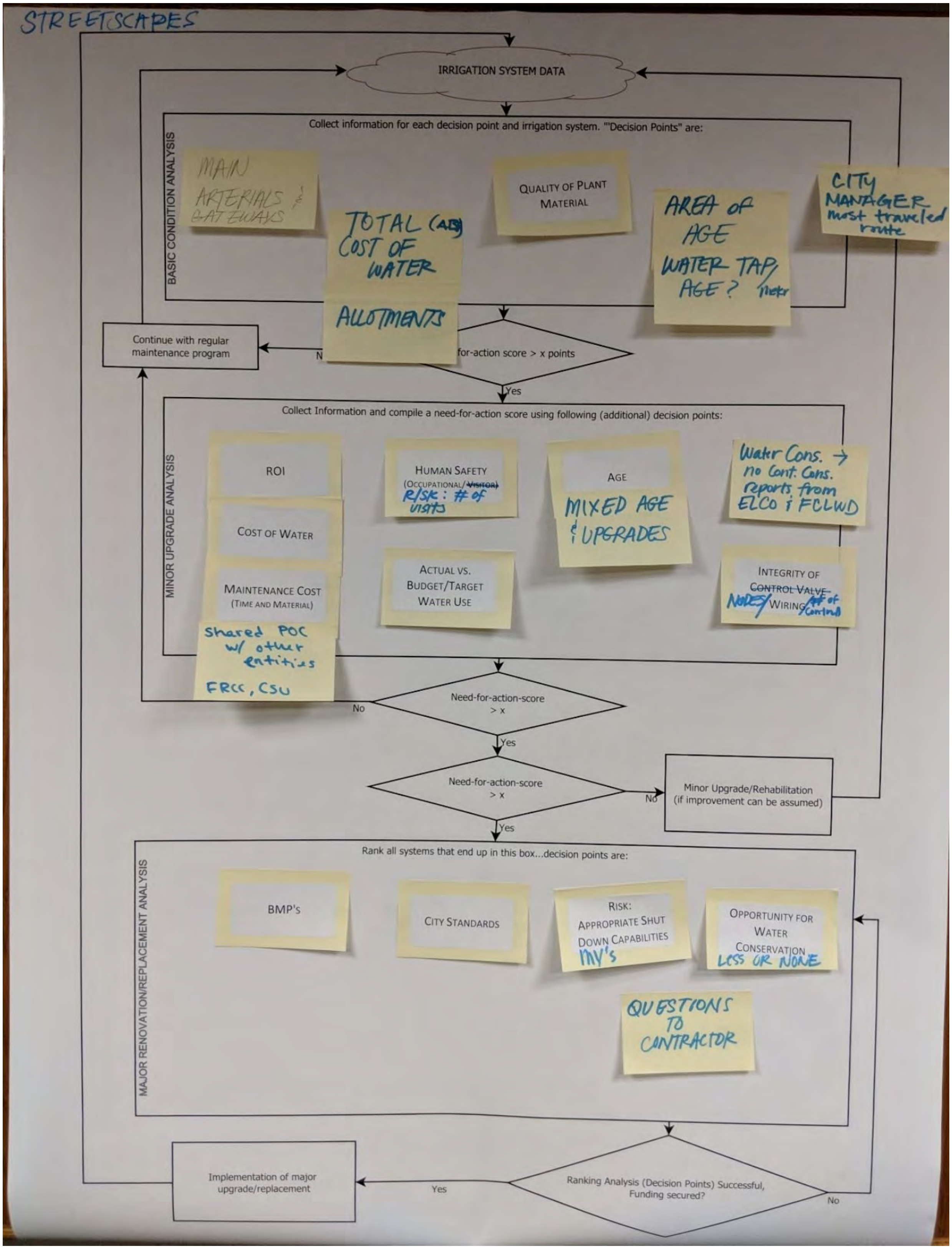


FIGURE 17 GROUP EXERCISE RESULTS - STREETSCAPES

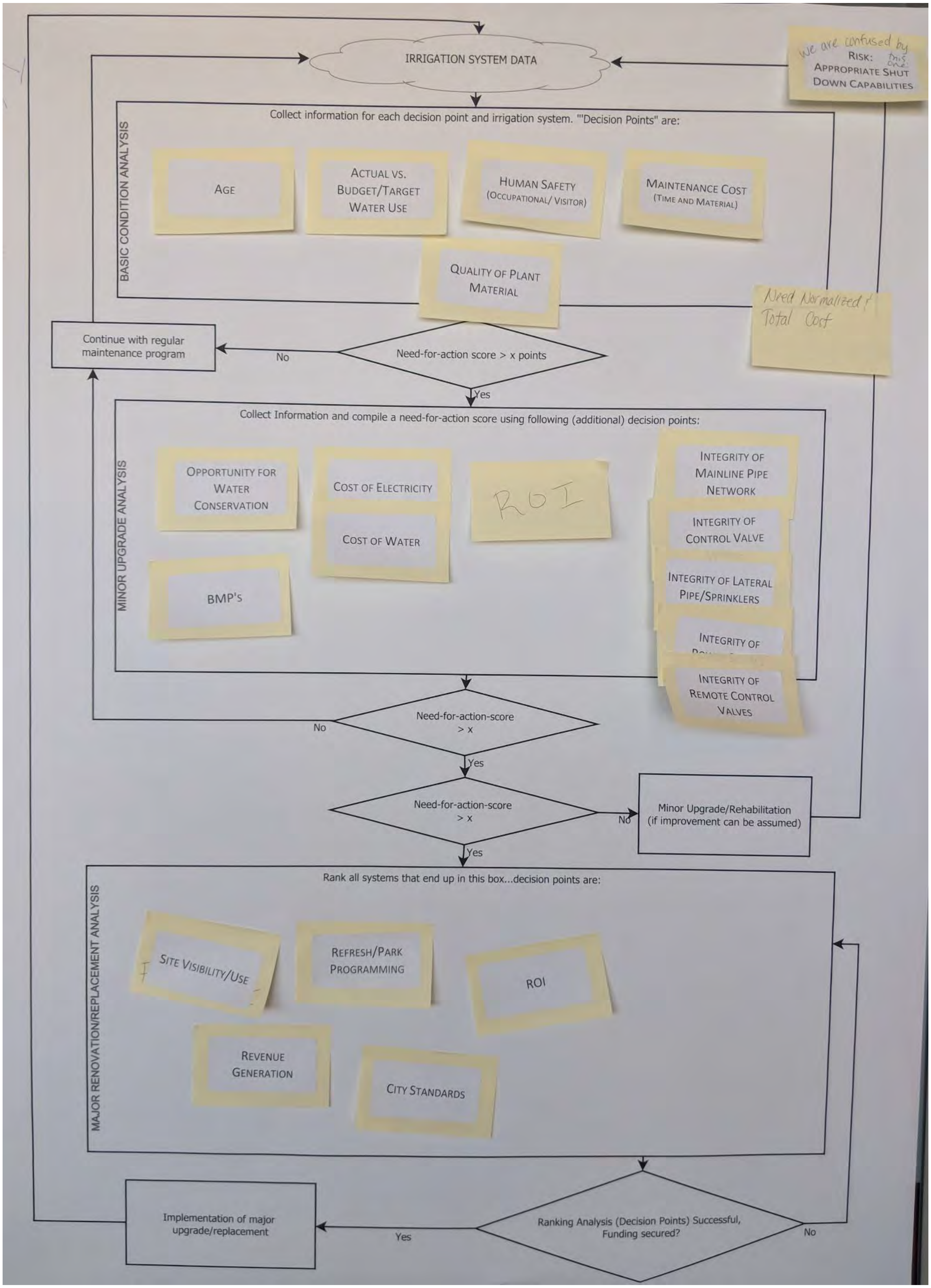
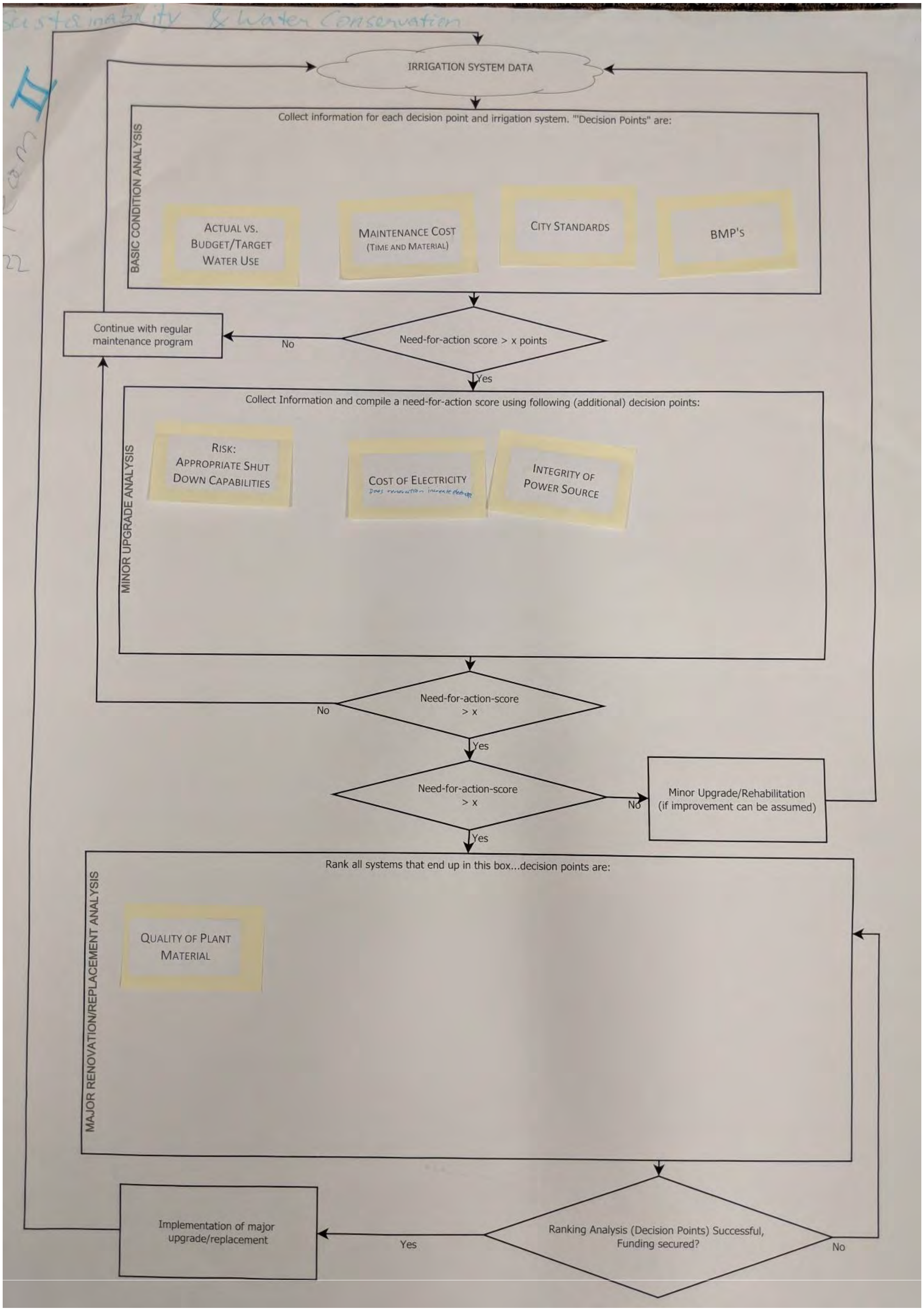


Figure 18 Group exercise results - Water Conservation and Sustainability Services


Sustainability & Water Conservation
IRRIGATION SYSTEM DATA
BASIC CONDITION ANALYSIS
Collect information for each decision point and irrigation system. "'Decision Points" are:
Actual vs. Budget/Target Water Use
Maintenance Cost (Time and Material)
City Standards
BMP's
Continue with regular maintenance program
No
Need-for-action score > x points
Yes
MINOR UPGRADE ANALYSIS
Collect Information and compile a need-for-action score using following (additional) decision points:
Risk: Appropriate Shut Down Capabilities
Cost of Electricity
Integrity of Power Source
No
Need-for-action-score > x
Yes
Need-for-action-score > x
No
Minor Upgrade/Rehabilitation (if improvement can be assumed)
Yes
MAJOR RENOVATION/REPLACEMENT ANALYSIS
Rank all systems that end up in this box...decision points are:
Quality of Plant Material
Implementation of major upgrade/replacement
Yes
Ranking Analysis (Decision Points) Successful, Funding secured?
No

FORT COLLINS IRRIGATION SYSTEM PLANNING TOOLBOX

DST Documentation

Contents

A Introduction

The City of Fort Collins Irrigation Masterplan implements processes and strategies for data driven irrigation infrastructure decision making. Goals are to maximize the effectiveness of investments and to ensure a transparent and data driven decision making process. At the core of this project is a Decision Support Tool (DST) providing a range of features helping to attain these objectives. This document describes the DST, it's features and how to use them.

The tool consists of several components. The DST's irrigation system **inventory** stores data about all irrigation sites in a relational table structure. The tool further implements a **weighted sum model** (WSM)[1] which processes *Performance Indicators* (PIs, metrics) to calculate a standardized *System Condition Index* (SCI) for each irrigation system. A **ranking table** and site reports present the results of this calculation and form the basis for developing asset management decisions.

The first section of this document provides insights into the analysis theory and the technical implementation thereof. It describes all tool components, their technological environment and how the software integrates in an office PC setting. The second part of this document resembles a user manual. It covers all data management (*Inventory*) and data analysis user interfaces and use cases. A final section serves as a guide to interpret the results of an irrigation system condition analysis.

B Terminology and Acronyms

Below is a list of acronyms and terms that are important in the context of the Irrigation System Planning Toolbox.

Acronym or Term	Description
Decision Criteria	In decision theory, criteria values are the consequences of the decisions we make. In the context of the DST, performance indicators are the cause for a decision being more or less favorable. The terms describe the cause or the result of decisions and can be used interchangeable.
Decision Process	One of the tools of the Irrigation System Planning Toolbox. A flowchart that defines several processes and if-then statements to rank and filter investment alternatives.
DST	Decision Support Tool, in this context, it refers to the MS Excel based tool to calculate SCI's
FK	Foreign Key. A (often integer) database field used to reference parent table records.
GIS	Geographic Information System
Inventory	A data structure and its content that describes irrigation system infrastructure, and the infrastructure environment. The inventory forms the basis for system assessments.
MDCA	Multiple Criteria Decision Analysis
PI	Performance Indicator.
PI-Code	A code defined for each PI and sub-PI. It follows a distinct pattern that allows grouping sub-PIs.
PI-Function	A function that uses performance input variables and outputs a PI-Score.

PI-Label	A name tag for PIs
PI-Score	The score or numeric value for a specific PI and system.
PI-Weight	The importance that a PI has in the overall assessment of a system
PI-Variable	Input data for PI-Functions. Examples are system age, maintenance cost, or if the system has automatic shutdown capabilities.
PK	Primary Key. A (integer) database field with unique values used to identify table records.
RAMS	Resource Allocation Measurement System: A accounting database that the City of Fort Collins Parks department uses to track expenses and more.
***Ranking* Table**	The Ranking Table (found at the DST Ranking Analysis Worksheet) displays the result of the DST system analysis process. It lists all irrigation systems that are under investigation at the current analysis level and shows PI-scores and SCI's for each system.
SCI	System Condition Index. A calculated indicator that aims to describe the overall condition of an irrigation system.
System	In the context of this documentation, the term system refers to an irrigation system. It comprises the physical infrastructure required to irrigate landscaped areas.
UserForms	Documents used for data collection. To collect 2018 irrigation system (master and performance) data, an excel spreadsheet that allows user input has been developed.
***WaterUse* workbook**	*An* Excel workbook with a distinct layout used by the Parks Department to collect and store water consumption data.

C Technical Overview

C.1 Technologies

In order to allow for rapid development, user-friendliness and flexibility, the Microsoft Office software family forms the basis for the DST. It specifically uses the MS Excel and Word applications for data storage, user interfaces and reporting. The tool further relies on Visual Basic for Applications (VBA) for process automation. Within Excel, the tool uses the Microsoft Power Query[2] add-in and the Data Model[3,4] functionality to manage inventory data.

The tool consists of two files. The main document is a macro enabled Excel file that contains

- the inventory structures to store information,
- the tables and areas for user interaction,
- the logical formula functions and references for necessary calculations, and
- the VBA code for processes automation and usability.

The second file is a word document with which the user does not necessarily interact. It merely serves as a template for generating reports for individual irrigation systems. Figure 1 shows both files as colored hexagons.

The DST implementation resembles certain software architectural features. Multilayered design is one specific concept where software components are being separated into a presentation-, a business logic, and a data layer. Please refer to Appendix– Technical Details and Specifications for additional details on how DST components are structured to resemble this approach.

C.2 System Requirements, File Handling

The DST has been developed using MS Office 365 (MSO 16.0) on a windows 10 personal computer. Both, network and local folders are valid locations to store the DST files. It is possible to handle both files just like regular MS Office documents. It is valid to copy, paste or rename them. Multiple instances of the DST can be saved in a single folder and edited at the same time.

C.2.1 Enabling Macros

The DST relies heavily on VBA macros. Since macros can pose a security risk it is necessary to actively allow their execution. Excel typically shows a warning message when opening a macro enabled file. The user must confirm the warning message for the DST to work properly. To avoid repeating confirmation calls, a user may mark the DST file as a trusted document or self-certify it. Please see the MS Office documentation for more details.

C.3 Software and Data Components

The following sections describe in more detail the individual parts of the DST, what they do and how they work together. Figure 1 provides an overview of the tool components.

FIGURE 1 SCHEMATIC REPRESENTATION OF THE DST AND IT'S COMPONENTS

C.3.1 Irrigation System Inventory

Within the DST workbook, tables store information that describes irrigation systems and their environments (Parks). The arrangement of tables and columns forms a specific data structure that follows certain database schema design practices. Normalization, the process of breaking data up into separate tables and fields (columns), ensures maintainability and flexibility.

Figure 6 shows all inventory tables, their data fields and relations. Aligning with the concept of relational data base management systems (RDBMS), primary and foreign key fields reference data records within individual tables to each other. RDBMS products ensure data integrity through PK and FK fields. Since Excel does not provide the functionality of a RDBMS, the user must ensure data integrity manually.

The DST stores every Inventory table on a separate worksheet. Table 1 lists all inventory tables and their corresponding location. Please refer to D.5 for additional information.

C.3.2 Inventory Manager

Beyond the data structure, the DST workbook further provides data management and processing functionality. The inventory manager allows the user to:

- collect data from multiple *WaterUse* workbooks and worksheets
- collect data from multiple *UserForms*
- manually initiate query updates: The dotted lines in Figure 12 represent manual update actions required to populate inventory table changes to the power query and the data model module.

C.3.3 System Assessment

This part of the DST analyzes the data of an individual irrigation system. It references the relevant data records from query tables and processes this information based on predefined calculation patterns. A set of performance indicators and information about the availability of data records (warning and error messages) are the results of this analysis. Within the DST workbook, the worksheet *SystemAssessment* contains all ranges and worksheet functions necessary for the analysis.

Table Name	Worksheet	Type
System	TabSystem	Master Data
Component	TabComponent	Master Data
Area	TabArea	Master Data
Location	TabLocation	Master Data
Environment	TabEnvironment	Master Data
EnvLocation	TabEnvLocation	Master Data
ComponentType	TabComponentType	Meta/Analysis data
Location Type	TabLocation Type	Meta/Analysis data
Plant Material	TabPlant Material	Meta/Analysis data
BudgetType	TabBudgetType	Meta/Analysis data
Pindicator	TabPindicator	Meta/Analysis data
Budget	TabBudget	Performance Data
Perfomance	TabPerfomance	Performance Data
NoteParent	TabNoteParent	Performance Data
UserNote	TabUserNote	Performance Data

TABLE 1 IRRIGATION SYSTEM INVENTORY TABLE NAMES, THEIR LOCATION WITHIN THE DST AND INFORMATION ABOUT THE TYPE OF DATA THEY STORE

C.3.4 Ranking Analysis

A WSM implementation calculates an SCI for each irrigation system. The calculation takes place on the *RankingAnalysis* worksheet. While the default ranking of systems is based on the SCI, it is possible to apply any sort or filter action that is typically available for Excel tables[5,6]. VBA macros to perform various tasks are available through button controls. Please see the Performing a (Ranking) Analysis section for more details.

C.3.5 Report Generation

Individual reports for each site are available through a VBA routine. For each system that is flagged for export, it activates the *SystemAnalysis* and updates specific report queries (Pivot tables). A MS Word document references this data and the VBA routine initiates a PDF or Word export for each system.

C.3.6 Settings

The worksheet *Settings* contains tables and named ranges that hold DST settings. Following groups are available:

- **PI Weights per System Type:** The table contains PI Weights that are required to calibrate the ranking model
- **PI Data Requirements per Level of Analysis:** This table defines which PIs are relevant at which Analysis level. Having a stringent definition of required PIs for each analysis level helps to identify missing or erroneous data.
- **Analysis Levels**: This table contains SCI limits that affect the default filtering behavior of the ranking table.
- **Other DST Variables and Settings**: A set of calculation variables and constants.

D Using the DST

Since the DST is a normal macro enabled workbook, using it will be self-explanatory for most people who are familiar with MS Excel. This documentation points out the names of certain MS Excel features that the DST utilizes. The intention is to facilitate web research that might be necessary to familiarize with specific features.

D.1.1 Navigation

DST components are organized in labeled worksheets and the MS Excel **worksheet tabs** are used for navigation. Since the tool uses more than 20 worksheets (most of them to store inventory tables), only a subset of all tabs will be visible at the bottom of the window at once. Scrolling though the worksheet tabs or using the pop-up window is necessary to navigate to certain inventory tables. Please refer to online resources[7] for more details.

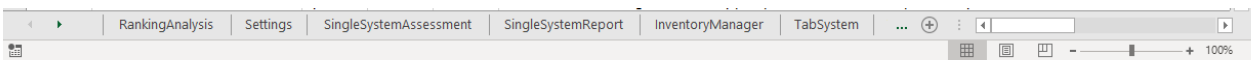


FIGURE 2 THE MS EXCEL WORKSHEET TABS AND STATUS BAR

D.2 Performing a (Ranking) Analysis

The first worksheet in the DST workbook contains the WSM result matrix. This sheet is central in analyzing the condition of an irrigation system. The following chapters describe the tools and functions that support the decision making process.

D.2.1 Ranking Table Layout

The DST organizes the WSM result matrix in an Excel table object. Columns contain system and system performance information. Each row is a single irrigation system. The table body range contains the PI-Score results and conditional formatting highlights the cells where data is missing (see Figure 3 below).

PI columns have two header rows. The actual header row of the table object contains *PI-Codes*. Although visible in Figure 3 below, the DST hides PI-Codes by default. The second header row shows *PI-Labels*.

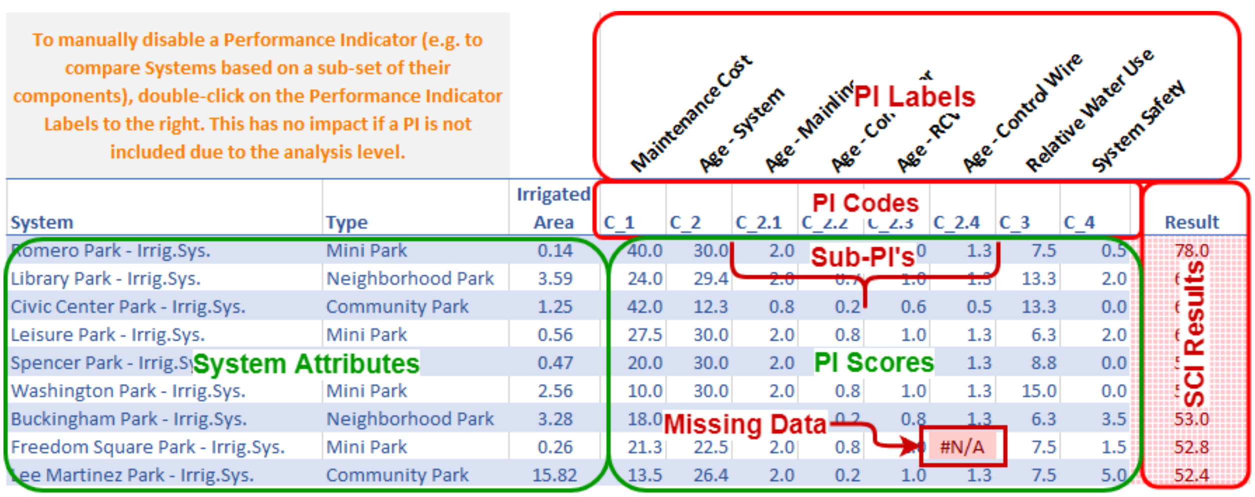


FIGURE 3: ELEMENTS OF THE RANKING TABLE

It is important to understand, that the table always stores all *PI-Scores* for all systems, irrespective to whether row filters or hidden columns are in effect.

D.2.2 Updating the Ranking Table

A first step in any analysis is to ensure that the tool displays the most recent data. Figure 5 highlights the buttons that are available to do so. The first button (“*Clear Table, Reload Systems*”) will completely rebuild the result table. This is necessary, if records in the inventory table *System* changed. The second button will only refresh the weighted *PI-Scores*. This is necessary if changes have been made to any other inventory table.

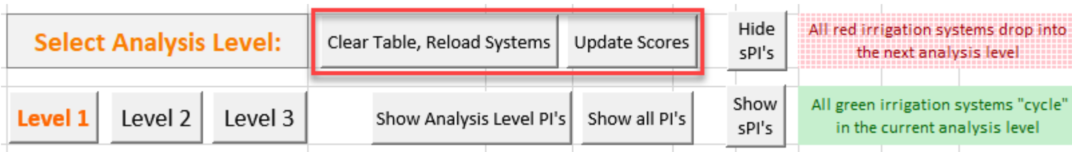


FIGURE 4: *RANKINGANALYSIS*: DATA-PULL AND RE-CALCULATION BUTTONS

D.2.3 Navigate and Modify the Ranking Analysis

Following sections describe navigation and filtering tools that the DST provides in addition to the default MS Excel table filtering and sorting capabilities[5,6]. Following examples show where basic sorting and filtering capabilities are useful:

- Compare only Mini Park irrigation systems
- Compare all irrigation systems that irrigate between 10 and 15 acres.
- Create a custom list for site report generation.

D.2.3.1 Analysis Levels

The Fort Collins Irrigation Masterplan defines a tiered decision making process. On the highest and most abstract level, the WSM uses as few PIs as possible. Level 2 and Level 3 analysis require more data (more PIs) to calculate a SCI.

Clicking on one of the level-buttons initiates two things:

- The DST takes into account only those PIs that are relevant for that level. All other PIs do not contribute to the resulting SCI as they are set to 0.
- PIs that are irrelevant at the current level are hidden, the matrix becomes clearer and is easier to read.

D.2.3.2 PI visibility

While changing to another analysis level automatically hides those PIs that are irrelevant for that level (set to 0) it is possible to unhide them by clicking on the button labeled “Show all PIs”. To reverse this action, one can either switch back and forth between analysis levels or use the “Show Analysis Level PIs” button.

D.2.3.3 Show and hide sub-PIs

Most PIs result from combining several *Sub-PIs* (sub-PI). Section Organizing Performance Indicators in the Project Report describes this concept in more detail [8(secB.4.3)]. The process takes place in the ranking matrix and every PI column is followed by a set of sub-PI columns. Two buttons, respectively labeled “Hide sub-PIs” and “Show sub-PIs”, are available to show or hide these columns. If the settings variable *V_PIVisLevelOnly (see* Analysis Settings) is set to true, only sub-PIs that are relevant at the current analysis level will be shown.

Changing the visibility has no effect on the calculation result SCI.

D.2.3.4 Enable and Disable PIs

Double-Clicking on a *PI-Label* (see Figure 3) enables/disables this indicator for all Irrigation systems. The *PI-Scores* are set to zero and the result column changes accordingly. This may change the ranking of the systems. This is relevant if one wants to compare irrigation systems based on a manually selected set of PIs. Ignoring PIs where the data quality is knowingly bad is another example where this may prove useful.

D.3 Drill Down on a Single System Analysis

Tracking the analysis results can provide essential insight into the reasons for outstandingly good or bad PI-Scores. A good understanding of the factors that lead to a SCI will reveal potential date inadequacies and allow a user to investigate and devise the most effective asset management strategies.

Analyzing the ranking table typically starts by looking at the top ranking systems. Looking for missing or exceptionally low and high PI-Scores in the ranking table is a good starting point. Many PIs are the result of several sub-PIs. Expanding the sub-PI table columns can reveal additional insights into what particular PI leads to a high PI-Score. This is especially true for C_2 (Age).

To find out more about the analysis calculations, a user can simply double-click on the system name in the ranking table column *System*. This will set the current system selection to that respective system and open the *SystemAssessment* worksheet. Alternatively, a user can also navigate to that worksheet and select the system under investigation with the drop down menu in cell C1:F1 manually. Both actions will update all data source references and the analysis will pull data for the system under investigation.

D.3.1 SystemAssessment worksheet investigation

This worksheet contains the logical worksheet formulas and references that are necessary to calculate PIs either based on a set of sub-PIs, or directly based on other predictors (i.e. measured variables that are used to calculate PIs). While the analysis calculations aim to be robust, erroneous *PI-Score* calculations may be the result of data inadequacies. Screening the calculations and the calculation input variables is a good way to identify data inconsistencies or outliers.

Most PI calculations take place in tables and each row contains data for a specific year. For rows in the *Age*, *Maintenance Cost*, and *Water Use* assessment, the tool will highlight warning and error messages in column M, if it detects missing or invalid data.

The worksheet highlights PI-Labels with a yellow cell formatting next to the PI-Values. This helps to find those PI-Scores, that initially caught a user's attention. The input variables for the PI-Score variables are generally available in adjacent cells. Be aware that some calculations are nested and complex. Many formulas are Array Formulas[9]. Please refer to the corresponding PI calculation descriptions in the *FC-MP-ProjectReport.docx*.

D.4 Generating Single Site Reports

The DST uses the list of sites that are visible in the ranking table as the basis for generating single site reports. Using MS Excel Table filters[5] is a convenient way to define sites for which reports are desired. The control button labeled "Generate Reports for Visible Rows" initiates the generation of all reports. All reports are saved in a folder called "IrrigationSystemReports". If that folder does not yet exist, the DST will create it as a sub-folder to its current file location.

To create single site reports, the DST needs to know where the report template word document is located. The file path can be set in the DST Settings.

D.5 Data Inventory Management

The following sections describe how to work with the irrigation system Inventory. They briefly list what information is relevant for the decision making process and how it is stored in a relational table structure. It is important to understand that, while the inventory manager provides import routines, a user can manually change table records anytime.

D.5.1 Relational Tables Data Management Concept

As mentioned in a previous section and as Figure 6 depicts, the DST Inventory stores information in several separate tables[10]. All tables are situated on separate worksheets within the DST workbook (see Table 1). Figure 5 shows an example of two related tables in the inventory structure.

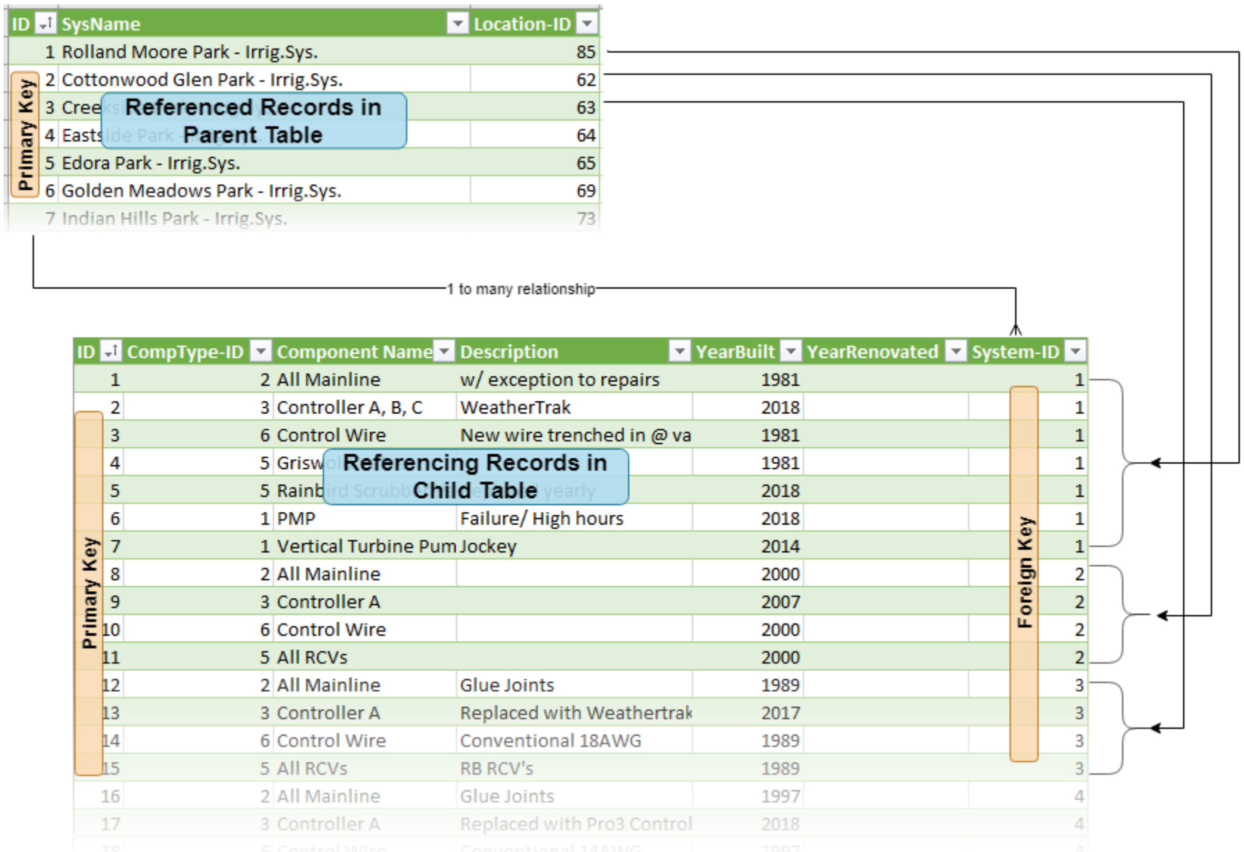


FIGURE 5: PARENT TO CHILD TABLE RELATIONSHIPS

Since Excel does not automatically ensure data integrity, the user must ensure sound data quality. This mainly refers to:

- "Entity Integrity: This is concerned with the concept of primary keys. The rule states that every table must have its own primary key and that each has to be unique and not null.
- Referential Integrity: This is the concept of foreign keys. The rule states that the foreign key value can be in two states. The first state is that the foreign key value would refer to a primary key value of another table, or it can be null. Being null could simply mean that there are no relationships, or that the relationship is unknown."[11]

Following examples show how a user might change table rows while maintaining data integrity:

- Insert an additional irrigation system component: A user must pay attention to two things when inserting a new record in a referencing table:
    - The primary key (PK) of the table *Component* must contain unique values. Since the DST inventory consistently uses integer values as PK's, an easy way to add a new PK is to find

the maximum value in the column *ID* of table *Component*. One can then increase this value by one and use result as the PK of the new record.
  - The referenced records must exist: The foreign key (FK) in column *System-ID* of table *Component* must exists in the PK field of table *System*.
- Delete a system: simply deleting a row in the table *System* would create orphaned records in the tables *Area*, *Budget*, *Component*, *NoteParent*, *Performance*. To avoid orphaned records, it is required to delete child records where the FK corresponds with the PK of the deleted system. It is good practice to delete the referenced record only after removing any referencing record.

D.5.2 Inventory Table Types

Information contained in the irrigation system inventory can be categorized with following structure:

- **System Data:** Persistent or temporary information about irrigation systems or the environment they are situated in.
  - **Master Data:** This information category describes physical aspects of irrigation systems and their environment. Data records of these tables are persistent. Example: the mainline component definition of a system does not change on an annual basis.
  - **Performance Data:** This information is temporary and may change on a regular basis. It aims to describe the performance and subsequently the condition of a physical infrastructure assets.
- **Meta Data:** Information in these tables is more persistent than master data. This information directly affects the business logic part of the DST (analysis, ranking). Examples are the definitions of component types (Mainline, Control Wire, Controller, etc.) or plant materials in the corresponding tables. Each plant material defines a specific crop coefficient which itself is a variable in the water budget calculation. Meta Data requires updates when the DST is being applied to new environments or if the analysis metrics (PIs) change.

Figure 6 shows the inventory data schema. It highlights master data tables in green/yellow, performance data in yellow, and meta data tables in green. It should be noted that the tool does not utilize all fields in the inventory schema. Unused fields allow to add additional functionality to the business logic of future releases.

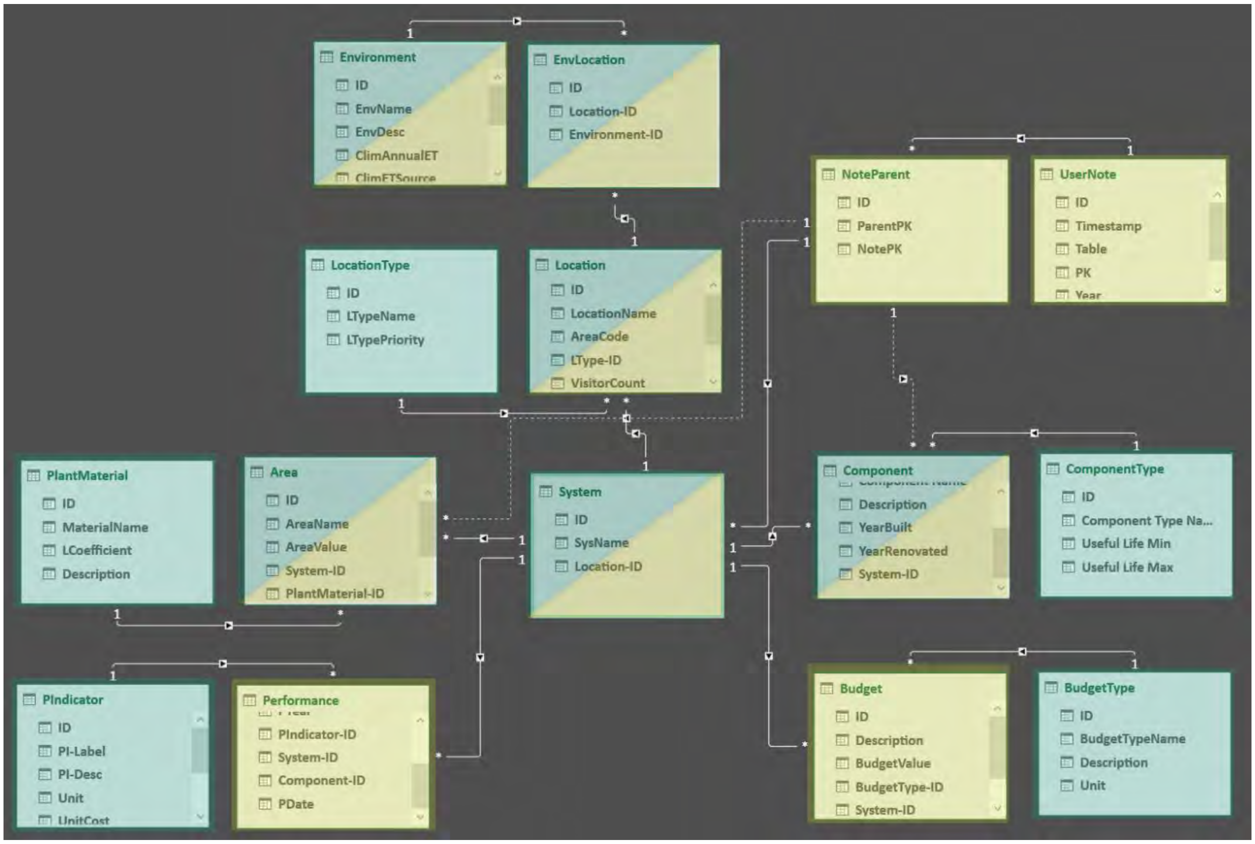


FIGURE 6 THE DST INVENTORY TABLE SCHEMA

D.5.2.1 Meta Data Definitions

Following meta data tables store information necessary to perform analysis calculations:

- **PIndicator**: each record describes a performance indicator. The DST uses this data to establish relationships between performance data, the DST settings (weights), and the columns in the ranking analysis table. *FC-MP-ProjectReport.docx* contains additional information about each PI.
- **BudgetType**: Defining allowances is required for the proper calculation of certain performance indicators. This table defines additional properties of these allowances. The DST business logic uses this information to filter for, group, and accumulate specific budget values.
- **ComponentType**: Each record in this table represents a component type. A component type has a specific minimum and maximum expected useful life. This information is relevant for calculating age based performance indicators.
- **PlantMaterial**: Each area definition references a plant material. A *PlantMaterial* record defines landscape or crop coefficients, a variable that the DST incorporates in automated water budget calculations.
- **LocationType:** Each location record references a location type. The DST uses this information to determine model weights. The user may use the location type for filtering purposes.

D.5.2.2 System Master Definitions

- **System:** Each record represents an irrigation system. This entity defines the system name and references the location at which that system resides.
- **Component:** An irrigation system consists of a minimum of four different technical irrigation system components. This table stores information about each system's mainlines, control wires, remote

control valves, controllers and, if existent, pump stations. A user may lump individual parts of a given component type together in one record, as long as the properties (age) of all pieces are similar. For example, two records can describe all remote control valves of a system. Record one describes all original valves from 1986. The second record would describe all valves that have been replaced over the course of the last 5 years. The latter record would average the YearBuilt value to e.g. 2016. Besides the primary and foreign key fields, C*omponentName* and *YearBuilt* must not be empty in order to avoid calculation errors.

- **Area**: To describe an irrigation system, it is required to document all (irrigated) areas. A user can define an infinite number of hydrozones and thereby increase the accuracy of water budget calculations. However, at the time of writing this document no irrigation system defined more than one area.
  Beyond calculating water budgets, the DST uses this information as a reference quantity when calculating certain PIs.
- **Location:** Stores information about the geographic location of the irrigation system. Each *Location* can have multiple *System* relationships.
- **Environment:** This entity stores meteorological data that is relevant for the analysis. If no budget data is available, the tool can use the fields precipitation, evapotransub-PIration, or reference evapotransub-PIration to calculate a water budget for a given year.
- **EnvLocation:** Records in this table link an environment with a location. This extra table is necessary to satisfy data management best practices. It resolves the issue of redundancy for "many-to-many" relationships: One *Location* can reference many environments (one for each year), and one *Environment* can reference many locations (use the same data for all sites in Fort Collins).

D.5.2.3 System Performance Definitions

As the DST is being used on a regular basis to help with asset management decisions, current system performance data and changes to the system must be added to the inventory. *Performance* and *Budget* table updates are the most frequent. Besides that, the DST implements a *UserNotes* table. It stores any unstructured text that may help at the most detailed level of analysis or that contains other useful information.

- **Performance**: Every record in this table provides information for a single performance indicator for a single year. Refer to the corresponding sections in the *FC-MP-ProjectReport.docx* for additional information about PIs and what their values represent. A record is valid if references to *PIndicator* and *System* records exists and if the fields *PValue* and *PYear* are not null and valid (Numeric).
- **Budget**: Records in this table are necessary to calculate certain PIs. At the time of writing this document, only water budgets exist. Other budgets limiting expenses, domestic water use or electrical power consumption may become relevant over time. The DST sums multiple records that define the same BudgetType-ID, System-ID and Year. This allows to define e.g. 12 budgets, each representing a whole year, or a single budget representing the same time period.
- **UserNotes, NoteParent:** In the current DST version, the UserNotes table stores the information users generated in the user form comment textbox during the 2018 data collection. As Figure 6 shows, the the NoteParent assignment table references it. The NoteParent assignment table references not only a System, but also an Area or a Component record. This construct allows to tie notes to the records of any of those parent tables.

D.5.3 Minimum System Definition

To properly describe an irrigation system, it is required to define at least the following records:

- One System where SysName and Location-ID is not null and valid.

- o At least four Component records, each referencing a different ComponentType record and where the YearBuilt or the YearRenovated is not null and valid.
- o At least one Area where AreaName, AreaValue and PlantMaterial-ID are not null and valid.
- o At least one year of performance data records for a Level I analysis.

D.5.4 Manually adding, editing or removing inventory records

Adding, editing or deleting any table record is as user friendly as changing MS Excel tables (formerly known as Lists)[12].

To insert a new row to an excel table, one can simply add content into a cell below the last row of the table. Excel then automatically extends the table range definition. Another option is to select any cell in the table, right click and then select Insert > Table Rows Above (Below) (see Figure 7, Tip: select multiple cells to insert multiple rows).

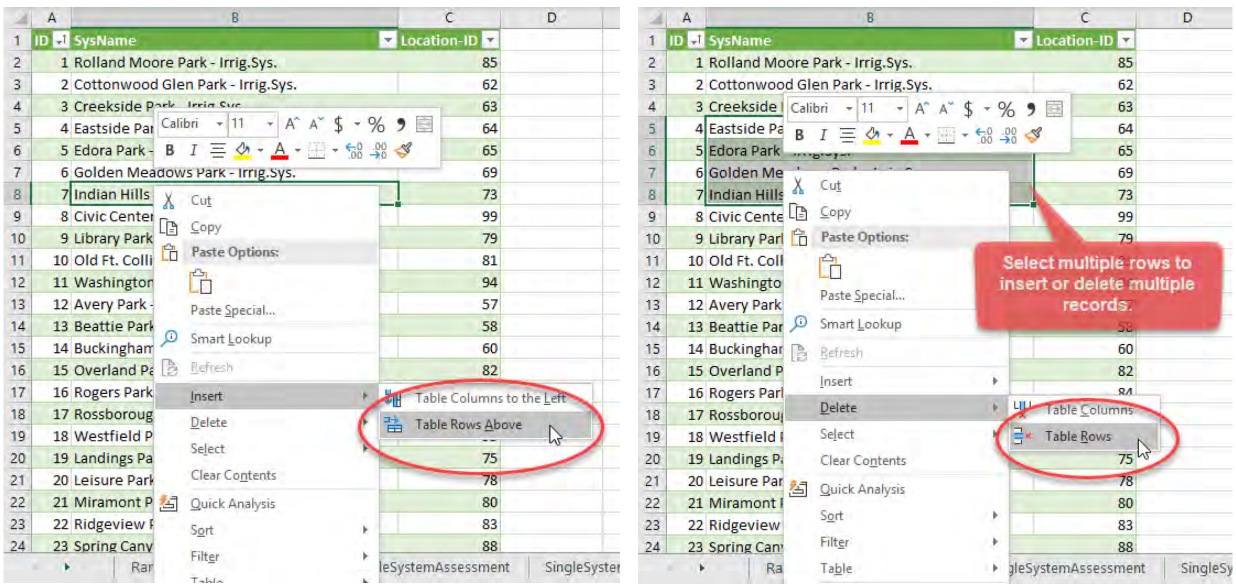


FIGURE 7: INSERTING AND DELETING TABLE ROWS

It is also possible to append multiple records to a table at the same time. This is relevant when data is being prepared in external spreadsheets. The initial data import covered several systems and multiple years. Water use, budget, maintenance cost, and data for one categorical PI have been derived from existing data sources and shaped into the inventory table format. These data sets have then been copied and appended to the existing tables.

As section Relational Tables Data Management Concept stresses, it is necessary to ensure data integrity with every table operation. A user must be aware that a parent table record may be referenced by a child table record.

D.5.5 Using DST Inventory Manager Tools

The DST Inventory Manager on worksheet *InventoryManager* provides import and data management routines. The two import routines for “User Form” and “Water Use” data collection consolidate data from multiple worksheets within a user-defined folder. To define the import folder, a user van either write the folder into the cell directly, or set it using the folder picker dialog. Besides the source folder, these routines also require the user to provide a year, for which the data is being imported.

The “Update Queries” routine performs internal data publishing actions.

D.5.5.1 Run User Form Import

This routine consolidates the information from any number of User Forms that reside in the *Import Source Folder* and imports it to the inventory. It compares the master data (see Inventory Table Types) in each form with the records that are already in the system. If a *System, Component,* or *Area* already exists, it will update the corresponding records. If the routine can not find a matching record, it inserts a new one. Following rules apply:

- Existing System: The routine will update a System record if it has the same Name (SysName) and if it references the same Location as the User Form Defines.
- Existing Area: The routine will update the first area that references the System the User Form defines. At the time of writing this document, this approach is sufficient as each irrigation system defines only one Area.
- Existing Component: The tool updates an existing component if it
    - references the same system,
    - has the same name, and
    - references the same component type.

D.5.5.2 Run Water Use Data Collection

This routine cycles through all worksheets of the Excel files in the data source folder. Chapter Data Availability in the Project Documentation contains additional information about this data structure. If the tool finds a system name, acreage, inches of water used, and inches of water budgeted on a worksheet, it appends this data to two new Excel tables. One table contains water use (performance)-, and the other table contains water budget data. Prior to a manual inventory import, this table is subject to additional data lookup and manipulation steps. The result of these efforts are tables, that have the same columns as the inventory tables. A user can then simply copy their rows into the inventory tables.

D.5.5.3 Query Updates

As MS Excel Power Query definitions do not update automatically, it is necessary to manually populate inventory changes. Figure 8 shows the inventory manager and highlights the button to update queries. Clicking the button will start updating all queries. It can take between several seconds to minutes to complete the task.

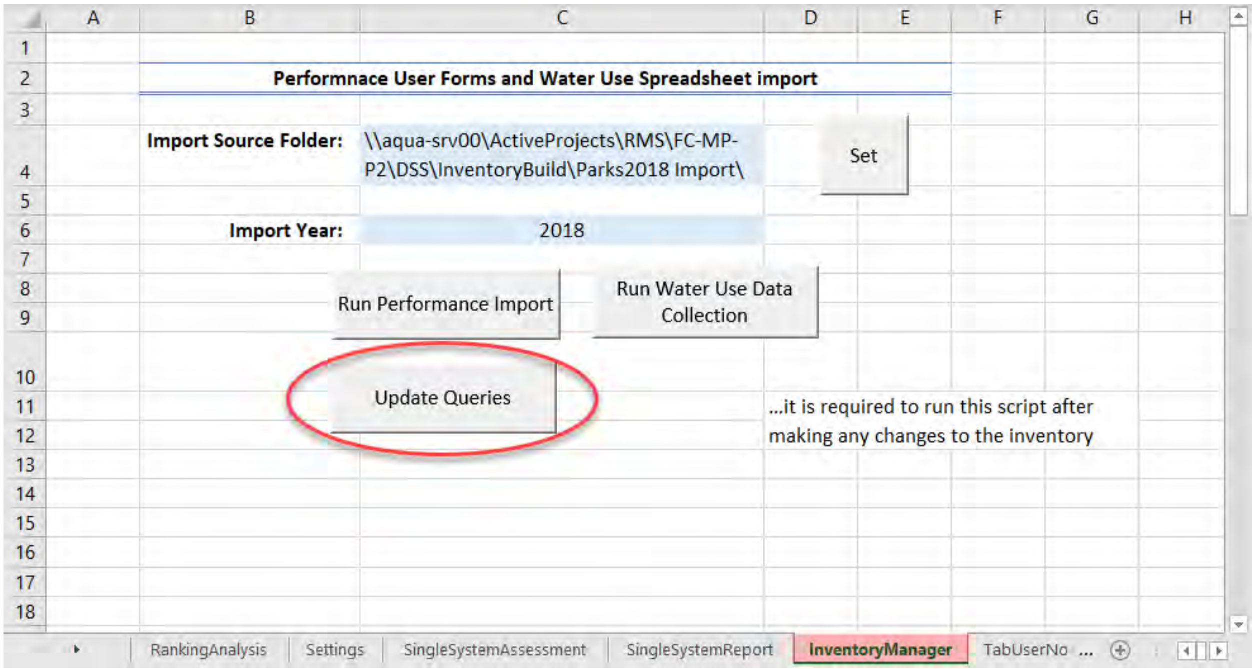


FIGURE 8: THE INVENTORYMANAGER WORKSHEET

D.6 DST Settings

This section describes variables and constants that affect the DST behavior. The tool implements variables as Named Ranges (cells with a specified name) or as table ranges on the *Settings* and the *InventoryManager* worksheet. Variables with a yellow cell background are reserved to conduct business logic operations. Users can change variables with a blue background color or in tables at will.

D.6.1 Analysis Settings

Three tables on the *Settings* worksheet are available to calibrate the WSM, configure PIs that are included in the analysis, and to adjust the report table filtering behavior.

D.6.1.1 Performance Indicator Weighting

Basic weighted sum models define a single weight vector (i.e. a list of values that has the same number of list elements as there are PIs). As Figure 9 shows, the DSM provides more flexibility by allowing to define one weight vector for each location type:

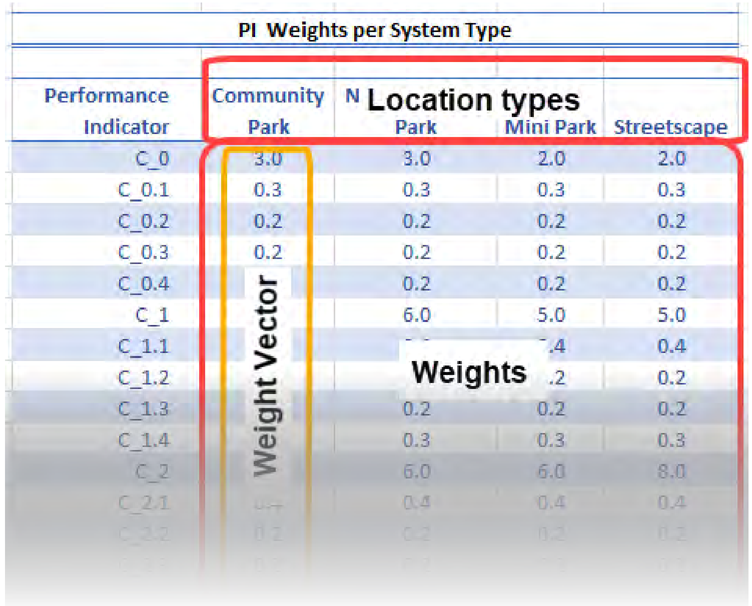


FIGURE 9: WEIGHT DEFINITIONS FOR DIFFERENT LOCATION/SYSTEM TYPES

When calibrating the WSM by adjusting the weights, it is important to consider following concepts and rules (see *FC-MP-ProjectReport.docx* for additional information):

- A user can arbitrarily define PI-Weights.
- sub-PI-Weights of a single PI must sum up to 1.
- Not all PIs have the same grading system. While the worst grade for C_2 (Age) is 5, the worst grade for C_1 (Maintenance Cost) is 10. As a result, C_1 affects the resulting SCI twice as strong as C_2 if both PIs have the same weighing.
    - Except for C_5.9 (Integrity RCV's), all categorical sub-PIs take the values 0 (good) or 1 (bad). Weights are therefore not skewed by their grading scales.

D.6.1.2 Data Requirement Settings

The table shown in Figure 10 allows to define sets of active PI for each Analysis Level.

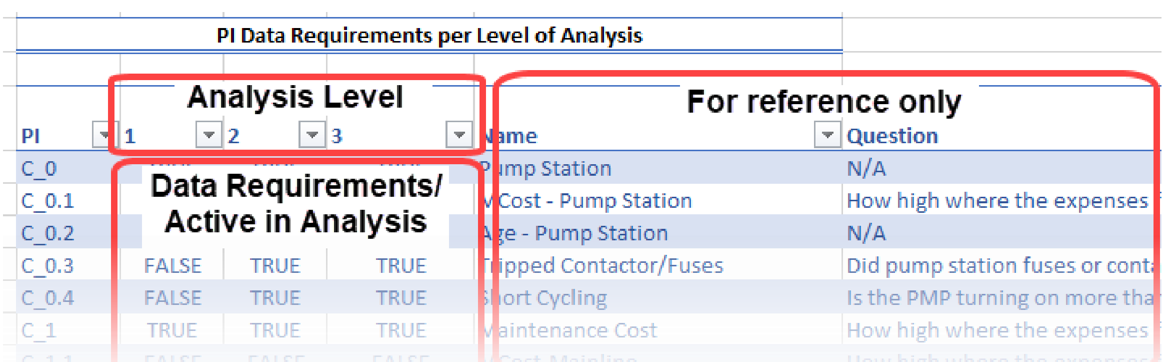


FIGURE 10: LEVEL BASED DATA REQUIREMENT SETTINGS

D.6.1.3 Analysis Level Limits

The DST uses the static SCI thresholds in this table to determine, if it flags a system as being relevant for the next higher analysis level. Be aware that a user shall only change values in column “Level SCI Limit” (see Figure 11).

Analysis Level SCI Thresholds		
Name	Value	Level SCI Limit
Level 1	1	45
Level 2	2	60
Level 3	3	80

FIGURE 11: ANALYSIS LEVEL SCI THRESHOLD SETTINGS

For example, if the Level 1 SCI of an irrigation system is below 45, the tool will highlight the SCI result cell with a green background. If it is above 45, it will highlight it with a red background. When the user then switches to the second level analysis, the ranking table will show only systems with a SCI higher than 45.

D.6.2 Other Tool Settings

Following additional settings fields enhance the flexibility of the DST:

V_ReportTemplate: This variable stores the path to the report template word document. A user can type or copy the path into the cell. A File Picker dialog is available through the “Set” button to the right of the variable cell.

V_RefYear: This variable controls the last year that the tool takes into consideration when using historic data to calculate the PI-Scores. Example: when this variable is set to 2019, only records prior to 2019 are considered in calculations. This is helpful when the user wants to assess the historic system condition development.

V_YrsOfData: The DST can take up to 6 successive years of data into consideration when calculating PI-Scores. A user may choose to consider fewer years if it is apparent that previous data is spotty or skewed.

V_EffPrecipRate: When no water budget data is available for a given year, the DST has the capability to calculate a water budget using environmental data, irrigated acreage and landscape coefficient date. This variable defines the effective precipitation for the budget calculation

V_ReplacementUnitCost: TBD

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F List of Figures

G Appendix– Technical Details and Specifications

Section Software and Data Components already describes the goal of separating a presentation-, business, and data layer components. This section describes some of the technical implications of this approach.

While most DST components are implemented a single workbook, it uses OLE[13] automation to generate reports with MS Word. Hence the software consists of two MS Office files: A macro enabled Excel Document and a MS Word file. Following list tries to categorize DST components according to their software layer:

- Irrigation system inventory (Data Layer):
  - Inventory tables
  - Power Query definitions
  - Data Model definitions
- Query result tables (Data Layer)
- The analysis logic (Business Logic) consisting of
  - Single system analysis (Excel formulas, user defined functions)
  - Ranking Analysis: A WSM (Ranking and weighing matrix)
- Other spreadsheet ranges:
  - Tool variables and configuration (Data Layer)
  - Data import (Business Logic)
- All VBA-code (Business Logic)

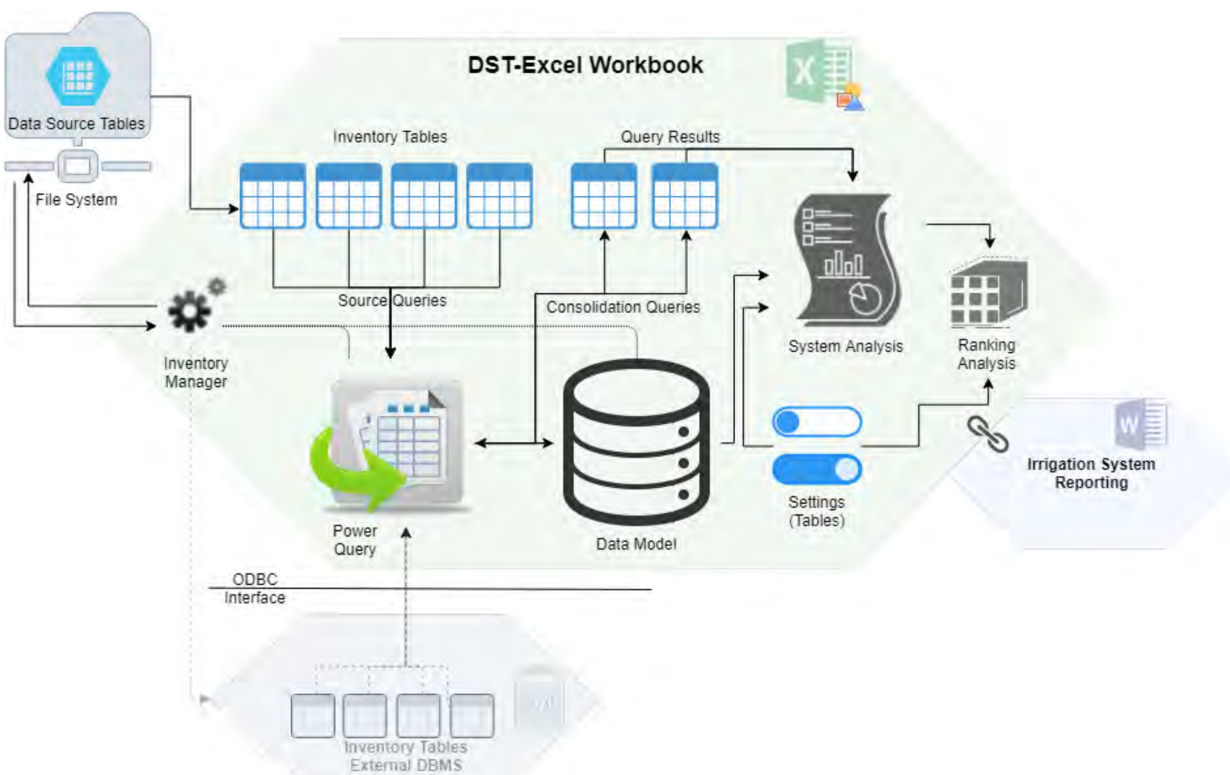

FIGURE 12: SCHEMATIC REPRESENTATION OF THE DECISION SUPPORT TOOL. DASHED LINES AND GREY ELEMENTS ARE NOT IMPLEMENTED.

Figure 12 shows the relationships between these elements, how the workbook interacts with a Word OLE object to generate reports, and its relationship with external data sources. It also highlights a valuable feature of the DST Architecture: Adhering to a relational table structure for the inventory, in combination with using the Power Query feature, allows to further improve the implementation of multilayered software architecture. For example, future DST releases could use an Open Database Connectivity (ODBC) interface to move the inventory component into an actual RDBMS.