A New Research Project/Agenda: Revisiting Waste Management Planning Concepts within the Context of Urban Transformations

Dr. Ahmed Gaber

Professor of Chemical Engineering,

Faculty of Engineering, Cairo University

November 5, 2018

Purpose Statement

- **Four planning concepts have been developed by the author to facilitate and establish solid waste master planning in Egypt. The concepts are presented in the next slide.**
- **The transformative action fields in cities have been discussed in the book "Humanity on the Move: Unlocking the Transformative Power of Cities" and shown on next slide.**

The purpose of this work is to initiate and frame a New Research Project aiming at extending the four solid waste planning concepts to integrate the transformative action fields in cities.

The Four Concepts, A Gaber 2017

Concepts		Brief Description
1	Service Provision Area (SPA)	A defined area in which all types of solid waste are generated, stored, and collected for transfer outside the area boundaries
2	Service Provision Plan (SPP)	A planning methodology to define the supply chain and value chain components for (1) waste community level collection & management, (2) waste transfer & transport, (3) waste processing and (4) waste disposal.
3	Resource Recovery Ladder (RRL)	A planning concept which allows for gradual improvement in resource recovery to maximize material and energy recovery from the collected waste.
4	Waste Management Breakdown Structure (WBS)	A planning methodology for clustering solid waste projects during the execution phase and operation phase.

Transformative Action Fields in Cities

Internationally discussed fields:

1. Decarbonization, energy and mitigation of climate change

2. Mobility and transport

3. Urban form

4. Adaptation to climate change,

5. Poverty reduction and socio-economic disparities

Fields that are given too little attention:

1. Urban land use

2. Materials and material flows

3. Urban health

Source :German Advisory Council on Global Change, Humanity on the Move: Unlocking the Transformative Power of Cities, 2016

Presentation Outline

Concept 1: Service Provision Area (SPA)

Concept 2: Service Provision Plan (SPP)

Concept 3: Resources Recovery Ladder (RRL)

Concept 4: Waste Management Breakdown Structure WBS

Concept 1: Service Provision Area (SPA)

Concept 1: Service Provision Area (SPA)

Population in each SPA is around 300,000

Each SPA has the following main characteristics:

- Urban structure
- Demographical structure
- Sociocultural characteristics
- Waste generation rate and composition
- Waste handling practices (informal and formal sectors)
- Waste management infrastructure

On the operational level, each SPA is subdivided into a number of "Zones". This is required for contractual and control reasons.

"شركة السبعين" للجمع والنقل تتعامل مع حوالي ٢٠ ألف وحدة سكنية، تولد حوالي ٧٠ طن/اليوم (بافتراض معدل التولد ٧، كجم/فرد/يوم

Concept 1: Service Provision Area (SPA)

Approximate Mixed MSW Generation: 200 ton/day

Basic Data	Existing MSW Management System	Other Wastes	Financial
• Location • Area • Population projections • Roads and transportation • Waste sources **(see next slide)**	• On-site storage • Collection system • Transportation system • Transfer stations • Treatment facilities • Temporary disposal sites • Sanitary landfill site • Existing accumulations	• Medical wastes • Industrial non-hazardous waste • Green waste • Construction/ demolition waste • Hazardous waste • Electronic waste	Cost of service: • Formal sector • Informal sector

Classification of Waste Generated from a Typical SPA

No.	Waste Source	Typical facilities and activities generating wastes in SPAs
1	**Residential**	Includes single and multi-story houses and high density apartments. Type of solid waste includes: food waste, rubbish, ashes and special wastes.
2	**Commercial**	Includes stores, restaurants, markets, office building, hotels, medical facilities etc. Type of waste includes food waste, rubbish, ashes, demolition and construction wastes, hazardous wastes.
3	**Institutional**	Schools, hospitals, police stations, governmental centers etc. Waste similar to residential and commercial is produced in these establishments.
4	**Municipal**	The term Municipal Solid Waste (MSW) is used for mixed or source-separated waste generated from residential, commercial and institutional facilities
5	**Industrial**	Generated from repair shops, gas stations, small industries. Typical small industries include: clothing, furniture, printing, leather, food. Type of waste includes MSW, hazardous wastes and industrial non-hazardous waste
6	**Open Areas**	Includes streets, vacant lots, play grounds, beaches, recreational areas etc. Type of waste includes special waste and rubbish.
7	**Inner-city utilities**	It includes water and wastewater pumping stations and Scalping plants . Waste is principally composed of screenings, residual sludge and other minor components.
8	**Green areas**	It includes biomass generated from parks, gardens, urban agriculture, trees trimmings

MSW Categories and Characterization

Secondary categories	Primary categories
1. Food waste 2. Yard waste 3. Other Biodegradable	1. Organics
4. Untreated 5. Treated	2. Wood
6. High gloss paper/card and wallpapers 7. Paper/ card - packaging 8. Newspapers	3. Paper
9. PETE 10. HDPE 11. Low quality plastics 12. Other hard plastics	4. Plastics
13. Clear Glass Container 14. Color Glass Container 15. Miscellaneous Non Packaging Glass	5. Glass
16. Clothes (Synthetic) 17. Clothes (Non-synthetic) 18. Non-clothing textiles	6. Textiles
19. Ferrous Packaging 20. Non-ferrous Packaging 21. Miscellaneous Ferrous and Non-ferrous	7. Metals
22. Batteries/ Accumulators 23. Miscellaneous hazardous waste	8. Hazardous
24. Composite /Complex packaging 25. Composite/ Complex Non-packaging	9. Composite
26. waste of electrical and electronic equipment	10. Mixed WEEE
27. Soil, Stones and other inerts	11. Inert
28. Household health care	12. HH Medical
29. <10mm	13. Fine particles
30. Liquid leftover and leachate	14. Liquids

Particle size classes

- >77 mm
- 55-77 mm
- 14-55 mm
- <14 mm

A. Chem. Composition

1. Carbone, 2. Nitrogn
3. Hydrogen, 4. Oxygen
5. Sulphur, 6. Chlorine
7. Phosphorous,
8. Heavy Metals
9. HHV, 10. TOC, 11. TIC
12.Water content, 13. Ash

The type and intensity of land uses – especially at the ground level – along with other community characteristics will determine the quantity of MSW generated, its categories and characterization.

Service Provision Areas (SPAs): National Level

Number of SPAs in all Governorates: 300

Approximate Mixed MSW national daily generation: 60,000 ton/day

Approximate Mixed MSW annual generation: 22 million ton/year

Number of SPAs in Cairo Governorate: 31

Number of SPAs in Giza Governorate: 26

SPAs-based MSW infrastructure national needs*			
Number of SPAs	**Number of transfer stations/material recycling facilities**	**Number of treatment plants**	**Number of sanitary landfills**
300	**300**	**150**	**50**

* New cities are not included

Concept 2: Service Provision Plan (SPP)

Concept 2: Service Provision Plan (SPP): Scope

The Service Provision Plan specifies “WHAT” to be done, “HOW”, ”WHEN”, “BY WHOM” and “AT WHAT COST” regarding four steps in MSW management: (1) Community level collection, (2) Transfer and Transport, (3) Treatment and Recycling and (4) Final Disposal.

Waste Generation and Community-Level Management

Waste Transfer and Transport

Waste Processing

Waste Disposal

Service Provision Plan (SPP): Functions

The Service Provision Plan divides all works and waste management related activities into four geographically separated FUNCTIONs (Fs). Each function specifies the technology applied and the associated management system.

Waste Generation and Community-Level Management

Waste Transfer and Transport

F2

Waste Processing

F3

Waste Disposal

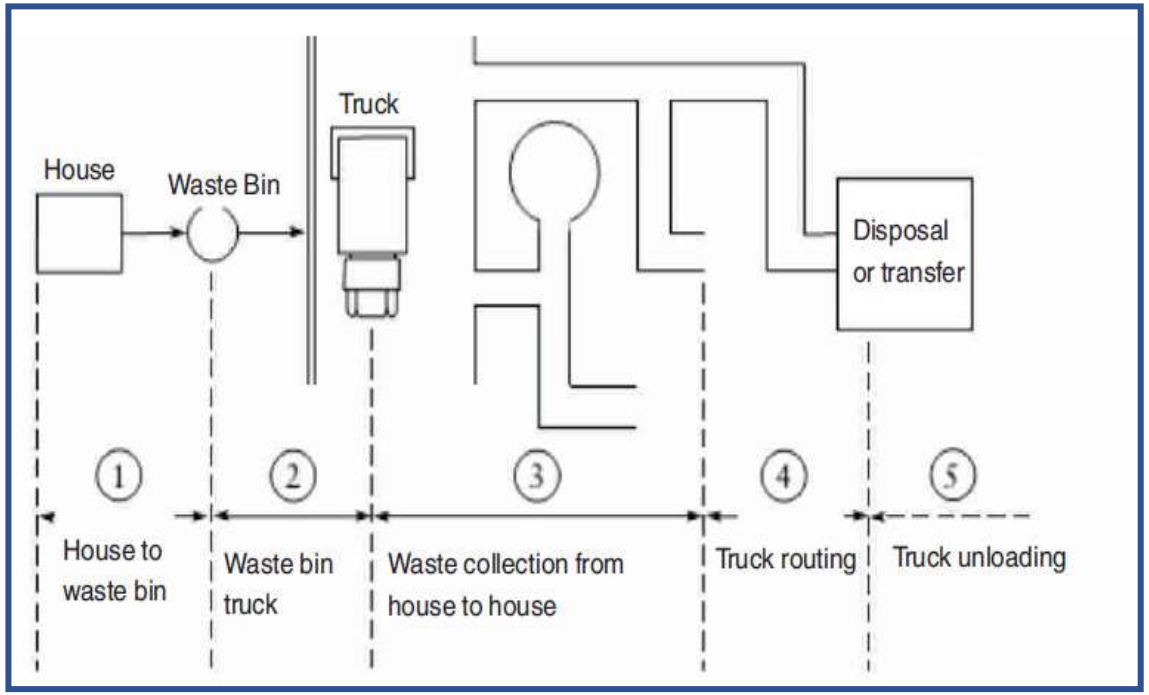
F4

F1

Function1: Waste Generation and Community-Level Management

Waste collection system defines: types of container, frequency of collection, types of collection services and routes as well as its user acceptance.

Most important for the design of a MSW collection system in SPA are: population, quantities of waste generated, waste composition, climate conditions, existing waste treatment facilities, public waste storage/disposal behavior, end product utilization, funding



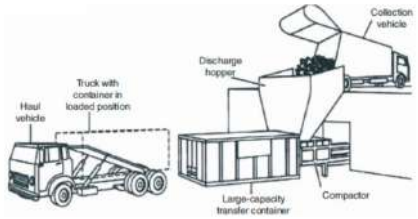
F2

Function2: Waste Transfer and Transport

Transfer and transport refers to the means, facilities and equipment used to affect the transfer of waste from one location to another (usually to more distant location).

Typically, the waste from relatively small collection vehicle is transferred to larger vehicle and is transported to distant location for safe disposal or further processing.

Transfer stations



Material Recycling Facilities: Dirty, Clean and Hybrid



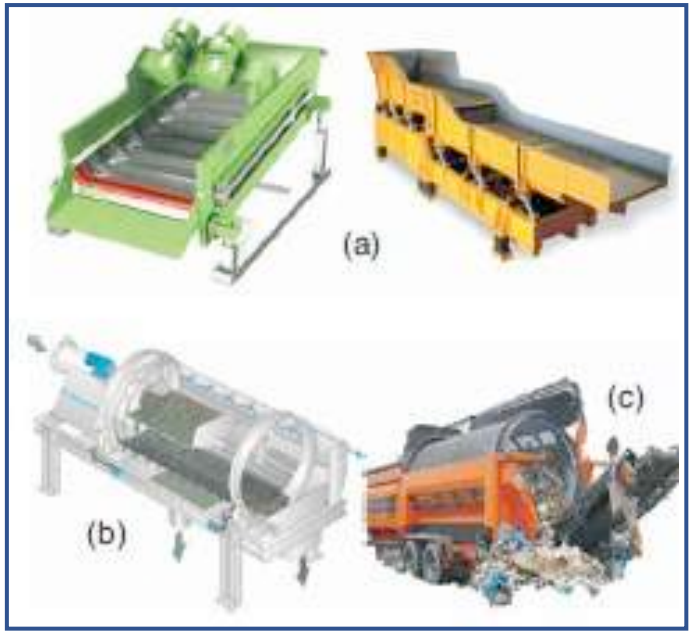



F3

Function3: Waste Processing

Waste Processing for Efficiency Improvement:

- Densification
- Mechanical Shredding
- Component Separation
- Moisture Reduction



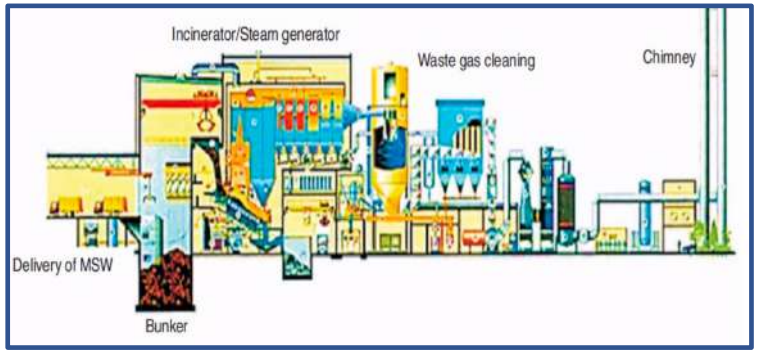
(a) Vibrating screens, (b) Rotary drum screen, © Trommel screen

Waste Processing for Material Recovery:

- Recovery of recyclables
- Recovery of the Energy Rich Fraction (ERF)
- Recovery of the biodegradable fraction in the form of compost

Waste Processing for Energy Production:

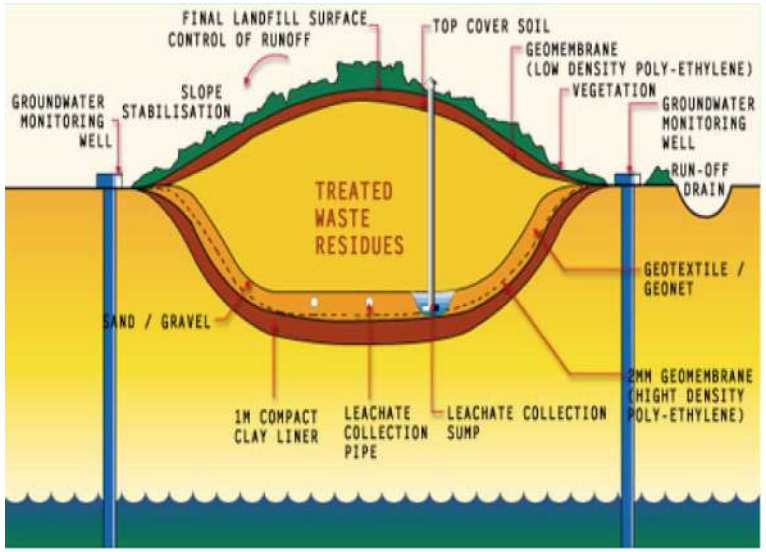
- Incineration
- Pyrolysis
- Bio-digestion



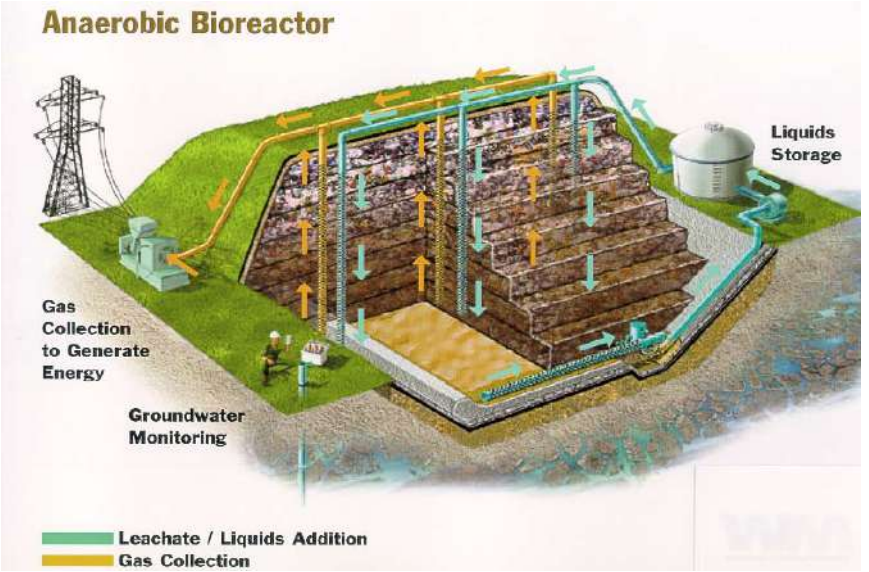
F4

Function4: Waste Disposal

Waste disposal deals with the safe containment of the untreated municipal solid waste, rejected materials coming from the composting facilities, material recovery facilities (MRF) and incineration facilities etc. Rejected or residual materials are those which cannot be recycled.



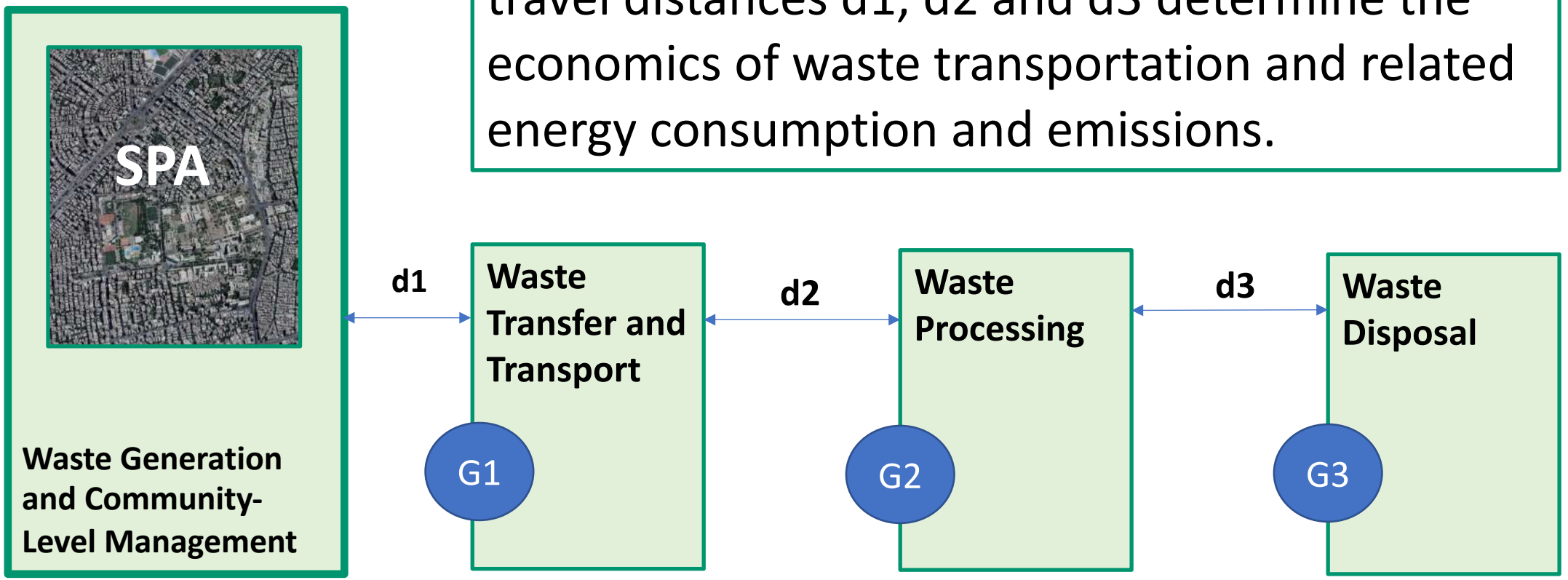
Source: Seoul National University; Design, operation and management of solid waste landfills; Laboratory of waste management and resource recirculation



Source: Don Davies Stantec Consulting Ltd.; 2010; Sustainable landfill biocell

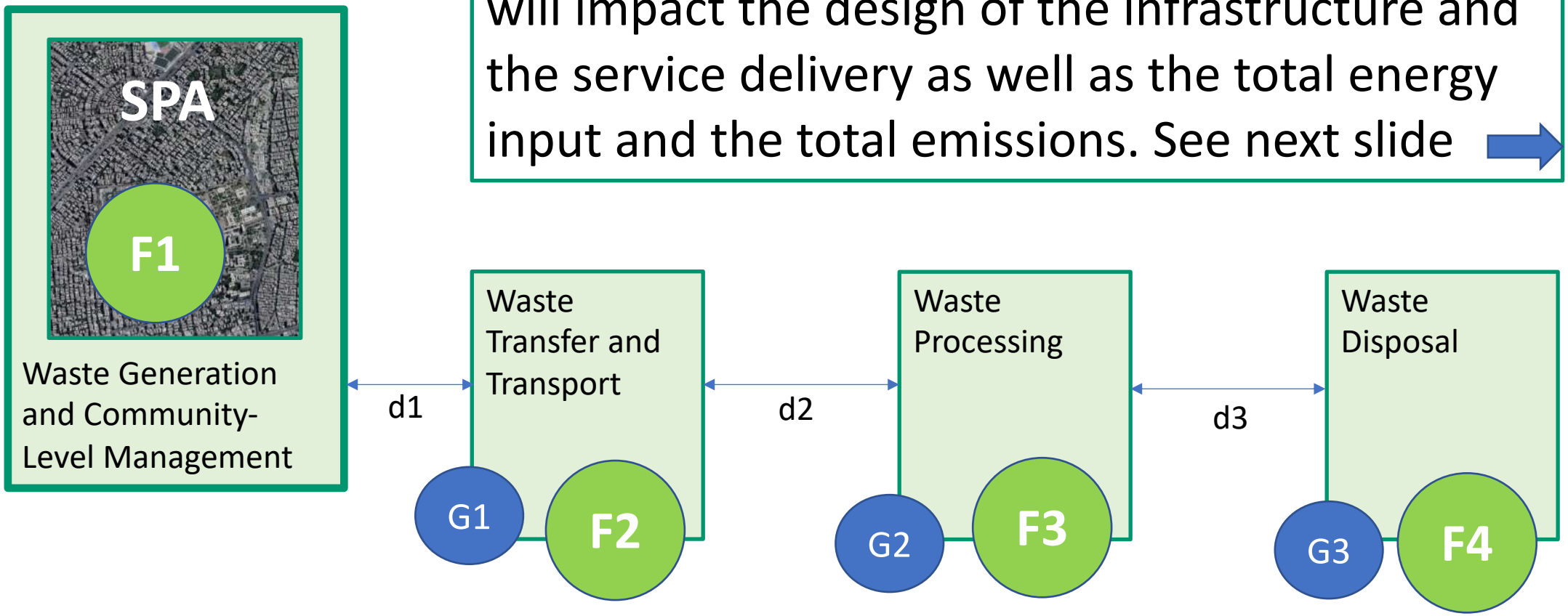
Service Provision Plan (SPP): Gates

The SPA specifies three Gates (Gs). The Gate concept is needed for contractual reasons. The travel distances d1, d2 and d3 determine the economics of waste transportation and related energy consumption and emissions.

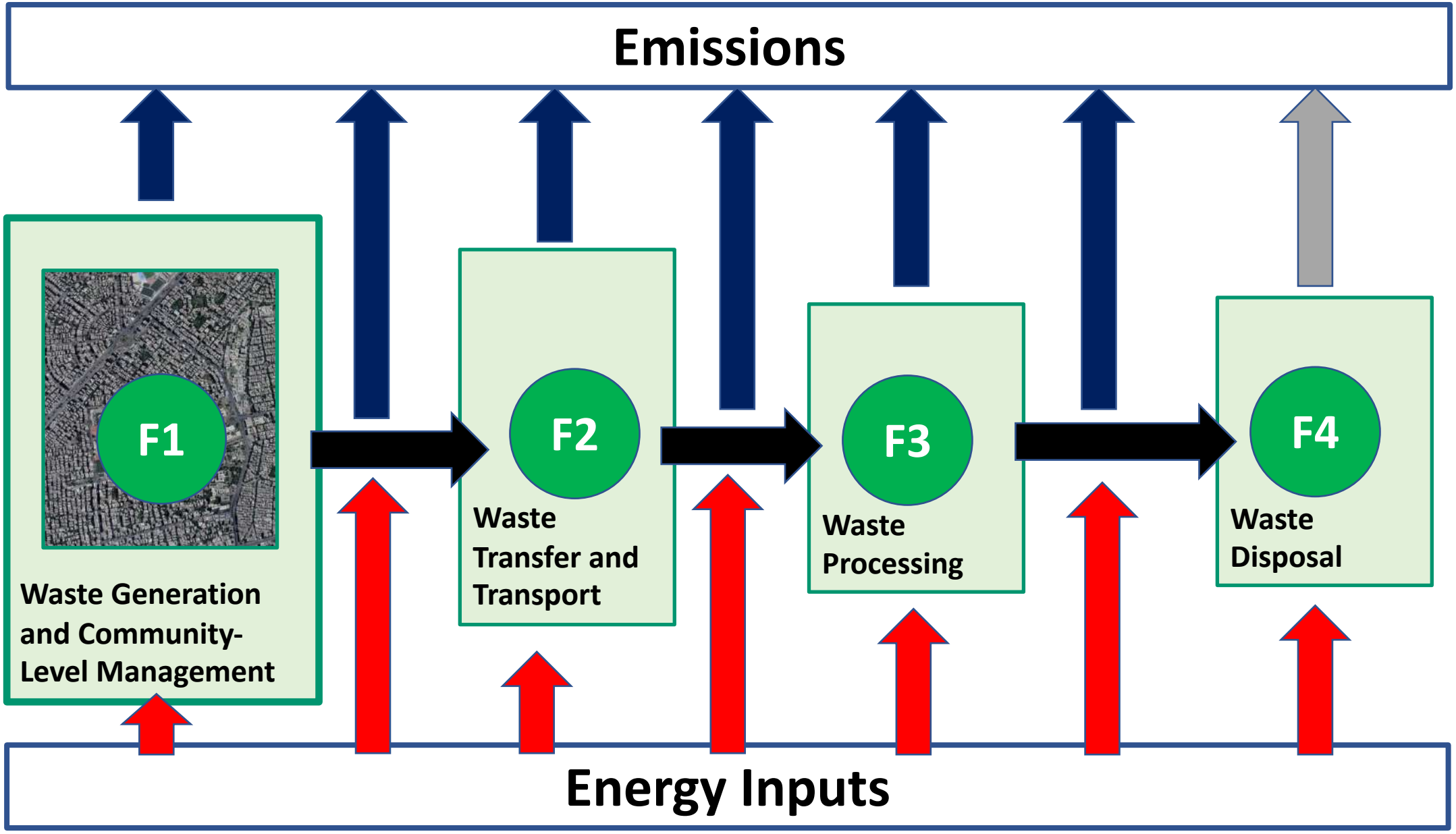


Service Provision Plan (SPP): Technology Combination

There are a wide range of technology options. The selection of the technology combination will impact the design of the infrastructure and the service delivery as well as the total energy input and the total emissions. See next slide



Service Provision Plan (SPP): Energy Inputs and Emissions



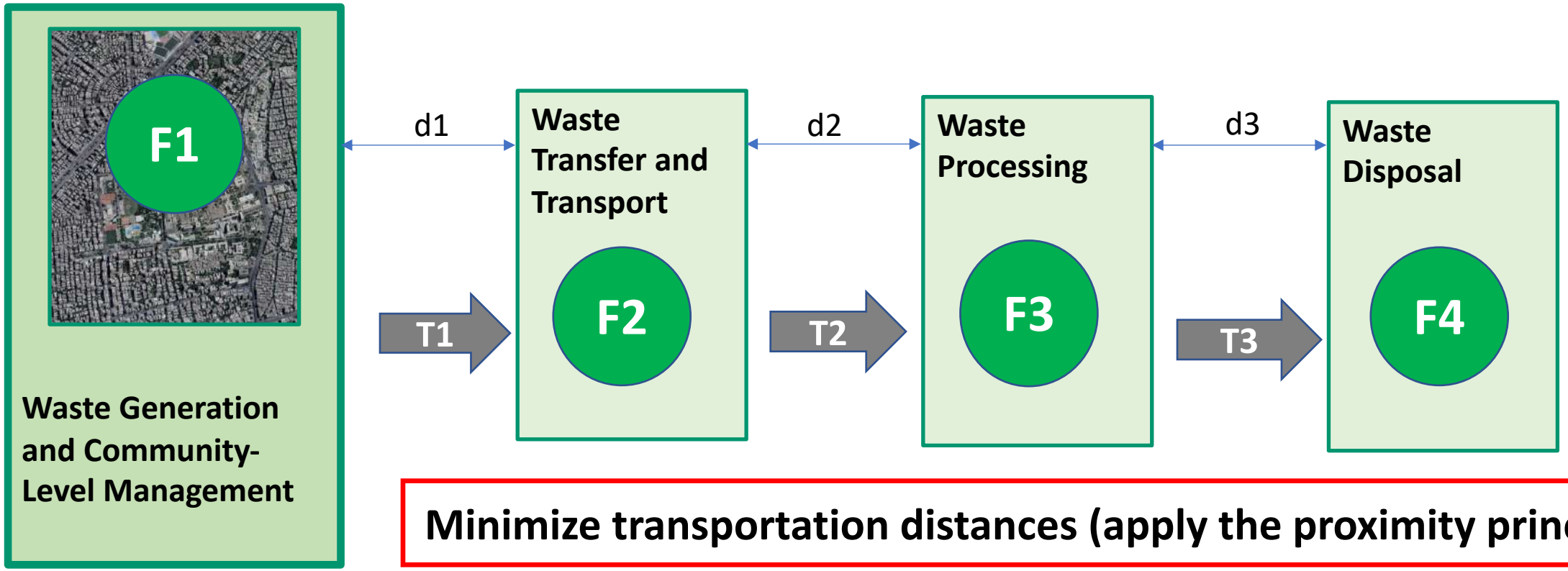
Service Provision Plan (SSP) – Urban Transformation Perspective

- Waste reduction program
- Source segregation program

- Recovery of recyclables
- Recovery of the ERF

Conversion of the OFMSW to Energy and liquid fertilizer

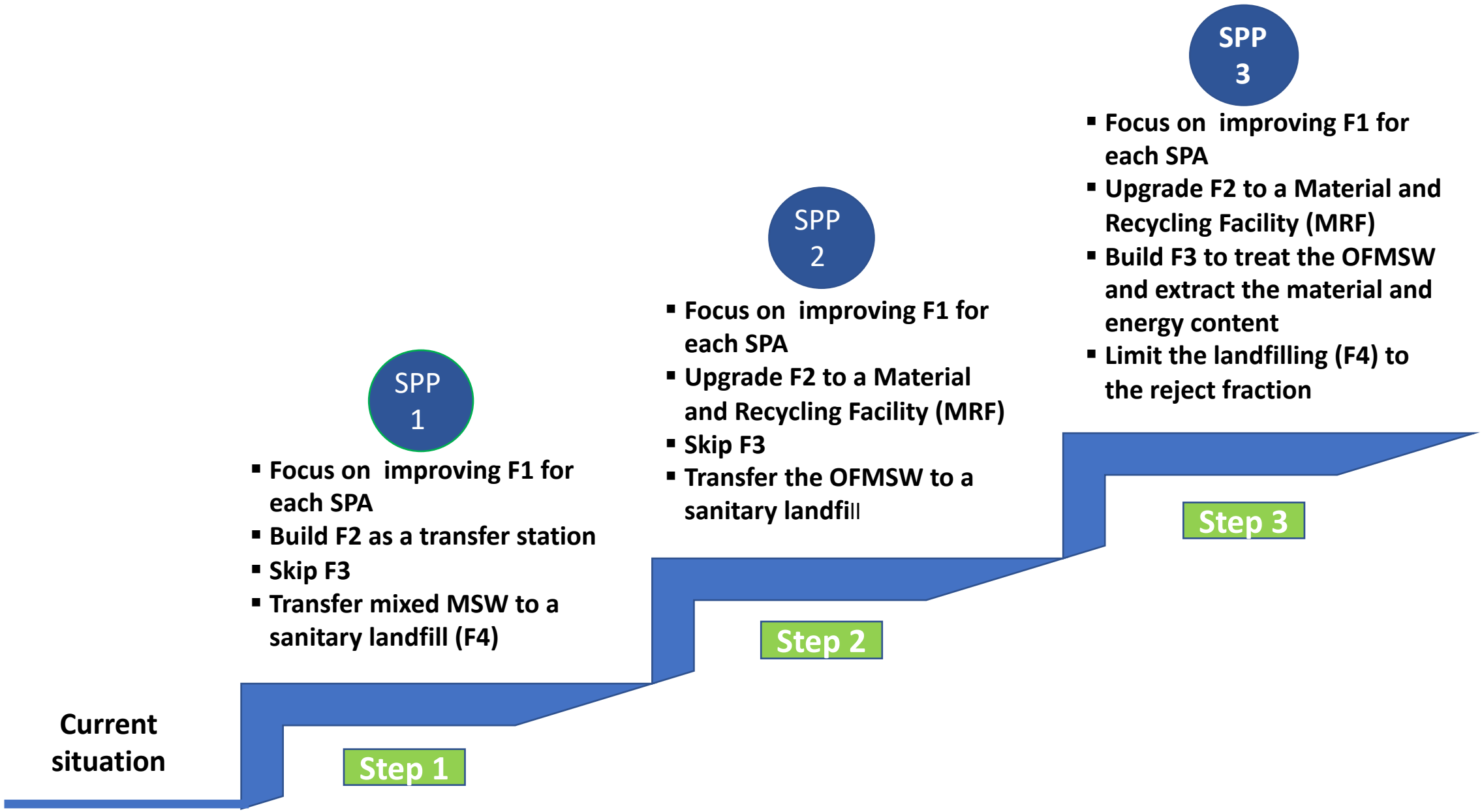
Minimization of Landfilling (to be limited to the reject fraction)



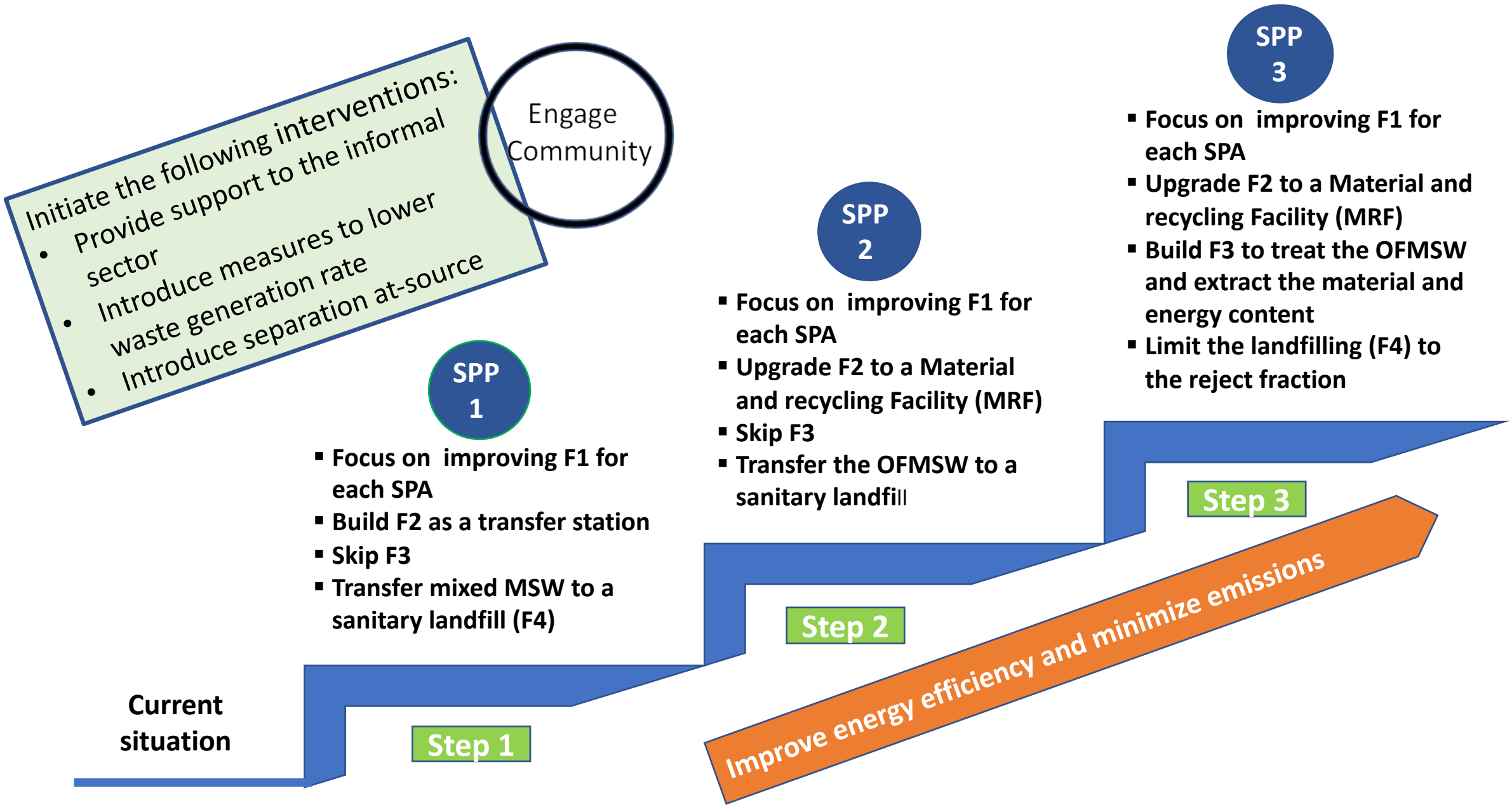
Minimize transportation distances (apply the proximity principle)

Concept 3: Resource Recovery Ladder (RRL)

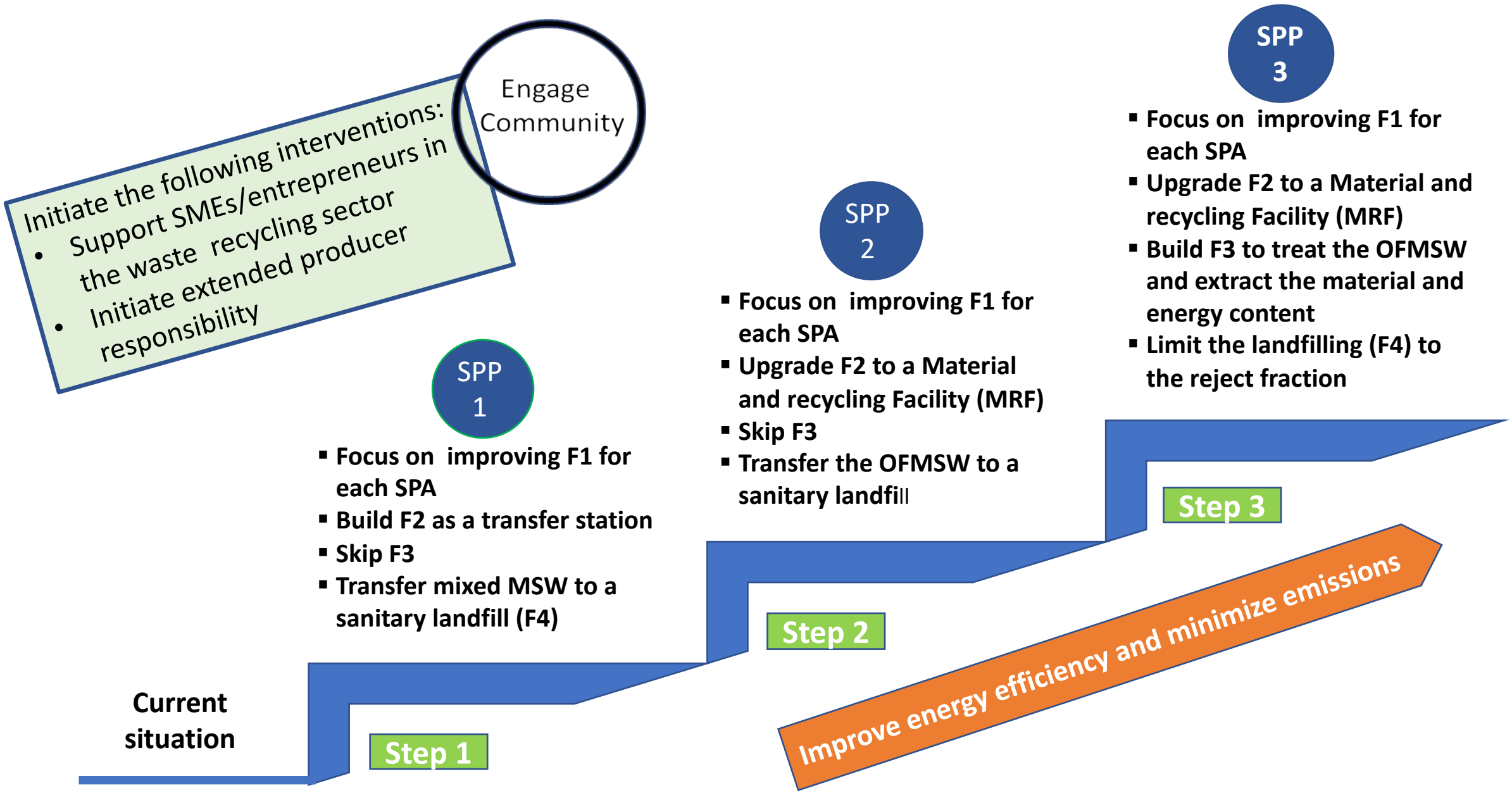
Resources Recovery Ladder (RRL)



Resources Recovery Ladder (RRL)



Resources Recovery Ladder (RRL)



Integration of RRL into SPP design: Service Provision Plan 1

F1

- Waste collection
- Primary storage
- Street sweeping
- Primary transportation

Mixed MSW

G1

F2

Transfer Station

Mixed MSW

G3

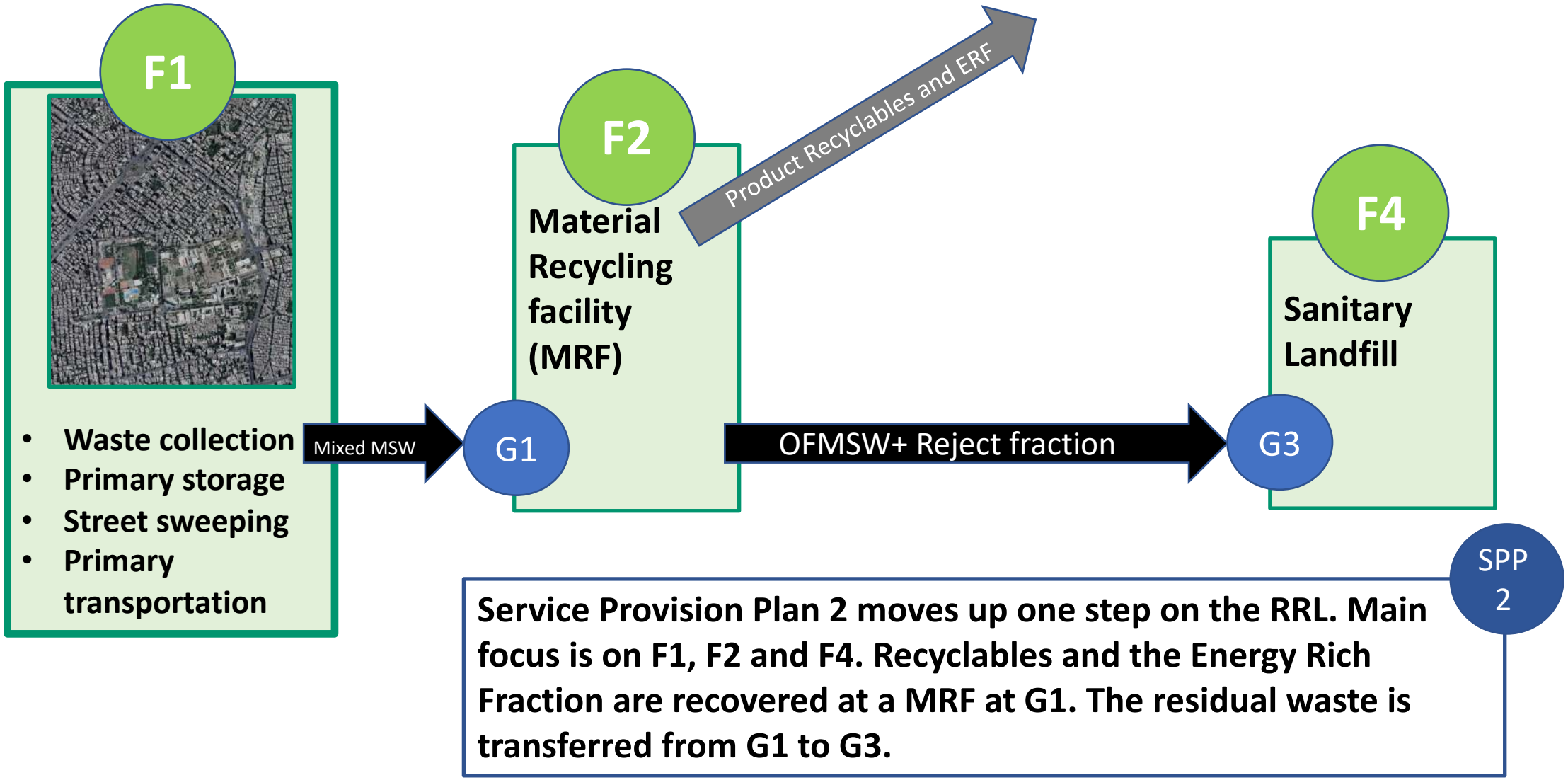
F4

Sanitary Landfill

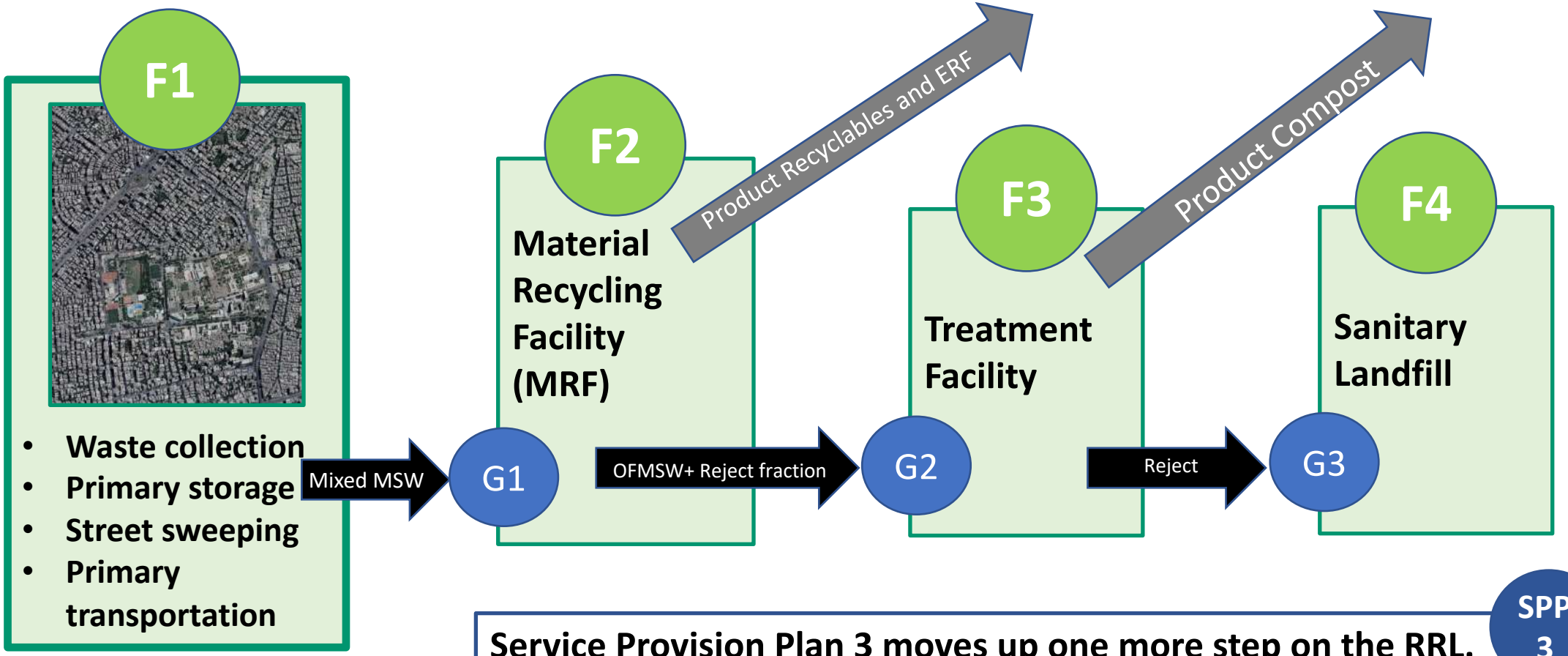
SPP 1

Service Provision Plan 1 starts at the bottom of the RRL. Sorting and recycling are left to the informal sector. Main focus is on F1 improvements and F4. Mixed MSW is transferred to a central sanitary landfill (G3) which is designed to accept waste collected from 6 SPAs.

Integration of RRL into SPP design: Service Provision Plan 2



Integration of RRL into SPP design: Service Provision Plan 3



SPP 3

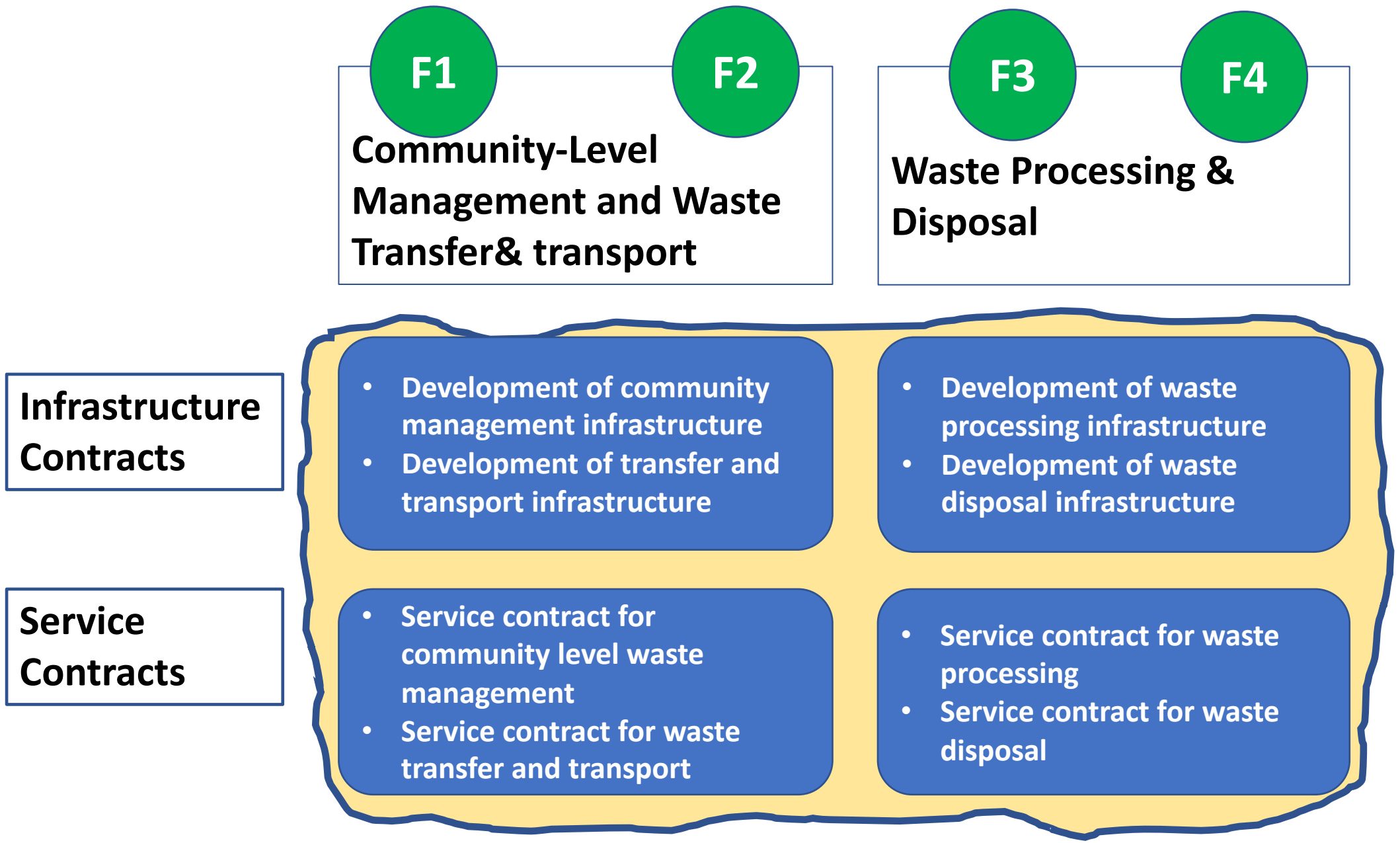
Service Provision Plan 3 moves up one more step on the RRL. Waste processing at G3 is established to utilize the OFMSW via different processes to recover the energy content and/or the biodegradable fraction in the form of compost. The major achievement is to limit landfilling at G3 to the reject fraction.

Concept 4: Waste Management WBS

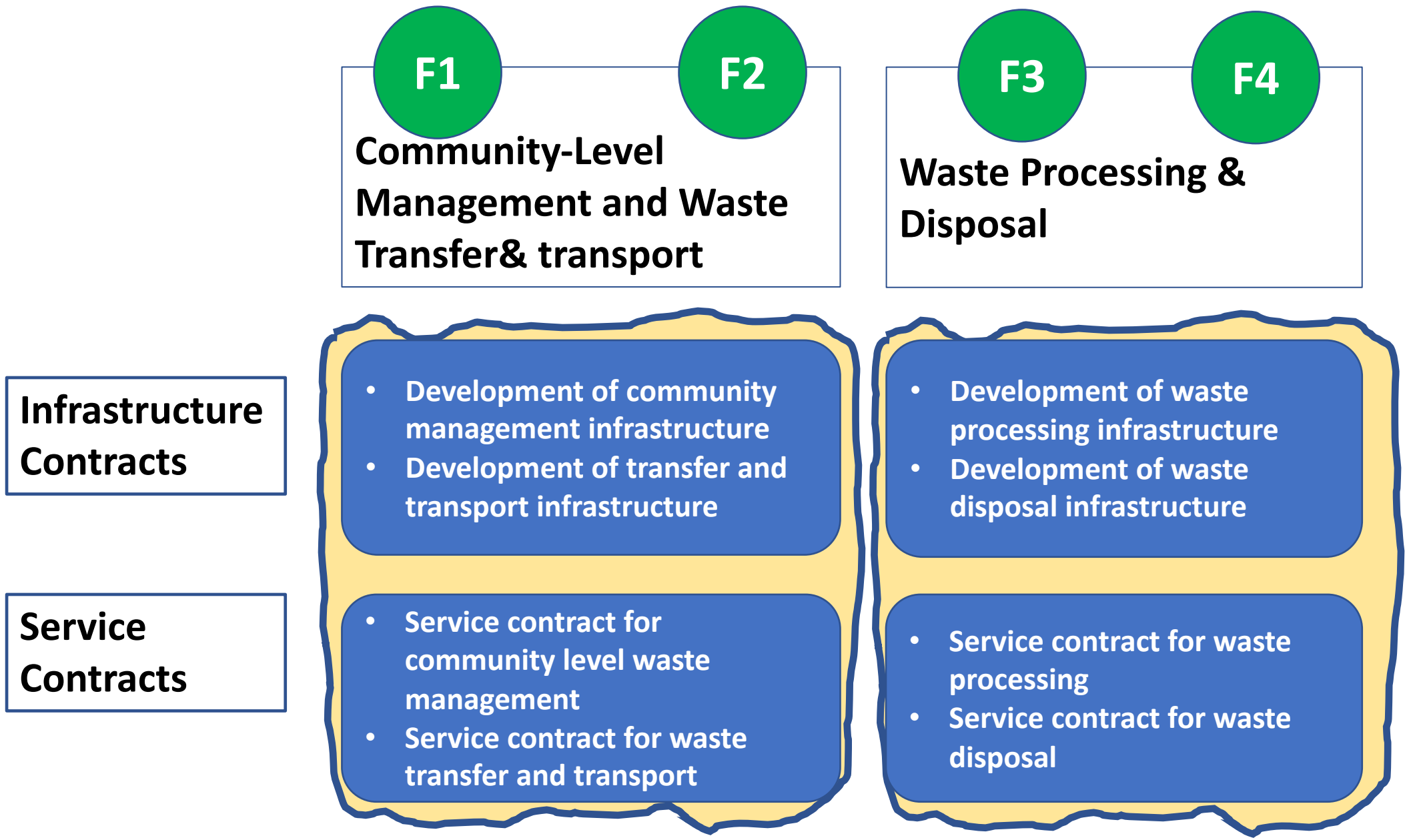
Work Breakdown Structure (WBS)

	F1	F2	F3	F4
	Community-Level Management and Waste Transfer& transport		Waste Processing & Disposal	
Infrastructure Contracts	• Development of community management infrastructure • Development of transfer and transport infrastructure		• Development of waste processing infrastructure • Development of waste disposal infrastructure	
Service Contracts	• Service contract for community level waste management • Service contract for waste transfer and transport		• Service contract for waste processing • Service contract for waste disposal	

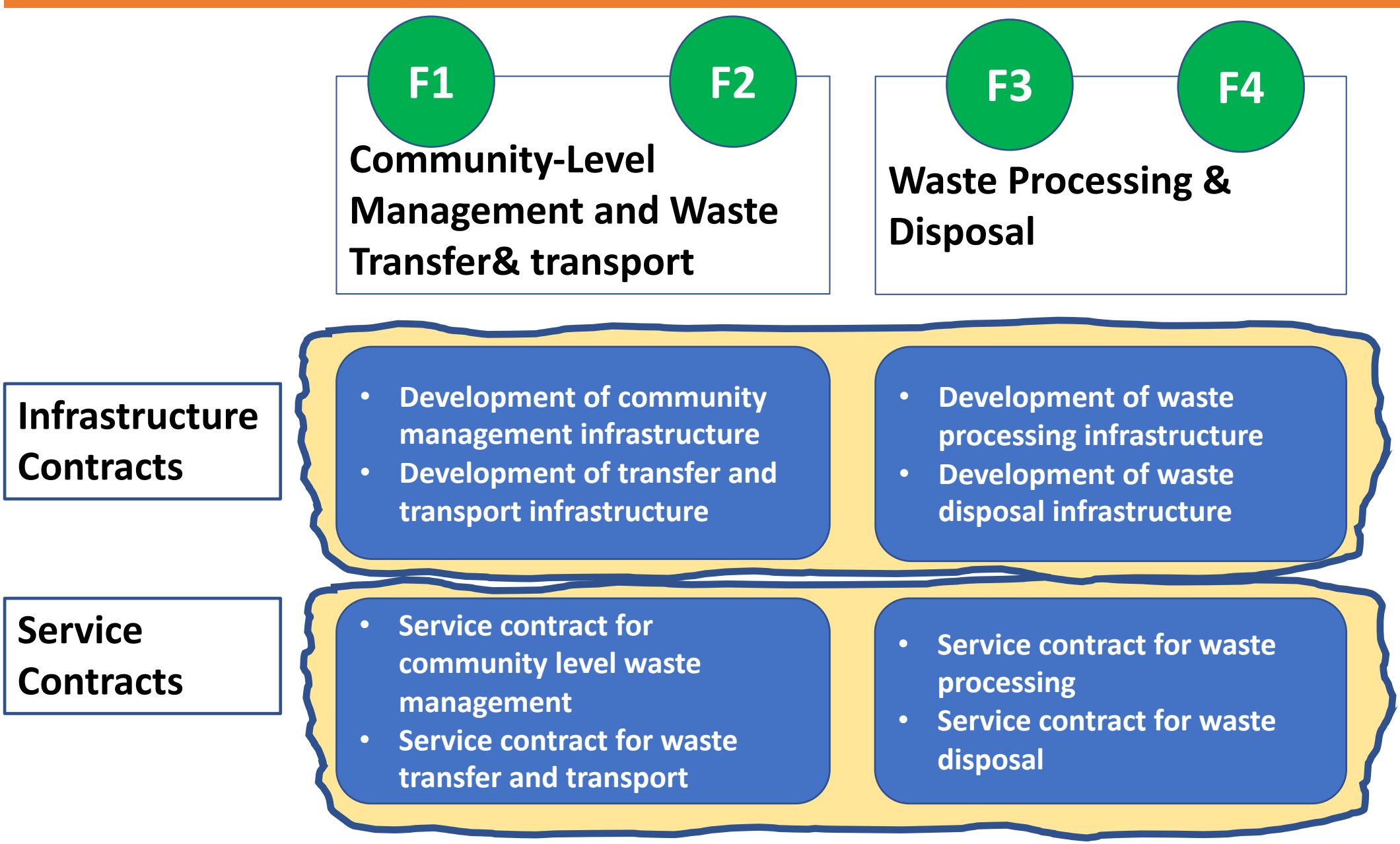
SPP-One contract approach



SPP-Two Contracts Approach (vertical)



SPP-Two Contracts Approach (horizontal)



Concluding Remark: A New Research Project

The Four Concepts, A Gaber 2017	
1	Service Provision Area (SPA)
2	Service Provision Plan (SPP)
3	Resource Recovery Ladder (RRL)
4	Waste Management Breakdown Structure (WBS)

Transformative Action Fields in Cities	
1	Decarbonization, energy and mitigation of climate change
2	Mobility and transport
3	Urban form
4	Adaptation to climate change
5	Poverty reduction and socio-economic disparities
6	Urban land use
7	Materials and material flow
8	Urban Health