SPECIFICATIONS
TORO SENTINEL WATER MANAGEMENT SYSTEM

1.0 – GENERAL OVERVIEW

A. The Water Management System shall be a Toro® Sentinel Water Management System.
B. The System shall include the following general components:
    1. Sentinel WMS Software
    2. Sentinel Field Satellites and (optional) MapTo Controllers
    3. Sentinel Communications Hardware
    4. Central Computer utilizing a Windows XP Operating System
C. The system central computer may be furnished by the owner or purchased as part of the Water Management System package from Toro. The personal computer must meet the minimum specifications as required by Sentinel WMS.
D. The Central Computer, if purchased from Toro, and the WMS Software shall be supported with a Toro NSN® support plan with a minimum of two years support coverage.
E. The Sentinel WMS Software shall have the following general Programming features:
    1. Access to all the programming features of Sentinel Controllers through PC-based WMS Software
    2. Controls up to 999 field satellites
    3. Group controllers into “systems” for system-wide adjustment of:
        a. Rain Days
        b. Percent Scale (Percent Adjust)
        c. ET adjustment from shared weather source
    4. 16 programs per field satellite.
    5. 8 start times per program
    6. 6-week Active Water Days scheduling
    7. Mark special dates on the on-screen calendar
    8. Set station run times individually, or in blocks
    9. Program irrigation to fit within a timed water window
    10. Make percent adjustments from 0–255%
    11. Set multiple station or program repeats
    12. Continuous Run feature allows programming for grow-in
    13. Rain Off from 0 to 250 days by controller, program or station, across the system.
    14. Percent Scale from 0–255% by controller, program or station, across the system.
    15. Set control parameters for each station:
        a. Station description
        b. Type description
        c. Flow
        d. Maximum flow
        e. Precipitation rate
        f. Plant factor
    16. ET-based watering by program
    17. Ability to display projected flow by program, controller, or system

F. The Sentinel WMS Software shall have the following general Maintenance & Reporting features:

1. Alarm reporting of communication issues from the central to the satellites, over- or under-flow conditions, overcurrent conditions, or power failures
2. Extensive reporting features:
    a. Run time reports
    b. Water usage
    c. Alarms
    d. Logging of system changes
    e. Water use, rain and ET accumulation
3. Flow Optimizing in order to optimize water demand and shorten water window
4. Ability to divide system into groups representing similar field attributes
5. Ability to redefine valve sequence without physically changing wire terminations in field satellite
6. Information overview by group and satellite
7. System status indications for individual field satellite
8. On-line help screens minimize training requirements
9. Map-based feedback on station status

G. The Sentinel WMS Software shall come standard with the following support:

1. All centrals come two years of NSN support. Training included.
2. Standard telephone modem or internet connection allows for remote access to WMS Software via pcAnywhere

2.0 – PROGRAMMING FEATURES

A. The Sentinel Water Management System shall allow Access to all the programming features of Sentinel Controllers through PC-based WMS Software for the programming of each Satellite/MapTo controller.

B. Each controller shall have 16 programs. Programs may be either irrigation of non-irrigation. Non-irrigation programs shall be for lighting, security, etc. Non-irrigation programs are independent of rain shutdown modes.

C. Each program shall have the following setup options:

1. Specified start times (1-8)
2. Hour/minute runtime format
3. Percent Scale
4. Cycle Delay
5. Program Repeats
6. Continuous Run (Continuous Program Repeat)
7. Water Window
8. Active Water Days Schedule Select
9. Activate Auxiliary Pump.
10. ET-based Run Time

D. Each Program can be assigned up to 48 stations in any order. Each station can have a run time of 0 to 255 per run and be repeated within the program.

E. Each program shall have up to 250 repeat cycles with 0 to 255 minute soak times.

F. Each program is capable of being disabled independently.

G. The WMS Software shall allow the end-user to redefine the remote control valve sequence for programming to be different than the physical attachments within each field controller.
H. The WMS Software shall allow all program modifications to be made from a single screen after initial setup.
I. The WMS Software shall flag any programming issues or conflicts that would cause station not to run
J. The WMS Software shall provide three methods for the calculation and adjustment of station runtimes:

1. Direct adjustment of run times by performing manual percentage adjustments.
2. Adjustments of run times based on reference evaportranspiration.
3. Calculation of run times based on automatic acquisition of evapotranspiration data.

K. Each controller shall have up to 16 watering days' schedules. A schedule is selected for each program. Multiple programs may share the same schedule. Each schedule shall have the following:

1. Rolling 6-week format
2. Ability to overlay on current calendar
3. Multiple standard Odd/Even or Interval options

L. The WMS Software shall have the ability to divide the irrigation system into separate satellite groups to allow central control of similar field conditions, including:

1. Rain Days
2. Percent Scale (Percent Adjust)
3. ET adjustment from shared weather source

M. The WMS Software shall have the ability to manually adjust (percentage increase/decrease) by station, program, satellite, group and/or the entire system.
N. System adjustment factors may be input via actual percentage or operation ET.
O. The central computer shall have the ability to connect to a Toro-specified weather station.

1. The weather station will measure and store temperature, relative humidity, dew point, wind speed and direction, and solar radiation for use in the calculation of evapotranspiration.
2. The central shall automatically communicate ET data to field controllers for recalculation of watering times.

P. The WMS Software shall predict and allow for system flow by program

1. The graph will calculate and display the maximum instantaneous flow as well as the total volume.
2. The system will display the projected flow for each minute of the irrigation schedule.

Q. The WMS Software shall have the ability to manually start programs for an individual satellite.
R. Manual programs may be started in normal or syringe/test mode.
S. The WMS Software shall have the ability to start a multi-manual cycle in a satellite, running up to six stations simultaneously with a run time of up to 255 minutes.
T. Utilizing Rain Days, the WMS Software shall have the ability to suspend the automatic operation of an individual station, program, group or entire system.

1. The hold duration shall be programmable for the current irrigation day up to 255 days.

U. The WMS Software shall have the ability to dictate reactions of non-irrigation devices through switch outputs.

V. The WMS Software shall be capable of displaying in English, French, Italian, Spanish, and simplified Chinese.

3.0 – MAINTENANCE AND REPORTING

A. The WMS Software shall allow each satellite to be operated directly from the central computer.
B. The WMS Software shall provide an automated mechanism for testing, measuring and recording nominal flow and current rates on a per station basis.
C. The WMS Software shall be capable of monitoring flow from multiple flow sensors displaying real time flow rates and total usage.
D. The WMS Software shall be capable of monitoring rainfall at a Weather Source and implementing a Rain Delay based on user-defined inputs including:

1. Rain Threshhold Amount
2. Sampling Period
3. Saved Rain off to activate when threshold reached
4. System to affect
5. Reset condition

E. The WMS Software shall be capable of automatically reporting/recording different system related alarm conditions generating a visual indicator when any alarms occur.
F. The WMS Software shall be capable of automatically reporting/recording different field satellite alarm conditions generating a visual indicator when any alarms occur.
G. The WMS Software shall provide a Satellite Alarm Report. This report will display and print satellite program data which show all start times, station run times, total program runtime, water days, and program setup information on a per program basis.
H. The WMS Software shall provide a Satellite Alarm Report. This report will display and print satellite alarm and warning events that show various field anomalies. Such events include:

1. Station upper and lower flow limit violations
2. Main line break
3. Unscheduled flow
4. Solenoid electrical current violations
5. Station short circuits
6. Power failures
7. Monthly water over budget
8. Wind/rain violations
9. Configuration related programming errors
10. Communication failures

I. The WMS Software shall provide a Central Alarm Report. This report will display and print central alarm and warning events which show system anomalies including but not limited to:

1. Weather station alarms,
2. Satellite program download failures
3. Water window violations
4. Operator programming errors
5. Communication connection failures

J. The WMS Software shall provide a Satellite Event Report. This report will display and print satellite events including but not limited to:

1. Individual station start/end times

2. Runtimes
3. Measured flow
4. Master valve and pump start/end times
5. Daily accumulation for flow meters, ET, and rainfall if applicable

K. The WMS Software shall provide an Evapo-Transpiration Report. This report will display and print ET data for any microclimate with user defined options:

1. Start/stop date period
2. Report by day, week, month
3. Sort by time or microclimate

L. The WMS Software shall provide a Flow Meter Report. The report will display and print flow meter data by flow meter for any individual, group, or all satellites with user defined options:

1. Start/stop date period
2. Report by day, week, and month
3. Resolution by satellite or system (totals)
4. Units of gallons
5. Show averages

M. The WMS Software shall provide a Water Usage Report. This will display and print water usage data which shows both runtime and flow data for any individual, group, or all satellites with user defined options:

1. Start/stop date period
2. Report by day, week, and month
3. Resolution to station, satellite, or system
4. Units
5. Show averages
6. Show measured versus calculated flow data

N. The WMS Software shall provide a rainfall report. This report will display and print rainfall data for any microclimate with user defined options:

1. Start/stop date period
2. Report by day, week, and month
3. Rainfall per microclimate
4. Show averages.

4.0 – COMPUTER TO SATELLITE COMMUNICATIONS

A. The central computer shall be capable of multiple communication modes, and must allow for mixed modes within the same system.

B. Computer to satellite communications methods can be:

1. Narrowband, UHF data radio
2. Spread Spectrum radio
3. Telephone (landline)
4. Cellular Technology
5. Ethernet
6. Fiber Optics

C. The addition of a remote transceiver assembly will permit utilizing multiple communications methods to remote field controllers.

D. All communications, regardless of mode, will be true two-way and will provide visual and/or audio confirmation of receipt.
E. The Sentinel Water Management System shall utilize two-way communication throughout the entire system. Data transmissions shall utilize appropriate protocols to insure reliable error-free communications.
F. The Water Management System shall support serial port expansion to accommodate singular, combined, and repeater communication modes.
G. The WMS Software shall provide alarms and diagnostics for verifying communication path performance and troubleshooting.
H. The Water Management System shall be capable of uninterrupted satellite operation in the event that the central computer is not operational or communication failure with one or more satellites has occurred.

SPECIFICATIONS
TORO® SENTINEL FIELD SATELLITE CONTROLLERS

1.0 – HARDWARE FEATURES

A. The field satellite shall use modular solid-state control technology and be capable of automatic, semi-automatic and manual operations.
B. The controller shall be programmable by the on-board keyboard with lighting optional back-lit LCD or by a laptop computer (unless a non-keypad model such as a MapTo universal).
C. The controller shall be housed in a locking stainless steel or powder-coated metal wall mount, or stainless steel or plastic pedestal.
D. Access to high voltage and 24-volt field wire shall be through a front door panel with a keyed lock.
E. Both the cabinet and interior assemblies shall be UL approved for outdoor and indoor applications.
F. The pedestal model shall be bolted into a concrete footing that has mounting bolts embedded in the concrete pad. The concrete pad shall be sloped away from the pedestal to prevent water accumulation around the base of the cabinet.
G. The controller shall be capable of operating at 115 V a.c. (+/- 10%) 50/60Hz and be capable of withstanding an incoming surge or electrical spike or 4.5 kV on the input side.
H. Each 24-volt station output shall be capable of delivering 0.5 amperes at (12VA) at 24 V a.c.
I. The controller shall be capable of operating six multiple stations for a total output current of 2.0 amperes at 24 V a.c.
J. The surge testing shall conform to the following standards:
    1. ICE 61000 Standard for Lighting Surge, 1089 Bellcore Testing, UL 1449.
K. The 24-volt outputs shall be offered with options for three levels of surge protection
L. The 24-volt output board with full surge shall be capable of withstanding field surges in excess of 20 KV at A.
M. The controller shall have manual activation switches and LEDs indicating station operation for each station.
N. The Stainless Steel Wall and Pedestal mount and Plastic Pedestal Mount Controllers shall be expandable in 12 station increments from 12 to 48 stations.
O. The controller shall have a master valve capability via a separate terminal block that is independent of the remaining station count. The master valve shall have the ability to be the programmed for either normally open or normally closed master valves.
P. The controller shall come standard with a “Dallas”-style for real-time clock retention in the event of a power failure. The controller shall maintain the time-of-day, day-of-week and user defined program for a period of 10 years.
Q. The satellite control module components shall be enclosed in a weather resistant plastic cabinet that is sealed against insects and other vermin that might cause failures.

2.0 – SCHEDULING CAPABILITIES

A. The controller shall have three modes of operation: stand-alone, off and centrally-controlled.
B. Time-of-day and day-of-week programming, and operational status shall be shown in LCD display.

C. While operating in stand-alone mode, the field satellite shall have a 12/24 hour real-time clock with adjustable day change hour. Time-of-day, day-of-week, programming and operational status shall be shown in LCD.
D. The controller shall have 16 independent programs divided into four clusters (A through D) with four programs within each cluster (1 through 4).
E. Each program shall be assigned to any of sixteen watering schedules which can be up to six weeks long with any combination of watering days.
F. Each program shall have eight start times, up to 99 repeat cycles and a programmable delay between cycles from 0-255 minutes.
G. The controller shall be capable of running any one or combination of programs continuously.
H. A water window may be entered for any program where watering will only take place between a start and end time.
I. Each station can be programmed independently from one another and have the ability to operate each station in one minute increments between one minute and 14 minutes.
J. The station will run continuously (infinite) when the run time is set at four hours and 15 minutes.
K. Each station may be assigned independently to any or all of the 16 programs.
L. The controller shall be capable of running any one or combination of programs simultaneously.
M. The controller shall have a program adjust feature that allows for independent percent-adjust feature that allows for independent percentage adjustment of each program from 10% to 250% in 1% increments.
N. The controller shall have a non-volatile memory that can maintain time and all programming functions for a period of 10 years or more in the event of a power loss.
O. When the controller is operating in either manual or automatic modes, the remaining run time may be displayed.
P. The controller shall have a multi-manual cycle that allows the simultaneous operation of one to six stations with independent station run times.
Q. The controller shall have the following additional standard features in a stand-alone mode:
    1. Alarm alerts against user errors for programming and communication
    2. Ability to create and store program for future use.
    3. On-line help screens for training of first time users
    4. Running programs based on ET data
    5. Reading and reacting to flows
    6. Capable of monitoring the current draw of any and all stations
R. The controller shall be capable of running irrigation programs based on Evapo-Transpiration (ET) input. When the ET functions are activated, the controller automatically adjusts program run times according to the ET data.
S. The controller hall be capable of displaying in English, French, Italian, or Spanish.
T. The controller shall have the ability to communicate with a MapTo Universal remote field satellite within radio reception range. The MapTo Universal module shall be available in 12, 24, 36, and 48 station increments and shall be capable of receiving program functions from another controller in either stand-alone or central modes. This feature shall not diminish or limit the number of programs or functionality of the “master” controller.

3.0 – MAINTENANCE & REPORTING

A. The controller shall be capable of (manually) monitoring the current draw of any and all stations. If the current exceeds allowable limits the station shall be shut down to protect the fuse. The program shall complete its cycle and provide an alarm alert of the high current station.
B. The controller shall be capable of reading and reacting to flow rates.
C. When the flow functions are activated, the controller automatically reads and records flow data.
D. Water usage for the current month, previous month and previous year accumulative totals are stored and are retrievable.
E. The controller shall be capable of reacting to unexpected, over or under flows by shutting down the station(s) or a master valve. A properly size and located flow meter is required to provide accurate flow data.
F. The controller shall have field diagnostics in stand-alone mode, when used in conjunction with a troubleshooting kit. This kit, when connected properly, shall have the availability to diagnose programming conflicts versus a physical hardware problem.
G. In a central mode the field satellite shall have the ability to forward sensor alarm alerts, communication alarms, and/or field programming changes via two-way radio or a remote transceiver via telephone.

4.0 – RADIO, HANDHELD & SENSOR FEATURES

A. The controller shall have a built-in two way radio that can communicate to a central computer, hand-held radio or remote transceiver module without any additional hardware.
    1. The radio shall be connected to a narrowband antenna.
    2. When in central mode, the two-way radio shall allow for field keypad changes to be uploaded as desired. The download interval and day change shall be used defined. Field changes made after the day change will affect the next active day's watering cycle.

B. The controller shall have sensor capability regardless of station count via a separate input board.
C. The sensor board shall be a standard feature and shall be capable of sensing open and closure of dry contact switches not exceeding 12 Volts DC.
D. Sensor inputs shall be capable of monitoring rain switches, freeze sensors, Et gauges, and various weather stations.
E. The controller shall have the ability to accept and execute commands from a portable hand-held radio remote having a maximum output power of 5 watts.
F. The hand-held remote radio shall not require the installation of a central computer and shall have the ability to communicate directly to a field satellite in a stand-alone mode.
G. The remote shall have the ability to execute the following commands:
    1. On/Off of individual stations
    2. On/Off of individual programs
    3. System wide or individual program shut down
    4. Two-way voice communication
    5. Selectable channels between wide-and narrow band frequencies
    6. Communication to an individual controller or multiple controllers on a site as defined by the end user.

H. The handheld will provide the ability for two-way voice communciations
I. The Handheld shall be Toro model SHHR

SPECIFICATIONS
TORO® SENTINEL ACCESSORY EQUIPMENT

1.0 - FLOW SENSORS

0.5", 0.75", 1.0" PVC [Tee] Irrigation Flow Sensor

A. The flow sensor shall be an in-line type with a non-magnetic, spinning impeller (paddle wheel) as the only moving part.
B. The electronics housing shall be glass-filled PPS.
C. The impeller shall be 300SST with a UHMWPE sleeve bearing.
D. The shaft material shall be tungsten carbide.
E. The electronics housing shall have two ethylenepropylene O-Rings and shall be easily removed from the meter body. The sensor electronics will be potted in an epoxy compound designed for prolonged immersion.
F. Electrical connections shall be 2 single conductor 18 AWG leads. Insulation shall be direct burial "UF" type colored red for the positive lead and black for the negative lead.
G. The sensor shall operate in line pressures up to 150 psi and liquid temperatures up to 110° F, and operate in flows of 2 feet per second to 20 feet per second with accuracy of ± 3-5%.
H. The sensor body shall be fabricated from Schedule 40 PVC Tees, available in 1/2", 3/4", and 1" with socket end connections.
I. This flow sensor shall be a Toro Model TFS-050, TFS-075, or TFS-100 sensor.

1.5", 2", 3" or 4" PVC [TEE] Irrigation Flow Sensor

A. The flow sensor shall be an in-line type with a non-magnetic, spinning impeller (paddle wheel) as the only moving part.
B. The electronics housing shall be glass-filled PPS.
C. The impeller shall be glass-filled nylon or Tefzel® with a UHMWPE or Tefzel sleeve bearing.
D. The shaft material shall be tungsten carbide.
E. The electronics housing shall have two ethylenepropylene O-Rings and shall be easily removed from the meter body. The sensor electronics will be potted in an epoxy compound designed for prolonged immersion.
F. Electrical connections shall be 2 single conductor 18 AWG leads 48 inches long. Insulation shall be direct burial "UF" type colored red for the positive lead and black for the negative lead.
G. The sensor shall operate in line pressures up to 100 psi and liquid temperatures up to 140° F, and operate in flows of 1⁄2 foot per second to 20 feet per second with linearity of ± 1% and repeatability of ± 1%.
H. The sensor body shall be fabricated from Schedule 80 PVC Tees, available in 1⁄2", 2", 3, and 4" with socket end connections.
I. his flow sensor shall be a Toro Model TFS-150, TFS-200, TFS-300, or TFS-400 sensor.

2.0 – CABLE FOR FLOW SENSORS

A. TFS series sensors may be located up to 2000’ from the controller.
B. All data communications wire connecting flow sensors to the electronics that are buried below grade, with or without conduit, shall be constructed to direct burial specifications similar to Telecommunications Exchange Cable (REA PE-89).
C. The cable shall be constructed of 20 AWG, or larger, copper conductors twisted into pairs of varying lengths to prevent cross talk. Conductors shall be insulated with polyethylene or propylene with a suggested working voltage of 350 volts.
D. The cable shall feature an aluminum-polyester shield and be finished with a black high-density polyethylene jacket. Cable should be equivalent to AT&T PE-39 or PE-89.

3.0 – SPLICES FOR FLOW SENSOR

A. All wire connections shall be watertight with no leakage to ground or shorting from one conductor to another.
B. All splices shall be made in accordance with National Electrical Code® Articles 300.5 (Underground Installations) and 110.14 (Electrical Connections) using 3M DBY-6 or DBR-6 connectors, which are UL listed under "UL 486D-Direct Burial", for wet or damp locations, 600 volts.

4.0 – WEATHER STATION

A. The weather station shall be located in an area “representing” the typical landscape to be irrigated.
B. The weather station / weather source shall be one of the following manufacturers and models.
    1. Davis Instruments
        a. Vantage Pro 2 Plus
        b. GrowWeather
    2. Campbell Scientific
        a. ET 107
        b. Turf Weather
    3. Irrisoft
        a. Weather Reach
C. The weather stations shall be installed as per manufacturer’s specifications.