US008020767B2

(12) **United States Patent**
Reeves et al.

(10) **Patent No.: US 8,020,767 B2**
(45) **Date of Patent: Sep. 20, 2011**

(54) **SYSTEMS AND METHODS FOR MONITORING A QUANTITY OF WASTE IN A WASTE TRANSFER STATION ENVIRONMENT**

(75) Inventors: **Theodore S. Reeves**, Springfield, VT (US); **Donald S. Buchanan**, Manchester, NH (US)

(73) Assignee: **Casella Waste Systems, Inc.**, Rutland, VT (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 740 days.

(21) Appl. No.: **11/384,303**

(22) Filed: **Mar. 21, 2006**

(65) **Prior Publication Data**

US 2007/0222600 A1 Sep. 27, 2007

(51) **Int. Cl.**
G06F 19/00 (2011.01)

(52) **U.S. Cl.** **235/385**; 235/384

(58) **Field of Classification Search** 235/384, 235/385
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,787,467	A *	11/1988	Johnson	177/50
5,014,206	A *	5/1991	Scribner et al.	701/207
5,340,968	A	8/1994	Watanabe et al.	
5,565,846	A	10/1996	Geiszler et al.	
5,712,789	A *	1/1998	Radican	700/226
5,837,945	A	11/1998	Cornwell et al.	
5,947,256	A	9/1999	Patterson	
6,206,282	B1	3/2001	Hayes, Sr. et al.	
6,520,544	B1	2/2003	Mitchell et al.	
6,690,402	B1	2/2004	Waller et al.	
6,729,540	B2 *	5/2004	Ogawa	235/384
6,759,959	B2	7/2004	Wildman	
2002/0072923	A1 *	6/2002	Guidry	705/1
2002/0105424	A1	8/2002	Alicot et al.	
2002/0154915	A1	10/2002	Bullock et al.	
2002/0196150	A1	12/2002	Wildman	
2003/0001726	A1	1/2003	Moore	
2003/0067381	A1	4/2003	Mitchell et al.	
2004/0004119	A1	1/2004	Baldassari et al.	
2004/0046672	A1	3/2004	Kasik et al.	
2004/0129781	A1	7/2004	Kreiner et al.	
2004/0133484	A1	7/2004	Kreiner et al.	
2004/0153379	A1	8/2004	Joyce et al.	
2004/0178264	A1	9/2004	Linton et al.	
2004/0027243	A1	12/2004	Carrender	
2005/0080520	A1 *	4/2005	Kline et al.	701/1

OTHER PUBLICATIONS

Anonymous, Wired?, Mar. 1, 1998, World Wastes; 41,3.*

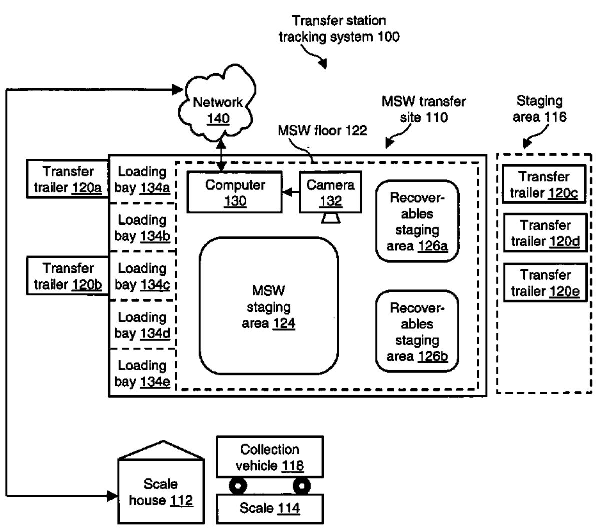
* cited by examiner

Primary Examiner — Daniel A Hess
Assistant Examiner — Michael Andler
(74) *Attorney, Agent, or Firm* — Wilmer Cutler Pickering Hale and Dorr LLP

(57) **ABSTRACT**

Systems and methods are provided for monitoring a quantity of waste in a waste transfer station environment. Embodiments of the invention maintain a running total of waste deposited within the waste transfer station by automating the process of recording the weights of vehicles depositing and removing waste from the waste transfer station.

26 Claims, 7 Drawing Sheets



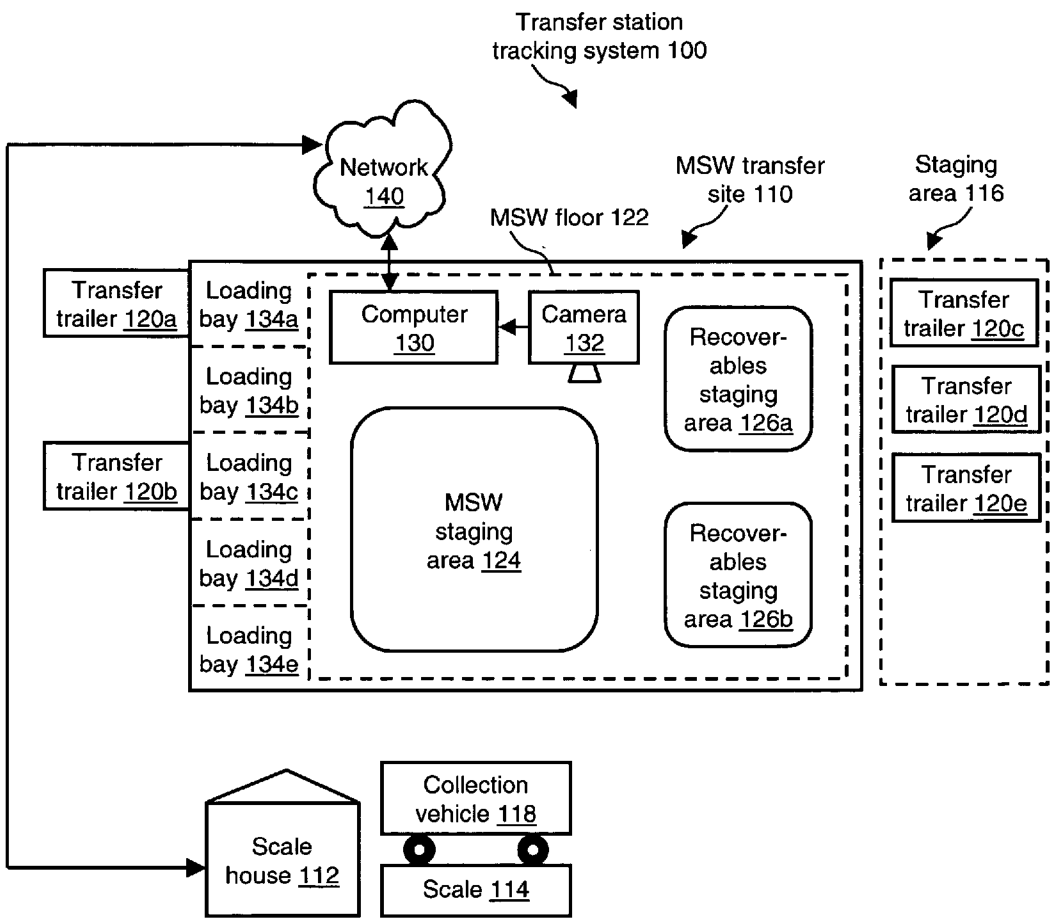

Transfer station
tracking system 100
Network
140
MSW transfer
site 110
Staging
area 116
MSW floor 122
Transfer
trailer 120a
Loading
bay 134a
Computer
130
Camera
132
Recover-
ables
staging
area 126a
Transfer
trailer 120c
Transfer
trailer 120d
Transfer
trailer 120e
Loading
bay 134b
Transfer
trailer 120b
Loading
bay 134c
MSW
staging
area 124
Loading
bay 134d
Recover-
ables
staging
area 126b
Loading
bay 134e
Scale
house 112
Collection
vehicle 118
Scale 114

FIG. 1

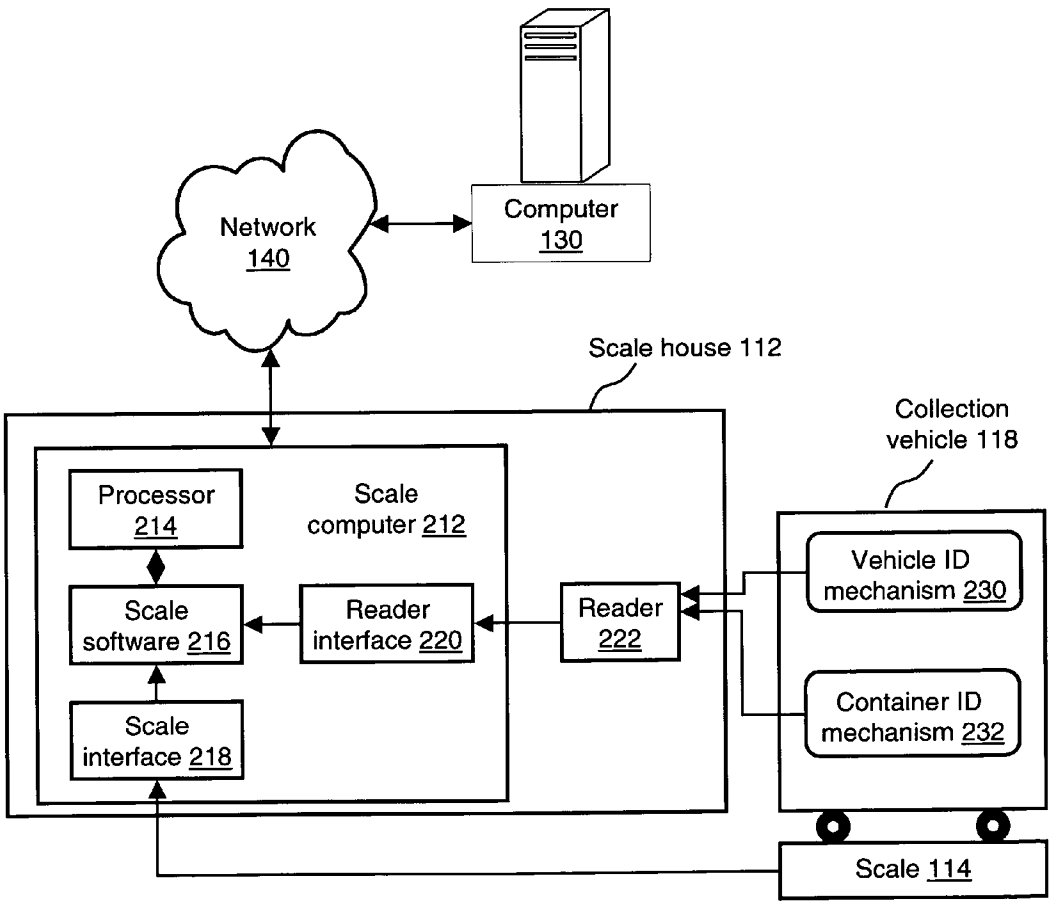
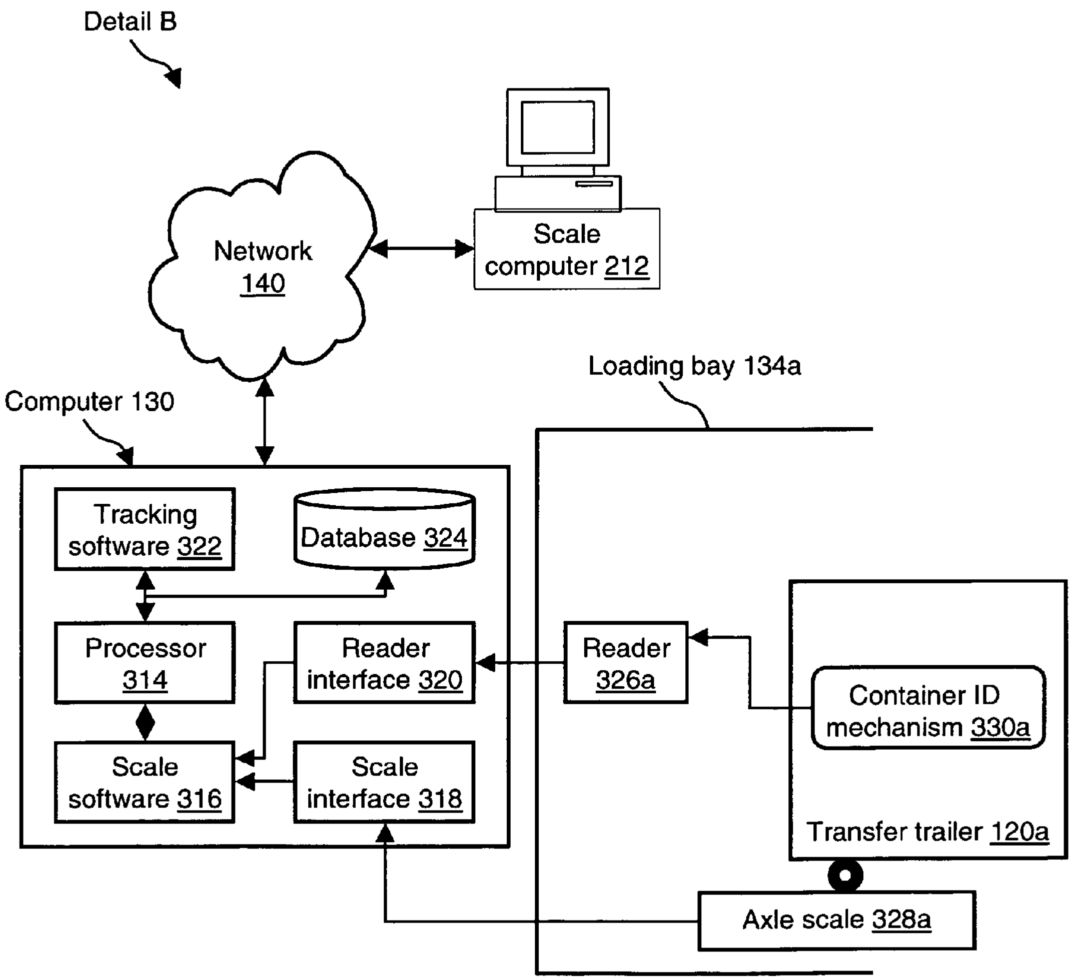

Computer
130
Network
140
Scale house 112
Collection
vehicle 118
Processor
214
Scale
computer 212
Scale
software 216
Reader
interface 220
Reader
222
Vehicle ID
mechanism 230
Container ID
mechanism 232
Scale
interface 218
Scale 114

FIG. 2



Detail B
Network 140
Scale computer 212
Loading bay 134a
Computer 130
Tracking software 322
Database 324
Processor 314
Reader interface 320
Reader 326a
Container ID mechanism 330a
Scale software 316
Scale interface 318
Transfer trailer 120a
Axle scale 328a

FIG. 3

Database 324

	Customer ID	Vehicle ID	Container ID	Time In	Weight in	Time out	Weight out
Collection vehicle 118a	Company A	2345		11-Aug-05 07:15	8.3	11-Aug-05 07:45	5.6
Collection vehicle 118b	Company B	6543		11-Aug-05 07:30	9.2	11-Aug-05 08:15	6.2
Transfer trailer 120a			6578A	11-Aug-05 08:00	5.0	11-Aug-05 12:30	16.4
Collection vehicle 118c	Company C	9807		11-Aug-05 08:07	8.6	11-Aug-05 08:37	5.1
Transfer trailer 120b			5467B	11-Aug-05 08:30	5.0	11-Aug-05 13:00	15.8
Collection vehicle 118d	Company D	2236		11-Aug-05 08:45	9.4	11-Aug-05 09:30	6.0
Collection vehicle 118e	Company E	5067		11-Aug-05 09:00	9.6	11-Aug-05 10:00	5.4
Collection vehicle 118f	Company F	1237		11-Aug-05 10:30	8.3	11-Aug-05 11:00	5.1
Transfer trailer 120c			5467B	11-Aug-05 09:15	5.0	11-Aug-05 13:30	16.6

FIG. 4

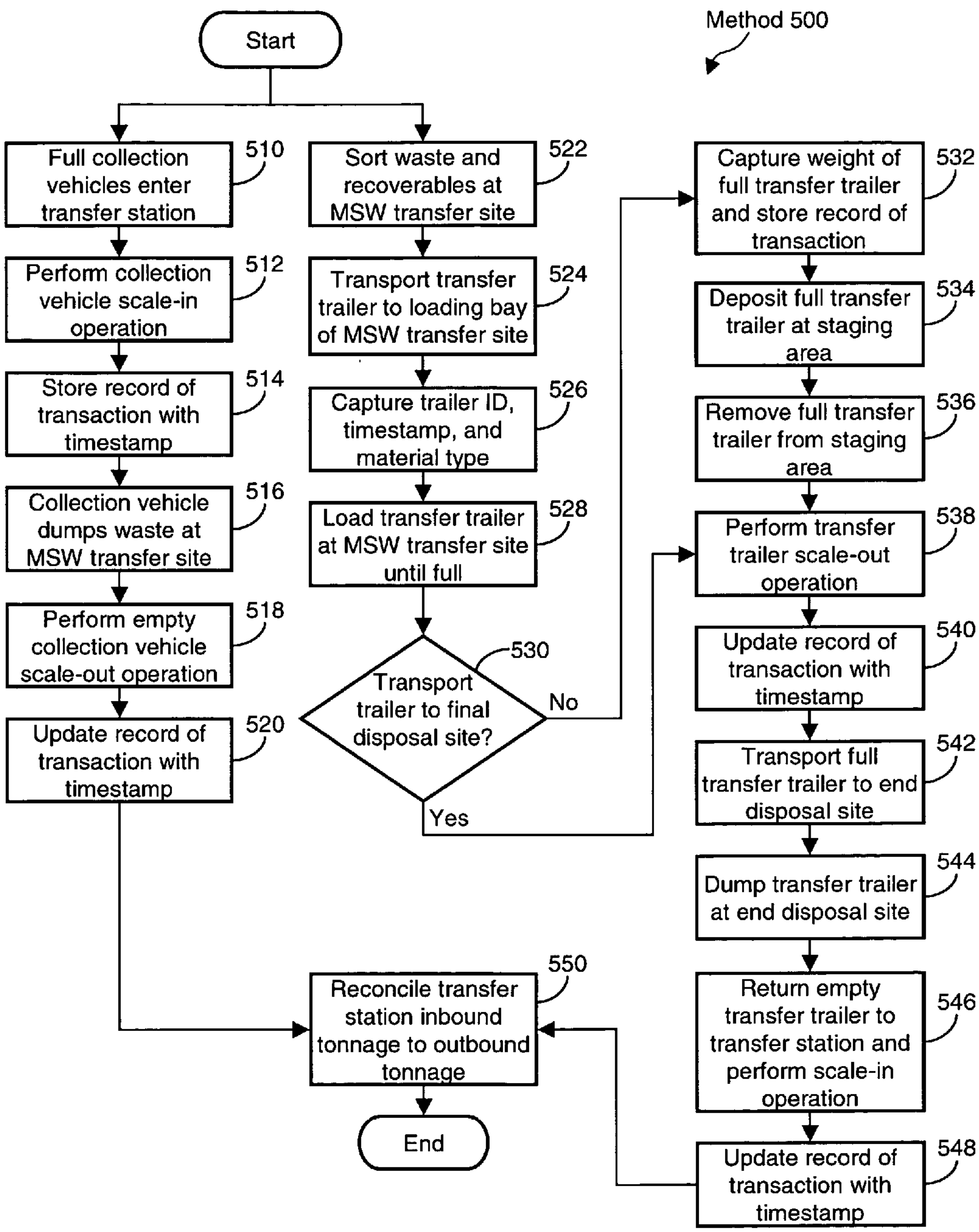

Method 500
Start
Full collection vehicles enter transfer station
510
Perform collection vehicle scale-in operation
512
Store record of transaction with timestamp
514
Collection vehicle dumps waste at MSW transfer site
516
Perform empty collection vehicle scale-out operation
518
Update record of transaction with timestamp
520
Sort waste and recoverables at MSW transfer site
522
Transport transfer trailer to loading bay of MSW transfer site
524
Capture trailer ID, timestamp, and material type
526
Load transfer trailer at MSW transfer site until full
528
Transport trailer to final disposal site?
530
No
Yes
Capture weight of full transfer trailer and store record of transaction
532
Deposit full transfer trailer at staging area
534
Remove full transfer trailer from staging area
536
Perform transfer trailer scale-out operation
538
Update record of transaction with timestamp
540
Transport full transfer trailer to end disposal site
542
Dump transfer trailer at end disposal site
544
Return empty transfer trailer to transfer station and perform scale-in operation
546
Update record of transaction with timestamp
548
Reconcile transfer station inbound tonnage to outbound tonnage
550
End

FIG. 5

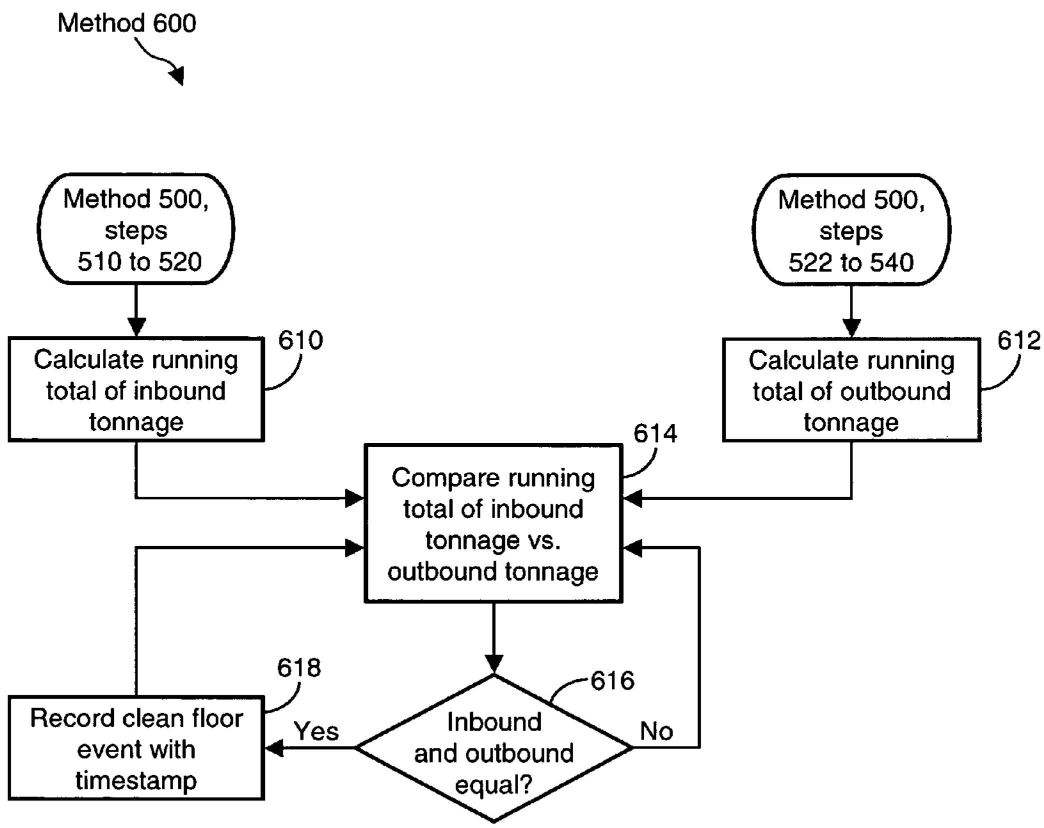

Method 600
Method 500, steps 510 to 520
Method 500, steps 522 to 540
Calculate running total of inbound tonnage
610
Calculate running total of outbound tonnage
612
Compare running total of inbound tonnage vs. outbound tonnage
614
Inbound and outbound equal?
616
Yes
No
Record clean floor event with timestamp
618

FIG. 6

Table 700

			Scale in		Scale out		Transaction	Total Net	Total Net	Overall Net
			Weight	Time Stamp/Data	Weight	Time Stamp/Data	Net Weight	Weight In	Weight Out	Weight
Line 1	Collection vehicle 118a	7:15	8.3	07:15/Data						
Line 2	Collection vehicle 118b	7:30	9.2	07:30/Data						
Line 3	Collection vehicle 118a	7:45			5.6	07:45/Data	2.7	2.7	0.0	+2.7
Line 4	Transfer trailer 120a	8:00	5.0	08:00/Data				2.7	0.0	+2.7
Line 5	Collection vehicle 118c	8:07	8.6	08:07/Data				2.7	0.0	+2.7
Line 6	Collection vehicle 118b	8:15			6.2	08:15/Data	3.0	5.7	0.0	+5.7
Line 7	Transfer trailer 120b	8:30	5.0	08:30/Data				5.7	0.0	+5.7
Line 8	Collection vehicle 118c	8:37			5.1	08:37/Data	3.5	9.2	0.0	+9.2
Line 9	Collection vehicle 118d	8:45	9.4	08:45/Data				9.2	0.0	+9.2
Line 10	Collection vehicle 118e	9:00	9.6	09:00/Data				9.2	0.0	+9.2
Line 11	Transfer trailer 120c	9:15	5.0	09:15/Data				9.2	0.0	+9.2
Line 12	Collection vehicle 118d	9:30			6	09:30/Data	3.4	12.6	0.0	+12.6
Line 13	Transfer trailer 120a	9:45			16.4	12:30/Data	11.4	12.6	11.4	+1.2
Line 14	Collection vehicle 118e	10:00			5.4	10:00/Data	4.2	16.8	11.4	+5.4
Line 15		10:15						16.8	11.4	+5.4
Line 16	Collection vehicle 118f	10:30	8.3	10:30/Data				16.8	11.4	+5.4
Line 17	Collection vehicle 118g	10:45	9.1	10:45/Data				16.8	11.4	+5.4
Line 18	Collection vehicle 118h	11:00	8.8	11:00/Data				16.8	11.4	+5.4
Line 19	Collection vehicle 118f	11:15			5.1	11:15/Data	3.2	20.0	11.4	+8.6
Line 20	Collection vehicle 118g	11:30	8.8	11:30/Data				20.0	11.4	+8.6
Line 21	Collection vehicle 118g	11:45			6.4	11:45/Data	2.7	22.7	11.4	+11.3
Line 22	Collection vehicle 118h	12:00			5.3	12:00/Data	3.5	26.2	11.4	+14.8
Line 23	Collection vehicle 118i	12:15			4.9	12:15/Data	3.9	30.1	11.4	+18.7
Line 24		12:30							11.4	+18.7
Line 25	Collection vehicle 118j	12:45	7.9	12:45/Data				30.1	11.4	+18.7
Line 26	Transfer trailer 120b	13:00			15.8	13:00/Data	10.8	30.1	22.2	+7.9
Line 27	Collection vehicle 118j	13:15			4.2	13:15/Data	3.7	33.8	22.2	+11.6
Line 28	Transfer trailer 120c	13:30			16.6	13:30/Data	11.6	33.8	33.8	**0.0**
Line 29		13:45								

FIG. 7

SYSTEMS AND METHODS FOR MONITORING A QUANTITY OF WASTE IN A WASTE TRANSFER STATION ENVIRONMENT

BACKGROUND OF THE INVENTION

1. Field of the Invention

Embodiments of the present invention relate to the field of solid waste and recyclables disposal. In particular, embodiments of the present invention relate to an automated tracking system that can be used to monitor a quantity of waste in a municipal solid waste transfer station environment.

2. Background Description

Waste management companies provide residential, commercial, and municipal waste management and recycling services for communities and organizations. Customers range from single residences to entire towns or companies. Municipalities may contract or otherwise engage a waste management service provider to handle their municipal solid waste (MSW). MSW is garbage, refuse, and other discarded materials that result from residential, commercial, industrial and/or community activities. MSW may also include mixed waste, such as unsorted waste from businesses or homes. MSW does not include, for example, hazardous waste, animal waste used as fertilizer, or sewage sludge.

Typically, a waste collector, which may be an entity employed by a local authority or a private firm to collect waste from residences, businesses and/or community bins, transports MSW to a transfer station, where the MSW is dumped and processed. A transfer station is an intermediate facility at which MSW is transferred from collection vehicles into larger trucks or rail cars, for transport to its final disposal destination—typically, a landfill. Mixed waste may be also sorted into constituent components at a transfer station to recover recyclable materials, such as wood, glass and/or metal.

To determine the weight of material deposited, the operation of a transfer station includes, for each collection vehicle, weighing the collection vehicle during a "scale-in" operation, the collection vehicle depositing its load at a designated dumping area, and weighing the collection vehicle again during a "scale-out" operation. During the scale-in and scale-out operations, the scale house operator manually enters into a computer information related to each transaction. Such information may include, for example, a vehicle identification (ID) number, a trailer ID number, a customer ID, a hauler ID, the generator of the waste (e.g., a business), the origin of the waste (e.g., a municipality), the waste type (e.g., MSW and/or recyclables), the quantity of special waste (e.g., number of tires, batteries, or propane tanks), and the calculated weight of the material to be dumped.

Once deposited at the designated dumping area, the waste is sorted into MSW and other recoverable materials, such as wood or metal. Subsequently, individual containers (transfer trailers) are loaded, for example, with MSW only, metal only, or wood only. Filled transfer trailers that contain MSW only are either transported to a landfill or temporarily placed in a staging area for later transport to a landfill. Likewise, any filled transfer trailers that contain only recoverable material, such as metal or wood, are either transported immediately to a recycling facility, or placed temporarily in a staging area for later transport to a recycling facility. Ideally, these containers would be completely full, but this is not necessary for proper operation of the system.

As each transfer trailer leaves the transfer station or is transported to the staging area within the MSW transfer station, a scale-out operation occurs to determine and track the waste unloaded by the transfer trailer. Again, this is a manual process of entering information into a computer. Manual tracking of waste within a MSW transfer station, for example, is performed by personnel using a computer keypad. Such manual operations are labor and time intensive, and thus inefficient and prone to error. We have discovered that there exists a need to automate the tracking of inbound waste, outbound waste, and internal movement of waste within a MSW transfer station.

State and local regulations govern the flow of material through each transfer station. As a result, each MSW transfer station has permit requirements that are based on state and local rules and/or regulations. One such regulation is a "clean floor" requirement, wherein the "floor" refers to a designated dumping area within the MSW transfer station. The clean floor requirement requires that the floor be free of all waste and recyclable materials at least once within a predetermined period of time, such as once every 24 or 48 hours. Consequently, there is a need to show that the volume of material dumped at the floor equals the volume of material removed from the floor within the given time period.

Clean floor log activities are manually entered into a computer. Thus, a clean floor log may not always be up to date or accurate. Consequently, due to delays that may be associated with manually entering data, the clean floor log may not always provide an indication that a clean floor event has occurred within the predetermined time cycle. Furthermore, the clean floor log must be provided, upon request, to a regulatory authority at any time. If the operator of a MSW transfer station is unable to satisfy the clean floor requirement of a regulatory authority, the operator is at risk of being fined or losing its operating permit. We have discovered that there exists a need to automate the monitoring of clean floor status in a way that facilitates the accurate reporting of the MSW clean floor status.

Another regulation that is based on state and local regulations pertains to the total elapsed time that an individual transfer trailer can remain within the MSW transfer station facility, from the time it begins to be filled with material. For example, once a transfer trailer begins to be filled, it must be transported from the MSW transfer station facility to it final destination within, for example, 24 or 48 hours. The tracking of each transfer trailer is also kept manually on a computer and is thus not always up to date and is subject, for example, to transcription errors. We have discovered that there is a need to automated the manner in which transfer trailers can be monitored. We have also discovered that there exists a need to automated reporting of the status of each transfer trailer and each trailer's movement.

SUMMARY OF EMBODIMENTS OF THE INVENTION

In one embodiment of the present invention, a system includes a reader for reading a first plurality of identifiers. Each of the first plurality of identifiers stores a vehicle identifier associated with a respective plurality of waste collection vehicles. A second plurality of identifiers is used to store a waste receptacle identifier associated with a respective plurality of waste receptacles.

A general purpose computer that uses a data repository is also provided. The data repository stores the read vehicle identifier associated with respective waste collection vehicles, and the read waste receptacle identifier associated with respective waste receptacles. In addition, the data repository stores a first plurality of values representing a weight difference, between a respective plurality of substantially full and substantially empty waste collection vehicles, at respective times.

The data repository further stores a second plurality of values representing a weight difference, between a respective plurality of substantially full and substantially empty waste receptacles, at respective times. The computer maintains a running total by utilizing the respective times, in a time sequenced manner, to add each of the first plurality of values and subtract each of the second plurality of values from the first plurality of values.

Before explaining embodiments of the invention in detail, it is to be understood that embodiments of the invention are not limited in their application to the details of construction and to the arrangements of the components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments and of being practiced and carried out in various ways.

BRIEF DESCRIPTION OF THE DRAWINGS

The Detailed Description including the description of preferred systems and methods embodying features of the invention will be best understood when read in reference to the accompanying figures wherein:

FIG. **1** is an exemplary block diagram of a transfer station tracking system in accordance with an embodiment of the present invention.

FIG. **2** is an exemplary block diagram of a networked scale house, a scale, and a collection vehicle of an embodiment of the transfer station tracking system of the present invention.

FIG. **3** is an exemplary block diagram of a networked transfer trailer, computer, and loading bay of an embodiment of the transfer station tracking system of the present invention.

FIG. **4** is an exemplary database of the transfer station tracking system.

FIG. **5** is a flow diagram of an exemplary method of using an embodiment of the transfer station tracking system.

FIG. **6** is an exemplary flow diagram of a method of tracking clean floor events, by use of the transfer station tracking system.

FIG. **7** is an exemplary electronic log.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

FIG. **1** is an exemplary block diagram of a transfer station tracking system **100** in accordance with an embodiment of the present invention. Transfer station tracking system **100** is generally installed within a municipal solid waste (MSW) transfer site **110**. A MSW transfer site **110** includes scale house **112**, staging area **116** and scale **114**. Scale **114** is used to weigh collection vehicle **118**, which is representative of one of several collection vehicles that arrive and depart from scale house **112**.

Transfer trailers such as **120***c*, **120***d*, **120***e* are shown positioned within staging area **116**. Transfer trailers **120***a* and **120***b* are respectively located at loading bays **134***a* and **134***c*. In general, transfer trailers **120***a-e* may be empty and waiting to be loaded, be already loaded and waiting to be transported to a landfill, or some combination thereof.

MSW transfer site **110** is, for example, a building or other structure within a typical MSW transfer station. MSW transfer site **110** includes MSW floor **122**, which is a designated area at which collection vehicles **118** dump MSW. Staging area **124** is an area for sorting materials, such as MSW, wood, or metal. Within MSW floor **122** is recoverables staging areas **126***a* and **126***b*. Recoverables staging areas **126***a*, **126***b*, may consist, for example, of piles of metal or wood that have been separated from the MSW. Also within or associated with MSW transfer site **110** is a standard computer **130** and a camera **132**. Computer **130** is general purpose standard computer, such as a desktop, or laptop, that can be connected to a computer network (not shown).

Camera **132** is a standard, video security camera, such as a Ganz D/N Hi/Res A/I 8.5-40 mm camera, that captures images of MSW floor **122** as needed. Camera can be connected to computer **130** through standard interfaces such as IEEE 1394 (FireWire) or Universal Serial Bus (USB). Multiple cameras **132** can be utilized at MSW transfer site **100**.

Loading bays **134***a-e* are areas where, for instance, the separated materials from MSW staging area **124** and recoverables staging areas **126***a*, **126***b* are loaded onto one or more transfer trailers **120**. Transfer trailers **120**, once loaded, are transported to either a final disposal site (not shown) or to staging area **116**, for later transport to the final disposal site. Staging area **116** is an area where empty transfer trailers **120** await transfer to loading bay **134** or where filled transfer trailers **120** await transport to a final disposal site. Empty transfer trailers **120** can then be returned back to the transfer sits **110**.

Scale house **112** and scale **114** are used to weigh collection vehicles **118** or transport trailers **120**. Scale house **112** is connected via network **140** to computer **130**. Scale **114** is a standard industrial weight scale, such as an axle scale. Collection vehicle **118** can be any commercial, industrial or residential collection vehicle.

FIG. **2** is an exemplary block diagram of scale house **112**, scale **114**, and collection vehicle **118** of an embodiment of the transfer station tracking system **100** of the present invention. Scale house **112** includes scale computer **212**, and reader **222**. Reader **222** is a commercially available ID tag reader system, such as the TI-RFID radio frequency identification (RFID) system, manufactured by Texas Instruments (Dallas, Tex.).

Scale computer **212** may be a standard computer, such as a desktop or laptop, that includes a standard processor **214**, scale software **216**, scale interface **218**, and reader interface **220**. Reader interface **220** is an electronic interface, such as a universal serial bus (USB) port, or a wireless interface such as Bluetooth, that allows data (e.g., RFID data) from reader **222** to be processed in scale computer **212**. Reader interface **220** interacts with scale software **216**. Scale software **216** receives data from scale interface **218** and transmits the data to processor **214**.

Scale software **216** is a commercially available application, such as supplied by PC Scale, Inc. (Oxford, Pa.), that facilitates transactions related to the scale-in and scale-out operations of collection vehicles **118** and transfer trailers **120**. For example, scale software **216** assigns a scale ticket number to each transaction and records, for example, an associated customer ID, material weight, material quantity, and material type. Information captured via scale software **216** is transferred to computer **130** for additional processing.

Collection vehicle **118** further includes vehicle ID mechanism **230** and container ID mechanism **232**. Vehicle ID mechanisms **230** are, for example, radio frequency identification (RFID) tag devices or bar codes that provide unique identification and application-specific data to reader **222**. Vehicle ID mechanism **230** identifies items such as the make of vehicle **118** and/or the vehicle (**118**) identification number (VIN).

In operation, collection vehicle **118** pulls onto to scale **114** for processing. Scale **114** measures the weight of the truck containing MSW, and transmits the data to scale interface **218**. Scale interface **218** is an electronic interface, such as a USB port, which allows data from scale **114** to be transmitted to scale software **216**, processor **214**, and computer **130** via network **140**. In this manner, collection vehicle **118** is weighted prior to depositing its MSW contents onto floor **122**, and is again weighed after depositing its contents onto floor **122**. The difference in weight equals the weight of MSW contents deposited onto floor **122**, as is shown and discussed, for example, in connection with FIG. **7**.

FIG. **3** is an exemplary block diagram of a networked transfer trailer **120***a*, computer **130**, and loading bay **134***a* of transfer station tracking system **100**. Computer **130** further includes processor **314**, scale software **316**, scale interface **318**, and reader interface **320**. Additionally, computer **130** executes tracking software **322** which is linked to database **324**. Reader interface **320** is an electronic interface, such as a USB port, that allows data (e.g., data stored in a RFID tag) from reader **326***a* to be processed by computer **130**.

Reader interface **320** allows data to be transmitted to scale software **316**. Scale software **316** receives data from scale interface **318** and transmits the data to processor **314**. Tracking software **322** processes data that is captured via scale software **216** (FIG. **2**) and scale software **316** during each scale-in or scale-out operation, for storage in database **324**. Software **322** calculates the net tonnage of waste present at MSW floor **122** at any given time. For example, software **322** keeps a running total of inbound tonnage that is deposited via collection vehicles **118** at MSW floor **122** and also keeps a running total of outbound tonnage that is transported via transfer trailers **120** out of MSW floor **122**.

In order to determine the net tonnage of material present on MSW floor **122** at any given time, a comparison of the running totals of inbound tonnage vs. outbound tonnage is performed by software **322**. Examples of the tracking operations of software **322** are described in connection with FIGS. **5** and **6**. Additionally, software **322** can track the status of transfer trailers **120** at any given time, as described in connection with FIG. **7**.

Database **324** is standard database, which contains a collection of data that is related to collection vehicles **118** and transfer trailers **120**. Database **324** resides in a memory device, such as a hard disk drive (not shown), of computer **130**.

Located within loading bay **134***a* is one or more readers **326***a* and scale **328***a*. Transfer trailer **120***a* further includes one or more container ID mechanisms **330***a* that uniquely identify transfer trailer **120***a*. ID mechanisms **330***a* can be, for example, RFID tags or bar codes that provide application-specific data to reader **326***a*.

Reader **326***a* is a commercially available ID tag reader system, such as the TI RFID system, manufactured by Texas Instruments (Dallas, Tex.). Axle scale **328***a* is an industrial weight axle scale that weighs a transfer trailer **120**. Axle scale **328***a* transmits data to scale software **316** via scale interface **318**. Scale interface **318** is an electronic interface, such as a USB port, which allows data from axle scale **328***a* to be transmitted to scale software **316**.

With continuing reference to FIGS. **1-3**, the operation of transfer station tracking system **100** to track the flow of collection vehicles **118** and transfer trailers **120**, and the associated tonnage of waste therein, is as follows.

Collection vehicles **118** containing MSW weigh in at scale house **112**, deposit their MSW on floor **122**, and weigh out at scale house **112** prior to leaving system **100**. The difference between the entering weight and the exiting weight of collection vehicle **118** provides the weight of deposited MSW.

With regard to each individual collection vehicle **118**, ID mechanisms, such as vehicle ID mechanism **230** and container ID mechanism **232**, can be scanned by reader **222** when collection vehicle **118** is proximate reader **222**. Such scanning can be automated or manual. ID data is transmitted to scale software **216** via reader interface **220**. Additionally, the weight of any given collection vehicle **118** is determined by scale **114** and transmitted to scale software **216** via scale interface **218**. Subsequently, data is captured by scale software **216** and transmitted to computer **130**, for processing via network **140** and storage within database **324**. ID data may also be stored locally in a database (not shown) on scale computer **212**.

Empty transfer trailers **120** within the transfer site **110** are transported to loading bay **134** for loading. Once filled, and just prior to being transported away from site **110** to a final disposal site, transfer trailers **120** undergo a scale-out operation at scale house **112**, and a scale-in operation when they return, in order to determine the tonnage of material that has been disposed of. Empty transfer trailers **120** are returned to the transfer site **110** for reuse. With regard to each individual transfer trailer **120**, such as transfer trailer **120***a*, ID mechanisms such as container ID mechanism **330***a*, are scanned by reader **326***a* when transfer trailer **120** is proximate reader **326***a*. The scanned ID data is transmitted to scale software **316** via reader interface **320**. Additionally, the weight of transfer trailer **120***a* is determined by axle scale **328***a* and transmitted to scale software **316** using scale interface **318**. Subsequently, data is captured automatically by scale software **316** and stored within database **324**, for processing by software **322**. Alternatively, the weight of transfer trailer **120***a* can be determined at scale house **112** via scale **114**.

Software **322** processes the data that is stored within database **324**, by tracking the total tonnage of waste dumped at MSW floor **122** by collection vehicles **118** and by tracking the total tonnage of waste removed from MSW floor **122** by transfer trailers **120**. In doing so, software **322** is able to calculate the net tonnage of waste that is present at MSW floor **122** at any given time, which is useful, for example, in determining when a clean floor event has occurred. Examples of specific uses of software **322** are found in more detail in reference to the methods of FIGS. **4**, **5**, and **6**.

FIG. **4** is an exemplary database **324** that can be used with system **100**. Database **324** includes, for example, data that reflects activity and information related or pertaining to collection vehicles **118***a-f*, and transfer trailers **120***a-c*. Exemplary data related to collection vehicles **118** and transfer trailers **120** can include a CUSTOMER ID, a VEHICLE ID, a CONTAINER ID, a TIME IN, a WEIGHT IN (e.g., in tons), a TIME OUT, and a WEIGHT OUT (e.g., in tons).

FIG. **5** illustrates a flow diagram of an exemplary method **500** of using transfer station tracking system **100**. Method **500** illustrates the sequence of events that collection vehicles **118** and transfer trailers **120** experience when they utilize and/or operate in accordance with system **100**.

Steps **510** through **520** and steps **522** through **548** can execute concurrently or sequentially. In addition, multiple streams of each process can be executed at the same time. The use of timestamps allows tracking software **322** to record and process multiple incoming trucks multiple outgoing transfer trailers at the same time.

At step **510**, a collection vehicle **118**, such as a collection vehicle **118***a*, which is filled with MSW or recyclables pulls up to scale house **112**. At step **512**, collection vehicle **118***a* pulls onto and is weighed by scale **114**. The resulting scale data that indicates the "full" weight of collection vehicle **118***a* is transmitted via scale interface **218** to scale software **216**. At substantially the same time, vehicle ID mechanism **230** and container ID mechanism **232** are scanned by reader **222**. Scanning can be performed manually, or in an automated manner. This data is transmitted via reader interface **220** to scale software **216**.

At step **514**, data that is captured at step **512** is transmitted from scale computer **212** to computer **130** via network **140**, and stored in database **324**. In particular, the weight of collection vehicle **118***a* and associated ID data is timestamped (i.e., includes current date and time) and stored in database **324**.

At step **516**, collection vehicle **118***a* deposits the waste (MSW) on MSW floor **122**. At step **518**, collection vehicle **118***a*, which is now emptied of MSW or recyclables, again pulls onto and is weighed by scale **114**. The resulting scale data, representative of the empty weight of collection vehicle **118***a*, is transmitted to scale computer **212**.

Alternatively, the empty weight of each collection vehicle **118**, such as collection vehicle **118***a*, may already be known and stored within computer **130** and/or scale computer **212**. In this case, the scale-out operation of step **518** may be omitted, or used as a verification step to verify that collection vehicle **118***a* is empty. Scale software **216** performs a calculation, to determine the difference between the "full" weight (captured at step **512**) and the empty weight of collection vehicle **118***a*. In doing so, the weight of the MSW material that was left on MSW floor **122** at step **516** is determined.

At step **520**, data collected in step **518** that is associated with collection vehicle **118***a* is transferred from scale computer **212** to computer **130** via network **140**, and the record of this transaction, which includes a timestamp, is stored in database **324**. Method steps **510** though **520** are exercised for any number of collection vehicles **118** that experience a scale-in and scale-out operation within system **100**. Furthermore, steps **510** though **520** can execute concurrently with steps **522** though **548**.

At step **522**, MSW that is deposited at step **516** is sorted into piles, such as an MSW only pile, which can be placed at MSW staging area **124**, and recoverables only (e.g., wood or metal), which can be placed at recoverables staging areas **126**.

At step **524**, a transfer trailer **120** such as transfer trailer **120***a*, which is empty and ready for loading, is transported to an unoccupied loading bay **134** such as loading bay **134***a*. At step **526**, when transfer trailer **120***a* is transported to loading bay **134***a*, the information stored in its associated ID mechanism **330***a*, along with a timestamp, is captured. For example, for transfer trailer **120***a* at loading bay **134***a*, container ID mechanism **330***a* is scanned by reader **326***a*, when transfer trailer **120***a* is proximate reader **326***a*. Scanning can be manual or automatic. Subsequently, reader **326***a* transmits the data to computer **130** via reader interface **320**, and the data is stored in database **324**. At step **528**, transfer trailer **120***a* is loaded, preferably until substantially full with material from MSW staging area **124** or recoverables staging areas **126**.

At decision step **530**, if transfer trailer **120***a*, which is full, is not ready to be transported to a final disposal site, method **500** proceeds to step **532**. However, if transfer trailer **120***a*, which is full, is able to be transported to a final disposal site, method **500** proceeds to step **538**.

At step **532**, transfer trailer **120***a* is weighed on axle scale **328***a*, and the resulting scale data that indicates the "full" weight of transfer trailer **120***a* is transmitted via scale interface **318** to computer **130**, wherein a record of this transaction, which includes a timestamp, is stored in database **324**. Alternatively, in the event that system **100** does not include an additional scale **324**, such as an axle scale, transfer trailer **120***a* is transported to scale house **112** and weighed on scale **114**. The resulting scale data that indicates the "full" weight of transfer trailer **120***a* is transmitted via scale interface **218** to scale computer **212**, and then transmitted via network **140** to computer **130**, wherein a record of this transaction, which includes a timestamp, is stored in database **324**. More specifically, and in either case, the weight and ID data of transfer trailer **120***a* is timestamped and stored in database **324**.

At step **534**, transfer trailer **120***a*, which is filled with material from MSW staging area **124** or recoverables staging areas **126**, is transported from loading bay **134***a* and deposited at staging area **116**. At step **536**, when a transport vehicle (not shown) is available, full transfer trailer **120***a* is transported away from staging area **116** to a final disposal site.

At step **538**, transfer trailer **120***a* pulls onto scale **114**, and a scale-out operation is performed. More specifically, transfer trailer **120***a* is weighed on scale **114**, and the resulting scale data that indicates the "full" weight of transfer trailer **120***a* is transmitted to scale computer **212** and stored in database **324**. At substantially the same time, ID mechanism **330***a* can be read by reader **222**. This ID mechanism uniquely identifies transfer trailer **120***a*. ID data is transmitted via reader interface **220** to scale computer **212**. Subsequently, transfer trailer **120***a*, which is filled with material from MSW staging area **124** or recoverables staging areas **126**, exits the transfer site **110**.

At step **540**, data collected at step **532** or step **538** that is associated with transfer trailer **120***a* is transmitted from scale computer **212** to computer **130** via network **140**, and the record of this transaction, which includes a timestamp, is updated and stored in database **324**. At step **542**, transfer trailer **120***a* is transported away from the transfer site **110** to its final disposal site. At step **544**, transfer trailer **120***a* arrives at the final disposal site and the materials therein are emptied.

At step **546**, transfer trailer **120***a*, which has been emptied, is transported back to the transfer site **110**, and a scale-in operation is performed using scale **114**. More specifically, emptied transfer trailer **120***a* is weighed on scale **114**, and the resulting scale data that indicates the empty weight of transfer trailer **120***a* is transmitted to scale computer **212**. At substantially the same time, ID mechanisms, such as container ID mechanism **330***a*, can be scanned by reader **222**.

Alternatively, if the weight of a particular transfer trailer **120***a* is known in advance, the known weight can be used to determine the weight of material within the transfer trailer. Knowing the weight of a particular transfer trailer **120***a* in advance makes it unnecessary for such transfer trailers to be weighed after their contents are emptied. For example, suppose it is known that a transfer trailer **120***a* weighs 1.0 tons, and the transfer trailer **120***a* weights 6.2 tons when initially weighted. From this it can be assumed that transfer trailer **120***a* contains 5.2 tons of MSW (6.2-1.0), which will be deposited on MSW floor **122**.

At step **548**, data collected at step **546** that is associated with transfer trailer **120***a* is transmitted from scale computer **212** to computer **130** via network **140**, and the record of this transaction, which includes a timestamp, is stored in database **324**. Steps **522** though **548** can be performed for any number of transfer trailers **120**.

At step **550**, the transfer site **110** inbound tonnage and outbound tonnage is reconciled preferably, but optionally, on a continuous basis. More specifically, software **322** can use data stored in database **324** to maintain a running total of MSW waste tonnage deposited by collection vehicles **118** on MSW floor **122**, such as captured in step **520**, and waste tonnage departing MSW floor **122** of MSW transfer site **110** in all transfer trailers **120**, such as captured in step **548**.

On a preferably regular basis, software **322** queries database **324**, analyzes timestamps, and subtracts the tonnage of waste that is removed via multiple transfer trailers **120** from MSW floor **122** from the tonnage of waste that is dumped via multiple collection vehicles **118** at MSW floor **122**. In other embodiments, reconciliation can be triggered by predetermined events. For example, a reconciliation can be performed at a collection vehicle scale-out operation, or a transfer trailer **120** scale-in operation. In doing so, software **322** provides a running calculation of the net tonnage of waste that is present at MSW floor **122**, for reporting the status of MSW floor **122** at any given time.

Additionally, a digital image of MSW floor **122** is captured periodically, timestamped by camera **132**, and stored in a memory device, such as a hard disk drive (not shown), of computer **130**. As a result of method **500**, specific information to confirm compliance with clean floor regulations can be accessed and demonstrated at any time, which is illustrated in method **600** below.

Software **322** can also be used to track the amount of time that a transfer trailer **120***a* can remain at a transfer site **110**. For example, a scale-in and scale-out timestamps can be used to determine the time that collection vehicles **118** and transfer trailers **120** are at transfer site **110**, as shown in FIG. **4**.

More particularly, and referring again to FIG. **5**, a transfer trailer is transported to loading bay **134** at step **524**. At step **526**, the ID information of the transfer trailer **120** and a time stamp is transmitted to computer **130** and stored in database **324**. Transfer trailer **120** is then loaded with MSW at step **528** to be transported to a final disposal site. If a transport vehicle is ready to transport the transfer trailer **120**, the transport vehicle proceeds to the scale-out operation at step **538**, and the transfer trailer ID along with the timestamp of the operation is recorded and transmitted to computer **130**. Software **322** then calculates the time difference between the timestamps recorded at step **526** and step **538**, representing when loading began and when the scale out operation was performed, respectively. This time difference is stored in database **324** along with the transfer trailer ID and both timestamps.

If a transport vehicle is not available, the process for calculating the time at the transfer station is similar. One difference is that the transfer trailer **120** is temporarily moved to the staging area **118** as shown at step **532**, and remains there until a transport vehicle becomes available.

When a transport vehicle does become available, a scale-out operation is performed as shown at step **538**, and transfer trailer **120** is transported away to a final disposal site. Weight and timestamp information is transmitted to database **324**, and software **322** performs the same steps for calculating and storing the time difference as described above in connection with steps **526-540**.

The empty weight of transfer trailer **120** may also be determined by weighing before transfer trailer **120** is filled, or after transfer trailer **120** is emptied. The filled weight may be measured shortly after filling, and before entering staging area **116**, or shortly prior to transfer trailer **120** exiting system **100**.

FIG. **6** illustrates an exemplary flow diagram of a method **600** of tracking clean floor events. At step **610**, the system **100** inbound tonnage is calculated, using data captured at step **520**. More specifically, tracking software **322**, in combination with database **324** maintains a running total of all waste tonnage that is deposited via multiple collection vehicles **118** at MSW floor **122**.

At step **612**, the system **100** outbound tonnage is calculated by using data that is captured at step **540**. More specifically, tracking software **322**, in combination with database **324**, maintains a running total of waste tonnage departing MSW floor **122**, in multiple transfer trailers **120**.

At step **614**, transfer site **110** inbound tonnage and outbound tonnage is reconciled. Preferably on a regular basis, tracking software **322** queries database **324**, analyzes timestamps, and subtracts the tonnage of waste that is removed via multiple transfer trailers **120** from MSW floor **122** from the tonnage of waste that is dumped via multiple collection vehicles **118**. In doing so, software **322** provides a running calculation of the net tonnage of waste that is present at MSW floor **122**, which can be used to report the status of MSW floor **122** at any given time.

At decision step **616**, based upon the calculations of step **614**, if it is determined that the inbound tonnage and outbound tonnage are equivalent, method **600** proceeds to step **618**. Alternatively, based upon the calculations of step **614**, if it is determined that the inbound tonnage and outbound tonnage are not equivalent, method **600** returns to step **614**.

At step **618**, a clean floor event is recorded. More specifically, this event is recorded, time stamped, and stored in database **324**. Additionally, a digital image of MSW floor **122** can be captured and timestamped by camera **132** and stored in a memory device, such as a hard disk drive (not shown), of computer **130**. The timestamp allows the captured image to be correlated with the clean floor event stored in the database and retrieved if necessary to demonstrate compliance with regulations. Alternatively, the captured image can be stored in database **322** along with the recorded clear floor event and timestamp, using a database system with the capability to store binary objects, such as Microsoft SQL server. As a result, a report of all transactions that lead up to and achieve the clean floor event, along with the associated digital image that is taken at the moment of occurrence, is available upon request. At the completion of step **618**, the method returns to step **614**.

An example log that results from the calculations of steps **614**, **616**, and **618** is shown in FIG. **7**. FIG. **7** is an exemplary electronic log **700** that is generated on a given date (not shown) by software **322**. Data stored in database **324** is used by software **322** to perform calculations. More specifically, table **700** shows transactions, in chronological order, related to collection vehicles **118** and transfer trailers **120**.

In this example, table **700** shows LINEs **1** to **26**, each of which represents a transaction. For each transaction, SCALE IN data and/or SCALE OUT data is logged, as well as the resulting TRANSACTION NET WEIGHT for either a given collection vehicle **118** or a given transfer trailer **120**. Accordingly, a running total of TOTAL NET WEIGHT IN, TOTAL NET WEIGHT OUT, and OVERALL NET WEIGHT is calculated (e.g., in tons) and logged by use of tracking software **322** of transfer station tracking system **100**.

In this example, it is assumed that LINE **1** of Table **700** is the first transaction immediately following a clean floor event, which is defined as an OVERALL NET WEIGHT equal to zero tons on MSW floor **122**. Table **700** shows a running calculation, in chronological order, of the OVERALL NET WEIGHT, which is the TOTAL NET WEIGHT OUT (in tons) subtracted from the TOTAL NET WEIGHT IN (in tons). LINE **26** of table **700** shows an OVERALL NET WEIGHT equal to zero and, thus, LINE **26** indicates that a clean floor event occurs at 13:30 on the given date. As a result, a report of all transactions that lead up to and achieve the clean floor event, along with the associated digital image that is taken at the moment of occurrence (i.e., 13:30 in this example), is available upon request.

We claim:

1. A system for monitoring waste at a waste transfer station that includes a scale area and a municipal solid waste (MSW) floor, comprising:

a reader for reading at a scale area:

i) a first plurality of identifiers, each of the first plurality of identifiers storing a vehicle identifier associated with a respective plurality of waste collection vehicles;

ii) a second plurality of identifiers, each of the second plurality of identifiers storing a waste receptacle identifier associated with a respective plurality of waste receptacles;

a second reader for reading at the MSW floor:

at least one of the second plurality of identifiers associated with one of a plurality of waste receptacles,

a general purpose computer comprising a scale interface utilizing a data repository that stores:

iii) the read vehicle identifier associated with respective waste collection vehicles;

iv) the read waste receptacle identifier associated with respective waste receptacles;

v) a first plurality of values representing a weight difference, between a respective plurality of non-empty and substantially empty waste collection vehicles, at respective times within the waste transfer station, wherein the first plurality of values respectively correspond to a weight of material deposited within the MSW floor; and

vi) a second plurality of values representing a weight difference, between a respective plurality of substantially non-empty and substantially empty waste receptacles, at respective times within the waste transfer station, wherein the second plurality of values correspond to a weight of material removed from the MSW floor,

vii) the computer maintaining a running total by utilizing the weight differences at the respective times, in a time sequenced manner, to add each of the first plurality of values and subtract each of the second plurality of values from the first plurality of values, wherein the running total is calculated in real time; and further wherein a running total value of zero indicates that no material is within the MSW floor; and

at least one camera and video recording device configured to capture at least one image of the MSW floor when the running total value is equal to zero.

2. The system of claim **1**, wherein the at least one image is used to confirm that there is no or substantially no material within the MSW floor when the running total value is equal to zero.

3. The system of claim **1**, further comprising a scale located within the scale area and electronically configured to transmit the first plurality of values and the second plurality of values to the data repository.

4. The system of claim **3**, wherein the first plurality of values are transmitted from the scale to the data repository using at least one network.

5. The system of claim **3**, wherein the second plurality of values are transmitted from the scale to the data repository using at least one network.

6. The system of claim **1**, wherein the first plurality of identifiers comprise at least one of a radio frequency identifier (RFID) tag and a bar code.

7. The system of claim **1**, wherein the second plurality of identifiers comprise at least one of a radio frequency identifier (RFID) tag and a bar code.

8. The system of claim **1**, wherein the general purpose computer utilizes at least one read vehicle identifier associated with the respective waste collection vehicles to track the location of at least one waste collection vehicle.

9. The system of claim **1**, wherein the scale interface allows data from a scale to be transmitted to the general purpose computer.

10. The system of claim **1**, wherein the general purpose computer generates an instruction to reuse the respective waste receptacles determined to be substantially empty.

11. The system of claim **1**, wherein the general purpose computer generates a record of each transaction determining at least one of the first plurality of values and second plurality of values.

12. The system of claim **1**, further comprising a scale located within the MSW floor and electronically configured to transmit the second plurality of values to the data repository.

13. The system of claim **12**, wherein the second plurality of values are transmitted from the scale to the data repository using at least one network.

14. The system of claim **12**, wherein the at least one scale is an axle scale.

15. The system of claim **1**, wherein the system is adapted to track the interchange of the plurality of waste receptacles with an individual vehicle.

16. A computer program product residing on a computer readable medium for monitoring a waste at a waste transfer station that includes a scale area and a municipal solid waste (MSW) floor, the computer program product comprising instructions for causing a computer to:

store a plurality of vehicle identifiers associated with a respective plurality of collection vehicles, wherein the vehicle identifiers are read at the scale area;

store a plurality of waste receptacle identifiers associated with a respective plurality of waste receptacles, wherein the waste receptacle identifiers are in at least one of the scale area or the MSW floor;

determine a first plurality of values, at respective times within a MSW floor, representing a weight difference between a respective plurality of non-empty and substantially empty collection vehicles, wherein the first plurality of values respectively correspond to a weight of material deposited within the MSW floor;

determine a second plurality of values, at respective times within the MSW floor, representing a weight difference between a respective plurality of non-empty and substantially empty waste receptacles, wherein the second plurality of values respectively correspond to a weight of material removed from the MSW floor;

utilize the respective times in a time sequenced manner to determine a running total by adding each of the first plurality of values and subtracting each of the second plurality of values from the first plurality of values, wherein a running value of zero indicates that no material is within the MSW floor; and

store at least one image of the MSW floor when the running total value is equal to zero.

17. The computer program product **16**, wherein the at least one image is used to confirm that there is no or substantially no material within the MSW floor when the running total value is equal to zero.

18. The computer program product of claim **16**, wherein the plurality of vehicle identifiers are read by a reading device prior to being stored.

19. The computer program product of claim **16**, wherein the plurality of waste receptacle identifiers are read by a reading device prior to being stored.

20. The computer program product of claim **16**, further comprising instructions to track the interchange of the plurality of waste receptacles with an individual vehicle.

21. A computer-implemented method for determining a quantity of waste within a waste transfer station that includes a municipal solid waste floor (MSW) floor, comprising:

a) storing at a first time a first collection vehicle weight and a collection vehicle identifier in a data repository;

b) depositing a waste content of the collection vehicle within the MSW floor;

c) storing in the data repository at a second time a difference between the first collection vehicle weight and a second collection vehicle weight determined subsequent to step b);

d) storing at a third time a first waste receptacle weight and a waste receptacle identifier in the data repository;

e) depositing waste content within the municipal solid waste floor into the waste receptacle;

f) storing in the data repository at a fourth time a difference between a second waste receptacle weight determined subsequent to step e) and the first waste receptacle weight;

g) repeating steps a)-c) and steps d)-f) until a time-sequenced running total of the weight difference in step c) minus the weight difference in step f) is equal to zero; and

h) recording and storing at least one image of the MSW floor when the running total of the weight difference in step c) minus the weight difference in step f) is equal to zero.

22. The computer-implemented method of claim **21** wherein the difference between the first collection vehicle weight and the second collection vehicle weight is electronically transmitted to the data repository.

23. The computer-implemented method of claim **21** wherein the difference between the second waste receptacle weight and the first waste receptacle weight is electronically transmitted to the data repository.

24. The computer-implemented method of claim **21**, wherein the at least one image is used to confirm that there is no or substantially no material within the MSW floor when the weight difference in step c) minus the weight difference in step f) is equal to zero.

25. The computer-implemented method of claim **21**, further comprising using a difference between the fourth time and the third time to determine a length of time that waste receptacle has been in the vicinity of the MSW floor.

26. The computer-implemented method of claim **21**, further comprising tracking the interchange of a plurality of waste receptacles with a particular vehicle.

* * * * *