

APPENDIX E

Best Management Practices Technology Effectiveness

| Applicable BMP Technologies - Description | Removal Efficiency Rating for Total Metals (1) | Performance Data Indicating CTR Concentrations Will be Achieved | Removal Efficiency Rating for Bacteria (1) | Removal Efficiency Rating for Sediment (1) | Watershed Characterization Implementation Issues | Relative Capital Costs | Relative O&M Costs | Retain BMP for Watershed Implementation Plan |
|---|--|---|--|--|--|--|---|--|
| 1. Adsorption/Ion Exchange – Granular Activated Carbon – Treatment Train – Equalization Basin to a Screen or Filter Bag to a Granular Activated Carbon (GAC) column fed by gravity | High | Data on the effectiveness of this technology for storm water applications is limited. Due to potential clogging and interferences from organic material, the efficiency of the GAC column may be reduced and outflow concentration may not meet CTR. | Medium GAC may promote consider-able microbial growth on carbon surface | Medium | Highly developed setting reduces lower cost opportunities to install this technology. Sufficient Public lands that are close to discharge points are only available in upper watersheds. Limited installation possibilities between the outfall and the Receiving waters. Remaining options are to locate systems within residential and commercial areas requiring buy-out of private property. | High Rated high compared to Retention Basin but provides greater benefit in reducing pollutants | High Spent GAC media may be considered hazardous waste | Yes Treatment system requires pretreatment and equalization through a retention-sedimentation basin. A smaller “package” treatment system may be applicable for small (<10acres) drainage area and design storm of 0.5 in. Larger drainage areas and storm events will require large areas for equalization and pretreatment. Regulatory issues will restrict placement of these systems above the outfalls on private lands or available public lands to which the storm flows will need to be conveyed, and potentially pumped. Reduction of flows through Low Impact Development has limited application due to built-out status of the watershed. |
| 2. Equalization, Chemical Precipitation Treatment (Sodium Sulfide) and Sand Filter – This is a chemical treatment process that includes equalization in a basin or vault followed by a treatment process of pH adjustment, precipitation, clarifier, and removal of fine particles using a sand filter prior to discharge into the receiving waters. | High | Data on the effectiveness of this technology for storm water applications is currently not available. This is an effective chemical treatment process that can meet the CTR concentrations for constant flows with consistent characteristics. The high variability of storm water flows and constituent concentrations may limit the effectiveness of this treatment system. | Medium | Medium | Same issues of developed setting as Technology No. 1. | High Not rated in Caltrans Guidance document – Treatment system will be high capital cost | High Sludge may be considered hazardous waste | Yes Treatment system has not been applied to storm water applications which are infrequent and highly variable. System will require trained operator, although some of the system can be automated. Effectiveness of this process requires continuous operation, which is not the case for periodic and variable storm flows. See Technology No. 1 regarding space constraint issues for equalization and pretreatment. |
| 3. Adsorption/Ion Exchange – Granular Activated Carbon (GAC) or Ion Exchange (IX) Media w/ Detention Sedimentation BMPs – Treatment Train – Storm water enters mixing chamber with GAC or IX media and then flows to sedimentation basin and finally filtration chamber | High | The effectiveness of this technology on storm water applications is dependent on volume of flows that are required for treatment. In order to allow sufficient mixing/ contact with GAC or IX, the flow needs to be controlled. This BMP may not meet CTR at higher flows where less contact would occur. | Medium | Medium | Same issues of developed setting as Technology No. 1. | High Rated high compared to retention basin but provides greater benefit in reducing pollutants | High | Yes See Technology No. 1 regarding space constraint issues for equalization and pretreatment. |
| 4. Adsorption/Ion Exchange – GAC Sandwich Filter and Blanket w/ Pretreatment Detention Sedimentation BMPs or Chemically Enhanced Detention Basin (CEDBs) – Storm water flows to Equalization / Detention Basin then to Filter Chamber/ Bed composed of GAC or IX underlain by a Sand Filter separated by Geotextile – discharge from Underdrains below Sand Filter. This system can be modified to incorporate these two steps into one CEDB if sufficient larger sediment is removed prior to entering CEDB to reduce clogging of the filter and treatment media. | High | The effectiveness of this BMP on storm water flows is in the pilot testing stage. Results reported by Caltrans and the Navy on pilot projects using activated alumina indicate technologies is effective in significantly reducing dissolved metals. The effectiveness of the BMP in meeting the CTR concentration will depend on the level of maintenance of the filter system which would be prone to clogging. Use of geotextiles can reduce clogging and O&M but relative O&M costs will be high. | Medium GAC may promote microbial growth | Medium | Same issues of developed setting as Technology No. 1. | High Rated high compared to retention basin but provides greater benefit in reducing pollutants | High Frequent clogging and short bedlife require high O&M Spent GAC / IX may be hazardous waste | Yes See Technology No. 1 regarding space constraint issues for equalization and pretreatment. |

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| 5. Adsorption/GAC or IX Sandwich Filter and Blanket w/ Pretreatment Detention Sedimentation using Plate and Tube Settlers - Similar technology to Item #3, but retention/sediment basin can be a vault or chamber that uses parallel plates or inclined tube to can increase sedimentation in smaller space | High | Same as Item #3. | Medium | Medium | Similar implementation issues to Technology # 3, however depending on the amount of storm flow to be treated, the pre-treatment step space requirements are reduced by the use of parallel plates or inclined tubes within the vault or chamber since these reduce velocity and increase retention time using a smaller volume to be retained. | High Rated high compared to retention basin but provides greater benefit in reducing pollutants | High | Yes See Technology No. 1 regarding space constraint issues for equalization and pretreatment. For smaller drainage area, use of an underground vault and treatment/filtration chamber may be possible where sufficient public space is available near the MS4 system. |
| 6. Adsorption/Ion Exchange – Ion Exchange Column – Treatment Train – Equalization Basin to a Screen or Filter Bag to a ion exchange (IX) column fed by gravity. IX resin could either be placed in pressure vessels or in a canister at the pond outlet | High | Data on the effectiveness of this technology for storm water applications is limited. Due to potential clogging if pretreatment does not remove enough sediment, and need to re-generate the IX resins, the efficiency of the GAC column may be reduced and outflow concentration may not meet CTR. | Medium | Medium | Same issues of developed setting as Technology No. 1. | High Rated high compared to retention basin but provides greater benefit in reducing pollutants | High Spent IX media can be considered hazardous waste | Yes See Technology No. 1 regarding space constraint issues for equalization and pretreatment. |
| 7. Modified Austin Sand Filter – This technology is modeled after partial sedimentation type Austin-style sand filters, but with 12-24 inches of IX media overlain by sand rather than typical 18 inches of sand. Media can be activated iron coated alumina or other IX media. | High | The effectiveness of this BMP on storm water flows is in the pilot testing stage. Results reported by Caltrans on pilot projects using activated alumina indicate technologies is effective in significantly reducing dissolved metals. The effectiveness of the BMP in meeting the CTR concentration will depend on the level of maintenance of the filter system which would be prone to clogging. | Medium | Medium | Technology is applicable to developed watersheds as it can be installed as a retrofit of existing storm drain channels system. <i>This BMP is undergoing pilot testing by Caltrans, and is limited in its treatment capacity.</i> | Medium | Medium | Yes This technology has limited treatment capacity because it is contained within a treatment chamber that is generally installed below ground. Therefore, this technology may have only select application to smaller drainage areas and portions of storm flows that through studies have identified a design storm or flow that should be treated to meet the objectives. Furthermore, this technology is in a testing stage. The effectiveness of this option to meeting the CTR and other constituent limits is not known. |
| 8. Bioretention – This is manufactured modular bioretention system that is used in urban setting as an alternative to traditional curbside landscaping. There are also non-proprietary systems. Storm water enters curb inlet and infiltrates through soil and engineered media. Infiltration seeps into perforated pipe that flows into storm drain system. Plantings use root system to reduce pollutants and uptake pore water. <i>This technology is limited to first flush treatment.</i> | High | Pollutant removal efficiency high for limited flow that the system can treat. Capacity of the system is dependent on soil and engineered media permeability and storage capacity. Data on removal of dissolved metals is limited. System is effective in removal of total metals and particulates that may be a source of dissolved metals in the receiving waters. Technology can not treat full storm flows. | High | High | Technology is applicable to developed watersheds as it can be installed as a retrofit of existing storm drain system. There are high space requirements within the right of way to install the system. This includes the plantings, soil and engineering media within the right of way. Implementation near coastal areas must consider potential groundwater/tidal influence issues. Implementation in the upper watershed must consider slope stability issues. | High Rated high compared to retention basin but provides greater benefit in reducing pollutants The cost will be high if implemented on a wide scale since the system capacity is relatively small. Construction in right of way may require traffic control. | Medium – Low Planting will require watering during dry season | Yes The technology is best applicable only to treatment of a small portion of storm events and therefore provides a “first flush” treatment option that can reduce particulates and total metals which may reduce dissolved metals concentrations at the storm drain outlets. BMP has limited applications where sufficient right of way is available to retrofit existing storm sewer and curb side plantings. |

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| <p>9. Chemical Treatment-Alum – Treatment Train – Alum is added through a chemical feed system to the storm water and then discharged to sedimentation basin where floc is settled out prior to discharge to receiving waters. A minimum of 1 minute retention time required after alum added before discharge to watershed.</p> | High | Technology has been successfully used for phosphorus and suspended solids removal, less application for dissolved metals. CTR likely not to be achieved with this technology, although total metals concentrations will be significantly reduced | Medium | High | Highly developed setting significantly reduces opportunities to install this technology. Sufficient Public lands close to discharge points only available in upper watersheds, limited installation above outfalls in residential and commercial areas | High Rated high compared to retention basin but provides greater benefit in reducing pollutants. | High Management and disposal costs of sludge Optimization of alum addition will vary with storm – high technical operational needs | No This treatment technology has relatively high costs and is rated as medium for all the constituents of concern. Application in developed setting also limited. Other technologies already listed provided greater efficiencies and greater chance of meeting treatment goals. |
| <p>10. Linear Bioretention Trenches – This is similar to Item #6, but is not a manufactured modular bioretention system rather a French drain type system into which sheet flow enters and infiltrates into a plant/filter medium underlain by a gravel and drain pipe system. The filter media is separated from the drain layer by a geotextile. <i>This BMP is more of a runoff and treatment volume reduction BMP as it is limited in its capacity.</i></p> | Medium | Pollutant removal efficiency high for limited flow that the system can treat. Capacity of the system is dependent on soil and engineered media permeability and storage capacity. Data on removal of dissolved metals is limited. System is effective in removal of total metals and particulates that may be a source of dissolved metals in the receiving waters. Technology can not treat full storm flows. <i>This BMP is more of a runoff and treatment volume reduction BMP as it is limited in its capacity unless additional storage is provided through installation of larger below ground drainage layers.</i> | High | Medium | Technology is applicable to developed watersheds as it can be installed as a retrofit of existing storm drain channels system. <i>This BMP is more of a runoff and treatment volume reduction BMP as it is limited in its capacity unless additional storage is provided through installation of larger below ground drainage layers.</i> Implementation near coastal areas must consider potential groundwater/tidal influence issues. Implementation in the upper watershed must consider slope stability issues. | Medium -Low The cost will be high if implemented on a wide scale since the system capacity is relatively small. Construction in right of way may require traffic control. | Medium – Low Planting will require watering during dry season | Yes BMP has limited applications where sufficient right of way is available to retrofit existing storm channels. The technology also is applicable only for <i>runoff and treatment volume reduction</i> of a small portion of storm events and therefore provides a “first flush” treatment option that can reduce particulates and total metals which may reduce dissolved metals concentrations at the storm drain outlets. |
| <p>11. Below Grade Infiltration Chambers – There are numerous available manufactured systems (Cultec Contractor, Recharger, Matrix, Rainstore, Stormcell, Stormchamber, Stormtech, & VersiCell) that provide temporary storage of storm water flows within sub-surface vaults or chamber that then allow for direct infiltration into the subsoils or first distribute the stored storm water through a seepage drainage bed that is then infiltrated into the sub-soils.</p> | High | This technology has been proven to meet required concentrations since the storm water is completely infiltrated into the sub-soils rather than discharged to the receiving waters. | High | High | The Watershed is characterized by poorly draining soils except in the lower watershed. The application of BMPs that use infiltration may be limited within the watershed. Site specific geotechnical investigations are needed to determine if subsurface soils provide adequate infiltration rates. Implementation near coastal areas must consider potential groundwater/tidal influence issues. Implementation in the upper watershed must consider slope stability issues. | High-Medium Rated high compared to retention basin but provides greater benefit in reducing pollutants | Medium-Low | Not for Widescale Implementation – May be applicable where site specific geotechnical investigations indicate subsurface soils have adequate infiltration rates to accommodate repeated storm events without resulting in flooding. Due to the low permeability of the soils within the upper portions of the watershed, the application of BMPs that use infiltration to treat full design flows is limited to a small percentage of watershed area. |

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| 12. Porous Pavement – Allows storm water to infiltrate through the pavement section to a stone “reservoir course” that stores the storm water until it infiltrates into the underlying soils. | High | This technology has been proven to meet required concentrations since the storm water is completely infiltrated into the sub-soils rather than discharged to the receiving waters. | High | High | The Watershed is characterized by poorly draining soils. The application of BMPs that use infiltration is limited within the watershed unless additional storage is provided through engineered below ground drainage layers. Underdrain systems will also be required to prevent built-up of head and potential structural damage. Site specific geotechnical investigations are needed to determine if subsurface soils provide adequate infiltration rates. | High Rated high compared to retention basin but provides greater benefit in reducing pollutants | Medium-Low | Yes – Limited Applications Where Engineered Drainage Layers and Under drain systems provided. Due to the low permeability of the soils within the upper portions of the watershed, the application of BMPs that use infiltration is limited to a small percentage of watershed area. Technologies that rely on infiltration can be engineered for low permeability soils if sufficient storage is provided through underground drainage layers and under drain systems. These engineered systems will still have finite storage capacity to treat large storm flows requiring by-pass systems to address flooding. |
| 13. Infiltration Basins – Basin are installed as an “off line” system that collected and stores a design storm volume and allows the storm water to infiltrate into the sub-soils | High | This technology has been proven to meet required concentrations since the storm water is completely infiltrated into the sub-soils rather than discharged to the receiving waters. | High | High | The Watershed is characterized by poorly draining soils. The application of BMPs that use infiltration is limited within the watershed. Site specific geotechnical investigations are needed to determine if subsurface soils provide adequate infiltration rates. Implementation near coastal areas must consider potential groundwater/tidal influence issues. Implementation in the upper watershed must consider slope stability issues. | Lower Rated lower compared to retention basin but provides greater benefit in reducing pollutants | Medium-Low | Not for Widescale Implementation – May be applicable where site specific geotechnical investigations indicate subsurface soils have adequate infiltration rates to accommodate repeated storm events without resulting in flooding. Due to the low permeability of the soils within the upper portions of the watershed, the application of these BMPs that uses infiltration is limited to a small percentage of watershed area. Although technologies that rely on infiltration can be engineered for low permeability soils if sufficient storage is provided through underground drainage layers, infiltration basins will require these systems across the basin and therefore function as a sand filter system with under drains. A sand filter alone will not meet the objectives. Therefore, this technology does not provide a cost effective alternative. |
| 14. Bio-swale with Infiltration – BMP uses vegetation to reduce transport of sediment and infiltration to treat the remaining flow – Application is limited to pre-treatment or to limited storm water flow or design flow. | High | This technology has been proven to meet required concentrations since the storm water is completely infiltrated into the sub-soils rather than discharged to the receiving waters. This BMP has limited applications due to the limited capacity. | High | High | The Watershed is characterized by poorly draining soils within the upper portions of the watershed. The application of BMPs that use infiltration is limited within the watershed. Site specific geotechnical investigations are needed to determine if subsurface soils provide adequate infiltration rates. Implementation near coastal areas must consider potential groundwater/tidal influence issues. Implementation in the upper watershed must consider slope stability issues. | High-Medium Rated high compared to retention basin but provides greater benefit in reducing pollutants | Medium-Low | Yes – As a runoff and treatment volume reduction technique Due to the low permeability of the soils within the upper portions of the watershed, the application of BMPs that use infiltration is limited to a small percentage of watershed area. Technologies that rely on infiltration can be engineered for low permeability soils if sufficient storage is provided through underground drainage layers and under drain systems. These engineered systems will still have finite storage capacity to treat large storm flows requiring by-pass systems to address flooding. |

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| <p>15. Low Impact Site Design (LID) Techniques – This includes collection, storage and reuse of runoff from roof drains. LID techniques also include porous pavement (#12), bioswales (#13), and bioretention (#8) technologies that use infiltration to reduce runoff flows and thus reduce pollutant loads</p> | High | LID techniques have the potential to meet the CTR concentrations if applied throughout the drainage area resulting in the significant reductions in runoff volumes and thus concentrations at the storm drain outlets. The performance of this technology will therefore depend on the level of implementation, and for infiltration techniques, the capacity of the soils to infiltrate and store runoff volumes. This BMP has limitations to full scale implementation in the Chollas Creek watershed which is built-out and has predominantly low permeability soils. These systems can include modification of existing subgrade soils and replacement of poorly draining soils with sand layers. | High | Medium | The Watershed is characterized by poorly draining soils within the upper portions of the watershed. The application of BMPs that use infiltration is very limited within the watershed unless additional storage is provided through engineered below ground drainage layers. Underdrain systems will also be required to prevent built-up of head and potential structural damage. | Medium | Medium | <p>Yes – As a runoff and treatment volume reduction technique</p> <p>Due to the low permeability of the soils within the upper portions of the watershed, the application of BMPs that use infiltration is limited to a small percentage of watershed area.</p> <p>Technologies that rely on infiltration can be engineered for low permeability soils if sufficient storage is provided through underground drainage layers and underdrain systems. These engineered systems will still have finite storage capacity to treat large storm flows requiring by-pass systems to address flooding.</p> <p>LID for new construction can reduce future potential increases in runoff volume and peak flows.</p> <p>This technology will be retained for use as a runoff and treatment volume reduction technique of storm water up to the capacity of the system.</p> |
| <p>16. Dry Weather and First Flush Diversion Structures –This technology would divert dry weather flows from selected storm drain outlets that are observed to pool nuisance flows at the discharge, and convey these flows to the existing sanitary sewer. These diversion structures can also divert a portion of the first flush of a storm event until a design flow is reached and is then bypassed.</p> | High | Metals exceedances are not an issue in dry weather flows, but may be accumulated in pools at some outlet structures that then are washed into the channel as part of the first flush. Pollutograph data is needed to assess if metals are a first flush issue that if diverted would reduce the flow weighted concentrations down to CTR values. | High | High | Highly developed nature of the watershed will impact implementation of this BMP that will require retro-fitting existing storm drain outlets and construction of conveyance lines to connect with the sanitary sewer. | Medium | Medium | <p>Yes</p> <p>This BMP is applicable only to those outlets where a connection to the sanitary sewer is feasible and where dry weather flows are sufficient and contain constituent concentrations in exceedances of the water quality objectives. The Watershed is generally dry during the dry weather period, but outlets are observed to pool nuisance flows near the discharge point. Pollutograph data is needed to assess whether dry weather and first flush diversions would be effective in reducing concentrations in flow weighted storm water samples to below the objectives for all the constituents under current and proposed TMDLs. The capacity of the existing sewer lines and the treatment plant also needs to be verified.</p> |
| <p>17. UV/Ozone – Treatment Train – This technology would treat discharge flows from selected storm drain outlets as the final stage in a treatment train to reduce bacterial loads through exposure to UV/Ozone energy sources. A treatment train is required to remove gross solids and particulates prior to treatment.</p> | Low | Metals exceedances are not treated by UV/Ozone treatment systems. | High | Low | Highly developed setting significantly reduces opportunities to install this technology. Sufficient Public lands close to discharge points only available in upper watersheds, limited installation above outfalls in residential and commercial areas | High. | High | <p>Yes</p> <p>Treatment system requires pretreatment and equalization through a retention-sedimentation basin. A smaller “package” treatment system may be applicable for small (<10acres) drainage area and design storm of 0.5 in. Larger drainage areas and storm events will require large areas for equalization and pretreatment. Regulatory issues will restrict placement of these systems above the outfalls on private lands or available public lands to which the storm flows will need to be conveyed, and potentially pumped.</p> |